

Optimal Tax Progression: Does it Matter if Wage Bargaining is Centralized or Decentralized?*

Thomas Aronsson and Magnus Wikström

Department of Economics, Umeå University
SE – 901 87 Umeå, Sweden

June 2011

Abstract

We study how the optimal use of labor income tax progression depends on whether the wage bargaining system is decentralized or centralized. Assuming a nonlinear labor income tax and an unrestricted profit tax, we show that a Utilitarian government is able to implement the first best resource allocation with a zero marginal labor income tax rate under decentralized wage bargaining, whereas centralized bargaining typically implies a progressive tax as well as unemployment. However, if the government and a (central) wage-setter bargain over wage formation *and* public policy, the resulting equilibrium is characterized by full employment and a zero marginal tax rate.

JEL classification: H21, H23, J51, J52

Keywords: Optimal taxation, tax progressivity, wage bargaining, corporatism.

* The authors would like to thank the Bank of Sweden Tercentenary Foundation, the Swedish Council for Working Life and Social Research, and the National Tax Board for generous research grants.

1. Introduction

It is well known that the effects of progressive labor income taxation in an economy with wage bargaining between trade unions and firms may differ fundamentally from those that would follow if the labor market is competitive. In a competitive labor market, increased tax progression typically increases the before-tax wage rate (through a reduction in the labor supply), whereas a trade-unionized labor market with involuntary unemployment may imply almost the opposite result: increased tax progression tends to push down the before-tax wage and, therefore, increase the number of employed persons along the labor demand function.¹ Yet, the degree of tax progression - measured as the difference between (or ratio of) the marginal and average labor income tax rates - that will follow from optimal nonlinear income taxation in a trade-unionized economy has received much less attention (see below).² To our knowledge, there are no earlier studies comparing centralized and decentralized wage bargaining from the point of view of optimal tax progression, i.e. how the optimal use of progression may vary depending on whether wage bargaining is centralized or decentralized. This is somewhat surprising considering that the structure of wage bargaining is important for wage and employment outcomes and, therefore, also for the economy as a whole.³ The purpose of the present paper is to fill this gap, by comparing the optimal tax policy under decentralized wage bargaining with the optimal policy that would follow with centralized wage bargaining.

Although there are many earlier studies on optimal taxation or tax reforms in economies with trade union wage formation,⁴ only a few of them have considered optimal nonlinear taxation in a general equilibrium framework. Fuest and Huber (1997) analyze the optimal tax policy of a Utilitarian government in an economy where the wage rate is decided upon in a (decentralized) wage bargain between the trade union and the firm, and the labor supply per

¹ There is a large body of empirical evidence showing that higher tax progression moderates wage claims; e.g., Layard (1982), Hersoug (1984), Malcolmson and Sartor (1987), Lockwood and Manning (1993), Holmlund and Kolm (1995), Tyrväinen (1995), Koskela and Vilmunen (1996) and Aronsson et al. (1997). Other studies show more complex relationships between tax progression and wages; for instance, by using Danish data, Lockwood et al. (2000) find evidence suggesting that the effects of higher tax progression on the before-tax wage rate is income dependent. Such a result is also to be expected, if the influence that trade unions have varies between different segments of the labor market. See also Brunello et al. (2002) for empirical evidence rejecting the prediction of the wage bargaining model.

² A progressive tax is often defined such that the marginal tax rate exceeds the average tax rate; see, e.g., Musgrave and Musgrave (1984).

³ There is a large literature that relates wage and employment outcomes to whether the wage bargaining system is decentralized or centralized; see, e.g., Calmfors and Drifill (1988) and Layard et al. (1991).

⁴ See, e.g., Palokangas (1987), Boeters and Schneider (1999), Sørensen (1999) and Koskela and Schöb (2002).

employee is fixed. They show that if the government has access to an unrestricted profit tax in addition to the labor income tax, it may implement the first best resource allocation with full employment, and the optimal tax mix implies a progressive labor income tax. With restricted profit taxation, on the other hand, the optimal labor income tax may be either progressive or regressive. Aronsson and Sjögren (2004a) instead assume that the labor supply per employee is endogenous, and that the wage rate is decided upon by a firm-specific monopoly trade union. Contrary to Fuest and Huber, their results show that the optimal mix of (unrestricted) profit taxation and nonlinear labor income taxation (i) leads to a first best resource allocation with full employment, *and* (ii) features a zero marginal labor income tax rate. By imposing a binding restriction on the profit tax, their result changes dramatically: the economy is, in this case, characterized by unemployment and a progressive labor income tax at the (second best) optimum.⁵

The present paper differs from the aforementioned studies in that we relate the use of labor tax progression to whether the wage bargaining system is centralized or decentralized, instead of to whether restrictions prevent the government from using profit taxes in the most beneficial way. We consider an economy with a full set of tax instruments in the sense that the government has access to an unrestricted profit tax in addition to the nonlinear labor income tax. This constitutes a reasonably realistic description of the tax instruments that many governments have at their disposal. Furthermore, a general labor income tax in combination with unrestricted profit taxation means that labor tax progression (if such a tax structure is used at all) is the outcome of an optimal choice by the government subject to the distortions created by the wage bargaining system; it is not due to any arbitrary restriction on the possibility to redistribute between workers and firms owners. Our study also contributes by presenting a more general framework for studying relationships between wages, labor supply and tax progression. Contrary to Fuest and Huber (1997), and in accordance with Aronsson and Sjögren (2004a), we assume that the hours of work per employee are endogenous, whereas we follow Fuest and Huber in assuming that the wage rate is decided upon in a right-

⁵ Aronsson and Sjögren (2004b) extend the analysis to a multi-country framework, where each country is characterized by wage bargaining at the firm level, and where domestic firms may move the production abroad in case the wage bargain fails. They show that each domestic government tends to choose too little labor tax progression (i.e. the marginal tax rate is too low relative to the average tax rate). The reason is that each national government neglects that a lower domestic wage rate leads to a higher reservation profit faced by foreign firms which, in turn, contributes to a lower wage rate and increased employment abroad. As a consequence, coordinated increases in the degree of tax progression can be used to increase the overall welfare.

to-manage framework. The latter accords well with the wage formation systems in many European countries.

Our distinction between decentralized and centralized wage bargaining refers to whether or not the government is first mover vis-à-vis the wage-setter. With decentralized wage bargaining, each trade union and (corresponding) firm is small relative to the economy as a whole and treats the public policy as exogenous, while the government will be assumed to recognize how its policy-choices influence the wage formation. This means that the government is Stackelberg leader and the wage-setter follower, which is the conventional order of decision-making in optimal tax models with trade-unionized labor markets. In practice, however, trade unions usually resist government intervention in wage formation, and if they are able to organize workers at a high level of aggregation, the government may no longer be able to commit to its tax policy, simply because the behavior of an economy-wide trade union might have a considerable effect on the government's budget constraint. We therefore argue that with centralized, economy-wide wage bargaining, the government is less likely to be able to act as first mover vis-à-vis the wage-setter. The wage-setter may even recognize – and take advantage of – how the outcome of the wage bargain influences the government's budget constraint. Two possible scenarios are discussed here: one in which the government and wage-setter are Nash competitors, and the other where the wage-setter is first mover vis-à-vis the government in the sense of incorporating how the unemployment benefit responds to a change in the wage rate. The latter is related to the discussion of encompassing coalitions in Olson (1982): the argument is that sufficiently large interest groups may internalize the effects of their actions on the public budget constraint.⁶ A natural extension of centralized bargaining is to consider a “corporative economy”, where the government and the labor market parties cooperate on wage formation *and* public policy. Therefore, we also analyze the implications of coordination in the sense that a central trade union and the government bargain over the wage rate as well as the tax and expenditure policy.

The outline of the study is as follows. In Section 2, we describe the model, which distinguishes between three types of consumers: employed and unemployed workers, and firm-owners whose income consists of the net of tax profit. We also characterize wage formation as well as analyze the outcome of optimization among agents in the private sector,

⁶ See also Summers et al. (1993) for an interesting analysis of how the behavior of encompassing coalitions may reduce the excess burden of taxation.

while the basic structure of the government's decision problem is described in Section 3. Section 4 characterizes the optimal tax structure under decentralized wage bargaining, and shows that the government can implement the first best resource allocation with a zero marginal labor income tax rate. The intuition is that the nonlinear labor income tax, in this case, constitutes a perfect instrument for influencing wage formation without distorting the labor supply behavior. A similar result was derived by Aronsson and Sjögren (2004a) in a simplified model with (firm-specific) monopoly trade unions, which means that we extend their result to the more general right-to-manage framework. We analyze optimal taxation under centralized, economy-wide wage bargaining in Section 5, and show that the optimal labor income tax is unambiguously progressive in the sense that the marginal income tax rate exceeds the average income tax rate, even if the government has access to an unrestricted profit tax for redistribution between workers and firm owners. Furthermore, this result holds irrespective of whether we assume that the government and wage-setter are Nash competitors or the wage-setter moves first. In Section 6, we consider a "corporative" economy in which the wage rate and public policy are determined simultaneously through a bargain between the government and the wage-setter. If the government and wage-setter are able to reach an agreement, the results show that the equilibrium will imply a zero marginal income tax rate and full employment. Section 7 concludes.

2. The Model and Behavior of the Private Sector

Consumers

The economy comprises three consumer-types: employed workers, unemployed workers and firm owners. The consumers have identical preferences represented by the utility function $u(c, z)$, where c is consumption and z leisure, and where leisure is defined by a time endowment, H , less the hours of work, l . To be able to distinguish between the three consumer-types, we use $u^e(\cdot)$, $u^u(\cdot)$ and $u^o(\cdot)$ to denote the utility of an employed worker, an unemployed worker and a firm-owner, respectively, despite that these three functions represent the same underlying preferences. There are N employed and $M-N$ unemployed workers, where M denotes the total work force.

The budget constraint faced by an employed worker is given by $c^e = wl - T(wl)$, where w is the hourly wage rate and $T(wl)$ the tax payment. The decision-problem facing an employed worker can then be written as

$$\max_l u^e(wl - T(wl), H - l)$$

and the first order condition for work hours becomes

$$u_c^e(1 - T'(wl))w - u_z^e = 0 \quad (1)$$

where subindices denote partial derivatives, i.e. $u_c^e = \partial u^e / \partial c^e$ and $u_z^e = \partial u^e / \partial z$, while $T'(wl) = dT(wl) / d(wl)$ is the marginal labor income tax rate. For further use, note also that we can write the labor supply elasticity with respect to the before-tax wage rate, κ , as follows:

$$\kappa = \frac{\partial l}{\partial w} \frac{w}{l} = -\frac{u_z^e / l - u_{cz}^e u_z^e / u_c^e + u_{cc}^e (u_z^e)^2 / (u_c^e)^2 - \zeta u_c^e}{u_{zz}^e + u_{cc}^e (u_z^e)^2 / (u_c^e)^2 - 2u_{cz}^e u_z^e / u_c^e - \zeta u_c^e} \quad (2)$$

where $u_{cc}^e = \partial^2 u^e / \partial (c^e)^2$, $u_{zz}^e = \partial^2 u^e / \partial z^2$ and $u_{cz}^e = \partial^2 u^e / \partial c^e \partial z$. In equation (2), we have used $w[1 - T'(wl)] = u_z^e / u_c^e$ from the first order condition presented in equation (1), as well as the short notation $\zeta = w^2 T''(wl) = w^2 d^2 T(wl) / d(wl)^2$ to capture the second order derivative of the labor income tax function. Note that equation (2) implicitly defines the labor supply elasticity with respect to the before-tax wage rate as a function of c^e , l and ζ , i.e. $\kappa = \kappa(c^e, l, \zeta)$. This insight, which follows by observing that u_c^e , u_z^e , u_{cc}^e , u_{zz}^e and u_{cz}^e are all functions of c^e and l , will be used below in the study of optimal taxation and public expenditure. We assume that the second order condition is satisfied, which implies that the denominator of equation (2) is negative.

Each unemployed worker receives a tax-free benefit, b , and faces the utility $u^u = u^u(b, H)$. Finally, firm-owners consume the after-tax profit and do not work, meaning that the utility facing each such firm-owner can be expressed as $u^o = u^o(c^o, H)$, where $c^o = (1 - s)\Pi$ is

consumption, Π profit-income (see below) and s the profit tax. Since the number of such firm-owners is not important, it will be normalized to one.

Firms

The production sector is characterized by identical competitive firms producing a homogenous good, and we normalize the number of such firms to one for notational convenience. Let L denote the total number of work hours used in production, measured as the hours of work per employee, l , times the number of employed persons, N , while $\Pi = F(L) - wL$ is the profit, where $F(L)$ is an increasing and strictly concave production function such that $F'(L) > 0$ and $F''(L) < 0$. The price of output has been normalized to one.

Maximizing profits with respect to L gives the labor demand, $L = L(w)$.

Trade Unions and Wage Formation

Following earlier comparable literature (Fuest and Huber 1997, Aronsson and Sjögren 2004a), each trade union is assumed to face a Utilitarian objective, and all workers are trade union members. By analogy to the treatment of the firms above, we normalize the number of trade unions to one. The objective function faced by the trade union is written as

$$U = N u^e (wl - T(wl), H - l) + (M - N) u^u (b, H). \quad (3)$$

We assume that the trade union recognizes that the employed members choose work hours according to equation (1) above. To begin with, we also assume that the trade union treats the policy instruments, i.e. the functional form and parameters of $T(\cdot)$ and the unemployment benefit, b , as exogenous. We can then derive

$$U_w = \frac{N}{w} \left[[\varepsilon(w) - \kappa] [u^e - u^u] + u_z^e l \right] \quad (4)$$

where $\varepsilon(w) = L'(w)w/L(w) < 0$ is the wage elasticity of labor demand and $\kappa = l_w w / l$ the wage elasticity of labor supply. To derive equation (4), we have used $u_c^e w (1 - T'(wl)) = u_z^e$ from equation (1).

The wage rate is determined in a bargain between the trade union and the firm. Assuming that the fallback utility facing the trade union is given by Mu^u , i.e. the utility that would follow from equation (3) if all members become unemployed, the utility-rent following the bargain is given by $U^r = U - Mu^u = N[u^e - u^u]$. Similarly, if the fall-back profit faced by the firm is zero, the Nash product underlying the bargain becomes

$$\Omega = [U^r]^\alpha [\Pi(1-s)]^{1-\alpha}. \quad (5)$$

The first order condition can then be written as

$$\Omega_w = 0 \leftrightarrow \alpha \frac{U_w}{U^r} - (1-\alpha) \frac{L}{\Pi} = 0 \quad (6)$$

where U_w is given by equation (4) above. We will return to the properties of equation (6) below.

3. Objective and Budget Constraint of the Government

We assume that the objective function of the government is given by a Utilitarian social welfare function

$$W = N u^e(c^e, H - l) + (M - N) u^u(b, H) + u^o((1-s)\Pi, H). \quad (7)$$

The government raises revenue through the labor income tax, $NT(\cdot)$, and the profit tax, $s\Pi$, which finances the unemployment benefit, $(M - N)b$. Note also that $T(\cdot)$ is a general income tax, which can be used to implement any desired combination of c^e and l . Therefore, it will be more convenient to write the public decision-problem such that c^e and l are direct decision-variables, instead of controlling c^e and l indirectly via the parameters of the tax function.⁷ By using $NT(wl) + s\Pi - (M - N)b = 0$ together with the private budget constraints, the government's budget constraint can then be written as

⁷ This approach is standard in the literature on optimal nonlinear income taxation.

$$s\Pi + (b + wl - c^e)N - bM = 0. \quad (8)$$

In addition to the budget constraint given by equation (8), the government also faces an employment constraint in the sense that the number of employed persons cannot exceed the work force, i.e.

$$M - N \geq 0. \quad (9)$$

4. Optimal Taxation and Decentralized Wage Bargaining

Under decentralized wage-setting, each wage-setter (trade union and corresponding firm) is small relative to the economy as a whole. It is, therefore, natural to assume that wage-setters treat economy-wide policy variables as exogenous, and that the government is first mover in the sense of recognizing how its policy influences the wage rate. To see the implications of this decision-structure, note that the first order condition for the wage rate in equation (6) can be written as

$$\alpha \frac{1}{w} \left[(\varepsilon(w) - \kappa) + \frac{u_z^e(c^e, H-l)l}{u^e(c^e, H-l) - u^u(b, H)} \right] - (1-\alpha) \frac{L(w)}{\Pi(w)} = 0. \quad (10)$$

By solving equation (10) for w , we can derive the wage equation

$$w = w(c^e, l, b, \kappa). \quad (11)$$

As explained above c^e and l are direct decision-variables in the optimal tax and expenditure problem. The labor supply elasticity with respect to the before-tax wage rate, κ , is also interpretable as a direct decision-variable: with c^e and l held constant, κ is determined by the second order derivative of the labor income tax function according to equation (2). One can show that if $\kappa > -1 (< -1)$, then $\partial\kappa/\partial\zeta < 0 (> 0)$. To simplify the optimal tax and expenditure problem below, we assume that the relevant range for κ is $(-1, \infty)$.⁸ In this case,

⁸ This assumption accords well with empirical evidence on the labor supply; see Blundell and MaCurdy (1999) for a literature review.

and for a given combination of c^e and l , the government can perfectly control κ via the second order derivative of the labor income tax function, $T''(wl)$. We will, therefore, treat κ as an additional decision-variable of the government. At the optimum, therefore, $\bar{T} = T(wl)/wl$, $T'(wl)$ and $T''(wl)$ can be inferred from the choices of c^e , l and κ .

The Lagrangean corresponding to the social decision-problem can then be written as

$$\mathcal{L} = N u^e(c^e, H - l) + (M - N) u^u(b, H) + u^o(\Pi(1 - s), H) + \mu[s\Pi + (b + wl - c^e)N - bM] + \gamma[M - N] \quad (12)$$

in which μ and γ are Lagrange multipliers. Note first that by using $N = L(w)/l$, the partial derivative of the Lagrangean with respect to the before-tax wage rate, with c^e , l , b and s held constant, is given by

$$\frac{\partial \mathcal{L}}{\partial w} = \frac{L_w}{l} (u^e - u^u) - u_c^o L(1 - s) + \mu L \left(1 - s + \varepsilon \left(\bar{T} + \frac{b}{wl} \right) \right) - \gamma \frac{L_w}{l}. \quad (13)$$

With equation (13) at our disposal, and by using $w = w(b, c^e, l, \kappa)$, the first order conditions can be written as

$$\frac{\partial \mathcal{L}}{\partial b} = (M - N)[u_c^u - \mu] + \frac{\partial \mathcal{L}}{\partial w} \frac{\partial w}{\partial b} = 0 \quad (14a)$$

$$\frac{\partial \mathcal{L}}{\partial c^e} = N[u_c^e - \mu] + \frac{\partial \mathcal{L}}{\partial w} \frac{\partial w}{\partial c^e} = 0 \quad (14b)$$

$$\frac{\partial \mathcal{L}}{\partial l} = -\frac{N}{l}(u^e - u^u) - Nu_z^e + \mu w N \left(1 - \bar{T} - \frac{b}{wl} \right) + \gamma \frac{N}{l} + \frac{\partial \mathcal{L}}{\partial w} \frac{\partial w}{\partial l} = 0 \quad (14c)$$

$$\frac{\partial \mathcal{L}}{\partial s} = \pi(\mu - u_c^o) = 0 \quad (14d)$$

$$\frac{\partial \mathcal{L}}{\partial \kappa} = \frac{\partial \mathcal{L}}{\partial w} \frac{\partial w}{\partial \kappa} = 0 \quad (14e)$$

together with the complementary slackness condition $\gamma(M - l/w) = 0$. We can now derive the following result:

Proposition 1. *If the government is first mover vis-à-vis the wage-setter, the optimal resource allocation is first best, and is characterized by (i) full employment and (ii) a zero marginal labor income tax rate, $T'(wl)=0$.*

Proof: see the Appendix.

The intuition behind Proposition 1 is straightforward: the government has a sufficient number of instruments to control all endogenous variables (c^e, l, w, c^u, c^o) in the economy. To be more specific, the optimal choice of κ means that equation (13) reduces to read $u^e - u^u + \mu(T + b) - \gamma = 0$, implying $\gamma > 0$ and $N = M$ in equilibrium. The remaining first order conditions can be used to show that $T'(wl)=0$. As such, the government may implement full employment by exercising control over the wage rate (through an appropriate choice of κ) and implement the desired distribution between consumer-types (through appropriate choices of tax payments and unemployment income) without distorting the labor supply incentives. Aronsson and Sjögren (2004a) derived an analogous result in a model with (firm-specific) monopoly trade unions, whereas Proposition 1 differs from a corresponding result derived by Fuest and Huber (1997), who assume right-to-manage wage formation (as we do) while treating the hours of work per employee as fixed. Instead, they found that the optimal policy mix that leads to full employment includes a progressive labor income tax such that $\bar{T} < T'(wl) < 1$.

5. Optimal Taxation and Centralized Wage Bargaining

In this section, we address centralized wage formation in the sense that an economy-wide trade union bargains with an employer association. As we indicated in the introduction, with centralized wage bargaining, it is not necessarily the case that the government has a first-mover advantage when choosing the tax and expenditure policy. We begin by considering a scenario where the government and the wage-setter are Nash-competitors and move simultaneously. This means that the wage-setter treats the policy variables as exogenous (as before), *and* that the government treats the wage rate as exogenous. We will then briefly consider a decision-problem where the wage-setter moves first. In the next section, a

corporative economy will be examined, where the trade union and the government bargain over the wage rate and the policy variables.

As before, the outcome of the wage bargain can be described by equation (6). The objective function of the government is represented by (7), while the budget and employment constraints are given by equation (8) and (9), respectively. Under centralized wage bargaining, the government treats the wage rate as fixed and will, therefore, not in general be able to implement full employment, which means that $\gamma = 0$.⁹ In this case, equation (14e) will become redundant. The first order conditions for b , c^e and l change to read

$$\frac{\partial \mathcal{L}}{\partial b} = (M - N)(u_c^u - \mu) = 0 \quad (15a)$$

$$\frac{\partial \mathcal{L}}{\partial c^e} = N(u_c^e - \mu) = 0 \quad (15b)$$

$$\frac{\partial \mathcal{L}}{\partial l} = N(\mu w - u_z^e) - (L/l^2)(u^e - u^u) - \mu(L/l^2)(b + wl - c^e) = 0 \quad (15c)$$

while the first order condition for s remains as in equation (14d). First, note that by combining equations (14d), (15b) and (15c), we have $u_c^e = u_c^u = u_c^o$, meaning that the marginal utility of consumption is equalized among consumer-types. Using the first order condition for work hours given by (1) together with equation (15b) gives $\mu w - u_z^e = T'(\cdot)w u_c^e$. Substituting into equation (15c), rearranging and using the private budget constraint, we can derive the following expression:

$$T'(wl) - \bar{T}(wl) = \frac{u^e - u^u}{u_c^e wl} + \frac{b}{wl} \quad (16)$$

where $\bar{T}(w) = T(wl)/(wl)$ is the average labor income tax rate. As indicated above, a progressive tax system is typically defined such that the marginal tax rate exceeds the average tax rate, i.e. $T'(\cdot) - \bar{T} > 0$. Note that this applies to equation (16) since, first, the “replacement ratio” b/wl is positive, and, second, $u^e - u^u > 0$. This latter follows from the first order

⁹ The argument that the optimal tax policy does not implement full employment is not dependent on the assumption that the government treats the wage rate as fixed. It will always apply unless the government can perfectly control the wage rate via policy.

condition for wage determination by noticing that $u^e - u^u \leq 0$ would imply that this condition no longer holds (at least for $\kappa > \varepsilon(w)$). A Nash-equilibrium is a wage rate, average and marginal labor income tax rates, unemployment benefit, and profit tax such that equations (6), (14d), (15a), (15b), (15c) and the government's budget constraint are fulfilled simultaneously. The second result is portrayed below:

Proposition 2. *If the government treats the hourly wage rate as exogenous when determining the optimal tax and expenditure policy, the resulting labor income tax will be progressive, and the Nash-equilibrium is characterised by less than full employment.*

Since the government is unable to reach full employment through policies designed to influence wage formation, it will implement a “work sharing” arrangement: by reducing the hours of work per employee through a progressive labor income tax, the number of employed persons increases. Equation (16) shows that the greater the utility difference between employment and unemployment, or the larger the benefit paid out to each unemployed, the more progressive will be the labor income tax (measured by the difference between the marginal and average rate). The intuition is, of course, that any of these components contributes to increase the cost of unemployment (either through lost utility or lost public revenue).

To go further and characterize the relationship between unemployment and taxation in terms of observable variables under centralized wage-setting, let us consider the special case where the wage rate is decided upon by an economy-wide monopoly trade union. The first order condition for wage formation then reduces to read $U_w = 0$, where U_w is defined by equation (4). By using $u_z^e = u_c^e w [1 - T'(wl)]$ from equation (1) and substituting into equation (4), the first order condition for the wage rate becomes

$$(\varepsilon(w) - \kappa)(u^e - u^u) + u_c^e (1 - T'(\cdot))wl = 0. \quad (17)$$

Solving equation (17) for $(u^e - u^u)/u_c^e wl$ and substituting the resulting expressions into equation (16), one obtains

$$T'(\cdot) = \frac{1}{1 - \varepsilon(w) + \kappa} + \frac{\kappa - \varepsilon(w)}{1 - \varepsilon(w) + \kappa} \cdot \frac{1}{UR} \left[\bar{T} + \frac{s\pi}{Mwl} \right] \quad (18)$$

where we have used the government's budget constraint to eliminate b . In equation (18), the marginal labor income tax rate is expressed in terms of measurable quantities, where $UR = (M - N) / M$ is the unemployment rate. Defining $\bar{S} = s\pi / Mwl$ as the average profit tax to work income, and solving equation (18) for the unemployment rate, we have

$$UR = \frac{(\kappa - \varepsilon(w))[\bar{T} + \bar{S}]}{(1 - \varepsilon(w) + \kappa)T'(\cdot) - 1}. \quad (19)$$

Equation (19) has a simple interpretation. The term within square brackets in the numerator represents "average taxation". It is the sum of the average labor income tax rate and the average profit tax to worker income. In the Nash-equilibrium, the unemployment rate is proportional to average taxation and inversely related to the marginal labor income tax rate. Note also that, for given parameters of the tax system, numerically larger demand and supply elasticities tend to be associated with a lower unemployment rate as larger elasticities tend to increase the union's cost of a wage increase.

Trade Union Leadership

If we continue to assume that the government takes the wage rate as given when determining the optimal tax system, a natural question to ask is what incentives the centralized trade union may have to exploit how the government responds to a change in the wage rate. The idea is that the trade union knows that the government sets taxes and the unemployment benefit so that the marginal utility of consumption is equalized between employed and unemployed workers. Using equations (15a) and (15b), we have $u_c^e(wl - T(wl), H - l) = u_c^u(b, H)$.

Differentiating this expression with respect to w and b and rearranging yields

$$\frac{db}{dw} = \frac{u_{cc}^e(1 - T'(\cdot))(l + wl_w) - u_{cc}^e l_w}{u_{cc}^u}. \quad (20)$$

A sufficient condition for db/dw to be positive is that $u_{zc}^e l_w \geq 0$, which would follow if $l_w \geq 0$ and $u_{zc}^e \geq 0$. Let $b = b(w)$ denote the relationship between b and w implied by the condition that $u_c^e = u_c^u$. Strategic leadership by the trade union then implies that the wage bargain is carried out under the additional constraint $b = b(w)$. The first order for the wage rate in equation (6) - i.e. $\Omega_w = 0$ - which was derived with b held constant, is then replaced by

$$\Omega_w + \alpha \frac{(M - N)}{U^r} u_c^u b_w = 0. \quad (21)$$

By comparison, equation (21) contains an additional term, which is positive if $b_w > 0$. The trade union would then benefit from increasing the wage rate beyond that of the Nash equilibrium. The following result applies:

Proposition 3. *If the wage-setter is acting Stackelberg leader vis-à-vis the government, and if $l_w \geq 0$ and $u_{zc}^e \geq 0$, the wage rate is higher and the level of employment lower than under Nash-competition.*

Note that equation (16) still applies, which means that the labor income tax is progressive also when the wage-setter acts as first mover. However, it is not possible, in general, to show whether tax progressivity (as measured by the difference $T'(\cdot) - \bar{T}$) is higher or lower under trade union leadership than under Nash-competition.

6. A Corporative Approach to Taxation, Public Expenditure and Wage Formation

In this section, we consider a corporative economy, in which the government and a trade union cooperate in determining the wage rate, tax policy and public expenditure. Here, the labor market will be described in terms of a monopoly trade union, whose objective, U , is given by equation (3). The monopoly union assumption simplifies the analysis and appears to us to be reasonable in this case: a trade union strong enough to bargain with the government over public policy is most likely also a dominant actor in the labor market. The objective function faced by the government, W , is given by equation (7).

If the bargain fails, we assume that the resource allocation is governed by the centralized wage formation model described in the previous section, which gives the optimal tax structure as presented in Proposition 2. Let U^c and W^c be the utility faced by the trade union and the government, respectively, if the bargain fails, i.e. the fallback utilities of relevance in the simultaneous cooperation on public policy and wage formation. These reservation utilities are predetermined and, therefore, treated as fixed. We can then write the Nash-product governing the (simultaneous) wage and policy bargain as follows:

$$\Lambda = \tilde{W}^\varphi \tilde{U}^{1-\varphi} \quad (22)$$

where $\tilde{W} = W - W^c$ and $\tilde{U} = U - U^c$ are the utility-rents from the bargain, and φ the bargaining power of the government.

By analogy to the analyses carried out above, the decision-problem set out here is described such as to choose w , b , c^e , l and s to maximize the Nash-product given by equation (22) subject to the labor demand, $L = L(w)$, the government's budget constraint in equation (8) and the employment constraint in equation (9). The Lagrangean corresponding to this decision-problem will be written as

$$\mathcal{L} = \varphi \ln \tilde{W} + (1-\varphi) \ln \tilde{U} + \mu [s\Pi + (b + wl - c^e)N - bM] + \gamma [M - N]. \quad (23)$$

The full set of first order conditions are presented in the Appendix. By using these conditions, one can immediately notice that the social marginal utility of consumption is equalized among consumer-types in equilibrium in the sense that

$$\left[\frac{\varphi}{\tilde{W}} + \frac{(1-\varphi)}{\tilde{U}} \right] u_c^e = \left[\frac{\varphi}{\tilde{W}} + \frac{(1-\varphi)}{\tilde{U}} \right] u_c^u = \frac{\varphi}{\tilde{W}} u_c^o = \mu,$$

and that the first order condition for the wage rate can be rewritten to read

$$\left[\frac{\varphi}{\tilde{W}} + \frac{(1-\varphi)}{\tilde{U}} \right] (u^e - u^u) + \mu(T + b) - \gamma = 0.$$

Therefore, $\gamma > 0$ and $N = M$ in equilibrium. The first order condition for l then implies $u_c^e w = u_z^e$. We have derived the following result:

Proposition 4. *In a corporative economy, where the government and economy-wide trade union bargain over public policy and the wage rate, the optimal resource allocation is characterized by (i) full employment and (ii) a zero marginal labor income tax rate, $T'(wl) = 0$.*

Note that the resource allocation in the corporative economy is not the same as under decentralized wage bargaining: since the objectives underlying policy differ between these two allocations, the distribution of resources between the consumer-types will also differ. Both resource allocations will, nevertheless, be characterized by full employment and a zero marginal labor income tax rate. The intuition is that the socially optimal wage rate equalizes the aggregate supply and demand in the labor market. With decentralized wage formation, as in Section 4, the government was able to reach full employment by using the second order derivative of its own income tax (which, in that case, constitutes a perfect instrument for influencing the wage rate); in the corporative economy analyzed here, the wage rate is, instead, a direct decision-variable in the economy-wide bargain. In either case, and with access to a general labor income tax and unrestricted profit taxation, the decision-maker can attain the desired redistribution on a lump-sum basis (by altering the average tax paid by the employed, the unemployment benefit and the profit tax) without distorting the labor supply behavior.

7. Summary and Discussion

This paper concerns optimal labor tax progression in imperfectly competitive labor markets where we make a difference between decentralized and centralized wage formation. Using a right-to-manage framework, we first show that, if wage formation is decentralized in the sense that a large number of firms and trade unions bargain over wages, the government can implement the first-best full employment outcome by using the curvature of the labor income tax function to control the wage rate. In that case, the marginal labor income tax rate will be zero at the optimum. Centralized wage formation is modelled by assuming that the government will not be able to act as a first-mover vis-à-vis the wage-setter. Here, we distinguish between two main cases: (i) the government and the labor market parties play a non-cooperative Nash-game (or Stackelberg game, in which the wage-setter is leader), and (ii) a corporative economy where the government and wage-setter engage in a cooperative bargain over wage formation *and* public policy. In the former case, we have unemployment

and progressive labor income taxation at the (second best) optimum; in the latter, the equilibrium is characterized by full employment and a zero marginal labor income tax rate.

The two cases of centralized wage formation discussed in the paper represent polar positions. Direct bargaining between a trade union and the government may be seen as an extreme form of income policy, while in the noncooperative Nash-game the government does not try to influence the wage rate at all. In reality, governments do try to influence wage determination, often by talks, formal and informal agreements. Such arrangements may successfully lead to wage and price moderation. However, the results derived in the paper show that, *unless* the government can fully control wage formation directly or indirectly, the resulting equilibrium will imply less than full employment and the optimal labor income tax will be progressive.

Appendix

Proof of Proposition 1

Equation (14e) implies $\partial \mathcal{L} / \partial w = 0$ (since $\partial w / \partial \kappa$ is generally nonzero), in which case the final term on the right hand side of equation (14a), (14b) and (14c), respectively, vanishes. Then, by using equations (14a), (14b) and (14d), we can derive $u_c^e = u_c^u = u_c^o$, in which case equation (13) reduces to read

$$(u^e - u^u) + \mu(T + b) - \gamma = 0. \quad (\text{A1})$$

Now, since $(u^e - u^u) > 0$ and $\mu(T + b) > 0$ at the optimum, equation (A1) implies $\gamma > 0$, so $M = N$. Then, by using equations (14b) and (A1) to substitute for μ and γ , respectively, in equation (14c), we have $u_z^e / u_c^e = w$, implying $T'(wl) = 0$. ■

The First Order Conditions in the Corporative Model

By using $\partial \Pi / \partial w = -L$, the first order conditions can be written as

$$\begin{aligned}\frac{\partial \mathfrak{L}}{\partial w} &= \left[\frac{\varphi}{\tilde{W}} + \frac{(1-\varphi)}{\tilde{U}} \right] (u^e - u^u) \frac{L_w}{l} - \frac{\varphi}{\tilde{W}} u_c^o L(1-s) \\ &+ \mu \left((1-s)L + (T+b) \frac{L'(w)}{l} \right) - \gamma \frac{L_w}{l} = 0\end{aligned}\quad (\text{A2})$$

$$\frac{\partial \mathfrak{L}}{\partial b} = \left\{ \left[\frac{\varphi}{\tilde{W}} + \frac{(1-\varphi)}{\tilde{U}} \right] u_c^u - \mu \right\} (M - N) = 0 \quad (\text{A3})$$

$$\frac{\partial \mathfrak{L}}{\partial c^e} = \left\{ \left[\frac{\varphi}{\tilde{W}} + \frac{(1-\varphi)}{\tilde{U}} \right] u_c^e - \mu \right\} N = 0 \quad (\text{A4})$$

$$\frac{\partial \mathfrak{L}}{\partial l} = \left[\frac{\varphi}{\tilde{W}} + \frac{(1-\varphi)}{\tilde{U}} \right] \left[-\frac{N}{l} (u^e - u^u) - N u_z^e \right] + \mu w N \left(1 - \bar{T} - \frac{b}{wl} \right) + \gamma \frac{N}{l} = 0 \quad (\text{A5})$$

$$\frac{\partial \mathfrak{L}}{\partial s} = \left[-\frac{\varphi}{\tilde{W}} u_c^o + \mu \right] \Pi = 0. \quad (\text{A6})$$

References

Aronsson, T., Wikström, M., and Brännlund, R. (1997). Wage determination under non-linear taxes: Estimation and an application to panel data. *Oxford Economic Papers*, 49, 404-418.

Aronsson, T., and Sjögren, T. (2004a). Is the optimal labor income tax progressive in a unionized economy? *Scandinavian Journal of Economics*, 106, 661-675.

Aronsson, T., and Sjögren, T. (2004b). Efficient taxation, wage bargaining and policy coordination. *Journal of Public Economics*, 88, 2711-2725.

Boeters, S., and Schneider, K. (1999). Government versus union: The structure of optimal taxation in a unionized labor market. *Finanzarchiv*, 56, 174-187.

Blundell, R., MacCurdy, T. (1999). Labor supply: A review of alternative approaches. In O. Ashenfelter and D. Card (eds.), *Handbook of Labor Economics*, Vol. 3 (pp. 1559-1695). Elsevier Science B.V.

Brunello, G., Parisi, M.L., and Sonedda, D. (2002). Labor taxes and wages: Evidence from Italy. *CESifo Working Paper* No. 715.

Calmfors, L., and Drifill, J. (1988). Centralization of wage bargaining and macroeconomic performance. *Economic Policy*, 6, 13–61.

Fuest, C., and Huber, B. (1997). Wage bargaining, labor-tax progression, and welfare. *Journal of Economics*, 66, 127-150.

Hersoug, T. (1984). Union wage responses to tax changes. *Oxford Economic Papers*, 36, 37-51.

Holmlund, B., and Kolm, A-S. (1995). Progressive taxation, wage setting and unemployment – theory and Swedish evidence. *Swedish Economic Policy Review*, 2, 423-460.

Koskela, E., and Schöb, R. (2002). Optimal factor income taxation in the presence of unemployment. *Journal of Public Economic Theory*, 4, 387-404.

Koskela, E., and Vilmunen, J. (1996). Tax progression is good for employment in popular models of trade union behavior. *Labour Economics*, 3, 65-80.

Layard, R. (1982). Is incomes policy the answer to unemployment? *Economica*, 49, 219-239.

Layard, R., Nickell, S., and Jackman, R. (1991). *Unemployment: Macroeconomic performance and the labour market*. Oxford: Oxford University Press.

Lockwood, B., and Manning, A. (1993). Wage setting and the tax System. *Journal of Public Economics*, 53, 1-29.

Lockwood, B., Slok, T., and Tranäs, T. (2000). Progressive taxation and wage setting: Some evidence for Denmark. *Scandinavian Journal of Economics*, 102, 707-723.

Malcolmson, J. M., and Sartor, N. (1987). Tax push inflation in a unionized labour market. *European Economic Review*, 31, 1581-1596.

Musgrave, R., and Musgrave, P. B. (1984). *Public finance in theory and practice*. McGraw-Hill, New York.

Olson, M. (1982). *The rise and decline of nations*. New Haven: Yale University Press.

Palokangas, T. (1987). Optimal taxation and employment policy with a centralized wage setting. *Oxford Economic Papers*, 39, 799-812.

Summers, L., Gruber, J., and Vergara, R. (1993). Taxation and the structure of labor markets: The case of corporatism. *Quarterly Journal of Economics*, May, 385-411.

Sörensen, P.B. (1999). Optimal tax progressivity in imperfect labor markets. *Labour Economics*, 6, 435-452.

Tyrväinen, T. (1995). Wage setting, taxes and demand for labour: Multivariate analysis of cointegrating relations. *Empirical Economics*, 20, 271-297.