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TAX PROGRESSION, STRUCTURE
OF LABOUR TAXATION
AND EMPLOYMENT

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TAX PROGRESSION, STRUCTURE
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Abstract

According to a widely held popular belief, a pure increase in tax progression decreases work effort, increases wages and is thus bad for employment under competitive labour markets. This paper studies the effects of labour taxes in a general equilibrium model of two countries with monopoly unions, where wages are not determined by equality of the demand for and supply of labour. It is shown that increased domestic tax progression, which keeps government tax revenue unchanged, decreases both the domestic and foreign wages and thus raises employment in both countries. Moreover, a revenue neutral restructuring of labour taxation from employers to workers in domestic country is good for employment in both countries, when the income tax base is smaller than payroll tax base. But when the income tax base is equal to the payroll tax base, a revenue neutral restructuring of labour taxation has no employment effect in either country.

Keywords: tax progression, payroll taxes, unemployment.

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I. INTRODUCTION

It is a widely held popular belief that the more progressive the tax system, the greater is the disincentive to work effort. In isolating the effect of increased progressivity as such it is desirable to assume that the average tax rate could in some sense be held as constant. One alternative is to assume that progression is increased subject to the constraint that the "real income" of the workers does not change. An alternative standard would be that of constant tax revenue. Under both standards increased tax progression does decrease work effort by increasing the wage rate and is thus bad for employment under competitive labour markets (see e.g. Sandmo, 1983). This result is due to the negative substitution effect of the tax rate on labour supply.

Labour is typically taxed from both sides of market. Employees pay income taxes while payroll taxes and social security contributions are levied on employers. At the general level, one should expect that the incidence of labour taxation is independent of which side the tax is levied on. Indeed, many empirical studies of wage formation treat income and payroll tax rates symmetrically. Likewise, often in theoretical studies of tax incidence and wage formation no distinction is made between income and payroll taxes. This would be relevant for perfectly competitive labour market.

One can argue, however, that in unionised labour markets wages are not determined by equality of the demand for and supply of labour, but are subject to bargaining. This raises a question of what are the wage and employment effects of increased progressivity and the structure of labour taxation under these circumstances and more generally a question of whether the structure of labour markets matters in terms of policy effects. The purpose of this paper is to address these questions by constructing a general equilibrium model of two countries, where each country

specialises in the production of a homogeneous product, domestic and foreign goods are imperfect substitutes in consumption and wages are determined by monopoly unions. Perhaps surprisingly we show that increased domestic tax progression, which keeps government tax revenue unchanged, decreases both the domestic and foreign wages and thus raises employment in both countries. It is also shown that a revenue neutral restructuring of labour taxation from employers to workers in domestic country is good for employment in both the domestic and the foreign country, when the income tax base is smaller than payroll tax base. But when the income tax base is equal with the payroll tax base, a revenue neutral restructuring of labour taxation has no employment effect in either country. Effects of taxation thus appear to be very sensitive the structure of labour markets.

The paper is organised as follows. Section 2 presents goods market behaviour, the tax system and wage determination by monopoly unions. The general equilibrium is solved for the real exchange rate and the price levels in section 3. General equilibrium effects of various shifts in tax parameters are presented in section 4. Finally, there is a brief concluding section.

II. GOODS MARKET, MONOPOLY UNIONS AND TAXES

A two-country world with international trade is analysed. Firms in each country produce a homogeneous good and specialise in the production of their own exportable. The domestic good and the foreign good are imperfect substitutes in consumption. There are no assets, so equilibrium always requires balanced trade and monetary issues need not be considered. Labour is immobile between countries.¹

Households maximise utility, which depends on the consumption of the home products (x_1) and foreign products (x_2), subject to the household budget constraint

¹ This section draws from Driffill and van der Ploeg (1993).

$$x_1 + ex_2 = I = pu, \quad (1)$$

where I , p , and e denote income, the ideal price index associated with the composite commodity u (the ideal consumer price index or CPI), and the real exchange rate (price of foreign products in terms of home products), respectively. For convenience, the utility function is of the Cobb-Douglas variety,

$$U(x_1, x_2) = x_1^{1-\alpha} x_2^\alpha. \quad (2)$$

The demand for home products and foreign products is thus given by

$$x_1 = (1 - \alpha)I; \quad x_2 = \alpha I/e \quad (3)$$

and the ideal CPI is given by

$$p = [(1 - \alpha)^{1-\alpha} \alpha^\alpha]^{-1} e^\alpha \equiv \Omega e^\alpha. \quad (4)$$

A depreciation of the real exchange rate raises the relative price of imported goods and thus raises the CPI.

Firms operate under perfect competition and choose their demand for labour (L) to maximise profits, $\pi = f(L) - (1 + s)wL$, where $f(L) = AL^\gamma$ is a production function with diminishing returns to labour ($\gamma < 1$), and w and s denotes the product wage and the employer's payroll tax, respectively. This yields the demand for labour

$$L[(1 + s)w] = (A\gamma)^\delta [(1 + s)w]^{-\delta}, \quad (5)$$

where $\delta \equiv (1 - \gamma)^{-1} > 1$ and the supply of goods

$$Q[(1+s)w] = A(A\gamma)^c [(1+s)w]^{-c}, \quad (6)$$

where $c \equiv \delta\gamma$, as decreasing functions of the product wage. The producer price has been normalised to one. Equilibrium on goods market requires $Q[(1+s)w] = x_1 + x_2^*$, where x_2^* denotes exports (as foreign variables are denoted with an asterisk).

Let trade unions fix the wage and assume that firms set employment unilaterally. Assume, for convenience, that the trade union's utility function is of the utilitarian form and linear in terms of after-tax wages and employment.

$$V\left(\frac{\hat{w}}{p}, L\right) = L[w(1+s)]\left(\frac{\hat{w}}{p} - b\right), \quad (7)$$

where $\hat{w} = w(1-t) + at$, t and a denote the (constant) marginal tax rate and the level of tax exemption, and b denotes the utility of leisure time or outside option.

Decentralised trade unions are so small that they ignore the effect of raising their wages on their country's real exchange rate and CPI. Decentralised monopoly unions thus set wages so as to maximise (7) subject to labour demand (5). This gives

$$w = \frac{pb - ta}{(1-t)m}. \quad (8)$$

where $m \equiv (1 - 1/\delta)$. The optimal wage rate for the monopoly union depends positively on the valuation of leisure b and negatively on the wage elasticity of labour demand δ . As for the tax parameters in a partial equilibrium one gets (when p is constant) $w_a = -t[(1-t)m]^{-1} < 0$ and $w_t = (wm - a)[(1-t)m]^{-1} = ?$ and $w_s = 0$. For later purposes it is useful to elaborate the w_t -expression a bit.

Substituting the right hand side of (8) for w in (7) gives the indirect utility function for the monopoly union $V(t, a) = u^0$ in terms of t and a . Now $V_a = tLp^{-1} > 0$ and

$V_t = -(w-a)Lp^{-1} < 0$ so that one can invert V for a such that $a = g(t, u^0)$. Substituting this for a in $V(t, a)$ yields the compensated indirect utility function $V^*[t, g(t, u^0)] = u^0$ (see e.g. Diamond and Yaari (1972)). This answers the following question: If the marginal tax rate t is increased, how much the tax exemption a has to be changed so as to keep the utility of the trade union unchanged? Differentiation gives $V_t^* + V_a^*g_t = 0$ so that

$$g_t = -\frac{V_t^*}{V_a^*} = \frac{(w-a)}{t} > 0. \quad (9)$$

It is known that

$$w(t, g(t, u^0)) = w^c(t, u^0), \quad (10)$$

where w^c is the compensated wage function (the minimum wage to achieve a level of utility u^0 at the marginal tax rate t). Differentiation of (10) with respect to t gives $w_t^c = w_t + w_a g_t$ so that

$$w_t = w_t^c - \frac{(w-a)}{t} w_a. \quad (11)$$

This is the Slutsky equation for the wage rate, where the ambiguous total effect has been decomposed into the substitution effect (w_t^c) and income effect $-(w-a)t^{-1}w_a$.

The income effect is positive, while the substitution effect

$$w_t^c = -\frac{w/\delta}{(1-t)m} \quad (12)$$

is negative.

The government tax revenue is defined as

$$T = t(w-a)L + swL, \quad (13)$$

if $w - a > 0$. The tax revenue is assumed to be distributed back to households in a lump-sum fashion so that

$$I = \hat{w}L + \pi + T = f(L) = Q[(1 + s)w]. \quad (14)$$

The total domestic income is thus equal to the value of domestic production.

III. GENERAL EQUILIBRIUM

The remaining task is to put elements of the model together so as to form a general equilibrium model with two countries. In what follows foreign variables are denoted with an asterisk. The condition for balanced trade is $x_2^* = ex_2$, which can be used to solve for the equilibrium real exchange rate. Utilising the equation (3) one obtains $e = \frac{\alpha^* I^* / e^*}{\alpha I / e}$. Since $e^* = e^{-1}$, using equation (14) this yields

$$e = \frac{\alpha I}{\alpha^* I^*} = \frac{\alpha Q[(1 + s)w]}{\alpha^* Q^*[(1 + s^*)w^*]} = E \left[(1 + s)w, (1 + s^*)w^* \right]. \quad (15)$$

When countries have the same production technology, we have a more specific equation $e = \left(\frac{\alpha}{\alpha^*} \right) \left[\frac{(1 + s)w}{(1 + s^*)w^*} \right]^{-c}$, where $c \equiv -\frac{wQ_w}{Q}$ denotes the elasticity of output with respect to the product wage.

Substitution of the right hand side of (15) for e into the expression of the CPI (4) yields

$$p = \Omega e^\alpha = P \left[(1 + s)w, (1 + s^*)w^* \right]. \quad (16)$$

The corresponding expression of the CPI for the foreign country is (since $e^* = e^{-1}$)

$$p^* = \Omega^* (e^*)^{\alpha^*} = P^* \left[(1 + s)w, (1 + s^*)w^* \right] \quad (17)$$

An intuitive explanation for the response of the CPI to changes in gross wages is straightforward. An increase (a decrease) in the domestic (foreign) gross wage depresses aggregate supply of goods at home. This induces an increase in the relative price of home products, so that the real exchange rate appreciates (depreciates), and the CPI falls (increases). Hence, an increase (a decrease) in the domestic (foreign) gross wage leads to a larger increase in the consumption wage.

In general equilibrium the domestic and foreign wages can be expressed as functions of the price level, valuation of leisure, wage elasticity of labour demand and tax parameters as follows

$$w = \frac{P[(1 + s)w, (1 + s^*)w^*]b - ta}{(1 - t)m}; \quad (18)$$

$$w^* = \frac{P^*[(1 + s)w, (1 + s^*)w^*]b^* - t^*a^*}{(1 - t^*)m^*}. \quad (19)$$

As for the adjustment of domestic and foreign wages we follow a formulation used in the stability analysis of oligopoly equilibrium (see Dixit, 1986). It is shown in appendix that this system of equations is stable.

IV. GENERAL EQUILIBRIUM EFFECTS OF TAXES

We are now in a position to develop the general equilibrium effects of changes in the tax parameters. The following definitions are used in what follows:

Definitions A:

$$\begin{aligned} \theta &\equiv (1-t)m > 0; & \theta^* &\equiv (1-t^*)m^* > 0; & z &\equiv (\theta - bP_w)^{-1} > 0; \\ z^* &\equiv (\theta^* - b^*P_w^*)^{-1} > 0; & y &\equiv bP_w \cdot z > 0; & y^* &\equiv b^*P_w^* z^* > 0; \\ \phi &\equiv 1 - y(1+s)y^*(1+s^*) = zz^*[\theta\theta^* - \theta b^*P_w^* \cdot (1+s^*) - \theta^* bP_w(1+s)] > 0. \end{aligned}$$

Signs of these definitions follow from the price equations (16) and (17) and their property that $P_w P_w^* - P_w \cdot P_w^* = 0$.

IV.1. Comparative statics

As for the domestic tax exemption we obtain from equations (18) and (19)

$$\begin{aligned} w_a &= \{[P_w w_a(1+s) + P_w \cdot w_a^*(1+s^*)]b - t\} / \theta & \text{and} \\ w_a^* &= \{[P_w^* w_a(1+s) + P_w^* \cdot w_a^*(1+s^*)]b^*\} / \theta^*. \end{aligned}$$

Simple calculations give

$$\tilde{w}_a = \frac{-tz}{\phi}; \quad (20)$$

$$\tilde{w}_a^* = \frac{-tzy^*(1+s)}{\phi}. \quad (21)$$

It can be shown on the basis of (20) and (21) and labour demand that

Proposition 1: An increase in the domestic tax exemption decreases the domestic and foreign nominal wage rates and raises employment in both countries.

Proof: See the definitions A and equation (5). ∇

The economic forces at work can be described as follows: In the first stage, a rise in domestic tax exemption decreases the domestic wage rate. This increases the supply of home goods thus depreciating the domestic currency and appreciating the foreign currency. An appreciation of the foreign currency, in turn, decreases the foreign price level. The foreign union reacts by reducing its wage claim. A reduced foreign

wage rate feeds back to the domestic wage rate via the exchange rate appreciation (nominated in the domestic currency) which tends to raise the domestic wage rate. However, since the first stage effects dominate the feedback effect, the exchange rate depreciates in the home currency and the wage rate decreases in both countries. Hence, employment determined unilaterally by firms is boosted in both countries as a result of a rise in the domestic exemption.

As for the income tax rate, equations (18) and (19) yield $w_t = \{[P_w w_t(1+s) + P_w \cdot w_t^*(1+s^*)]b + wm - a\} / \theta$, and $w_t^* = \{[P_w^* w_t(1+s) + P_w^* \cdot w_t^*(1+s^*)]b^*\} / \theta^*$ so that

$$\tilde{w}_t = \frac{(wm - a)z}{\phi}; \quad (22)$$

$$\tilde{w}_t^* = \frac{(wm - a)zy^*(1+s)}{\phi}. \quad (23)$$

Utilising the (partial equilibrium) Slutsky equation (11) the total (general equilibrium) effects can be decomposed as

$$\tilde{w}_t = \tilde{w}_t^c - \frac{(w-a)}{t} \tilde{w}_a, \quad (24)$$

where $\tilde{w}_t^c = w_t^c \theta z / \phi$ is negative. Now one gets

Proposition 2: The domestic income tax rate has an ambiguous effect on wages and employment in both countries in general. However, when the utility of leisure time is higher than the real value of tax exemption an increase in the domestic tax rate increases the domestic and the foreign wage rates and thus decreases employment in both countries.

Proof: See the definitions A and equation (5). The condition $b - a/P > 0$ implies that $wm - a > 0$ at optimum. ∇

A rise in the income tax rate raises the wage requirement by the monopoly union due to the income effect. On the other hand, a trade-off between w and L changes so that due to the substitution effect it becomes more beneficial to the trade union to want more L and less w . When the utility of leisure time is higher than the real value of tax exemption, the income effect dominates the substitution effect². Hence an increase in the tax rate increases the domestic wage and decreases the domestic employment. This depreciates the foreign currency and increases the foreign CPI and thus the foreign wage level. Thus employment falls in the foreign country as well.

Finally, as for a change in the employer's payroll tax rate, equations (18) and (19) imply $w_s = [P_w w_s(1+s) + P_w w + P_w \cdot w_s^*(1+s^*)]b/\theta$ and $w_s^* = [P_w^* w_s(1+s) + P_w^* w + P_w^* \cdot w_s^*(1+s^*)]b^*/\theta^*$ so that

$$\tilde{w}_s = \frac{w\theta^* z z^* b P_w}{\phi} ; \quad (25)$$

$$\tilde{w}_s^* = \frac{w z z^* \theta b^* P_w^*}{\phi} . \quad (26)$$

Proposition 3: An increase in the domestic payroll tax rate decreases the domestic nominal wage rate and increases the foreign nominal wage. Both domestic and foreign employment goes down.

Proof: From the definitions A and from equations (16) and (17) we know that $\tilde{w}_s < 0$ and $\tilde{w}_s^* > 0$; thus foreign demand for labour decreases. What happens to the domestic gross wage can be derived as follows. From (18) and (19) one can infer that since $\tilde{w}_s < 0$ and $\tilde{w}_s^* > 0$, then $\partial P/\partial s < 0$ and $\partial P^*/\partial s > 0$. From (16) one infer that

² A large body of empirical evidence supports this finding, see, e.g. Layard, Nickell and Jackman (1991) for a survey.

an increase (a decrease) in the domestic CPI implies an appreciation (a depreciation) of the exchange rate. From (15) we obtain that $\text{sgn}(e_s) = \text{sgn}\{(Q_w/Q)[\tilde{w}_s(1+s) + w] - (Q_w^*/Q^*)[\tilde{w}_s^*(1+s^*)]\}$. Since $e_s < 0$ and since $\tilde{w}_s^* > 0$, $Q_w^* < 0$, and $Q_w < 0$, then $\tilde{w}_s(1+s) + w > 0$ and thus $\partial L/\partial s < 0$. ∇

A partial equilibrium effect of the payroll tax is zero with constant gross wage elasticity of labour demand. In a general equilibrium, however, a rise in the domestic payroll tax increases the gross wage rate and thereby reduces the supply of home goods. This, in turn, leads to an appreciation of the domestic currency and to a fall in the price level. Hence, domestic wage rate decreases but less than a rise in the payroll tax rate.³ An increase in the foreign nominal wage w^* is due to a depreciation of foreign currency which boosts the foreign price level. Since the gross wages go up in both countries, employment is reduced.

IV.2. A pure rise in the income tax progression

It might be tempting, but wrong, to argue that the Slutsky equations (24) convey everything that one has to say about the general equilibrium effects of increased tax rate. The Slutsky equations are results that apply to a simultaneous increase in the marginal as well as the average tax rates. In indicating the effects of increased progressivity as such the average tax rate should in same sense be held as constant. Let us, therefore, consider the effect of a compensated change in the marginal income tax rate, which keeps the tax revenue unchanged. From the government tax revenue requirement (13) one gets $dT = (\partial T/\partial a)da + (\partial T/\partial t)dt = 0$, when $ds = 0$. This gives a change in the tax exemption as a function of a change in the domestic wage and a change in the marginal tax rate,

$$\left[\frac{da}{dt} \right]_{dT=ds=0} = -\frac{\partial T/\partial t}{\partial T/\partial a} = -\frac{\beta \left[\left(1 - \frac{a}{w}\right)(1+s) + \Lambda \frac{\partial [w(1+s)]}{\partial a} \right]}{\beta \left[-\frac{t(1+s)}{w} + \Lambda \frac{\partial [w(1+s)]}{\partial a} \right]} , \quad (27)$$

³ This lies in conformity with empirical evidence, see e.g. Holm, Honkapohja and Koskela (1994).

where $\beta \equiv \frac{Lw}{1+s}$ and $\Lambda \equiv \left(\frac{s+t}{w}\right) \left[1 - \delta \left(1 - \frac{ta}{w(s+t)}\right)\right]$.

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 income tax rate (the tax exemption) is positive (negative), the Dupuit-Laffer-curve is upward-sloping.⁴ The simultaneous increases in the income tax rate t and the tax exemption a make the tax schedule more progressive, while keeping the tax revenue constant. This can be regarded as the pure change in progressivity in the ex post sense.⁵

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 domestic progression on the domestic gross wage can be expressed as

$$\left[\frac{d[w(1+s)]}{dt}\right]_{dT=ds=0} = -\left[\frac{\beta(1+s)^2}{\partial T/\partial a}\right] \left(\frac{t}{w}\right) \tilde{w}_t^c, \quad (28)$$

where the expression (27) has been utilised. Utilising the total differential $d[w^*(1+s^*)] = \{\partial[w^*(1+s^*)/\partial a]\}da + \{\partial[w^*(1+s^*)/\partial t]\}dt$ and the fact, from equations (20) to (23), that $\tilde{w}_a^* = y^*(1+s)\tilde{w}_a$ and $\tilde{w}_t^* = y^*(1+s)\tilde{w}_t$, the effects of a pure rise in the domestic progression on the foreign gross wage can be described as

$$\left[\frac{d[w^*(1+s^*)]}{dt}\right]_{dT=ds=0} = y^*(1+s) \left[\frac{d[w(1+s)]}{dt}\right]_{dT=ds=0} \quad (29)$$

We are now in a position to state:

⁴ For empirical evidence in relevance of this assumption, see Fullerton (1982).

⁵ See Musgrave and Thin (1948) for a seminal article on various definitions of progressivity.

Proposition 4: If the Dupuit-Laffer-curve is upward-sloping, a compensated increase in the domestic tax progression (i) decreases the domestic and foreign gross wage rate and boosts employment in both countries⁶, (ii) increases government tax revenue in the foreign country if the foreign tax exemption is zero.

Proof. (i) From (20) and (22) one obtains that $\tilde{w}_t^c \equiv \tilde{w}_t + \frac{\tilde{w}_a(w-a)}{t} = \frac{-wz/\delta}{\phi} < 0$. When the Dupuit-Laffer-curve is upward-sloping, $\partial T/\partial a < 0$, and thus the domestic gross wage decreases. Since $y^* > 0$ (definitions A) the foreign gross wage decreases. The effects on labour demand follows from equation (5) (ii) See appendix IIa. ∇

A compensated increase in the domestic marginal income tax rate decreases domestic wage directly via the negative substitution effect of the tax rate. A fall in the domestic wage increases supply of the home goods thus depreciating the domestic currency and appreciating the foreign currency. An appreciation gives rise to a fall in the foreign price level so that the foreign monopoly union reduces its wage claim. Thus employment is boosted via the demand for labour in both countries by a rise in the income tax progression of the home country. If the foreign tax exemption is zero, then a fall in the foreign gross wage induces an increase in the foreign tax revenue due to the assumption of elastic labour demand.

IV.3. A revenue-neutral restructuring of labour taxation.

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 practice. Therefore, it is of interest to study the

⁶ Koskela and Vilminen (1994) 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.

structure of labour taxation and its potential impacts of gross wages and employment.

In what follows, we study a revenue-neutral restructuring of labour taxation. This is a policy reform which shifts tax burden from employers to workers, while keeping the government tax revenue unchanged. From the government tax revenue requirement (13) one gets that $dT = (\partial T/\partial s)ds + (\partial T/\partial t)dt = 0$, when $da = 0$. 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 are kept constant

$$\left[\frac{ds}{dt} \right]_{dT=da=0} = -\frac{\partial T/\partial t}{\partial T/\partial s} = -\frac{\beta \left[\left(1 - \frac{a}{w}\right)(1+s) + \Lambda \frac{\partial[w(1+s)]}{\partial t} \right]}{\beta \left[(1-t) + \Lambda \frac{\partial[w(1+s)]}{\partial s} \right]} \quad (30)$$

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 domestic gross wage can be expressed as

$$\left[\frac{d[w(1+s)]}{dt} \right]_{dT=da=0} = \left(\frac{\beta(1+s)}{\partial T/\partial s} \right) \left[\tilde{w}_t(1-t) - \tilde{w}_s \left(1 - \frac{a}{w}\right)(1+s) - (w-a) \right], \quad (31)$$

where the expression (30) has been utilised. Using (22) and (25) equation (31) can be reduced to

$$\left[\frac{d[w(1+s)]}{dt} \right]_{dT=da=0} = \left(\frac{\beta(1+s)}{\partial T/\partial s} \right) \left[(-w)(1-t) \left(\frac{a}{w} \right) \left(\frac{z}{\phi} \right) \left(\frac{1}{\delta} \right) \right]. \quad (32)$$

Analogously, 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 foreign gross wage can be expressed as

$$\left[\frac{d[w^*(1+s^*)]}{dt} \right]_{dT=da=0} = \left(\frac{\beta(1+s^*)}{\partial T/\partial s} \right) \left[\tilde{w}_t^*(1-t) - \tilde{w}_s^* \left(1 - \frac{a}{w}\right)(1+s) \right]. \quad (33)$$

$$\text{since } \left[\frac{\partial[w^*(1+s^*)]}{\partial t} \right] \left[\frac{\partial[w(1+s)]}{\partial s} \right] - \left[\frac{\partial[w^*(1+s^*)]}{\partial s} \right] \left[\frac{\partial[w(1+s)]}{\partial t} \right] = 0.$$

Using (22) and (25) equation (31) is reduced to

$$\left[\frac{d[w^*(1+s^*)]}{dt} \right]_{dT=da=0} = \left(\frac{\beta(1+s^*)}{\partial T/\partial s} \right) \left[(-w)(1-t) \left(\frac{a}{w} \right) \left(\frac{z}{\phi} \right) \left(\frac{1}{\delta} \right) \right] y^*(1+s). \quad (34)$$

One the bases of equations (32) and (34) one is able to establish

Proposition 5: If the Dupuit-Laffer-curve is upward-sloping, a revenue-neutral policy reform which reduces the domestic payroll tax (i) decreases the domestic and foreign gross wage rate, when the income tax base due to the tax exemption is smaller than the payroll tax base, but has no effect when the tax bases are equal, (ii) boosts employment in both countries when the domestic tax exemption is positive, but has no effect when the bases are equal, (iii) has no effect on government tax revenue in the foreign country when the domestic tax bases are identical, but increases it when the domestic tax exemption is positive and the foreign one is zero..

Proof: (i) When the Dupuit-Laffer-curve is upward-sloping, $\partial T/\partial s > 0$, then from (32) and (34) $\left[\frac{d[w(1+s)]}{dt} \right]_{dT=da=0} < 0 (=0)$ and $\left[\frac{d[w^*(1+s^*)]}{dt} \right]_{dT=da=0} < 0 (=0)$ when $a > 0$ ($a=0$). (ii) The effects on labour demand follows from equation (5). (iii) See appendix IIb. ∇

This can be explained as follows: On the one hand, a revenue-neutral restructuring of domestic labour taxation towards the income tax base tends to increase the domestic wage rate (proposition 2), but to decrease it due to a drop in domestic payroll tax (proposition 3). On the other hand, in addition to this indirect effect the payroll tax has a positive direct effect on the gross wage. If the tax bases for income and payroll taxes are identical, these effects cancel each other so that the domestic gross wage rate does not change as a result of the policy reform. Under these circumstances domestic employment - which depends on the domestic gross wage - remains unchanged as well. This also means that there are no repercussions from domestic gross wages via the exchange rate on the foreign gross wage either. Thus the domestic and foreign CPI do not change either. Under the identical tax bases for income and payroll taxes a revenue neutral restructuring of labour taxation does not matter at all.

The situation is, however, different under the more realistic assumption, where the tax base for income taxation is smaller than the one for payroll taxation due to the tax exemption. The tax exemption weakens the positive effect of income tax rate on the domestic wage rate (see the expression (22)) for the reason that a rise in the income tax rate also raises the value of tax exemption for workers. This in turn tends to decrease wage rate (see proposition 1). Hence, a revenue-neutral restructuring of labour taxation towards income taxation tends to give less pressure for wages to rise. Hence, the domestic gross wage rate falls and domestic employment boosts. A fall in the domestic gross wage rate increases the supply of home goods, leading to an appreciation of the foreign currency. Consequently, the foreign price level and the foreign wage rate fall so that foreign employment goes up as well. If the foreign tax exemption is zero, then a fall in the foreign gross wage induces an increase in the foreign tax revenue due to the assumption of elastic labour demand.

Finally, as for interpretation of empirical wage equations it should be noted that the irrelevance condition of nominal incidence of labour taxes holds (does not hold) when the tax exemption is zero (positive), i.e. $\varepsilon_{1-t}^w + \varepsilon_{1+s}^w + 1 = \left(\frac{z}{\phi}\right)\left(\frac{a}{w}\right)(1-t) > 0$, where $\varepsilon_{1+s}^w \equiv \frac{\tilde{w}_s(1+s)}{w} < 0$ and $\varepsilon_{1-t}^w \equiv -\frac{\tilde{w}_t(1-t)}{w} < 0$.⁷

IV.4. Some co-ordinated policy changes in the domestic and foreign countries

Thus far we have looked at the general equilibrium effects of changes in the tax parameters of the home country. As is evident from propositions 4 and 5, the foreign country will benefit or suffer from unco-ordinated changes in taxes in the home country. Therefore, it is of interest to see the general equilibrium effects of co-ordinated changes in the tax parameters. The effects of the co-ordinated changes in the tax exemption ($da = da^*$), in the payroll tax rate ($ds = ds^*$), in the pure progression, and the restructuring of labour taxation on the domestic nominal or gross wages are

$$\frac{dw}{da} = \tilde{w}_a + \tilde{w}_{a^*} = \frac{-[tz + t^*z^*y(1+s^*)]}{\phi} ; \quad (35)$$

$$\frac{dw}{ds} = \tilde{w}_s + \tilde{w}_{s^*} = \left(\frac{zz^*}{\phi}\right) b\theta^*(wP_w + w^*P_{w^*}) ; \quad (36)$$

$$\left[\frac{d[w(1+s)]}{dt}\right]_{dT=ds=0} + \left[\frac{d[w(1+s)]}{dt^*}\right]_{dT^*=ds^*=0} = \left[\frac{d[w(1+s)]}{dt}\right]_{dT=ds=0} + y(1+s^*)\left[\frac{d[w^*(1+s^*)]}{dt^*}\right]_{dT^*=ds^*=0} ; \quad (37)$$

⁷ For example, Holm et al (1994) found that the irrelevance condition does not hold in the Finnish manufacturing sector, which is natural given the asymmetrical tax bases for income and payroll taxes.

$$\begin{aligned} & \left[\frac{d[w(1+s)]}{dt} \right]_{dT=da=0} + \left[\frac{d[w(1+s)]}{dt^*} \right]_{dT^*=da^*=0} = \left[\frac{d[w(1+s)]}{dt} \right]_{dT=ds=0} \\ & + y(1+s) \left[\frac{d[w^*(1+s^*)]}{dt^*} \right]_{dT^*=da^*=0} ; \end{aligned} \quad (38)$$

respectively.

Proposition 6: i) Co-ordinated increases in the tax exemption, in the pure tax progression and in the revenue-neutral restructuring of labour taxation towards the income tax rate in both countries (with the positive tax exemptions) lead to a larger decrease in the gross wage and a higher increase in employment than unilateral increases. ii) When countries are identical, a co-ordinated decrease in the payroll tax in both countries decreases the gross wage and thus boosts employment in both countries, while has no effect on the nominal wage rates.

Proof: (i) Follows directly from the definitions A, namely that $z > 0$, $z^* > 0$, $y > 0$, and $\phi > 0$, and from propositions 4 and 5. From proposition 4 we know that $\left[\frac{d[w^*(1+s^*)]}{dt} \right]_{dT=ds=0} = y^*(1+s) \left[\frac{d[w(1+s)]}{dt} \right]_{dT=ds=0}$ and thus $\left[\frac{d[w(1+s)]}{dt^*} \right]_{dT^*=ds^*=0} = y(1+s^*) \left[\frac{d[w^*(1+s^*)]}{dt^*} \right]_{dT^*=ds^*=0}$. From proposition 5 we know that $\left[\frac{d[w^*(1+s^*)]}{dt} \right]_{dT=da=0} = y^*(1+s^*) \left[\frac{d[w(1+s)]}{dt} \right]_{dT=da=0}$ and thus $\left[\frac{d[w(1+s)]}{dt^*} \right]_{dT^*=da^*=0} = y(1+s) \left[\frac{d[w^*(1+s^*)]}{dt^*} \right]_{dT^*=da^*=0}$. (ii) Follows directly from proposition 3. When countries are identical, $P_w + P_{w^*} = 0$, and thus the nominal wages are constant. ∇

Thus, co-ordinated changes in the tax exemption, in the pure tax progression and in the revenue neutral restructuring of labour taxation towards the income tax rate

affect more strongly than their unilateral changes in individual countries. This is because of the externality created by tax policy of one country via the exchange rate on another country's price level and wage rate. For example, an increase in the foreign tax exemption decreases the foreign nominal wage, appreciates the exchange rate denominated in the domestic currency. Thus the price level and thereby the domestic wage rate decrease. When countries are identical the ratio of the domestic wage rate on the foreign wage rate is independent on the co-ordinated changes in taxation and thus the exchange rate does not change. As for a co-ordinated payroll tax cuts, their effects on the domestic nominal wages cancel each other, if countries are identical; according to equation (35) a fall in s tends to increase the domestic nominal wage by increasing the domestic price level, while a fall in s^* tends to decrease it via decreasing the domestic price level.

V. CONCLUDING REMARKS

This paper has studied the effects of labour taxes in a general equilibrium model of two countries. Each country specialises in the production of a homogeneous product, domestic and foreign goods are imperfect substitutes in consumption and wages are determined by monopoly unions in both countries.

It has been shown that under plausible circumstances a compensated increase in the domestic tax progression, which keeps the government tax revenue unchanged, decreases both domestic and foreign nominal wage and is thus good for employment in both countries. This striking result is due to the fact that the substitution effect of the income tax rate on the wage rate is negative. Foreign wage rate also decreases since a fall in the domestic wage rate increases the supply of home goods and appreciates the foreign currency. This leads to a fall in the foreign price level,

which in turn gives rise to a decrease in the wage set by the foreign monopoly union.

Often in theoretical studies of tax incidence and wage formation no distinction is made between income and payroll taxes, while they seem to have different effects on wages in practise. The paper shows that a revenue-neutral restructuring of labour taxation from employers to workers in the domestic country decreases the domestic gross wage and is thus good for domestic employment when the income tax base is smaller than the payroll tax base due to tax exemption. On the other hand, if the income tax base is equal to the payroll tax base, then the revenue neutral restructuring does not affect either domestic or foreign employment.

As for the co-ordinated changes in tax parameters, a co-ordinated increase in pure progression in both countries and a co-ordinated restructuring of labour taxation in both countries leads to a larger decrease in the gross wage and thus a larger increase in employment than an unilateral change in individual countries, when the tax exemptions are positive in both countries.

There are several areas for further research. First, analysis has revealed that an individual country's tax policy spills over to another country. This raises a question of what happens under tax competition. Second, the goods market has been assumed to be competitive. One would like to know whether this matters for results, or is only an analytical convenience. Finally, and importantly, one should do empirical research about the wage effects of progression and restructuring of labour taxation. In fact, some empirical evidence for the wage moderation effects of tax progression are presented in Lockwood and Manning (1993) for the United Kingdom, in Holmlund and Kolm (1994) for Sweden and in Malcomson and Sartor (1987) for Italy.

REFERENCES

- Diamond, P., A. and Yaari, M., 1972, Implications of the theory of rationing for consumer choice under uncertainty, *American Economic Review*, 333-343.
- Dixit, A., 1986, Comparative statics for oligopoly, *International Economic Review*, 27, 107-122.
- Driffill, J. and van der Ploeg, F., 1993, Monopoly unions and the liberalisation of international trade, *The Economic Journal*, 103, 379-385.
- Fullerton, D., 1982, On the possibility of an inverse relationship between tax rates and government revenues, *Journal of public Economics*, 3-22.
- Holm, P., Honkapohja, S., and Koskela, E., 1994, A monopoly union model of wage determination with capital and taxes: an empirical application to the Finnish manufacturing, *European Economic Review*, 285-303.
- Holmlund, B. and Kolm, A.-S., 1994, Progressive taxation, wage setting and unemployment: theory and Swedish evidence, Department of Economics, Uppsala University, mimeo.
- Koskela, E. and Vilmunen, J., 1994, Tax progression is good for employment in popular models of trade union behaviour, Bank of Finland, DP 3/94, forthcoming in *Labour Economics*.
- Layard, R., Nickell, S. and Jackman, R., 1991, *Unemployment: Macroeconomic performance and the labour market*, Oxford University Press, Oxford.
- Lockwood, B., and Manning, A., 1993, Wage setting and the tax system: theory and evidence for the United Kingdom, *Journal of Public Economics*, 1-29.
- Malcomson, J. and Sartor, N., 1987, Tax push inflation in a unionized labor market, *European Economic Review*, 31, 1581-1596.
- Musgrave, R., A. and Thin, T., 1948, Income tax progression, 1929-1948, *Journal of political Economy*, 498-514.
- Sandmo, A., 1983, Progressive taxation, redistribution and labour supply, *The Scandinavian Journal of Economics*, 311-323.

APPENDICES

I: Stability of the system of wage equations

The equations (18) and (19) can be rewritten as

$$\Theta \equiv w\theta - P[(1+s)w, (1+s^*)w^*]b + ta = 0; \quad (A1)$$

$$\Theta^* \equiv w^*\theta^* - P^*[(1+s)w, (1+s^*)w^*]b^* + t^*a^* = 0. \quad (A2)$$

The partial derivatives of the equations with respect to the wage rates are:

$$\Theta_w = \theta - bP_w(1+s); \quad \Theta_{w^*} = -bP_{w^*}(1+s^*); \quad (A3)$$

$$\Theta_w^* = \theta^* - b^*P_w^*(1+s^*); \quad \Theta_{w^*}^* = -b^*P_{w^*}^*(1+s). \quad (A4)$$

The system of wage equations are stable, since $\Theta_w > 0$, $\Theta_{w^*}^* > 0$ and the determinant $D \equiv \Theta_w \Theta_{w^*}^* - \Theta_w^* \Theta_{w^*}$ is positive. This can be seen as follows:

$$D = \underbrace{\theta\theta^*}_{+} - \underbrace{\theta b^* P_{w^*}^*(1+s^*)}_{+} - \underbrace{\theta^* b P_w(1+s)}_{+} + b(1+s)b^*(1+s^*) \underbrace{(P_w P_{w^*}^* - P_w^* P_w)}_{=0}. \quad (A5)$$

II: The effects of domestic tax instruments on the foreign tax revenue :

a: Differentiating $T^* = t^*(w^* - a^*)L^* + s^*w^*L^*$ with respect to t one obtains

$$\left[\frac{dT^*}{dt} \right]_{dT=ds=0} = \beta^* \Lambda^* \left[\frac{d[w^*(1+s^*)]}{dt} \right]_{dT=ds=0}, \quad \text{where} \quad \beta^* \equiv \frac{L^* w^*}{1+s^*} \quad \text{and}$$

$$\Lambda^* \equiv \left(\frac{s^* + t^*}{w^*} \right) \left[1 - \delta^* \left(1 - \frac{t^* a^*}{w^*(s^* + t^*)} \right) \right]. \quad \text{When } a^* = 0, \Lambda^* < 0, \text{ and thus the}$$

government revenue increases. When $a^* > 0$, the sign of Λ^* is ambiguous.

b: Differentiating $T^* = t^*(w^* - a^*)L^* + s^*w^*L^*$ with respect to s one obtains

$$\left[\frac{dT^*}{dt} \right]_{dT=da=0} = \beta^* \Lambda^* \left[\frac{d[w^*(1+s^*)]}{dt} \right]_{dT=da=0} > 0 (=0), \quad \text{when } a > 0 \text{ and } a^* = 0$$

($a = 0$), since $\Lambda^* = ?$ when $a = a^* > 0$.

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