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# TAX PROGRESSION AND STRUCTURE OF LABOUR TAXATION IN AN OPEN ECONOMY GENERAL EQUILIBRIUM MODEL WITH MONOPOLY UNIONS

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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 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, tax coordination.
JEL Classification: H22, J23, J51.

TIIVISTELMÄ: Melko yleisesti omaksutun käsityksen mukaan verotuksen progression kasvu annetulla verotulokertymällä vähentää työnteon kannustimia, nostaa palkkoja ja vähentää työllisyyttä. Pitääkö tämä käsitys paikkansa talouksissa, joissa palkat eivät määräydy kysynnän ja tarjonnan mukaan, vaan niistä neuvotellaan työntekijöiden ja yritysten välillä? Paperissa analysoidaan työn verotuksen vaikutuksia kahden maan yleisen tasapainon mallissa, missä hyödykemarkkinoilla vallitsee täydellinen kilpailu, maat erikoistuvat oman hyödykkeen tuotantoon ja monopolivoimaa omaavat ammattiliitot asettavat palkat. Paperissa osoitetaan, että kotimaisen verotulokertymän säilyttävän työtuloverotuksen progression kasvu parantaa työllisyyttä molemmissa maissa. Lisäksi osoitetaan, että verotulokertymän säilyttävä työtuloverotuksen painopisteen siirtäminen palkkatulojen verotuksen suuntaan vähentämällä työnantajan SOTU-maksuja lisää työllisyyttä kummassakin maassa, jos työtuloveropohja vähennyksistä johtuen on pienempi kuin SOTU-maksijen veropohja. Jos veropohjat ovat identtisiä, kyseisellä politiikkareformilla ei ole työllisyysvaikutuksia.

AVAINSANAT: Veroprogressio, työnantajan sosiaaliturvamaksut, verokoordinaatio.
JEL Classification: H22, J23, J51.

# 1. 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, does increase 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 and social security contributions 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 probably 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, where domestic and foreign goods are imperfect substitutes in consumption and where 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. Effects of taxation appear to be very sensitive the structure of labour markets. It is also shown that a revenue neutral restructuring of labour taxation from employers to workers in domestic country is good for employment both in domestic and 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.

The paper is organised as follows. Section 2 presents goods market behaviour, the tax system and wage determination by monopoly unions and 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.

## 2. 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

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$$x_1 + ex_2 = m = pu, \qquad (1)$$

where m, 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,

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

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

$$x_1 = (1 - \alpha)m \; ; \; x_2 = \alpha m/e \qquad (3)$$

and the ideal CPI is given by

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

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

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

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

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

where $c \equiv \delta\gamma$, as decreasing functions of the product wage. 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.[2] 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.

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

where $\hat{w} = w(1-t) + at$, where $t$ 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

$$w = \frac{pb - ta}{(1-t)(1-1/\delta)}. \tag{8}$$

The optimal wage rate for the monopoly union depends positively on the valuation of leisure and negatively on the wage elasticity of labour demand. As for the tax exemption $a$ and the marginal tax rate $t$ one gets (when $p$ is constant) $w_a = -t[(1-t)(1-1/\delta)]^{-1} < 0$ and $w_t = [w(1-1/\delta) - a][(1-t)(1-1/\delta)]^{-1} = ?$. 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 $V^*\left[t, g\left(t, u^0\right)\right] = u^0$ (see e.g. Diamond and Yaari (1972)). The compensated indirect utility function answers the following question: If the marginal tax rate $t$ is

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[2]    See Oswald (1985) for a survey of various trade union models.

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

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

(9)

It is known that

$$w\left(t, g\left(t, u^0\right)\right) = w^c\left(t, u^0\right),$$

(10)

where $w^c$ is the compensated wage function, which gives 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

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

(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

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

(12)

is negative. Finally, one obtains from (8) that $w_s = 0$, i.e. the partial equilibrium effect of the payroll tax on wage is zero.

The government tax revenue is defined as

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

(13)

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

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

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

## 3. General equilibrium

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. From (3) $e = \dfrac{\alpha^* m^*/e^*}{\alpha m/e}$ one obtains, since $e^* = e^{-1}$,

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

When countries have the same production technology, $e = \left(\dfrac{\alpha}{\alpha^*}\right)\left[\dfrac{(1+s)w}{(1+s^*)w^*}\right]^{-c}$, where $c \equiv -\dfrac{wQ_w}{Q}$ 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) then gives

$$p = \Omega e^\alpha = P\left[\underset{-}{(1+s)w}, \underset{+}{(1+s^*)w^*}\right]. \tag{16}$$

The intuition for the response of the CPI to changes in wages is straightforward. An increase (a decrease) in the domestic (foreign) product wage depresses aggregate supply of goods at home and thus induces in equilibrium an increase in the relative price of home products, an appreciation (a depreciation) of the real exchange rate, and a fall (a rise) in the CPI. Hence, an increase (a decrease) in the domestic (foreign) product wage leads to a larger increase in the consumption wage.

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

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

Thus in general equilibrium we have the domestic and foreign wages as functions of the price level, valuation of leisure, wage elasticity of labour demand and tax parameters as follows

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

## 4. General equilibrium effects of tax parameters

## 4.1. Comparative statics

Let us now turn to develop the general equilibrium implications of changes in the tax parameters. What happens if the domestic tax exemption is changed? From equations (18) we obtain $w_a = \{[P_w w_a(1+s) + P_{w^*} \cdot w_a^*(1+s^*)]b - t\}/\theta$ and $w_a^* = \{[P_w^* w_a(1+s) + P_{w^*}^* \cdot w_a^*(1+s^*)]b^*\}/\theta^*$, where $\theta = (1-t)(1-1/\delta)$ and $\theta^* = (1-t^*)(1-1/\delta^*)$. Simple calculations give

$$\tilde{w}_a = \frac{-tz}{\phi} ; \quad \tilde{w}_a^* = \frac{-tzy^*(1+s)}{\phi} , \qquad (19)$$

where $z \equiv (\theta - bP_w)^{-1} > 0$, $z^* \equiv (\theta^* - b^* P_{w^*}^*)^{-1} > 0$, $y \equiv bP_{w^*} \cdot z > 0$, $y^* \equiv b^* P_w^* z^* > 0$ and, since $P_w P_{w^*}^* - P_{w^*} \cdot P_w^* = 0$, $\phi \equiv 1 - y(1+s)y^*(1+s^*)$ $= zz^*[\theta\theta^* - \theta b^* P_{w^*}^*(1+s^*) - \theta^* bP_w(1+s)] > 0$. It can be shown

*Proposition 1:* A ceteris paribus increase in the domestic tax exemption

i) decreases the domestic and foreign nominal wage rates,

ii) depreciates the exchange rate when countries are identical,

iii) increases (decreases) the domestic (the foreign) CPI when countries are identical,

iv) and raises employment in both countries.

*Proof:* (i) From equations (19) we know that $\tilde{w}_a < 0$, and $\tilde{w}_a^* < 0$. (ii) From (15), when countries are identical $\text{sgn}(e_a) = \text{sgn}[(Q_w/Q)\tilde{w}_a(1+s) - (Q_{w^*}^*/Q^*)\tilde{w}_a^*(1+s^*)]$ $= -\text{sgn}\{\tilde{w}_a[1 - y^*(1+s^*)]\} > 0$, where $1 - y^*(1+s^*) > 0$, since $P_{w^*}^* = -P_w^*$, and thus $e_a^* = -\dfrac{e_a}{e^2} < 0$. (iii) From (16) and (17) $p_e > 0$ and $p_{e^*}^* > 0$, respectively. (iv) From (15) $L_w < 0$ $\nabla$

A rise in domestic tax exemption decreases the domestic wage directly and the foreign wage indirectly via the following mechanism: a fall in the domestic wage decreases the foreign price level, which in turn lowers the wage requirement of the foreign monopoly union. Hence, employment determined unilaterally by firms goes up in both countries. When countries are identical, the exchange rate depends only on the difference between the foreign and the domestic wage rates. Since the effect of the domestic tax exemption on the domestic wage rate dominates its effect on the foreign wage rate, an increase in the domestic tax exemption increases (decreases) the exchange rate denominated in the domestic (foreign) currency, and thus price level increases (decreases) in home (foreign) country.

As for a change in the tax rate, from equations (18) we obtain
$w_t = \{[P_w w_t(1+s) + P_{w^*} w_t^*(1+s^*)]b + w(1 - 1/\delta) - a\}/\theta$, and
$w_t^* = \{[P_w^* w_t(1+s) + P_{w^*}^* w_t^*(1+s^*)]b^*\}/\theta^*$ so that

$$\tilde{w}_t = \frac{[w(1 - 1/\delta) - a]z}{\phi} \quad ; \quad \tilde{w}_t^* = \frac{[w(1 - 1/\delta) - a]zy^*(1+s)}{\phi}. \tag{20}$$

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

$$\tilde{w}_t = \tilde{w}_t^c - \frac{(w-a)}{t}\tilde{w}_a \quad , \tag{21}$$

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

*Proposition 2:* When the utility of leisure time is higher than the real value of tax exemption, at optimum, a ceteris paribus increase in the domestic tax rate

i) increases the domestic and nominal foreign wage rates,

ii) appreciates the exchange rate when countries are identical,

iii) decreases (increases) the domestic (the foreign) CPI when countries are identical,

iv) and decreases employment in both countries.

*Proof:* (i) From equations (20) we know that $\tilde{w}_t > 0$, and $\tilde{w}_t^* > 0$, at optimum, when $b - a/P > 0$. (ii) From (15), when countries are identical $\text{sgn}(e_t) = \text{sgn}[(Q_w/Q)\tilde{w}_t(1+s) - (Q_w^*/Q^*)\tilde{w}_t^*(1+s^*)] = -\text{sgn}\{\tilde{w}_t[1 - y^*(1+s^*)]\} < 0$. (iii) From (16) and (17) $p_e > 0$ and $p_e^* < 0$ , respectively. (iv) From (15) $L_w < 0$. $\nabla$

The effects of the domestic marginal tax rate on the domestic and foreign wages are ambiguous in general reflecting negative substitution and positive income effects. A rise in the 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 effects dominates the substitution effects[3] and thus an increase in the tax rate increases the domestic wage and decreases the domestic employment. This increases the foreign CPI and thus the foreign wage level, implying lower employment in the foreign country as well. When countries are identical, the exchange rate depends only on the difference between the foreign and the domestic wage rates. Since the effect of the domestic tax rate on the domestic wage rate dominates its effect on the foreign wage rate, an increase in the domestic tax rate

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

decreases (increases) the exchange rate denominated in the domestic (foreign) currency, and thus price level decreases (increases) in home (foreign) country.

As for a change in the employer's payroll tax rate, from equations (18) we obtain

$$w_s = [P_w w_s(1+s) + P_w w + P_{w^*} w_s^*(1+s^*)]b/\theta \qquad \text{and}$$

$$w_s^* = [P_w^* w_s(1+s) + P_w^* w + P_{w^*}^* w_s^*(1+s^*)]b^*/\theta^* \quad \text{so that}$$

$$\tilde{w}_s = \frac{w\theta^* zz^* bP_w}{\phi} \quad ; \qquad \tilde{w}_s^* = \frac{wzz^*\theta b^* P_w^*}{\phi}. \qquad (22)$$

It can be shown that

*Proposition 3:* A ceteris paribus increase in the domestic payroll tax rate

i) decreases (increases) the domestic (foreign) nominal wage rate,

ii) decreases (increases) the domestic (foreign) CPI,

iii) appreciates the exchange rate, and

iv) decreases domestic and foreign employment.

*Proof:* (i) From (16) and (17) we know that $P_w < 0$ and $P_w^* > 0$, respectively. (ii) From (18) one can infer that since $\tilde{w}_s < 0$ and $\tilde{w}_s^* > 0$, then $\partial P/\partial s < 0$ and $\partial P^*/\partial s > 0$. (iii) From (16) one infer that an increase (a decrease) in the domestic CPI implies an appreciation (a depreciation) of the exchange rate. (iv) 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 $\partial L/\partial s < 0$. $\nabla$

The general equilibrium effect of a rise in the domestic payroll tax rate s is negative (positive) for domestic (foreign) wages.[4] Hence, domestic (foreign) CPI has to decrease (increase) for that to happen. This means an appreciation of the exchange rate. Foreign employment decreases due to a rise in foreign wage rate. The same happens to domestic employment as well; though a rise in domestic payroll tax rate

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[4] This lies in conformity with empirical evidence in terms of the domestic wage effect, see e.g. Holm, Honkapohja and Koskela (1994).

decreases the domestic tax rate on the one hand, it on the other hand increases labour cost directly. The latter effect dominates the former and hence domestic employment goes down.

## 4.2. A pure rise in the tax progression

It might be tempting, but wrong, to argue that the Slutsky equations (21) 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 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,

$$\left[\frac{da}{dt}\right]_{dT=ds=0} = -\frac{\partial T/\partial t}{\partial T/\partial a} = -\frac{\beta\left[(1-\frac{a}{w})(1+s)+\Lambda\frac{\partial[w(1+s)]}{\partial t}\right]}{\beta\left[-\frac{t(1+s)}{w}+\Lambda\frac{\partial[w(1+s)]}{\partial a}\right]}, \tag{23}$$

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

The relationship between the tax revenue and the tax rates is called the Laffer-curve. If the relationship between the tax revenue and the marginal tax rate (the tax exemption) is positive (negative), the Laffer-curve is upward-sloping. Assuming the simultaneous increases in the marginal tax rate t and the tax exemption a we 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]

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

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

$$\left[\frac{d[w(1+s)]}{dt}\right]_{dT=ds=0} = -\left[\frac{\beta(1+s)^2}{\partial T/\partial a}\right]\left(\frac{t}{w}\right)\tilde{w}_t^c, \tag{24}$$

when the expression (23) has been utilized. Since $d[w^*(1+s^*)] = \{\partial[w^*(1+s^*)/\partial a]\}da + \{\partial[w^*(1+s^*)/\partial t]\}dt$ and since $\tilde{w}_a^* = y^*(1+s)\tilde{w}_a$ 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 expressed similarly as

$$\left[\frac{d[w^*(1+s^*)]}{dt}\right]_{dT=ds=0} = y^*(1+s)\left[\frac{d[w(1+s)]}{dt}\right]_{dT=ds=0} \tag{25}$$

We are now in a position to state:

*Proposition 4:* If the Laffer-curve is upward-sloping, a compensated increase in the domestic tax progression[6]

i) decreases the domestic and foreign gross wage rate,

ii) depreciates the exchange rate, when countries are identical,

iii) increases (decreases) the domestic (foreign) CPI when countries are identical,

iv) increases the government revenue in the foreign country, when the domestic tax exemption is zero, and

v) increases employment in both countries.

*Proof.* (i) From (19) and (20) one obtains that $\tilde{w}_t^c \equiv \tilde{w}_t + \dfrac{\tilde{w}_a(w-a)}{t} = \dfrac{-wz/\delta}{\phi} < 0$. When the Laffer curve is upward-sloping, $\partial T/\partial a < 0$. (ii) When countries are

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[6]    Koskela and Vilmunen (1994a) 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.

identical, $\text{sgn}\left[\dfrac{de}{dt}\right]_{dT=ds=0} > 0$ and thus $\text{sgn}\left[\dfrac{de^*}{dt}\right]_{dT=ds=0} < 0$, since

$$\text{sgn}\left[\frac{de}{dt}\right]_{dT=ds=0} = \text{sgn}\left[\left(\frac{Q_w}{Q}\right)\left[\frac{d[w(1+s)]}{dt}\right]_{dT=ds=0} - \left(\frac{Q^*_{w^*}}{Q^*}\right)\left[\frac{d[w^*(1+s^*)]}{dt}\right]_{dT=ds=0}\right]$$

$= -\text{sgn}\left\{\left[\dfrac{d[w(1+s)]}{dt}\right]_{dT=ds=0}[1-y^*(1+s)]\right\} > 0.$ (iii) From (16) and (17) $p_e > 0$ and

$p^*_{e^*} > 0$, respectively. (iv) Differentiating $T^* = t^*(w^* - a^*)L^* + s^*w^*L^*$ with respect

to t one obtains $\left[\dfrac{dT^*}{dt}\right]_{dT=ds=o} = \beta^*\Lambda^*\left[\dfrac{d[w^*(1+s^*)]}{dt}\right]_{dT=ds=o}$, where $\beta^* \equiv \dfrac{L^*w^*}{1+s^*}$

and $\Lambda^* \equiv \left(\dfrac{s^*+t^*}{w^*}\right)\left[1-\delta^*\left(1-\dfrac{t^*a^*}{w^*(s^*+t^*)}\right)\right]$. $\Lambda^* < 0$, when $a^* = 0$. (v) This fol-

lows directly from (5). ∇

A compensated increase in the domestic tax rate decreases domestic wage directly via the negative substitution effect of the tax rate[7]. A foreign wage is also decreased since a fall in the domestic wage decreases the foreign price level which in turn gives rise to a decrease in the wage set by the foreign monopoly union. Consequently, employment in both countries is boosted by a pure rise in the tax progression in the home country. The government tax revenue in foreign country is increased due to a fall in foreign wage, when the foreign tax exemption is zero. When countries are identical, the exchange rate depends only on the difference between the foreign and the domestic wage rates. Since the effect of the domestic tax exemption on the domestic wage rate dominates its effect on the foreign wage rate, an increase in the domestic tax exemption increases (decreases) the exchange rate denominated in the domestic (foreign) currency and thus price level increases (decreases) in home (foreign) country.

## 4.3. 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

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[7] Lockwood and Manning (1993) have presented empirical evidence from U.K., which is actually consistent with this prediction.

to have different effects on wages in practise. Therefore, it is of interest to study the structure of labour taxation and its potential impacts of gross wages 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. 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 tax rate, when the tax revenue are kept constant

$$\left[\frac{ds}{dt}\right]_{dT=da=0} = -\frac{\partial T/\partial t}{\partial T/\partial s} = -\frac{\beta\left[(1 - \frac{a}{w})(1+s) + \Lambda\frac{\partial[w(1+s)]}{\partial t}\right]}{\beta\left[(1-t) + \Lambda\frac{\partial[w(1+s)]}{\partial s}\right]}. \tag{26}$$

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

$$\left[\frac{d[w(1+s)]}{dt}\right]_{dT=da=0} = \left(\frac{\beta(1+s)}{\partial T/\partial s}\right)\left[\tilde{w}_t(1-t) - \tilde{w}_s\left(1 - \frac{a}{w}\right)(1+s) - (w-a)\right], \tag{27}$$

when the expression (26) has been utilized. Using (20) and (22) equation (27) can be reduced to

$$\left[\frac{d[w(1+s)]}{dt}\right]_{dT=da=0} = \left(\frac{\beta(1+s)}{\partial T/\partial s}\right)\left[(-w)(1-t)\left(\frac{a}{w}\right)\left(\frac{z}{\phi}\right)\left(\frac{1}{\delta}\right)\right]. \tag{28}$$

Analogously, since $d[w^*(1 + s^*)] = \{\partial[w^*(1 + s^*)/\partial s]\}ds + \{\partial[w^*(1 + s^*)/\partial t]\}dt$ and

since $\left[\frac{\partial[w^*(1+s^*)]}{\partial t}\right]\left[\frac{\partial[w(1+s)]}{\partial s}\right] - \left[\frac{\partial[w^*(1+s^*)]}{\partial s}\right]\left[\frac{\partial[w(1+s)]}{\partial t}\right] = 0$, the effects of this policy reform on the foreign gross wage can be expressed as

$$\left[\frac{d[w^*(1+s^*)]}{dt}\right]_{dT=da=0} = \left(\frac{\beta(1+s^*)}{\partial T/\partial s}\right)\left[\tilde{w}_t^*(1-t) - \tilde{w}_s^*\left(1 - \frac{a}{w}\right)(1+s)\right]. \tag{29}$$

Using (20) and (22) equation (29) is reduced to

$$\left[\frac{d[w^*(1+s^*)]}{dt}\right]_{dT=da=0} = \left(\frac{\beta(1+s^*)}{\partial T/\partial s}\right)\left[(-w)(1-t)\left(\frac{a}{w}\right)\left(\frac{z}{\phi}\right)\left(\frac{1}{\delta}\right)\right]y^*(1+s). \qquad (30)$$

One the bases of equations (28) and (30) one is able to claim

*Proposition 5:* If the 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) depreciates (has no effect) the exchange rate with the positive (zero) tax exemption, when countries are identical,

iii) increases (decreases) the domestic (foreign) CPI with the positive tax exemption; but leaves the price levels unchanged with the zero tax exemption, when countries are identical,

iv) affects ambiguously (has no effect) the government revenue in the foreign country, when the tax exemption is positive (zero), and

v) increases employment in both countries, when the tax exemption is positive.

*Proof:* (i) If the Laffer-curve is upward-sloping, $\partial T/\partial s > 0$, and then from (28) and

(30) $\left[\dfrac{d[w(1+s)]}{dt}\right]_{dT=da=0} < 0 \,(=0)$ and $\left[\dfrac{d[w^*(1+s^*)]}{dt}\right]_{dT=da=0} < 0 \,(=0)$ when

$a > 0 \,(a=0)$. (ii) When countries are identical,

$$\text{sgn}\left[\frac{de}{dt}\right]_{dT=da=0} = \text{sgn}\left[\left(\frac{Q_w}{Q}\right)\left[\frac{d[w(1+s)]}{dt}\right]_{dT=da=0} - \left(\frac{Q_{w^*}^*}{Q^*}\right)\left[\frac{d[w^*(1+s^*)]}{dt}\right]_{dT=da=0}\right]$$

$$= -\text{sgn}\left\{\left[\frac{d[w(1+s)]}{dt}\right]_{dT=da=0}[1-y^*(1+s)]\right\} > 0 \,(=0), \text{ when } a > 0 \,(a=0). \text{ (iii) From}$$

(16) and (17) $p_e > 0$ and $p_e^* < 0$, respectively. (iv)

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

$$\Lambda^* \equiv \left(\frac{s^* + t^*}{w^*}\right)\left[1 - \delta^*\left(1 - \frac{t^* a^*}{w^*(s^* + t^*)}\right)\right] = ?, \text{ when } a > 0. \text{ (v) This follows directly}$$

from (5). ∇

This can be explained as follows: On the one hand, a revenue neutral restructuring of domestic labour taxation towards income tax base tends to increase the domestic wage rate (proposition 2i), while to decrease it due to a drop in domestic payroll tax (proposition 3i). In addition to the inderect 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 with the implication 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 symmetric 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 positive tax exemption. The existence of positive tax exemption weakens the positive effect of income tax rate on the domestic wage rate (see the expression (20)) for the reason that a rise in the income tax rate raises the value of tax exemption for workers. This in turn tends to decrease wage rate (see proposition 1i). Hence, a revenue neutral restructuring of labour taxation towards income taxation tends to give less pressure than in the case of the symmetric tax base for wages to rise so that the domestic gross wage rate falls and domestic employment boosts. A fall in the domestic gross wage rate depreciates the exchange rate, increases (decreases) the domestic (foreign) price levels, when countries are identical, and gives rise to a decrease in the foreign wage rate thus boostering foreign employment as well.

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 $\varepsilon_{1-t}^w \equiv -\frac{\tilde{w}_t(1-t)}{w} < 0$.[8]

## 4.4. Some coordinated 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 noted in propositions 4 and 5, the foreign country might 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 coordinated changes in the tax parameters. The effects of i) the coordinated change in the tax exemption (da = da*), ii) the coordinated change in the payroll tax (ds = ds*), iii) the coordinated change in the pure progression, and iv) the coordinated change in de jure incidence in labour taxation on the domestic nominal or gross wages are

i) $\quad \dfrac{dw}{da} = \tilde{w}_a + \tilde{w}_{a^*} = \dfrac{-[tz + t^* z^* y(1+s^*)]}{\phi}$ ; $\qquad\qquad\qquad$ (31)

ii) $\quad \dfrac{dw}{ds} = \tilde{w}_s + \tilde{w}_{s^*} = \left(\dfrac{zz^*}{\phi}\right) b\theta^*(wP_w + w^* P_{w^*});$ $\qquad\qquad$ (32)

iii) $\quad \left[\dfrac{d[w(1+s)]}{dt}\right]_{dT=ds=0} + \left[\dfrac{d[w(1+s)]}{dt^*}\right]_{dT^*=ds^*=0} = \left[\dfrac{d[w(1+s)]}{dt}\right]_{dT=ds=0}$ $\qquad$ (33)

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

iv) $\quad \left[\dfrac{d[w(1+s)]}{dt}\right]_{dT=da=0} + \left[\dfrac{d[w(1+s)]}{dt^*}\right]_{dT^*=da^*=0} = \left[\dfrac{d[w(1+s)]}{dt}\right]_{dT=ds=0}$ $\qquad$ (34)

$\qquad\qquad\qquad\qquad +y(1+s)\left[\dfrac{d[w^*(1+s^*)]}{dt^*}\right]_{dT^*=da^*=0};$

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[8]    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. See also Koskela and Vilmunen, 1994b.

respectively. Now one gets

*Proposition 6:*

i) A coordinated increase in the tax exemption, in pure tax progression and in revenue neutral restructuring of labour taxation towards the income tax rate in both countries (with the positive tax exemptions) leads to a larger decrease in the gross wage and a larger increase in employment than a unilateral increase, but leave the exchange rate and thus the domestic and foreign CPI are unchanged when countries are identical.

ii) A coordinated 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 rate, the price level and the exchange rate, when countries are identical.

*Proof:* (i) Follows directly from that $z > 0$, $z^* > 0$, $y > 0$, and $\phi > 0$, and from propositions 4 and 5. From proposition 4 we know that

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

$$\left[ \frac{d[w(1+s)]}{dt^*} \right]_{dT^*=ds^*=0} = y(1+s^*) \left[ \frac{d[w^*(1+s^*)]}{dt^*} \right]_{dT^*=ds^*=0}. \quad \text{From proposition 5 we}$$

know that $\left[ \dfrac{d[w^*(1+s^*)]}{dt} \right]_{dT=da=0} = y^*(1+s^*) \left[ \dfrac{d[w(1+s)]}{dt} \right]_{dT=da=0}$ and thus

$$\left[ \frac{d[w(1+s)]}{dt^*} \right]_{dT^*=da^*=0} = y(1+s) \left[ \frac{d[w^*(1+s^*)]}{dt^*} \right]_{dT^*=da^*=0}. \quad \text{When countries are}$$

identical the difference between the domestic and foreign wage rate does not change and therefore the exchange rate and the price indexes are unchanged. (ii) When countries are identical, $P_w + P_{w^*} = 0$, and therefore, since $ds = ds^*$, the exchange rate remains constant, e.g. (15), implying, in turn, that the price levels remains constant, e.g. (4). $\nabla$

According proposition 6i coordinated 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 has to do with the externality created by tax policy of one country via the exchange rate on another country's 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, decreases the price level and thereby the domestic wage rate. When countries are perfectly identical the ratio of the domestic wage rate on the foreign wage rate is independent on the coordinated changes in taxation and thus the exchange rate does not change.

As for a coordinated payroll tax cuts, their effects on the domestic nominal wages cancel each other, if countries are identical; according to equation (32) 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.

## 5. Concluding remarks

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

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 decreases 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. Therefore, it is of interest to study the potential impacts of the structure of labour taxation. The paper shows that the 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 coordinated changes in tax parameters, a coordinated increase in pure progression in both countries and a coordinated 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 particular, one would like to know whether the irrelevance condition for nominal incidence of labour taxes holds.

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