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Optimal Factor Income Taxation in the Presence of Unemployment*

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Abstract

According to conventional wisdom internationally mobile capital should not be taxed or should be taxed at a lower rate than labour. An important underlying assumption behind this view is that there are no market imperfections, in particular that labour markets clear competitively. At least for Europe, which has been suffering from high unemployment for a long time, this assumption does not seem appropriate. This paper studies the optimal factor taxation in the presence of unemployment which results from the union-firm wage bargaining both with optimal and restricted profit taxation when capital is internationally mobile and labour immobile. In setting tax rates the government is assumed to behave as a Stackelberg leader towards the private sector playing a Nash game. The main conclusion is that in the presence of unemployment, the conventional wisdom turns on its head; capital should generally be taxed at a higher rate than labour.

Keywords: optimal factor income taxes, union wage bargaining, unemployment
JEL-classification: H21, J51, C70.

1. Introduction

The more integrated the world economy becomes, the more important it is for open economies to know how to tax factor income in the least distortive way. Since MacDougall (1960), the standard recommendation for small open economies has been to rely only on profit and labour taxes and not to tax internationally mobile capital at source. This result is often associated with the Diamond-Mirrlees (1971) production efficiency result, which states that the government should only tax commodities which enters the utility function of households. As the domestic capital stock does not enter the utility function, it should not be subject to taxation (cf. Homburg 1999 for a recent discussion).

This strong statement has been questioned for several reasons. First, open economies with market power in either the world capital market or the output market may tax capital at source to change the world interest rate or the terms of trade, respectively, in their favour. Secondly, for various reasons such as imperfect observability, legal constraints, etc. it may not be possible to fully tax pure rents, in which case the government is forced to also rely on distortionary taxes. Then, the standard result not to tax internationally mobile capital may not hold because taxes on factors of production may possibly act as imperfect substitutes for the missing profit tax. In the theory of optimal taxation, the Ramsey rule and its special case, the 'inverse elasticity rule', tell how distortionary taxes should then be designed so as to minimize the excess burden of the tax system: the government should levy the highest tax on the most inelastic activity. This argument lies behind the conventional belief that internationally mobile capital should not be taxed or (if profit taxation is restricted) should be taxed at a lower rate than labour because capital is more sensitive than labour to changes in its own tax rates.[1]

An important underlying assumption behind the whole strand of the debate is that labour markets clear competitively and – although they may be distortive – labour taxes do not cause unemployment. At least for Europe, which has been suffering from high unemployment for a long

[1] Cf. e.g. Eggert and Haufler (1999) for a recent elaboration of this argument.

time, this assumption does not seem appropriate.[2] However, few papers have dealt with this question so far. Bovenberg and van der Ploeg (1996) study optimal taxation, optimal provision of public goods and environmental policy in the presence of involuntary unemployment due to the fixed net-of-tax wage. They show that the optimal labour tax rate strikes a balance between two objectives. Firstly, the labour tax serves the purpose of raising tax revenues. Secondly, a subsidy component is used to offset the labour market rationing due to a too high net-of tax wage rate. Richter and Schneider (2000) show in a monopoly union model that if profit taxation is restricted, the capital tax may be used as an indirect tool to reduce the labour market distortion due to the union's ability to raise the net-of-tax wage above the marginal cost of labour, when it affects the labour demand elasticity and hence the monopoly power of the trade union.[3]

This paper re-examines optimal factor taxation for a small open economy in the presence of unemployment by generalizing the earlier findings. We construct a model of the union-firm wage bargaining where capital is internationally mobile and labour immobile. In setting tax rates the government is assumed to behave as a Stackelberg leader towards the private sector playing a Nash game.

We extend the framework developed by Koskela and Schöb (1998) to analyse the employment and welfare effects of a revenue-neutral *factor tax reform,* which increases the source-based capital tax and reduces the labour tax, to allow for the derivation of *optimal tax formulae*. The model considers a small open economy, where the exported domestic production is represented by a single firm facing monopolistic competition from abroad. Capital is assumed to be perfectly mobile across countries, while labour is internationally immobile. Wage and thereby unemployment determination is modelled by the 'right-to-manage' approach, according to which the wage rate is negotiated in a bargaining process between the representative trade union and the firm and the firm then unilaterally determines employment. The government levies taxes subject to various constraints so as to maximize total surplus, which is linear in workers' net-of-tax wage income, the money-metric

[2] Cf. Daveri and Tabellini (2000) for recent empirical evidence about unemployment and growth effects of labour taxes in OECD countries.

[3] See Section 5 for a more detailed discussion of the existing literature and its relation to our findings.

utility which the unemployed derive from leisure and unemployment benefit payments, and the net-of-tax profits.

In this framework study the rules for optimal factor taxes in the presence of unemployment when the government is restricted in taxing pure profits and explore its implications, both for individual factor taxes and for the structure of factor income taxation. Our main conclusion is that in the presence of unemployment the conventional wisdom turns on its head; capital should generally be taxed at a higher rate than labour. Countries with rigid labour markets should therefore be very careful in adopting tax policies which are appropriate for countries where labour markets are sufficiently flexible.

Intuitively, there are two reasons for this result. Firstly, in the presence of involuntary unemployment the supply of labour is locally infinitely elastic. According to the inverse elasticity rule this would suggest that labour should not be taxed at a higher rate than capital. Secondly, involuntary unemployment due to the wage rate being higher than the competitive wage rate means that the private marginal cost of labour exceeds the social marginal cost of labour. A way to increase employment and hence welfare is to subsidize labour input relative to capital input, for which social marginal cost equals the world interest rate.

However, the qualitative result that the optimal capital tax should exceed the labour tax rate may not hold if the impact of the tax system on wage negoatiations is strong and the substitutability between capital and labour is low. In this case, factor income taxes may also be used as an indirect policy instrument affecting the wedge the negotiated net-of-tax wage rate drives between private and social marginal cost of labour.

The paper is organized as follows: Section 2 presents the basic model and some comparative statics results, which are needed later on, while Section 3 sets up the social welfare maximization problem under the appropriate constraints. The optimal factor tax formulae are presented in Section 4, followed by a discussion of its various cases. We relate our results to the existing literature in Section 5. Finally, Section 6 concludes.

2. The model

We apply the framework which has been used by Koskela and Schöb (1998) to analyze the employment and welfare effects of a revenue-neutral tax reform which increases the source-based capital income tax and reduces labour taxes. We consider a small open economy, where domestic production is represented by a single monopolistic firm which produces good Y with capital K and labour L as inputs. Capital is assumed to be perfectly mobile between countries so that its supply is infinitely elastic while labour is internationally immobile. Technology is assumed to be linear-homogeneous and is represented by a constant elasticity of substitution production function

$$Y = f(L,K) = \left[L^{\frac{s-1}{s}} + K^{\frac{s-1}{s}} \right]^{\frac{s}{s-1}} \tag{1}$$

where σ denotes the elasticity of substitution between factors of production. The monopolistic firm exports its entire production and faces output demand $D(p)$, which is decreasing in the price p, measured in terms of an import good which serves for public and private consumption. The output demand is assumed to be isoelastic, i.e.

$$Y = D(p) = p^{-\varepsilon} \tag{2}$$

with $\varepsilon \equiv -\left(\partial D(p)/\partial p\right) \cdot p/D(p)$ denoting the price elasticity of output demand. The closer substitutes for good Y on the world market are, the more elastic output demand becomes. The firm maximizes profits, given by

$$\pi = p(Y)Y - \tilde{r}K - \tilde{w}L, \tag{3}$$

where it considers input prices $\tilde{r}$ and $\tilde{w}$ as given. The gross interest rate $\tilde{r}$ consists of the net-of-tax interest rate plus a source-based capital tax, i.e. $\tilde{r} = (1+t_r)r$, with t_r denoting the capital tax rate. The gross wage $\tilde{w}$ consists of the net-of-tax wage w, which is negotiated between the trade union and the firm, plus the labour tax, i.e. labour taxes and social security contributions t_w, so that $\tilde{w} = (1+t_w)w$.

To guarantee a profit maximum, the output demand elasticity must exceed unity, i.e. $\varepsilon > 1$, in which case profit maximization implies that the firm will set a price which exceeds the constant marginal cost $c(\tilde{w}, \tilde{r})$ by a constant mark-up factor $\varepsilon/(\varepsilon - 1) > 1$.

All N workers of the economy are represented by a trade union which maximizes its N members' net-of-tax income. Each member supplies one unit of labour if employed, or zero labour if unemployed. The net-of-tax income of a working member hence equals the net-of-tax wage rate w. Being unemployed a trade union member has an outside option b which depends the unemployment benefit transfers b^0 from the government and on the utility derived from leisure $b - b^0$. The objective function of the trade union can thus be written as

$$V^* = wL + b(N - L).^4 \tag{4}$$

The wage rate is determined in a bargaining process between the trade union and the firm and the firm then unilaterally determines employment. This is modelled by using a 'right-to manage' model which represents the outcome of the bargaining by an asymmetric Nash bargaining. The fall-back position of the trade union is given by $V^0 = bN$, i.e. if the negotiations break down, all members receive their reservation wage equal to the outside option. The fall-back position of the firm is given by zero profits, i.e. $\pi^0 = 0$. Using $V \equiv V^* - V^0$, the Nash bargaining maximand can be written as

$$\Omega = V^{\beta}\pi^{1-\beta}, \tag{5}$$

with β representing the bargaining power of the trade union. The first-order condition with respect to the net-of-tax wage rate is

$$\Omega_w = 0 \iff \beta\frac{V_w}{V} + (1-\beta)\frac{\pi_w}{\pi} = 0. \tag{6}$$

Using a CES production technology we will apply the explicit formulation of the wage elasticity of labour demand, $\eta_{L,\tilde{w}} \equiv L_{\tilde{w}}\tilde{w}/L = -\sigma + s(\sigma - \varepsilon)$, with $s = \tilde{w}L/cY$ being the cost share of labour (cf. Koskela and Schöb 1998) to further develop condition (6),

$$\Omega_w = 0 \Leftrightarrow (w - b)\big(\beta\eta_{L,\tilde{w}} + (1-\beta)s(1-\varepsilon)\big) + w\beta = 0. \tag{7}$$

[4] The assumption of a linear objective function is for analytical and expository convenience. All qualitative results can be shown to hold for objective functions of the trade union, which are concave and isoelastic in terms of the wage rate and the outside option.

Equation (7) implicitly determines the negotiated net-of-tax wage from Nash bargaining as a function of the tax policy parameters t_w and t_r so that we have $w = w(t_w, t_r)$.

To derive the optimal tax formulae we have first to know how wage negotiations are affected by the tax system. We therefore provide some comparative statics results we will use later on. The effect of a change in the labour tax rate on the net-of-tax wage rate is

$$w_{t_w} = -\frac{\Omega_{wt_w}}{\Omega_{ww}} = -\frac{(w-b)zw}{x + (w-b)z(1+t_w)}, \tag{8}$$

with $x = \beta(1+\eta_{L,\tilde{w}}) + (1-\beta)(1-\varepsilon)s$ and $z = [\beta(\sigma-\varepsilon) + (1-\beta)(1-\varepsilon)]s_{\tilde{w}}$. As the second-order condition is assumed to hold throughout, i.e. $\Omega_{ww} = x + (w-b)z(1+t_w) < 0$, we can infer that $\text{sign}\,(w_{t_w}) = \text{sign}\,(z) = \text{sign}\,(-s_{\tilde{w}})$ if labour and capital are price complements $\sigma < \varepsilon$, as we will assume in what follows. (Note that $\varepsilon > 1$). For a CES production technology, the partial derivative of the cost share of labour with respect to the gross wage rate is given by

$$s_{\tilde{w}} = \frac{s}{\tilde{w}}(1-s)(1-\sigma)\begin{Bmatrix} > \\ = \\ < \end{Bmatrix} 0 \Leftrightarrow \sigma \begin{Bmatrix} < \\ = \\ > \end{Bmatrix} 1,$$

so that we have

$$w_{t_w} \begin{cases} < 0 & \text{as} \quad \sigma < 1 \\ = 0 & \text{as} \quad \sigma = 1. \\ > 0 & \text{as} \quad \sigma > 1 \end{cases} \tag{9}$$

The effect of factor taxes on the negotiated net-of-tax wage depends on what happens to the wage elasticity of labour demand when factor taxes will change. If the elasticity of substitution is less than one, an increase in the labour tax rate will lead to an increase in the cost share of labour *s*. A larger share *s* implies that the wage elasticity of labour demand is higher in absolute terms. Hence, the trade union benefits less from demanding higher wages and the net-of-tax wage rate falls. By contrast, when the elasticity of substitution is higher than one, the cost share of labour *s* decreases due to higher labour taxes, so that the wage elasticity of labour demand is lower in absolute terms. The trade union benefits more from demanding higher wages and the net-of-tax wage increases. By contrast, the firm loses less due to a wage increase and becomes less resistent to a wage increase. In the case of a Cobb-Douglas production function with the elasticity of substitution being one, the wage elasticity is constant so that factor taxes will have no effect on the negotiated net-of-tax wage.

An exogenous increase in the capital tax rate has an effect on the cost share of labour opposite to that of the increase in the labour tax rate.[5] Hence, depending on the elasticity of substitution, the total effect of an increase in t_r is:

$$w_{t_r} \begin{cases} >0 & \text{as} \quad \sigma < 1 \\ =0 & \text{as} \quad \sigma = 1. \\ <0 & \text{as} \quad \sigma > 1 \end{cases} \tag{10}$$

The interpretation of (10) is analogous to that presented for the labour tax rate.

Next, we consider the government budget. The government requires a fixed amount of tax revenues to finance the public good G and, in addition, it has to pay unemployment benefits b^0 to all $N - L$ unemployed workers. The government levies the labour tax t_w on wage income and a source-based tax on domestic capital input t_r. In addition there is a profit tax t_π on domestic profits so that the government budget constraint is given by

$$t_w wL + t_r rK + t_\pi \pi = G + b^0 (N - L). \tag{11}$$

To focus on efficiency aspects of the optimal tax structure only, we assume linear preferences and thereby consider the total surplus as an appropriate social planner's objective function (cf. Summers, Gruber and Vergara 1993). The total surplus consists of the wage income equal to wL, which accrues to workers, $b(N - L)$, the money metric-utility unemployed derive from leisure and unemployment benefit payments, and the net-of-tax profit income $(1 - t_\pi)\pi$. As we hold G constant we suppress the term G in the total surplus function. Furthermore, the income from the domestic capital stock is also assumed to be constant and therefore is not explicitly considered in the welfare function either. All domestic profits go to domestic capitalists.[6] Hence, the social welfare function is given by

$$S = wL + b(N - L) + (1 - t_\pi)\pi. \tag{12}$$

[5] This can be seen from deriving the cost share of capital $(1 - s)$ with respect to the capital tax rate (cf. Koskela and Schöb 1998).

[6] For an analysis when foreigners receive a fraction of domestic profits, see Huizinga and Nielsen (1997).

3. Social welfare maximization

We consider a model with a Stackelberg game structure, where the government chooses tax rates first by anticipating the implications for the wage negotiation and employment and the labour organizations then determine the wage rate in a wage negotiation, taking the tax rates as given. The model is solved in reverse order by using backward induction.

The government maximizes the total surplus (12) subject to the budget constraint of the government (11), the outcome of the wage negotiation, which is implicitly given by the first-order condition of the Nash bargaining (7), and the constraint on the profit tax rate (14):

$$\underbrace{\max}_{t_w, t_r, t_\pi, w} S = wL + b(N-L) + (1-t_\pi)\pi,$$

s.t.

$$t_w wL + t_r rK + t_\pi \pi = G + b^0(N-L). \tag{11}$$

$$\Omega_w = 0 \Leftrightarrow (w-b)\big(\beta\eta_{L,\tilde{w}} + (1-\beta)s(1-\varepsilon)\big) + w\beta = 0. \tag{7}$$

$$t_\pi \leq \bar{t}_\pi \tag{14}$$

The Lagrangian for the social welfare maximization is

$$\mathrm{L} = wL + b(N-L) + (1-t_\pi)\pi - \lambda\big(G + b^0(N-L) - t_w wL - t_r rK - t_\pi \pi\big) - \mu\Omega_w + \varphi(\bar{t}_\pi - t_\pi) \tag{15}$$

where λ, μ and φ describe the shadow prices of the constraints (11), (7) and (14), respectively. Using the following expressions of the factor demand elasiticities: $\eta_{K,\tilde{w}} = K_{\tilde{w}}\tilde{w}/K = s(\sigma-\varepsilon)$, $\eta_{L,\tilde{r}} = L_{\tilde{r}}\tilde{r}/L = (1-s)(\sigma-\varepsilon)$ and $\eta_{K,\tilde{r}} = -\sigma + (1-s)(\sigma-\varepsilon)$ the first-order conditions with respect to the profit tax rate, the two factor tax rates and the net-of-tax wage rate can be expressed (after some manipulations) as follows:

$$\mathrm{L}_{t_p} = 0 \quad \Leftrightarrow \quad \pi(\lambda-1) = \varphi, \tag{16a}$$

$$\mathrm{L}_{t_w} = \big[w - (b-\lambda b^0) + \lambda t_w w\big]L\eta_{L,\tilde{w}} + \lambda t_r rK\eta_{K,\tilde{w}} + (\lambda-1)(1-t_\pi)\tilde{w}L - \mu\Omega_{wt_w}(1+t_w) = 0, \tag{16b}$$

$$\mathrm{L}_{t_r} = \big(w - (b-\lambda b^0) + \lambda t_w w\big)L\eta_{L,\tilde{r}} + \lambda t_r rK\eta_{K,\tilde{r}} + (\lambda-1)(1-t_\pi)\tilde{r}K - \mu\Omega_{wt_r}(1+t_r) = 0, \tag{16c}$$

$$\mathrm{L}_w = \left(w - (b - \lambda b^0) + \lambda t_w w\right) L \eta_{L,\tilde{w}} + \lambda t_r r K \eta_{K,\tilde{w}} - (\lambda - 1)\left(t_\pi - t_w/(1+t_w)\right)\tilde{w}L - \mu \Omega_{ww} w = 0 \,. \quad (16d)$$

By inspecting the complementary slackness condition

$$\bar{t}_\pi - t_\pi \geq 0, \;\; \varphi \geq 0, \;\; \varphi\left(\bar{t}_\pi - t_\pi\right) = 0,$$

we can distinguish two cases. The first case can be discussed informally. If $\varphi = 0$, the profit tax constraint is not binding and the government can choose the profit tax rate optimally and need not employ non-distortionary taxation to raise revenue. This has two implications. First, the optimal capital tax is zero. Second, the government will use a labour subsidy to internalize the labour market imperfection. Intuitively, whatever net-of-tax wage rate is fixed in the wage negotiation between the trade union and the firm, with unrestricted profit taxation the government can choose an appropriate wage tax that guarantees that the marginal productivity of labour equals the marginal social cost of labour. This restores production efficiency, eliminates involuntary unemployment and maximizes social welfare.[7]

The more relevant and interesting case where profit taxation is restricted and the government has to rely on distortionary taxes will be discussed in the next section.

4. Optimal factor tax formulae

In practice, the case of unrestricted profits is for several reasons the exceptional rather than the normal case. Firstly, tax authorities may have difficulties in distinguishing between pure profits and return to capital investments. Secondly, optimal profit taxation may be impossible if there are institutional or legal constraints. Hence, we now turn to the more relevant case where $\varphi > 0$, i.e. the profit tax constraint is binding and the profit tax rate is set at the upper bound for the profit tax rate $\bar{t}_\pi$.

[7] For a formal derivation of the optimal first-best tax formulae see the discussion paper version of this paper, Koskela and Schöb (2000). The former result of zero optimal capital tax can also be found for the special case of the monopoly union model by Boeters and Schneider (1999) and by Richter and Schneider (2000). The latter result of optimal labour subsidy confirms for a unionized labour market the result by Guesnerie and Laffont (1978) according to which in a first-best world, the output of a price maker should be subsidized such that the market price equals the marginal cost.

As profits are always positive, it can be seen directly from equation (16a) that $\lambda > 1$, i.e. the marginal cost of public funds exceeds unity. This means that the government has to apply distortionary taxes to raise revenues for the finance of public goods. But the tax induced distortion is not the only distortion the economy faces. The labour market constraint also becomes binding so that the government cannot offset costlessly the inefficiency caused by setting the net-of-tax wage rate w above the social cost of working, $b - b^0$. Formally, the shadow price μ, which represents the social cost of labour market imperfection, can be signed by subtracting (16d) from (16b):

$$\mu \Omega_{ww} w \left[-\frac{\Omega_{wt_w}(1+t_w)}{\Omega_{ww} w} + 1 \right] = -(\lambda - 1) wL < 0 . \tag{17}$$

As it is shown formally in Appendix 1, the term in brackets on the left-hand side is positive. This means that the net-of-tax wage elasticity with respect to the labour tax rate is always larger than –1, which is also in conformity with empirical studies (cf. e.g. Lockwood and Manning 1993 and Holm, Honkapohja and Koskela 1994). Hence, condition (17) can hold only if $\mu > 0$, i.e. reducing the labour market distortion due to wage negotiations is always welfare improving. The lower the net-of-tax wage rate as a result of the wage negotiation, the lower the welfare loss of distortive taxes will be. This will be true irrespective of the question of whether the net-of-tax wage rate changes or not as a consequence of a tax rate change.

Solving the system of equations (16b)-(16c) with respect to the tax rates, making use of $\lambda > 1$ and $\mu > 0$ and using the calculations given in Appendix 2, we obtain the general optimal factor tax formulae

$$\left(\frac{t_r}{1+t_r} \right) = \frac{1}{\varepsilon} \left(1 - \frac{1}{\lambda} \right) (1 - \bar{t}_\pi) + \frac{\mu}{\lambda} \left(\frac{\Omega_{wt_w}(1+t_w)}{(1-s)cY\sigma} \right) \tag{18}$$

and

$$\left(\frac{t_w}{1+t_w} \right) = -\frac{1}{\lambda} \left(\frac{w - (b - \lambda b^o)}{\tilde{w}} \right) + \frac{1}{\varepsilon} \left(1 - \frac{1}{\lambda} \right) (1 - \bar{t}_\pi) - \frac{\mu}{\lambda} \left(\frac{\Omega_{wt_w}(1+t_w)}{scY\sigma} \right) \tag{19}$$

where Ω_{wt_w} has been defined in the context of equation (8).

4.1 Optimal factor taxes when the net-of-tax wage rate remains unchanged

To interpret the optimal tax formulae, we will start with the benchmark case where the net-of-tax wage rate does not depend on the tax rates for labour and capital. This is the case of a Cobb-Douglas production function where the elasticity of substitution equals unity. As conditions (9) and (10) show, the net-of-tax wage rate is independent of the tax rates in this case because of the constant elasticity of labour demand. Therefore the last terms of the optimal tax formulae for the capital tax and the labour tax vanish.

Equation (18) then shows that when the price elasticity of output demand ε is less than infinite the capital tax becomes strictly positive. We might refer to this as the Ramsey component of the capital tax rate. The positive capital tax results from restrictive profit taxation, which forces the government to rely on distortionary taxation. The capital tax rate is higher, the lower the feasible profit tax rate $\bar{t}_\pi$ and the higher the marginal cost of public funds λ.

The first term of the optimal labour tax formula (19) on the right-hand side represents the subsidy component of the tax rate which is used to reduce the wedge between the social marginal cost of labour and the private marginal cost of labour which equals the net-of-tax wage rate. This term is increasing in the marginal cost of public funds λ as the subsidy has to be financed by distortionary taxes and becomes more costly with higher λ. There is a second positive term, a Ramsey component of the labour tax rate which is precisely the same than in the case of the optimal capital tax rate. It represents the optimal tax one should levy on labour to minimize the excess burden of taxation. As the wage subsidy part is at least partially offset by the Ramsey component it is unclear whether the optimal labour tax rate is negative (as in the case of unrestricted profit taxation) or positive. These results can be summarized in two propositions.

PROPOSITION 1 (CAPITAL TAX RATE): If the government cannot set the profit tax optimally and factor taxes will have no effect on the wage negotiation, the government should levy a positive capital tax.

PROPOSITION 2 (LABOUR TAX RATE): If the government cannot set the profit tax optimally and factor taxes will have no effect on the wage negotiation, the optimal tax treatment of labour will consist of a subsidy component and a Ramsey tax component.

In the literature, it is sometimes assumed that the labour organisations and the government play Nash, i.e. the government set taxes by taking the net-of-tax wage rate determined in wage negotiations as given and the labour organizations in turn take the tax rates as given (cf. Hersoug 1984). Different to the maximization problem presented above, the optimal tax formulae for this case can be calculated by maximizing social welfare with respect to conditions (11) and (14) only because the government takes the net-of-tax wage rate as given. Because this is equivalent to the maximization problem where the labour market distortion constraint is not binding, the optimal factor tax formulae are the same as in the case of constant wage elasticity of labour demand demand, so that different to the case of the Stackelberg game considered here, the optimal tax rates are always independent of the size of the elasticity of substitution. Hence, we can conclude that if the government cannot set the profit tax optimally and the government and the labour organizations play Nash, capital taxes should always be non-negative and exceed the labour tax rate.[8] Furthermore, it should be mentioned that any other causes of wage rigidity would lead to similar optimality conditions as well.

4.2 Optimal factor taxes when the net-of-tax wage rate changes

Now we consider the case where the elasticity of substitution between factors of production differs from one. In this case the outcome of the wage negotiation is affected by changes in factor taxation as we showed in Section 2 and an additional term enters in both optimal tax formulae – the second and third terms on the right-hand side in (18) and (19) respectively – which captures the effect that changes in the net-of-tax wage rate will have on the optimal factor taxes. As $sign(\Omega_{wt_w}) = sign(w_{t_w})$, the sign of the last term depends on the elasticity of substitution [cf. condition (9)]. Hence, from equation (18) we can deduct

[8] See Koskela and Schöb (2000) for a proof.

PROPOSITION 3 (CAPITAL TAX RATE): If the government cannot set the profit tax optimally and factor taxes will affect the wage negotiation, the optimal capital tax should fall short of (exceed) the Ramsey component if the elasticity of substitution between capital and labour is smaller (greater) than one.

This result has a natural interpretation. If the elasticity of substitution between capital and labour is less than one, a fall in the capital tax rate decreases the net-of-tax wage rate so that the labour market distortion due to the difference between the net-of-tax wage w and the social marginal cost of labour becomes smaller. Exploiting this beneficial effect requires *cet. par.* a lower capital tax rate. On the contrary, if the elasticity of substitution exceeds one, then a rise in the capital tax rate will decrease the net-of-tax wage rate and thereby reduce the labour market distortion.

With respect to the labour tax rate, we obtain

PROPOSITION 4 (LABOUR TAX RATE): If the government cannot set the profit tax optimally and factor taxes affect the wage negotiation, the optimal labour tax should exceed (fall short of) the Ramsey component plus the wage subsidy if the elasticity of substitution between capital and labour is smaller (greater) than one.

Proposition 4 has an interpretation analogous to Proposition 3. With the elasticity of substitution being less than one, a rise in the labour tax rate decreases the net-of-tax wage rate so that the labour market distortion becomes smaller. Then the labour market distortion can be decreased by raising the labour tax rate. Vice versa happens with the elasticity of substitution being higher than one.

4.3 The optimal factor tax structure

The optimal tax structure can be seen by subtracting equation (18) from equation (19):

$$\left(\frac{t_r}{1+t_r}\right)-\left(\frac{t_w}{1+t_w}\right)=\frac{1}{\lambda}\left(\frac{w-(b-\lambda b^o)}{\tilde{w}}\right)+\frac{\mu}{\lambda}\left(\frac{\Omega_{wt_w}(1+t_w)}{cY\sigma s(1-s)}\right) \tag{20}$$

As the Ramsey components of the capital tax and the labour tax are identical, they do not enter equation (20). Equation (20) shows that when the factor taxes have no effect on the wage negotiation, i.e. when the elasticity of substitution equals unity, the optimal capital tax rate strictly exceeds the optimal labour tax rate in the presence of unemployment. If the wage negotiation is affected by the factor taxes, then one should increase the capital tax and decrease the labour tax even further if the elasticity of substitution exceeds one. Only if σ is less than one, it is optimal to increase the labour tax rate and decrease the capital tax rate to alleviate the labour market distortion. For the latter case, it cannot be ruled out that the labour tax rate exceeds the capital tax rate. These findings are summarized in

> PROPOSITION 5 (TAX STRUCTURE): If the government cannot set the profit tax optimally, the capital tax rate should be higher than the labour tax rate if the elasticity of substitution is greater than or equal to one. If the elasticity of substitution is less than one, then the relative size of optimal factor taxes remains ambiguous a priori.

For the Cobb-Douglas case, Proposition 5 implies that in the absence of any labour market distortions and the price elasticity of output demand being less than infinite, factor tax rates should be equal. The reason for equiproportional Ramsey components can be seen from applying the so-called 'inverse elasticity rule', according to which the Ramsey components in (18) and (19) are equal. In the standard literature on taxing mobile capital (see e.g. Bucovetsky and Wilson 1991, Eggert and Haufler 1999), this 'inverse elasticity' argument has been put forward to justify a zero tax on capital, which is infinitely elastic in supply, and a positive tax on labour, whose supply elasticity is finite. But in the presence of unemployment the result no longer holds. Firstly, under involuntary unemployment the supply of labour is locally infinitely elastic, which suggests according to the inverse elasticity rule that labour should not be taxed at a higher rate than capital. Secondly, there is a distortion in the labour market and the net-of-tax wage rate exceeds the marginal disutility of labour. This is an argument for the government to subsidize labour relative to capital.

5. Related literature

There is a recent literature which deals with the optimal factor taxation in the presence of unemployment. The paper by Bovenberg and van der Ploeg (1996), mentioned in the introduction, shows for a fixed net-of-tax wage rate, that the labour tax rate should be higher (the labour subsidy lower), the higher the marginal cost of public funds and the lower the profit tax rate, *cet. par*. The subsidy component is used to offset the labour market rationing due to a too high net-of tax wage rate. Our Proposition 2 generalizes their findings to the case of endogenous wage determination where the tax system might affect the net-of-tax wage rate.

Richter and Schneider (2000) show in a monopoly union model that if profit taxation is restricted, the capital tax may be used as an indirect tool to reduce the labour market distortion due to the union's ability to raise the net-of-tax wage above the marginal cost of labour, when the capital tax rate affects the labour demand elasticity and hence the possibility of the monopoly trade union to extract rents. This result (see their Proposition 7(ii)) is in line with our Proposition 3 and shows that non-zero capital tax rates are in general desirable (i) to minimize the excess burden of taxation if profit taxation is restricted and (ii) to reduce the labour market distortion due to monopoly union power if the net-of-tax wage rate is affected by the capital tax rate. Furthermore, they show that if profits are fully taxed away, i.e. the profit tax rate is fixed at 100%, the capital tax should be positive or negative depending on whether the capital tax can alleviate or worsen the labour market imperfection. This result (their Proposition 8) is a special case of our Proposition 3: if $\bar{t}_\pi = 1$, the Ramsey component of the capital tax rate vanishes.[9]

If there are labour market imperfections, it is not sufficient to tax away all profits to obtain an optimal capital tax rate equal to zero. Only if there is no restriction on profit taxes at all – either because public expenditures can be fully financed by profit taxation or other non-distorting taxes are available – the optimal capital tax rate is always zero. Therefore, the well-known results of optimal taxation in economies with competitive labour markets (see e.g. Bucovetsky and Wilson 1991, Razin

[9] Similar results are derived by Boeters and Schneider (1999) for the monopoly union case and Fuest and Huber (1999) for Nash bargaining.

and Sadka 1991 and for a recent discussion Eggert and Haufler 1999) can be generalized if profits can be taxed optimally.

Boeters and Schneider (1999) also compare the model where the government is a Stackelberg leader with the model where there is a Nash game between the government which sets the tax rates, and the monopoly union which sets the net-of-tax wage rate.[10] They show that under the Nash assumption the capital income should not be taxed and labour should be subsidized. This can be considered as a special case of our Propositions 1 and 2, whereby they assume that $\bar{t}_\pi = 1$ (see our discussion at the end of Section 4.1). Only if profits are not fully taxed away, a positive capital tax should be imposed. This confirms the results derived by Bruce (1992), Mintz and Tulkens (1996) and Huizinga and Nielsen (1997) for the case of competitive labour markets, namely, that if profit income cannot be fully taxed, a source-based capital tax serves as a tool to tax profit indirectly. See also Keen and Piekkola (1997), who establish a simple weighted average rule for the optimal taxation of international capital income under the conditions where lump-sum taxes are unavailable.

6. Conclusions

It is well known that if it is not possible to tax pure profits fully, the government is forced to rely on distortionary taxes. In the theory of optimal taxation, the Ramsey rule and its special case, the 'inverse elasticity' rule, tell how the distortionary taxes should be then designed so as to minimize the excess burden of the tax system. The inverse elasticity rule requires that the government levies the highest tax rate on the most inelastic activity. This argument lies behind the conventional wisdom that internationally mobile capital should not be taxed or should be taxed at a lower rate than labour because capital is regarded as being more sensitive than labour to changes in its own tax rates.

[10] Fuest and Huber (1999) also analyze the Nash game between the government and the labour organizations. However, they assume that the government takes the gross wage as given. Although it does not matter whether one assumes that the net-of-tax wage or the gross wage is determined in wage negotiations for the Stackelberg game, the Nash outcome crucially depends on what the government considers to be unaffected by its own actions.

Applications of the Ramsey rule or of the inverse elasticity rule usually assume that there are no other market imperfections, in particular that labour markets clear competitively. At least for Europe, which has been suffering from high unemployment for a long time, this assumption does not seem appropriate. Hence, it is important to ask whether the conventional wisdom, according to which capital should be taxed at a lower rate than labour, still holds in the presence of unemployment.

In this paper we have studied the optimal factor taxation in the presence of unemployment which results from the union-firm wage bargaining both with optimal profit taxation and with restricted profit taxation when capital is internationally mobile and labour immobile. Our main conclusion is that in the presence of unemployment the conventional wisdom turns on its head; capital should generally be taxed at a higher rate than labour. The optimal levels of factor taxes depend on specific features of the situation, like the game structure between the government and the private sector, the properties of production technology and the question of whether unrestricted profit taxation is feasible or not. Countries with rigid labour markets should therefore be very careful in adopting tax policies which are appropriate for countries where labour markets are sufficiently flexible.

Appendix 1: Net-of-tax wage elasticity

Using the explicit formulations from the CES production function for the second derivatives, $\Omega_{ww} = x + (w-b)z(1+t_w) < 0$ and $\Omega_{wt_w} = x + (w-b)zw$ with $x = \beta(1+\eta_{L,\tilde{w}}) + (1-\beta)(1-\varepsilon)s$ and $z = [\beta(\sigma-\varepsilon) + (1-\beta)(1-\varepsilon)]s_{\tilde{w}}$ the change in the net-of-tax wage rate due to a change in the labour tax rate, w_{t_w}, is given by:

$$w_{t_w} = -\frac{\Omega_{wt_w}}{\Omega_{ww}} = -\frac{(w-b)zw}{x+(w-b)z(1+t_w)}. \tag{A1}$$

Substituting this into the definition of the net-of-tax wage elasticity yields

$$\omega_{t_w} \equiv \frac{w_{t_w}(1+t_w)}{w} = \frac{-(w-b)z}{x(1+t_w)^{-1}+(w-b)z}.$$

The condition $\omega_{t_w} > -1$ holds if $y < 0$. Calculating the net-of-tax-wage rate from the first-order condition (7) yields

$$w = x^{-1}(x-\beta)b \tag{A2}$$

As $w > b$ it follows immediately from inspection of (A2) that $\beta > 0$ implies $y < 0$. Hence, $\omega_{t_w} > -1$. Q.E.D.

Appendix 2: Derivation of the optimal factor tax formulae

For the case $\varphi = 0$ and hence $t_\pi = \bar{t}_\pi$, rearranging the equations (16b) and (16c) yields

$$\begin{pmatrix} wL\eta_{L,\tilde{w}} & rK\eta_{K,\tilde{w}} \\ wL\eta_{L,\tilde{r}} & rK\eta_{K,\tilde{r}} \end{pmatrix}\begin{pmatrix} \lambda t_w \\ \lambda t_r \end{pmatrix} = \begin{pmatrix} (1-\lambda)(1-\bar{t}_\pi)\tilde{w}L - \left(\dfrac{w-(b-\lambda b^0)}{w}\right)wL\eta_{L,\tilde{w}} + \mu\Omega_{wt_w}(1+t_w) \\ (1-\lambda)(1-\bar{t}_\pi)\tilde{r}K - \left(\dfrac{w-(b-\lambda b^0)}{w}\right)wL\eta_{L,\tilde{r}} - \mu\Omega_{wt_w}(1+t_w) \end{pmatrix}, \tag{A3}$$

with $\Omega_{wt_r} = -\Omega_{wt_w}(1+t_w)/(1+t_r)$ (cf. Koskela and Schöb 1998). Applying Cramer's rule and using the fact that the determinant of the left-hand side matrix is equal to $\Delta = wLrK\sigma\varepsilon$ yields

$$\lambda t_w = -\left(\frac{w-(b-\lambda b^0)}{w}\right) + \frac{(1-\lambda)(1-\bar{t}_\pi)}{wL\sigma\varepsilon}\left[\tilde{w}L\eta_{K,\tilde{r}} - \tilde{r}K\eta_{K,\tilde{w}}\right] - \mu\frac{\Omega_{wt_w}(1+t_w)}{\tilde{w}L\eta_{K,\tilde{r}} - \tilde{r}K\eta_{K,\tilde{w}}}, \tag{A4}$$

$$\lambda t_r = +\frac{(1-\lambda)(1-\bar{t}_\pi)}{rK\sigma\varepsilon}\left[\tilde{r}K\eta_{L,\tilde{w}} - \tilde{w}L\eta_{L,\tilde{r}}\right] + \mu\frac{\Omega_{wt_w}(1+t_w)}{\tilde{r}K\eta_{L,\tilde{w}} - \tilde{w}L\eta_{L,\tilde{r}}}. \tag{A5}$$

Using the explicit elasticity formulae, we have

$$\tilde{w}L\eta_{K,\tilde{r}} - \tilde{r}K\eta_{K,\tilde{w}} = cY\left(s\eta_{K,\tilde{r}} - (1-s)\eta_{K,\tilde{w}}\right) = -cY\sigma s\,. \qquad \text{(A6a)}$$

$$\tilde{r}K\eta_{L,\tilde{w}} - \tilde{w}L\eta_{L,\tilde{r}} = cY\left((1-s)\eta_{L,\tilde{w}} - s\eta_{L,\tilde{r}}\right) = -cY\sigma(1-s)\,. \qquad \text{(A6b)}$$

Hence, we end up with conditions (18) and (19). Q.E.D.

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