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UNIONS, LABOUR SUPPLY
AND STRUCTURE
OF TAXATION:
EQUAL TAX BASES

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ABSTRACT: This paper investigates the employment effects of changes in the structure of taxation and in the tax progression. The contribution is to add endogenous determination of working hours into a union wage setting model. Thus employment effects of any changes in taxation are derived as a labour supply response of workers to tax-induced changes in equilibrium wage. The main findings are the following: i) When hours and heads are perfect substitutes in production, introducing income tax progression at the margin decreases the gross wage rate. If, in addition, leisure is a normal good and wage elasticity of labour supply positive, then hours of work decreases and employment is boosted. ii) Restructuring labour taxation away from payroll tax leaves the gross wage rate, hours of work and employment unchanged, when the income tax base and the payroll tax base are equal. This equality holds when there is a given exemption from income taxes.

KEYWORDS: Tax progression, payroll tax, work sharing.

JEL classification: H20, H22, J51.

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TIIVISTELMÄ: Paperissa tutkitaan työtuloverotuksen progression ja rakenteen muutosten työllisyysvaikutuksia laajentamalla ns. monopoliliiton mallia ottamalla huomioon liiton jäsenten työtunteja koskevat päätökset ja verojärjestelmän vaikutus niihin. Tällöin veroreformien työllisyysvaikutukset riippuvat niiden vaikutuksista työtuntien tarjontaan ja palkanmuodostukseen. Verotuksen progression käyttöönotto vähentää palkkaa, jos työtunnit ja työntekijät ovat tuotannossa täysin toisiaan korvaavia. Jos lisäksi vapaa-aika on normaalihiödyke ja työn tarjonnan palkkajousto positiivinen, työtunnit vähenevät ja työllisyys kasvaa progression käyttöönoton seurauksena. Sitävastoin verotulokertymän säilyttävä työtuloverotuksen painopisteen muuttaminen palkansaajan työtuloveron ja työnantajan sosiaaliturvamaksujen välillä ei vaikuta palkkoihin, työtunteihin eikä työllisyyteen, silloin kun veropohjat ovat yhtä suuria eli kun verovähennys tehdään tuloveroista.

ASIASANAT: Tulovero progression, työnantajan sosiaaliturvamaksut, työaika

JEL luokittelu: H20, H22, J51.

1. INTRODUCTION

In conventional models of labour supply, any increase in the progressivity of income taxation tends to reduce the supply of hours. Similarly, higher wage rates tend to raise labour supply if the substitution effect dominates the income effect. This is a straightforward result which is also intuitively appealing (for a survey of labour supply models, see Pencavel 1986). When the after-tax reward for work effort is reduced by higher taxes, the supply of effort should diminish. However, opposite results have been also presented. It can be shown that in model where trade unions can set wages or wages are bargained, increased progression has a positive effect on employment.

Koskela and Vilmunen (1995) show that this is a common property of all popular union models: employment increases with tax progression in the monopoly union, the 'right-to-manage' and the efficient bargaining models. Similar ideas have recently been presented also by Lockwood and Manning (1993) and Holmlund and Kolm (1994) in the 'right-to-manage' context. Earlier models of so called tax-based incomes policy (TIP) are based on the same pattern; more progressivity in income taxation is argued to prevent excessive pay rises and thus raise employment (Layard, 1982).

The reason for this positive correlation between taxes and employment in union models is that utilitarian unions do not have the same marginal utility as their members. When marginal tax is higher, the union gains less by pay rise in terms of after-tax wage bill; it is more efficient for the union to increase its utility by wage moderation and higher employment. However, in all the above-mentioned papers the number of working hours is fixed. With the exception of the efficient bargain model, the positive employment effect comes via the reduced wage rate.

The purpose of this paper is to provide a synthesis of these two contracting views. This is done by developing a monopoly union model of wage determination in which individual workers are allowed to choose their supply of hours freely. The union has to take account of this individual optimisation in its own decision-making. In other words, the individual labour supply decision works as a constraint when the union decides the wage rate. The model is then used to investigate how revenue-neutral changes in income tax progressivity affect the equilibrium wage, supply of hours and employment.

Labour is typically taxed from both sides of market. Employees pay income taxes, while payroll taxes are levied on employers. While one might expect that the incidence of labour taxation is independent of which side the tax is levied on, many empirical studies have found that income and payroll taxes affect asymmetrically (see e.g. Holm, Honkapohja and Koskela, 1994). Holm and Koskela (1995) have shown in a monopoly union model with inelastic labour supply that a revenue-neutral restructuring of labour taxation does matter for the gross wage and employment if tax bases are unequal. In the case of equal tax bases, however, the irrelevance result holds. In what follows we re-examine this issue by allowing the hours of work to be endogenous and assuming that there is a fixed exemption from income taxes so that the income tax and payroll tax bases are the same.

With few exceptions the determination of hours has not been incorporated explicitly into a model of wage setting. Instead, there are quite a many papers on the wage and employment effects of work sharing, or models where working hours are assumed to be given exogenously. The results on the wage effects of changes in hours remain mixed (for a summary of the results, see Holm and Kiander, 1993). Hours of work has been analysed as a part of wage and employment determination in Calmfors (1985) and Oswald and Walker (1993). Calmfors uses a monopoly union model as the framework so study how reduction in working time affects

wages and employment. But he is not able to come up with unambiguous results. Oswald and Walker (1993) construct a labour contract model in which hours and wages are determined as the result of an efficient bargain and show how this can generate a downward-sloping loans in wage-hours space. The evidence from a big sample on male employees in the United Kingdom appears to lie in conformity with this. Neither Calmfors (1985) nor Oswald and Walker (1993, however, analyse effects of revenue-neutral restructuring of labour taxation.

The rest of the paper is organised as follows. The model with its analytical properties is laid down in the next section. Section 3 develops the implications of a changes in tax progression for the gross wage, hours of work and employment, while the effects of a revenue-neutral restructuring of labour taxation between the income tax and the employer's payroll tax are analysed in section 4. Section 5 concludes.

2. A MONOPOLY UNION MODEL WITH TAXES AND ENDOGENOUS LABOUR SUPPLY

This section uses a monopoly union model as the framework, incorporates endogenous labour supply and the tax system. Relevant comparative statics is also presented.

2.1 Workers

Workers are assumed to be able to choose their hours of work freely. Their indirect utility function is assumed to be of the form

$$v(\theta w, a) = \frac{k(\theta w)^{1+\alpha}}{1+\alpha} + \frac{a^{1+\beta}}{1+\beta}, \quad (1)$$

where $\theta \equiv 1 - t$, t is the income tax rate, w is the wage level, a is the lump-sum transfer and k is a scale parameter. (Partial derivatives are denoted by subscripts, thus $v_w \equiv \partial v / \partial w$ etc.). The marginal utilities of wage and lump-sum transfer are given by $v_w = k\theta^{1+\alpha}w^\alpha$ and $v_a = a^\beta$. Using Roy's identity the following formula for workers' supply of hours is obtained

$$h = k\theta^\alpha w^\alpha a^{-\beta}, \quad (2)$$

where it is assumed that $\alpha \in (-1, 1)$ and $\beta \in (0, 1)$. Thus in line with empirical findings the lump-sum transfer affects labour supply negatively, i.e. leisure is a normal good. On the other hand, specification (2) allows for either upward-sloping ($\alpha > 0$) or backward-bending ($\alpha < 0$) uncompensated labour supply. The Slutsky equations for the wage and income tax rate are $h_w = h_w^c + \theta h h_a$ and $h_t = h_t^c - w h h_a$, respectively, where h_w^c and h_t^c refer to the compensated effects of wage rate and income tax rate. Equation (2) yields

$$h_w = \frac{\alpha h}{w}; \quad h_a = \frac{-\beta h}{a} < 0; \quad h_t = \frac{-\alpha h}{\theta}; \quad (3a)$$

$$h_w^c = \frac{h}{w\theta} \left(\alpha + \frac{\beta w h \theta}{a} \right) > 0; \quad h_t^c = \frac{-h}{\theta} \left(\alpha + \frac{\beta w h \theta}{a} \right) < 0, \quad (3b)$$

where the parameter restriction $\alpha a + \beta w h > 0$ is assumed to hold due to the utility maximisation.

2.2 Firms

Firms are assumed to operate under perfect competition and choose their demand for heads (L) to maximise profits, $\pi = f(L, h) - (1 + s)whL$, where $f(L, h) = AL^\gamma h^\nu$ is a production function of the Cobb-Douglas variety with diminishing returns to heads and hours ($\gamma < 1$; $\nu < 1$), and s denotes the employer's payroll tax. The resulting labour demand equation is of constant elasticity type,

$$L[(1+s)w, h] = (A\gamma)^\delta [(1+s)w]^{-\delta} h^{-\sigma\delta}, \quad (4)$$

where $\delta \equiv (1-\gamma)^{-1} > 1$ and $\sigma \equiv 1-\nu < 1$. The equation (4) implies $L_w = -\delta L/w < 0$ and $L_h = -\sigma\delta L/h < 0$. Thus both the wage rate and the supply of hours affect the demand for employment negatively. When hours and heads are perfect substitutes in production, the absolute value of elasticity of employment with respect to hours of work is equal to one, i.e. $\varepsilon_h^L = -1$.¹

2.3 Trade union

Assume that all workers belong to a trade union which fixes the wage rate, while the firms set employment unilaterally.² The trade union's utility function is assumed to be of the utilitarian form

$$\Psi = (v(\theta w, a) - \tilde{v}(b))L, \quad (5)$$

where b denotes the utility of leisure time or outside option. Maximising (5) subject to (4) and using (1) gives the first-order condition for the wage rate

$$\Psi_w = Lv_w + (v - \tilde{v})(L_w + L_h h_w) = 0, \quad (6)$$

where $(v - \tilde{v})L_h h_w$ is an additional term due to endogeneity of hours of work. It is negative, if the labour supply is upward-sloping. Thus endogenous upward-sloping labour supply gives an incentive to the trade union to decrease its wage claim. An increase in the wage rate increases hours of work and thus decreases the demand for heads so that raising wage rate is more costly in terms of employment compared to the case of inelastic labour supply.

Using the parametrization (1) one can rewrite (6) as

¹ See e.g. Holm and Kiander for empirical analysis on the relationship between employment and hours of work.

² See Oswald (1985) and Creedy and McDonald (1991) for surveys of various trade union models.

$$\Psi_w = -\delta(1 + \alpha\sigma) \left[\frac{k(\theta w)^{1+\alpha}}{1 + \alpha} + \frac{a^{1+\beta}}{1 + \beta} - \tilde{v}(b) \right] + k(\theta w)^{1+\alpha} = 0, \quad (7)$$

where $1 + \alpha\sigma > 0$. Now $\Psi_{ww} = k\theta^{1+\alpha}w^\alpha(1 - \gamma)^{-1}[-\alpha\upsilon - \gamma(\alpha + 1)] < 0$ so that the second-order condition holds. The effects of the income tax rate t , the lump-sum transfer a and the payroll tax rate s on the wage rate are

$$w_t = \frac{w}{\theta} > 0; \quad w_a = \frac{-\delta(1 + \alpha\sigma)a^\beta}{-\Psi_{ww}} < 0; \quad w_s = 0, \quad (8)$$

respectively. The equilibrium wage increases with the income tax rate and decreases with the lump-sum transfer. The payroll tax rate has no effect. The wage effects of t and a are the usual ones. The condition that $w_s = 0$ is due to the assumption of the constant wage elasticity of labour demand.

For later purposes it is useful to elaborate w_t -expression in (8) a bit. Substituting the wage function $w(t, a)$ defined implicitly by (6) for w in (5) gives the indirect utility function for monopoly union as $\Psi^*(t, a) = \psi^0$. The envelope theorem implies

$$\Psi_a^* = Lv_a + (v - \tilde{v})L_h h_a > 0; \quad \Psi_t^* = -wh\Psi_a^* + (v - \tilde{v})L_h h_t^c = ? . \quad (9)$$

A rise in the lump-sum transfer increases welfare of the trade union both directly (the term Lv_a) and indirectly via decreasing supply of hours and thereby increasing employment (the term $(v - \tilde{v})L_h h_a$). As for the tax rate, it has a direct negative effect on the welfare of the trade union (the term $-wh\Psi_a^*$), but also an indirect positive effect (the term $(v - \tilde{v})L_h h_t^c$). The latter effect is due to the fact that the tax rate decreases hours of work and thereby increases employment, which is good for the members of the trade union, *ceteris paribus*.

One can now invert Ψ^* for a such that $a = E(t, \psi^0)$. Substituting this for a in $\Psi^*(t, a)$ yields the compensated indirect utility function³ $\Psi^*[t, E(t, \psi^0)] = \psi^0$. It answers the following question: If t is raised, how much a has to be changed so as to keep the utility of the trade union unchanged. Differentiation of Ψ^* gives $\Psi_t^* + \Psi_a^* E_t = 0$, so that $E_t = -\Psi_t^* / \Psi_a^*$. It is known that $w[t, E(t, \psi^0)] \equiv w^c(t, \psi^0)$, where w^c is the compensated wage function, which gives the minimum wage to achieve the level of utility ψ^0 at the tax rate t . Differentiating this identity with respect to t gives $w_t^c = w_t + w_a E_t$ so that one gets the Slutsky decomposition

$$w_t^c = w_t + whw_a - \frac{(v - \tilde{v})L_h h_t^c w_a}{\Psi_a^*}, \quad (10)$$

$$\text{where } w_t + whw_a = \frac{w(1 + \alpha)(1 - \gamma)}{\theta[-\alpha v - \gamma(\alpha + 1)]} < 0, \quad L_h < 0, \quad h_t^c < 0, \quad w_a < 0 \quad \text{and} \quad \Psi_a^* > 0.$$

The effect of the income tax rate on the compensated wage rate is thus ambiguous a priori. The economic interpretation is the following. In the usual monopoly union model with exogenous labour supply the last term in the r.h.s. of equation (10) vanishes so that $w_t^c < 0$. But the substitution effect of the income tax rate on hours of work is negative. This increases the demand for heads via the labour supply effect and thus tends to raise the wage rate, *ceteris paribus*.

When hours and heads are perfect substitutes in production it can be shown that

$$w_t^c < 0 \quad \text{if and only if} \quad v < \frac{t(1 + \alpha)}{(-\varepsilon_t^c)}, \quad (11)$$

where $\varepsilon_t^c < 0$ is the compensated tax elasticity of supply of hours (see Appendix A for details). The compensated wage effect of the tax rate is the more likely negative, the higher is the level of the tax rate (t) and the wage elasticity of labour supply (α), and the smaller is hours of work elasticity of output (v) and the compensated tax

³ For this concept, see Diamond and Yaari, 1972.

elasticity of hours of work (ε_t^c). In the case of the vertical labour supply ($\alpha = 0$) one gets

$$w_t^c < 0 \quad \text{if and only if} \quad \upsilon < \frac{\frac{t}{1-t}}{(-\varepsilon_t^c)} \quad (11')$$

This makes sense; the smaller is the response of compensated labour supply to the tax rate and the output to hours of work, the lower is the pressure for the wage rate to increase.

2.4 Government

The government tax revenue consists of the marginal income tax t , the lump-sum transfer a as a negative tax and proportional payroll tax s . It is defined as

$$T = (twh - a)L + swL = [(t + s)wh - a]L. \quad (12)$$

One should notice that (12) describes the situation with a given exemption from income taxes. This means that the income tax base and the payroll tax base are equal in this formulation, i.e. whL .

The tax parameters can be shown to affect the tax revenue as follows:

$$T_t = whL(1 + w_t\Lambda^1 + h_t\Lambda^2) ; \quad (13a)$$

$$T_a = whL(-1/(wh) + w_a\Lambda^1 + h_a\Lambda^2) ; \quad (13b)$$

$$T_s = whL(1 - \Lambda^3); \quad (13c)$$

where $\Lambda^1 \equiv \left(\frac{s+t}{w}\right)[1 + \alpha - \delta(1 + \alpha\sigma)\Omega]$; $\Lambda^2 \equiv \left(\frac{s+t}{h}\right)(1 - \delta\sigma\Omega)$; $\Lambda^3 \equiv \frac{(s+t)}{(1+s)}\delta\Omega$; and $\Omega \equiv 1 - \frac{a}{wh(s+t)}$ (see Appendix B for details). The variable Ω can be interpreted as an index, measuring the deviation of the tax system from proportionality. In the case of proportional tax system we have $\Omega = 1$, and

otherwise $\Omega < 1$. The sign of the term Λ^2 depends on the relative importance of heads and hours in production, since $\delta\sigma = (1 - \nu)(1 - \gamma)^{-1}$, and the relative size of the lump-sum transfer and the government tax revenue per worker. In special case, when heads and hours are perfect substitutes in production and the lump-sum transfer is zero (positive), $\Lambda^2 = 0 (> 0)$.

The relationship between the tax revenue and the tax rates is called the Dupuit-Laffer-curve. If the relationship between the tax revenue and the marginal tax rate and the payroll tax (the lump-sum transfer) are positive (is negative), the Dupuit-Laffer-curve is upward-sloping. In what follows we make this plausible assumption so that $T_t > 0$, $T_s > 0$, and $T_a < 0$.

3. TAX PROGRESSION, HOURS OF WORK AND EMPLOYMENT

Let us now turn to look at some policy issues and take first the issue of raising progressivity. Before proceeding one has to fix the standard for changes in tax policy. It might be tempting, but wrong, to argue that the Slutsky equations conveys everything that one has to say about the effects of increased progression. One must remember that the Slutsky equations are results that apply to a simultaneous increase in the marginal as well as the average tax rate. In isolating the effects of increased progressivity as such the average tax rate should in some sense be held constant.

The literature on this topic has indicated alternative solutions to the problem. One alternative would be to assume that progression is increased subject to the constraint that welfare of the trade union or the worker is held constant. This gives rise to substitution effects of the Slutsky equations and can be regarded as the pure rise in progressivity in the ex ante sense. An alternative standard - and the one which has perhaps a stronger appeal to economic intuition - is that of constant tax revenue. This means that the marginal tax rate is increased and it is compensated by a change

in lump-sum transfer so that the tax revenue, $T = [(s + t)wh - a]L$, does not change. This can be regarded as the pure change in progressivity in the ex post sense.⁴ One should ask whether this definition, whereby simultaneous increases in t and a are held to imply a higher degree of progression, can be given a deeper justification. Given that a more progressive tax schedule is more redistributive according to the criterion of Lorenz domination, then the residual progression - the elasticity of net income with respect to gross income - the acceptable measure of progressivity.⁵ In our context the residual progression is

$$\eta \equiv \frac{\partial c}{\partial(wh)} \frac{wh}{c} = (1 - t) \left(1 - t + \frac{a}{wh} \right)^{-1}, \quad (14)$$

where $c \equiv (1 - t)wh + a$ is the net income of the trade union member. Taking the differential of this expression with respect to t and a , it is easy to see that any simultaneous increase in t and a will reduce η and thereby make the tax schedule more progressive. This is the basic justification for identifying this type of linear shifts in the after tax budget constraint of the worker with increases in progressivity.

Let us now turn to consider the effect of a compensated change in the marginal tax rate, which keeps the tax revenue unchanged. From the government tax revenue requirement (12) one gets $dT = T_a da + T_t dt = 0$, when $ds = 0$ so that

$$\left[\frac{da}{dt} \right]_{dT=ds=0} = -\frac{T_t}{T_a} > 0, \quad (15)$$

where T_t and T_a are defined in equations (13a) and (13b), respectively. This gives a relationship between changes in the lump-sum transfer and the marginal tax rate when their effects on wages, hours of work and employment are taken into account.

⁴ It is easy to check that this schedule, given positive values of t and a , is progressive according to either of the following three definitions of progressivity, suggested by Musgrave and Thin (1948): (i) the average tax rate is increasing with the wage rate, (ii) the elasticity of the tax revenue function with respect to the income before tax is greater than one, and (iii) the elasticity of net income with respect to gross income is less than one.

⁵ See Lambert (1993) and Sandmo (1983).

The first question to ask is: what happens to the gross wage $w(1+s)$, when the income tax progression increases? Since $d[w(1+s)] = \{\partial[w(1+s)/\partial a]\} da + \{\partial[w(1+s)/\partial t]\} dt$, the effects of a pure rise in the progression on the gross wage can be expressed - using the Slutsky decomposition $h_t^c = h_t + whh_a$ and equation (10) - as

$$\left[\frac{d[w(1+s)]}{dt} \right]_{dT=ds=0} = \frac{(1+s)}{T_a} [w_a(-T_t) + w_t(T_a)] \quad (16a)$$

$$= \frac{Lwh(1+s)}{T_a} \left[(w_a wh + w_t) \left(\frac{-1}{wh} + h_a \Lambda^2 \right) - w_a h_t^c \Lambda^2 \right], \quad (16b)$$

$$= \frac{Lwh(1+s)}{T_a} \left[\underbrace{w_t^c}_{?} \left(\frac{-1}{wh} + h_a \Lambda^2 \right) + \underbrace{\Gamma w_a h_t^c}_{-} \right], \quad (16c)$$

$$\text{where } \Gamma = \left(\frac{L}{h\Psi_a^*} \right) \left[\frac{(v - \tilde{v})(-\gamma\delta)}{wh} - \Lambda^2 a^\beta h \right] < 0.$$

If compensated labour supply is perfectly inelastic, $h_t^c = 0$, then $whw_a + w_t < 0$ from (10) so that a rise in the income tax progression decreases the wage rate as can be seen from (16b) (see e.g. Koskela and Vilmunen, 1995).⁶ But allowing for endogenous labour supply the income tax progression tends to decrease supply of hours and thereby to increase the demand for heads by firms. This, in turn, brings an upward pressure for the wage rate set by the monopoly union. Thus, in general, the total effect is indeterminate.

One can see from (16c), however, that the positive compensated wage effect of the tax progression w_t^c is the sufficient condition for the positive wage rate effect. One gets from equation (11) and appendix A that the positive compensated wage effect is the more likely the higher is the tax elasticity of compensated labour supply and the

⁶ Lockwood and Manning (1993) have presented empirical evidence from the United Kingdom and Holmlund and Kolm (1994) from Sweden, which is actually consistent with this prediction.

hours of work elasticity of output. Both of these factors increases the pressure for the wage rate to increase with t .

The explicit condition for the effects of the tax progression on the gross wage rate is presented in Appendix C. In the case of perfect substitutability between heads and hours in production we have

$$\left[\frac{d[w(1+s)]}{dt} \right]_{dT=ds=0} < 0 \quad \text{if and only if} \quad \delta + \alpha < \frac{t(1+\alpha)\left(\frac{wh}{a}\right)(1+\beta)}{(-\varepsilon_t^c)}. \quad (17)$$

Thus even then assumption of perfect substitutability between heads and hours is not sufficient to fix the sign of the gross wage effect due to a change in income tax progression. The equation (17) suggests, however, that as the lump-sum transfer a becomes smaller so that we are closer to a proportional income tax system, it becomes more likely that the gross wage rate will decrease. One can summarise the findings in

Proposition 1: A revenue neutral increase in the income tax progression (i) has an a priori ambiguous effect on the wage rate, (ii) will decrease the wage rate, when the progressive taxation is introduced at the margin and heads and hours are perfect substitutes in production.

Proof: i) follows from (16a-16c) and (17). ii) follows from (17) and (3b) as a approaches zero. ∇

This makes intuitive sense. A rise in progression changes a trade-off between wage rate and employment in favour of employment so that the wage rate tends to fall. On the other hand, however, hours of work is discouraged, which increases the demand for heads and puts an upward pressure for the wage rate. If the progression

is introduced and there is perfect substitutability between heads and hours in production, the former effect dominates the latter and the wage rate decreases.

In the case of vertical labour supply ($\alpha = 0$), one can rewrite (17) as

$$\left[\frac{dw(1+s)}{dt} \right]_{dT=ds=0} < 0 \text{ if and only if } \delta < \frac{1+\beta}{\beta}. \quad (17')$$

Thus we have

Corollary: With zero wage elasticity of labour supply, a sufficient condition for a revenue-neutral increase in the tax progression to decrease the gross wage rate is that the absolute value of the wage elasticity of labour demand is less than two.

Proof: Since $\beta \in (0, 1)$, then $\frac{1+\beta}{\beta} \in (2, \infty)$, and thus the condition $\delta < 2$ is sufficient for that the gross wage rate decreases due to a increase in the tax progression. ∇

The smaller the labour supply reaction to an increase in the lump-sum transfer is, and the smaller the wage elasticity of labour demand is, the more likely the wage rate effect of a rise in progression is negative. In the special case of inelastic labour supply - usually adopted in trade union models - one gets $\left[\frac{dw(1+s)}{dt} \right]_{dT=ds=0} < 0$ as $\beta = 0$ (see e.g. Koskela and Vilmunen, 1995).

Turning to the effects of a change in progression on supply of hours, we have to account not only for the direct effects, but also for the indirect effects due to a change in the wage rate. Since $h = h(\theta w, a)$ the effects of a pure rise in the income tax progression on the hours of work can be expressed as

$$\left[\frac{dh}{dt} \right]_{dT=ds=0} = \left(\frac{h_w}{1+s} \right) \left[\frac{d((1+s)w)}{dt} \right]_{dT=ds=0} + h_t + h_a \left[\frac{da}{dt} \right]_{dT=ds=0} \quad (18a)$$

$$= \left(\frac{1}{T_a} \right) [(-T_t)(h_w w_a + h_a) + (T_a)(h_w w_t + h_t)] . \quad (18b)$$

Now one can establish:

Proposition 2: A revenue-neutral increase in the income tax progression decreases the hours of work, when leisure is normal good and the wage elasticity of hours of work is positive.

Proof: $T_a < 0$ and $T_t > 0$ due to the upward-sloping Dupuit-Laffer-curve. Using (3a) and (3b) and (8) one realises that $h_w w_t + h_t = 0$. When the wage elasticity of hours of work is positive, $h_w > 0$, and leisure is normal good, $h_a < 0$, from (18b) one gets

$$\left[\frac{dh}{dt} \right]_{dT=ds=0} < 0, \text{ since } w_a < 0. \quad \nabla$$

Thus under quite plausible assumptions the standard result about the labour supply response to a change in progression holds in the context of the monopoly union model as well. The total labour supply effect results from direct effects of tax parameters and from indirect effects due to a change in the wage rate. As for the income tax rate, its direct labour supply effect and the indirect wage effect cancel each other. A rise in lump-sum transfer will decrease labour supply directly and indirectly via a decrease in the wage rate required by the trade union.

Finally, turning to employment effects, one has to distinguish between wage rate and hours of work channels in $L = L[(1+s)w, h]$, so that the effects of a pure rise in the tax progression on employment can be, after some manipulation, expressed as

$$\left[\frac{dL}{dt} \right]_{dT=ds=0} = L_w \left[\frac{d((1+s)w)}{dt} \right]_{dT=ds=0} + L_h \left[\frac{dh}{dt} \right]_{dT=ds=0} \quad (19a)$$

$$= \frac{-\delta L}{T_a} \left[(-T_t) \left[\frac{w_a}{w} (1 + \alpha\sigma) + \sigma \frac{h_a}{h} \right] + (T_a) \left[\frac{w_t}{w} (1 + \alpha\sigma) + \sigma \frac{h_t}{h} \right] \right], \quad (19b)$$

where $\frac{w_t}{w} (1 + \alpha\sigma) + \sigma \frac{h_t}{h} = \frac{1}{\theta} > 0$. What happens to employment, depends among others on the wage effect which is ambiguous a priori. However, one can see from (19a) that when both the gross wage and the hours of work decrease, employment increases so that⁷

Proposition 3: When leisure is normal good and the wage elasticity of hours of work is positive, then the sufficient condition for a revenue-neutral increase in the income tax progression to increase employment is that the wage rate does not increase.

Proof: Follows directly from proposition 1 and proposition 2. ∇

With inelastic labour supply a rise in the tax progression decreases the gross wage rate and increases employment via the labour demand. When hours of work is endogenous, employment is affected via two additional channels of influence: i) Under plausible assumptions hours of work decrease due to an increase in the tax progression, which tends to increase employment. ii) A fall in hours of work pushes the gross wage rate up so that employment tends to decrease. If the wage rate effect remains negative -the direct effect of the tax progression on the gross wage rate dominates its indirect effect via labour supply- then employment increases.

⁷ Koskela and Vilmunen (1995) have analysed this question in a partial equilibrium context with various popular trade union models. They have shown that a revenue neutral increase in the income tax boosts employment in all popular models of trade union behaviour, i.e. the monopoly union model, the "right-to-manage" model and in the efficient bargaining model.

4. RESTRUCTURING OF LABOUR TAXATION, HOURS OF WORK AND EMPLOYMENT

Often in theoretical studies of tax incidence and wage formation no distinction is made between income and payroll taxes, while income taxes and payroll taxes seem to have different effects on wages in practise.⁸ Therefore, it is of interest to study the structure of labour taxation and its potential impacts on gross wages, hours of work and employment. More specifically, we study the revenue neutral restructuring of labour taxation, i.e. a policy reform, which shifts tax burden from employers to workers, while keeping the government tax revenue unchanged. The government revenue function (12) with a given exemption from income taxes implies that the income and the payroll tax bases are equal.

One gets $dT = T_s ds + T_t dt = 0$, when $da = 0$ from the government tax revenue requirement (12). This gives a change in the payroll tax as a function of a change in the domestic wage and a change in the marginal income tax rate, when the tax revenue is kept constant

$$\left[\frac{ds}{dt} \right]_{dT=da=0} = -\frac{T_t}{T_s} < 0, \quad (20)$$

where T_t and T_a are defined in equations (13a) and (13b), respectively, and the sign is due to the assumption of the upward-sloping Dupuit-Laffer-curve.

Since $d[w(1+s)] = \{\partial[w(1+s)/\partial s]\}ds + \{\partial[w(1+s)/\partial t]\}dt$, the effects of this policy reform on the gross wage can be expressed as

$$\left[\frac{d[w(1+s)]}{dt} \right]_{dT=da=0} = \left(\frac{1+s}{T_s} \right) \left[(-T_t) \left(\frac{w}{1+s} \right) + (T_s) w_t \right] \quad (21a)$$

⁸ See Lockwood and Manning (1993) as well as Holm, Honkapohja and Koskela (1994) for some evidence.

$$= \left(\frac{(1+s)whL}{T_s} \right) \left[w_t - \frac{w}{1+s} + w_t \left(-\Lambda^3 - \frac{w\Lambda^1}{1+s} \right) - \frac{wh_t\Lambda^2}{1+s} \right], \quad (21b)$$

$$= \left(\frac{(1+s)whL}{T_s} \right) \left(\frac{w(t+s)}{(1-t)(1+s)} \right) [1 - 1 - \alpha + \alpha\sigma\delta\Omega + \alpha - \alpha\sigma\delta\Omega] = 0, \quad (21c)$$

where $\Omega \equiv 1 - \frac{a}{(t+s)wh}$. Thus one can say that

Proposition 4: A revenue-neutral restructuring of labour taxation away from the payroll tax has no effect on the gross wage.

Proof: See equation (21a)-(21c). ∇

This follows from the fact that the income tax base and the payroll tax base are identical, namely whL . Under these circumstances the cross wage increasing and decreasing effects cancel each other.⁹

Turning to the effects of restructuring of labour taxation on supply of hours, we have to account not only for the direct effects, but also for the indirect effects due to a change in the wage rate, since $h = h[(1-t)w, a]$. The effects of this policy reform on the hours of work can be expressed as

$$\left[\frac{dh}{dt} \right]_{dT=da=0} = h_1 \left[-w + \frac{(1-t)}{(1+s)} \left[\frac{d((1+s)w)}{dt} \right]_{dT=da=0} - \frac{(1-t)w}{(1+s)} \left[\frac{ds}{dt} \right]_{dT=da=0} \right] \quad (22a)$$

$$= h_1 \left[-w + \frac{(1-t)}{(1+s)} \left[w_t(1+s) + w \left[\frac{ds}{dt} \right]_{dT=da=0} \right] - \frac{(1-t)w}{(1+s)} \left[\frac{ds}{dt} \right]_{dT=da=0} \right] \quad (22b)$$

$$= h_1 [-w + w_t(1-t)] = 0, \quad (22c)$$

where $h_1 \equiv \partial h / \partial(\theta w)$.

⁹ The same result has been derived for inelastic labour supply in Holm and Koskela (1995).

The first term (in 22a) measures the direct effect of policy reform, whereas last two terms take into account the indirect effect of it via the nominal wage rate.

Proposition 5: A revenue-neutral restructuring of labour taxation away from the payroll tax does not change the hours of work, when tax bases are equal.

Proof: Follows directly from equations (22a)- (22c). ∇

A rise in income tax rate decreases labour supply directly and leads to a rise in the wage rate which in turn tends to decrease labour supply. This latter indirect effect cancels the direct effect so that hours of work remains unchanged.

Finally, since $L = L[(1+s)w, h]$, the effects of a policy reform on employment can be expressed as

$$\left[\frac{dL}{dt} \right]_{dT=da=0} = L_w \left[\frac{d((1+s)w)}{dt} \right]_{dT=da=0} + L_h \left[\frac{dh}{dt} \right]_{dT=da=0} . \quad (23)$$

Thus we have

Proposition 6: A revenue neutral restructuring of labour taxation away from the domestic payroll tax does not change employment, when tax bases are equal.

Proof: See proposition 4 and 5. ∇

The revenue-neutral restructuring changes neither the gross wage rate nor hours of work; hence employment remains constant as well. Thus in the case with a given exemption from income taxes the income and the payroll tax bases are equal and

hence switching between them matters neither the cross wage rate nor hours of work nor employment.

5. CONCLUDING REMARKS

This paper investigates the employment effects of changes in the structure of taxation and in the tax progression. The contribution is to add endogenous determination of working hours into a union wage setting model. Thus employment effects of any changes in taxation are derived as a labour supply response of workers to tax-induced changes in equilibrium wage.

The main findings are the following: i) When hours and heads are perfect substitutes in production, introducing income tax progression at the margin decreases the gross wage rate. If, in addition, leisure is a normal good and wage elasticity of labour supply positive, then hours of work decreases and employment is boosted. ii) Restructuring labour taxation away from payroll tax leaves the gross wage rate, hours of work and employment unchanged, when the income tax base and the payroll tax base are equal. This equality holds when the income tax is constant and there is a given exemption from income taxes.

There are several interesting areas for further research. First, we have analysed the case with a given exemption from income taxes so that the income and the payroll tax bases have been equal. Another possibility is to assume that exemption is from labour income. This changes the set up by making tax bases unequal and one should study tax policies in that case as well. Second, though employment is quite likely boosted by a rise in income tax progression, consumption-leisure choice is distorted. This raises a welfare issue of what is the optimal structure of labour taxation.

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APPENDICES

A: The compensated wage effect of income tax w_t^c

Recall from the equation (10) that

$$w_t^c = w_t + whw_a - \frac{(v - \tilde{v})L_h h_t^c w_a}{\Psi_a^*}. \quad (\text{A1})$$

Using equations (6), (9), (8), (3a) and (3b) one obtains

$$w_t^c = \underbrace{\frac{-w(1-\gamma)}{\theta[\alpha v + \gamma(1+\alpha)]}}_{-} \underbrace{\left[1 + \frac{h\theta w\sigma\beta}{(1+\alpha\sigma)a} \right]^{-1}}_{+} D, \quad (\text{A2})$$

where $D \equiv (1 + \alpha\sigma)^{-1} \left\{ 1 + \alpha + \sigma[1 - \delta + \alpha(1 - \sigma\delta)] \left(-\frac{\theta h_t^c}{h} \right) \right\}$. Thus if $D > 0$ then $w_t^c < 0$. Since $(1 + \alpha\sigma) > 0$, $D > 0$ if and only if

$$\sigma[1 - \delta + \alpha(1 - \sigma\delta)] > \frac{\frac{h}{\theta}(1 + \alpha)}{h_t^c} \equiv \frac{\frac{t}{1-t}(1 + \alpha)}{\varepsilon_t^c}, \quad (\text{A3})$$

where ε_t^c is the compensated tax elasticity of individual supply of hours. When heads and hours are perfect substitutes in production $1 - \sigma\delta = 0$, and since $\sigma \equiv 1 - v$, $D > 0$ if and only if

$$v < \frac{\frac{t}{1-t}(1 + \alpha)}{(-\varepsilon_t^c)}, \quad (\text{A4})$$

where v is the output elasticity of hours in the production function.

B: The income tax rate and government tax revenues.

The equation (12a) in the text is derived in what follows. The effect of the income tax rate on the government tax revenue, defined as $T = (twh - a)L + swhL = [(t+s)wh - a]L$, is obtained as:

$$T_t = \{wh + (t+s)[w_t h + w(h_w w_t + h_t)]\}L + [(t+s)wh - a][L_w(1+s)w_t + L_h(h_w w_t + h_t)] \quad (B1)$$

$$= Lwh \left[1 + (t+s) \left(\frac{w_t}{w} + \frac{h_w w w_t}{h w} + \frac{h_t}{h} \right) \right] + Lwh(t+s) \left(1 - \frac{a}{(t+s)wh} \right) \left[\frac{L_w(1+s)w w_t}{L w} + \frac{L_h h}{L} \left(\frac{h_w w w_t}{h w} + \frac{h_t}{h} \right) \right]. \quad (B2)$$

Since $\frac{L_w(1+s)w}{L} = -\delta$; $\frac{L_h h}{L} = -\delta\sigma$; and $\frac{h_w w}{h} = \alpha$, equation (B2) can be written as

$$T_t = Lwh \left\{ 1 + (t+s) \frac{w_t}{w} [1 + \alpha - \delta(1 + \alpha\sigma)\Omega] + (t+s) \frac{h_t}{h} (1 - \delta\sigma\Omega) \right\} \quad (B3)$$

$$= Lwh(1 + w_t \Lambda^1 + h_t \Lambda^2), \quad (B4)$$

where $\Omega \equiv 1 - \frac{a}{(t+s)wh}$, $\Lambda^1 \equiv \left(\frac{s+t}{w} \right) [1 + \alpha - \delta(1 + \alpha\sigma)\Omega]$, and $\Lambda^2 \equiv \left(\frac{s+t}{h} \right) (1 - \delta\sigma\Omega)$.

The effects of the tax exemption and the payroll tax rate on government tax revenue can be derived analogously.

C: The gross wage rate effect of the income tax progression.

Recall from equation (16b) that

$$\left[\frac{d[w(1+s)]}{dt} \right]_{dT=ds=0} = \underbrace{\frac{Lwh(1+s)}{T_a}}_{-} \underbrace{\left[(w_a wh + w_t) \left(\frac{-1}{wh} + h_a \Lambda^2 \right) - w_a h_t^c \Lambda^2 \right]}_{\equiv G}. \quad (C1)$$

Using (10) and (8) one obtains

$$G = \underbrace{\frac{(1+\alpha)(1-\gamma)}{\theta h[\alpha v + \gamma(1+\alpha)]}}_{+} \left\{ 1 + \left[\frac{\delta(1+\alpha\sigma)h_t^c}{(1+\alpha)} - whh_a \right] \Lambda^2 \right\}. \quad (C2)$$

Thus $\left[\frac{d[w(1+s)]}{dt} \right]_{dT=ds=0} < 0$ as $G < 0$. From (C2) one can be seen that $G > 0$ if and only if

$$\delta(1+\alpha\sigma) < \frac{\frac{t}{h}(1+\alpha)(whh_a - 1/\Lambda^2)}{\varepsilon_t^c}. \quad (C3)$$

When heads and hours are perfect substitutes $G > 0$ if and only if

$$\delta + \alpha < \frac{t(1+\alpha)\left(\frac{wh}{a}\right)(1+\beta)}{(-\varepsilon_t^c)}. \quad (C4)$$
