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LABOUR TAXATION AND THE DEGREE OF CENTRALISATION IN A TRADE UNION MODEL WITH ENDOGENOUS LABOUR SUPPLY

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Abstract: This paper considers the effect of labour taxation on wages and employment in a trade union model with endogenous working hours. In the model, individuals choose working hours with a given wage rate, competive firms decide on employment taking wages and working hours as given and a monopoly union sets wages allowing for the response of both workers and firms. Heads and hours are assumed to be perfect substitutes in production. The government collects taxes on wages and uses the revenue to finance unemployment benefits and public good. Having derived the results of the conventional decentralised union model we show that when the centralised union perceives the link between taxes paid and public good provided, it will lead to wage moderation and higher employment. Also, wages and employment are shown to be less sensitive to increases in the wage taxation in the centralised union case. In the extreme, if individual worker's marginal utility from public good is sufficiently high, a tax increase can even improve employment. This somewhat surprising result arises because labour supply effect dominates the wage effect on labour demand.

Key words: Union models, Labour taxation, Degree of centralisation, Working hours

Tiivistelmä: Tässä tutkimuksessa tarkastellaan palkkaverotuksen vaikutusta palkkoihin ja työllisyyteen ammattiliittomallissa, jossa työn tarjonta määräytyy endogeenisesti. Malli olettaa, että yksilöt valitsevat työtunnit ottaen palkan annettuna. Voittoa maksimoivat, kilpailevat yritykset päättävät työllisyydestä ottaen palkan ja työtunnit annettuina. Palkan asettaa monopoliliitto, joka ottaa huomioon sekä yksilöiden että yritysten käyttäytymisen. Pääluvun ja työtuntien oletetaan olevan täydellisiä substituutteja tuotannossa. Julkinen valta verottaa palkkoja ja käyttää verotulot sekä työttömyysturvan että julkishyödykkeen rahoittamiseen. Tutkimuksessa johdetaan tavanomaisen hajautetun liiton tasapaino ja osoitetaan, että mikäli ns. keskitetty liitto ottaa huomioon palkkapolitiikan vaikutuksen julkisen talouden tasapainoon, palkat jäävät alhaisemmiksi ja työllisyys paranee. Keskitetyn liiton tapauksessa palkat ja työllisyys ovat myös vähemmän herkkiä palkkaverotuksen muutoksille. Ääritapauksessa, mikäli julkishyödykkeen rajahyöty on riittävän korkea, verojen korottaminen voi jopa edistää työllisyyttä. Tämä jossain määrin yllättävä tulos syntyy, koska työtuntien tarjontavaikutus dominoi palkkavaikutusta työllisyyden määräytymisessä.

Asiasanat: Ammattiliittomallit, työn verotus, työmarkkinoiden keskittyneisyys, työtuntien määräytyminen

Contents

1 Introduction

The recent empirical studies of European unemployment suggest that the size of the distortionary effects of labour taxes on unemployment may depend upon labour market institutions, in line with the arguments of Summers, Gruber and Vergara (1993). In more corporatist countries, labour taxes tend to have less distortionary effect on employment than in the countries where wage bargaining is more decentralized. In particular, distortionary effect of labour taxes on employment is suggested to be largest in the countries with industrial level wage bargaining systems. Daveri and Tabellini (2000) find that on average the observed rise of about 14 percentage points in the labour tax rate corresponds to a rise in unemployment of about 4 percentage points in continental Europe during the last 25 year period. However, their empirical results also suggest that labour taxes are considerably more harmful for employment in the countries with industry level bargaining structure. Kiander, Kilponen and Vilmunen (2000) find similar evidence with somewhat larger data set of 17 OECD countries. Their empirical results suggest that 10 percentage point reduction in tax on labour income would imply around 2-3 percentage points decrease in unemployment rate in the countries with industry level bargaining system during the period of 1973 - 1996, but no statistically significant effect in the countries with centralized or competitive wage bargaining systems.

Analytic studies that explore the relationship between labour market institutions, the degree of wage bargaining in particular, and taxation owns much to the seminal paper of Summers Gruber and Vergara (1993). They use an efficient bargaining framework and suggest that distorting effect of labour tax declines along the degree of encompassment of the unions. Essentially their encompassing argument exploits the assumption that corporatist unions recognize that their members represent a significant group of tax-payers and hence bear the costs of reductions in the size of the tax base. In this way, large enough unions internalize the government budget constraint in choosing wage and labour input levels.

In the spirit of Summers et al (1993), this paper studies the relationship between labour taxation and the degree of centralisation in a somewhat broader model of the unionised labour markets, where labour supply is endogenised through individual choice of working hours. In Summers et al (1993), wages and employment are jointly determined in a bargaining game between unions and firms. In our model, monopoly union decides upon wages, but the supply of working hours is determined competitively by individual workers. The decision on employment is then made by profit maximising firms.[1] Compared to Summers' et al (1993) linear utility case and somewhat arbitrary "encompassment argument", we assume that the degree of encompassment of the centralised union depends directly upon marginal utility of public good of the workers.

We show that the wage moderation effect of centralized wage determination, which arises from internalisation of the government's budget, holds even with en-

[1] Holm, Kiander and Koskela (1995) use similar framework to analyse the effects of tax structure in the decentralised union case.

dogenous supply of working hours. However, with endogenous labour supply, wage tax not only has less distorting effect on employment in the centralised case, but can also improve employment if the marginal utility from public good is sufficiently large..

The structure of the paper is as follows: Section 2 introduces the preliminaries common for the two frameworks. Section 3 describes the problem and results from the model with decentralised monopoly union. Section 4 does the same in centralised union framework. Section 5 presents some concluding remarks.

2 Preliminaries

Consider the following broad model of labour markets: Individuals choose working hours taking the wage as given, firms choose employment taking wages and working hours as given and a monopoly union sets wages allowing for the response of both workers and firms. Within this framework, the determination of wages, working hours and employment is sensitive to a number of assumptions that can be made on institutional arrangement such as taxation, unemployment benefits, public expenditure and, not least, the degree of centralisation of the union.

In our setting, the question of the degree of centralisation of the union boils down to the question of whether the union recognises the connection between wages and public budget.[2]If the union is relatively small, decentralised, it is plausible to assume that it ignores the connection between taxes paid and amount of public goods received. If the union is large, centralised, it has to pay attention to the consequences of its wage policy on government budget, in particular on the provision of public good.

Before turning to the union policies, let us introduce the underlying assumptions of firm and individual behaviour.

2.1 Firm behaviour

Throughout the paper we assume that the number of workers and hours are perfect substitutes in production i.e.

$$Q(N,h) = f(Nh) \tag{1}$$

The level of employment is determined by the competitive profit maximising firms

$$\max_N \left[f(Nh) - whN\right] \tag{2}$$

The first order condition is

$$\begin{aligned} f'(Nh)\,h &= wh \\ &\Longleftrightarrow \\ f'(Nh) &= w \end{aligned} \tag{3}$$

For analytical simplicity, we assume that the production function takes the following simple form

$$f(Nh) = (Nh)^{\gamma} \ ,\gamma < 1 \tag{4}$$

Under this assumption (3) yields

$$\begin{aligned} \gamma (Nh)^{\gamma-1} &= w \\ &\Rightarrow \\ N(w,h) &= \left(\frac{\gamma}{w}\right)^{\frac{1}{1-\gamma}} h^{-1} \end{aligned} \tag{5}$$

[2]For an alternative approach where a centralised union takes account of the link between wages and general price level see e.g. Driffill & van der Ploeg (1993).

which is the demand for labour. In what follows we assume that the firms are not rationed in the labour market and employment equals labour demand. From (5) we get

$$\epsilon^d \equiv -\frac{\partial \log N}{\partial \log w} = \frac{1}{1-\gamma} > 1 \tag{6}$$

which is the wage elasticity of employment with fixed working hours and

$$\frac{\partial \log N}{\partial \log h} = -1 \tag{7}$$

which is the elasticity employment with respect to working hours.

2.2 Individual behaviour and labour supply

As for the individuals, we normalise the total number to unity, out of which N are employed and $1 - N$ are unemployed. The utilities of employed and unemployed individuals are given by

$$\begin{aligned} U_e &= y_e - v(h) + z(G) \\ U_u &= y_u + z(G) \end{aligned} \tag{8}$$

y_e and y_u denote after tax income of employed and unemployed respectively. $v(h)$ is some convex function denoting disutility from work. We normalise also total time endowment to unity, so that $(1 - h)$ is the time spent on other non-productive activities, such as leisure. We assume that $v(h)$ has the following properties

$$\begin{aligned} v_h &> 0 \\ v_{hh} &> 0 \\ v(0) &= 0 \\ v(1) &< \infty \end{aligned}$$

$z(G)$, in turn, is some concave function, denoting utility from public good, G. Throughout the paper we assume that public good has a constant positive marginal utility less than one $0 < z_G < 1$. Assumption that the marginal utility from public good is less than one, effectively means that marginal utility from private consumption is always higher than the marginal utility from public good. We will see later on that when wage determination is centralized this assumption is necessary for net labour income to be positive in equilibrium. Net labour incomes for employed (y_e) and unemployed (y_u) are defined as

$$\begin{aligned} y_e &= wh(1-\tau) \\ y_u &= w_u(1-\tau_u) \end{aligned} \tag{9}$$

where w is wage set by the union, w_u is an exogenous unemployment benefit and h is hours worked determined by the individuals. Finally, τ and τ_u are the proportional tax rates on wages and unemployment benefits, respectively.

For later use we note that

$$\begin{aligned} U_e - U_u &= y_e - y_u - v(h) \\ &= wh\,(1-\tau) - w_u(1-\tau_u) - v(h) \end{aligned} \tag{10}$$

An individual employed worker solves the following problem

$$\begin{aligned} &\max_h U_e \\ &s.t. \\ y_e &= wh(1-\tau) \end{aligned} \tag{11}$$

This yields the first order condition

$$(1-\tau)w - v'(h) = 0 \tag{12}$$

In order to derive explicit analytic solution for the model, we assume that

$$v(h) = \frac{1}{\delta}h^{\delta},\ \delta > 1$$

Consequently, (12) yields

$$h = ((1-\tau)w)^{\frac{1}{\delta-1}} \tag{13}$$

Under this formulation the (uncompensated) own price elasticity of labour supply is given by

$$\epsilon^s \equiv \frac{\partial \log h}{\partial \log w} = \frac{1}{\delta - 1} \tag{14}$$

2.3 Government budget

We assume that the government collects taxes on wages and unemployment benefits at rates (τ) and (τ_u) respectively. Tax revenues are used to finance costs of the unemployment benefits (w_u) and provision of public good (G). Under these premises, the government budget constraint can be written

$$G = \tau whN - (1-\tau_u)w_u(1-N) \tag{15}$$

where w, h, and N are wages, hours worked and employment as defined above.

3 Decentralised Union

Let us first turn to a model with decentralised labour market, where the unions do not take into account the consequences of their wage policy on the government budget. We can therefore treat the provision of public good as given.

With the assumption of "small union" holding, we also pay attention to the taxation of unemployment benefits that has been shown to be an important determinant of the results in the trade union models.[3] Consequently, the decentralised utilitarian union solves the following maximisation problem

$$\begin{aligned} \max_{w} V &= NU_e + (1-N)\,U_u \\ & \quad s.t. \\ N &= n(w, h(w)) \\ U_e &= u\,(w, h\,(w)) \end{aligned} \tag{16}$$

Union's utility function (16) can be rewritten conveniently as

$$V = N(U_e - U_u) + U_u$$

so that the first order condition then becomes

$$\frac{dV}{dw} = (U_e - U_u)\frac{dN}{dw} + N\frac{dU_e}{dw} = 0 \tag{17}$$

$\frac{dU_u}{dw}$ does not enter into the first order condition of the union, because U_u is unaffected by the changes in w, when the union takes G as given. To express the first order condition conveniently in the elasticity form, we multiply both sides of (17) by $\frac{w}{N}$ to get

$$\frac{dV}{dw}\frac{w}{N} = (U_e - U_u)\frac{dN}{dw}\frac{w}{N} + \frac{dU_e}{dw}w = 0 \tag{18}$$

Applying envelope theorem, we find that

$$\frac{dU_e}{dw} = \frac{\partial U_e}{\partial w} + \frac{\partial U_e}{\partial h}\frac{\partial h}{\partial w} = \frac{\partial U_e}{\partial w} = h(1-\tau) \tag{19}$$

Namely, when the working hours are determined optimally by the workers, as defined in (13), small changes in working hours do not change the utility of the workers. That is, $\frac{\partial U_e}{\partial h} = 0$. Therefore, we may express the first order condition conveniently as

$$-(U_e - U_u)\epsilon + wh(1-\tau) = 0 \tag{20}$$

where

$$\epsilon \equiv -\frac{dN}{dw}\frac{w}{N} = -\frac{\partial N}{\partial w}\frac{w}{N} - \frac{\partial N}{\partial h}\frac{\partial h}{\partial w}\frac{w}{N} \equiv \epsilon^d + \epsilon^s > 0 \tag{21}$$

[3] A thorough analysis of the various arrangements for taxing unemployment benefits and their effects in the trade union model with exogenous labour supply is provided in Koskela & Schöb (1999).

denotes the total elasticity of labour demand with respect to wage and it constitutes of both the direct and the indirect effect of wage on labour demand.

Substituting $(U_e - U_u)$ from (10) into the first order condition we obtain

$$\begin{aligned} -(U_e - U_u)\epsilon + wh(1-\tau) &= 0 \\ &\Leftrightarrow \\ -\left[wh\,(1-\tau) - w_u(1-\tau_u) - v(h)\right]\epsilon + wh(1-\tau) &= 0 \\ &\Leftrightarrow \\ (1-\epsilon)\,(1-\tau)\,wh + \epsilon\,(w_u(1-\tau_u) + v(h)) &= 0 \qquad (22) \end{aligned}$$

Solving for wage yields then

$$\begin{aligned} w(h) &= \frac{w_u(1-\tau_u) + v\,(h)}{h\,(1-1/\epsilon)\,(1-\tau)} \\ &= \frac{1}{(1-1/\epsilon)}\left[\frac{(1-\tau_u)w_u}{(1-\tau)\,h} + \frac{v\,(h)}{(1-\tau)\,h}\right] \qquad (23) \end{aligned}$$

Equation (23) gives the union wage for fixed working hours. It decomposes the wage rate to that prevailing in the conventional monopoly union model with zero disutility labour and perfectly inelastic labour supply ($h = 1$) and an additional term allowing for the disutility of labour. With total elasticity of labour demand with respect to wage greater than one ($\epsilon > 1$), the additional term is positive i.e. the wage rate is higher if the disutility of labour is allowed for. The last line of (23) suggests that the monopoly union wage is a mark up over the reservation wage of its members. The size of the mark up, determined by the first term in the right hand side of (23), depends on the elasticity of labour demand. With endogenous labour supply the reservation wage, captured by the term within square brackets, consists of unemployment pay per hour and the value of lost leisure "gross of tax".

3.1 Equilibrium

Given the decision rules for wages (23), hours supplied (13) and employment (5) we can now determine the labour market equilibrium. Substituting for $v(h) = \frac{1}{\delta}h^{\delta}$ and solving the set of two equations (23) and (13) yields

$$w = (1-\tau)^{-1}\,(1-\tau_u)^{\frac{\delta-1}{\delta}}\left(\frac{w_u}{1-1/\delta-1/\epsilon}\right)^{\frac{\delta-1}{\delta}} \qquad (24)$$

$$h = (1-\tau_u)^{\frac{1}{\delta}}\left(\frac{w_u}{1-1/\delta-1/\epsilon}\right)^{\frac{1}{\delta}} \qquad (25)$$

Recalling (5) and substituting (24) and (25), respectively, yields the equilibrium level of employment

$$N = (\gamma\,(1-\tau))^{\frac{1}{1-\gamma}}\left(\frac{(1-\tau_u)\,w_u}{1-1/\delta-1/\epsilon}\right)^{-\frac{\delta-\gamma}{\delta(1-\gamma)}} \qquad (26)$$

Using (24) and (25) the after tax earnings of an employed worker can be expressed conveniently as

$$y_e \equiv wh(1-\tau) = \frac{(1-\tau_u)\, w_u}{1 - 1/\delta - 1/\epsilon} \tag{27}$$

Consequently, we can express w, h and N as functions of the after tax income as follows

$$w = (1-\tau)^{-1} y_e^{\frac{\delta-1}{\delta}} \tag{28}$$

$$h = y_e^{\frac{1}{\delta}} \tag{29}$$

$$N = ((1-\tau)\,\gamma)^{\frac{1}{1-\gamma}}\, y_e^{-\frac{\delta-\gamma}{\delta(1-\gamma)}} \tag{30}$$

3.2 Tax policy

Let us now consider the effects of changes in the wage tax, τ, on the equilibrium values of wages, working hours and employment. Noticing from (27) that $\partial y_e / \partial \tau = 0$, the above formulas directly imply that

$$\frac{\partial w}{\partial \tau} > 0 \tag{31}$$

$$\frac{\partial N}{\partial \tau} < 0, \; \frac{\partial h}{\partial \tau} = 0 \tag{32}$$

In the face of tax change, optimal response of the union is to keep the after tax wage constant (28). Thus, there is a complete after tax wage resistance, or in other words, tax changes are completely borne by the employer. This is the conventional result of the monopoly union model (e.g. Holmlund et al, 1989). Since the after wage determines supply of hours, the latter is unaffected by the changes in taxes in the equilibrium. Notice that we can express (24) alternatively as

$$w = (1-\tau)^{-\frac{1}{\delta}} (\tau^*)^{\frac{\delta-1}{\delta}} \left(\frac{w_u}{1 - 1/\delta - 1/\epsilon} \right)^{\frac{\delta-1}{\delta}} \tag{33}$$

where $\tau^* \equiv \left(\frac{1-\tau_u}{1-\tau}\right)$. This formulation suggests that the effect of wage taxes on the wage rate comes from two separate channels. The first is related to the individual supply of labour hours and is reflected by the first term in the right hand side of (33): higher wage tax makes leisure more valuable. The second effect is related to the union's incentive to set a gross wage as a mark-up of the reservation wage: higher wage tax has an additional effect to the extent that it increases the after tax value of unemployment benefits ($\partial \tau^* / \partial \tau$). If the tax rate on unemployment benefits is increased accordingly[4], the latter effect disappears. However, contrary to the model with exogenous labour supply, the wage tax has a negative effect on employment even if $\tau_u = \tau$. Notice also that when considering the effects of pure wage taxation we can set $\tau_u = 0$ without loss of generality.

[4]To be exact, taxation of benefits must be adjusted so that $\frac{1-\tau_u}{1-\tau}$ remains constant. This is of course so if we consider the special case where the two tax rates are identical by definition, $\tau_u \equiv \tau$.

4 Centralised Union and the Role of Public Expenditure

The above conventional results are valid in the world where the unions are large enough to negotiate wages of their members, but too small to bear the aggregate consequences of their action on the public expenditure. This section allows unions to see "beyond the budget constraint of the government". For simplicity, and without lost of generality, we abstract from unemployment benefit tax τ_u and assume that unemployment benefits are exogenously fixed in net terms. Consequently, the government budget constraint (15) now takes a simplier form

$$G = \tau whN - w_u(1 - N) \tag{34}$$

We assume that individuals and firms behave as above.[5] However, unions take into account the effect of wage policy on the government's budget. Formally, the union's problem can be expressed

$$\begin{aligned}
\underset{w}{max} V &= NU_e + (1 - N)\,U_u \\
& \quad s.t. \\
N &= n(w, h(w)) \\
U_e &= u\,(w, h\,(w)\,, G) \\
U_u &= u\,(w_u, G) \\
G &= g(w, h(w), N)
\end{aligned} \tag{35}$$

We will next provide a detailed solution for the centralised union's maximisation problem. Remembering again that the union's utility can be written

$$V = N(U_e - U_u) + U_u$$

we can express the first order condition as follows

$$\frac{dV}{dw} = (U_e - U_u)\frac{dN}{dw} + N(\frac{dU_e}{dw} - \frac{dU_u}{dw}) + \frac{dU_u}{dw} = 0 \tag{36}$$

Notice that now $\frac{dU_u}{dw}$ enters into the first order condition because U_u is affected by the changes in wage w through the public good G. Let us first consider the total derivative $\frac{dU_e}{dw}$ in (36). This can be written

$$\frac{dU_e}{dw} = \frac{\partial U_e}{\partial w} + \frac{\partial U_e}{\partial h}\frac{\partial h}{\partial w} + \frac{\partial U_e}{\partial G}\frac{dG}{dw} = \frac{\partial U_e}{\partial w} + z_G\frac{dG}{dw} \tag{37}$$

[5] Calmfors and Driffill (1988) argue that labour demand elasticity is likely to change when wage setting becomes more centralised. Since our focus is on the wage formation mechanism as such, we assume that the external conditions are invariable.

where $z_G = \frac{\partial z(G)}{\partial G}$. This holds because $\frac{\partial U_e}{\partial h} = 0$, that is, when individual workers make labour supply decision optimally small changes in hours leave their utility intact. The derivative $\frac{dU_u}{dw}$, in turn, collapses to

$$\frac{dU_u}{dw} = \frac{\partial U_u}{\partial G}\frac{dG}{dw} = z_G \frac{dG}{dw} \tag{38}$$

because, we have assumed that w_u is fixed. Here z_G denotes a marginal utility of public good, which is assumed to be the same for both workers and unemployed. Notice immediately that the degree of "encompassment" i.e. the degree in which the centralized union compensates the effect of its wage on public good depends crucially upon z_G. For $z_G = 0$, individual workers would not gain any utility from public good and therefore (37) and (38) would actually be equal to those derived in decentralised union case. On the contrary, for $z_G > 1$, the centralized union would have incentive to "overcompensate" the effect of its wage policy on the provision of public expenditure. Our assumption of $z_G < 1$ effectively rules out this possibility.

Substituting (37) and (38) into (36) the first order condition reduces to

$$\frac{dV}{dw} = (U_e - U_u)\frac{dN}{dw} + N\frac{\partial U_e}{\partial w} + z_G \frac{dG}{dw} = 0 \tag{39}$$

Remembering that $\frac{\partial U_e}{\partial w} = h(1-\tau)$ and multiplying both sides by $\frac{w}{N}$, we find that

$$\frac{dV}{dw}\frac{w}{N} = -(U_e - U_u)\epsilon + Nh(1-\tau)\frac{w}{N} + z_G \frac{dG}{dw}\frac{w}{N} = 0 \tag{40}$$

In the next step we totally differentiate the government's budget constraint. This yields

$$\frac{dG}{dw} = \frac{\partial G}{\partial w} + \frac{\partial G}{\partial h}\frac{\partial h}{\partial w} + \frac{\partial G}{\partial N}\left(\frac{\partial N}{\partial w} + \frac{\partial N}{\partial h}\frac{\partial h}{\partial w}\right)$$

Again multiplying both sides by $\frac{w}{N}$ and substituting yields a more convenient formulation with elasticities

$$\frac{dG}{dw}\frac{w}{N} = \frac{\partial G}{\partial w}\frac{w}{N} + \frac{\partial G}{\partial h}\frac{\partial h}{\partial w}\frac{w}{N} - \frac{\partial G}{\partial N}(\epsilon^d + \epsilon^s) \tag{41}$$

The middle term in the right hand side of (41) can be further developed to

$$\frac{\partial G}{\partial h}\left(\frac{\partial h}{\partial w}\frac{w}{h}\right)\frac{h}{w}\frac{w}{N} = \frac{\partial G}{\partial h}\frac{h}{N}\epsilon^s$$

Utilising the government budget constraint (34) to derive

$$\begin{aligned}
\frac{\partial G}{\partial w} &= \tau h N \\
\frac{\partial G}{\partial h} &= \tau w N \\
\frac{\partial G}{\partial N} &= \tau w h + w_u
\end{aligned}$$

expression (41) collapses to

$$\begin{aligned}\frac{dG}{dw}\frac{w}{N} &= \tau hw + \tau wh\epsilon^{s} - (\tau wh + w_{u})(\epsilon^{d} + \epsilon^{s}) \\ &= \tau hw\left(1 - \epsilon^{d}\right) - w_{u}\epsilon \end{aligned} \tag{42}$$

Substituting (42) into the union's first order condition (40), we get

$$\frac{dV}{dw}\frac{w}{N} = -(U_{e} - U_{u})\epsilon + h(1-\tau)w + z_{G}\left(\tau hw\left(1 - \epsilon^{d}\right) - w_{u}\epsilon\right) = 0 \tag{43}$$

Furthermore, substituting the utility difference (10) with $\tau_{u} = 0$ yields

$$-(wh(1-\tau) - v(h) - w_{u})\epsilon + wh(1-\tau) + z_{G}\left(\tau hw\left(1 - \epsilon^{d}\right) - w_{u}\epsilon\right) = 0 \tag{44}$$

which, when solved for the wage rate, yields the following wage rule for the centralised union

$$w_{c}(h) = \frac{v(h) + w_{u}(1 - z_{G})}{h\left((1 - 1/\epsilon)(1-\tau) + z_{G}\tau\left(\epsilon_{d} - 1\right)/\epsilon\right)} \tag{45}$$

It can be easily shown that (45) collapses to (23) when $z_{G} = 0$. When the public good has a positive marginal utility, $z_{G} > 0$, and $\epsilon^{d} > 1$, it easy to see that $w_{c}(h)$ is unambiguously decreasing in z_{G}. This represents a pure wage moderation effect of public expenditure. The centralised union realises that higher wages and the consequent drop in employment implies lower supply of the public good. This is so because of two reasons: First, with $\epsilon^{d} > 1$ tax revenues decrease. Second, spending on unemployment benefits increase. This is evident from the government's budget constraint (34). Notice importantly that at given labour supply, it is not anymore optimal for the unions to keep after tax wage constant in the face of tax changes.

4.1 Equilibrium revisited

Solving equilibrium wages and hours from the system of two equations, representing the wage rule as derived in (45) and supply of hours as derived in (13), we find that equilibrium wage, hours and employment (5) can be expressed analogously with the decentralised case (see Appendix A for details)

$$w_{c} = (1-\tau)^{-1}(y_{ec})^{\frac{\delta-1}{\delta}} \tag{46}$$

$$h_{c} = (y_{ec})^{\frac{1}{\delta}} \tag{47}$$

$$N_{c} = (\gamma(1-\tau))^{\frac{1}{1-\gamma}}(y_{ec})^{-\frac{\delta-\gamma}{\delta(1-\gamma)}} \tag{48}$$

However, net labour income y_{ec} now reads

$$y_{ec} \equiv w_{c}h_{c}(1-\tau) = \left(\frac{w_{u}(1 - z_{G})}{(1 - 1/\epsilon - 1/\delta) + z_{G}\frac{\tau}{1-\tau}\frac{\epsilon_{d}-1}{\epsilon}}\right) \tag{49}$$

Notice again that (49) collapses into gross labour income in the decentralised union case (27) when $z_G = 0$ and $\tau_u = 0$. It is immediately clear that with $0 < z_G < 1$

$$y_{ec} < y_e \tag{50}$$

In other words, the after tax income is lower in the centralised union case (for a formal proof see Appendix B) . The wage moderation effect implied by (49) is larger the higher is the marginal utility from public good. It is indeed easy to show that w_c in (46) is decreasing in z_G.

Due to the above general formulas, the levels of wages, hours and employment in the decentralised and centralized case can be compared by evaluating the net labour incomes (y_e and y_{ec}) in the two cases. Following propositions can be put forward

Proposition 1 *Gross wage will be lower in the centralized case* $w_c < w$

Proposition 2 *Individual workers supply less hours in the centralized case* $h_c < h$

Proposition 3 *Employment will be higher in the centralized case* $N_c > N$

Proof. Follows directly from (50) combined with (28-30) and (46-48). ■

4.2 Tax policy revisited

As noted above, the after tax labour earnings (49) now depend on the tax rate on wages, τ. Differentiating (49) with respect to the tax rate gives (see Appendix C for details)

$$\frac{\partial y_{ec}}{\partial \tau} < 0 \tag{51}$$

The after tax income of the employed workers is no longer immune to tax changes. On the contrary, higher tax leads to a lower take-home-pay for an individual worker. Therefore, as opposed to the decentralized case, after tax wage resistance is incomplete. The union now internalises the increases in public expenditure and does not fully compensate the tax increase by higher wages as was the case with the decentralized union. With the help of (51) comparative statistic results of tax policy can now be derived.

For technical convenience we define $\mu \equiv (1 - \tau)$ and differentiate with respect to μ rather than τ. With this notation and using (46) we can derive elasticity of wage with respect to the wage tax as follows

$$\frac{\partial w_c}{\partial \mu}\frac{\mu}{w_c} = \frac{(\delta - 1)\,\varepsilon_{y\mu}}{\delta} - 1 \tag{52}$$

where

$$\varepsilon^c_{y\mu} \equiv \frac{\partial y_{ec}}{\partial \mu}\frac{\mu}{y_{ec}} > 0$$

is the elasticity of after tax income with respect to (one minus) the wage tax as derived in Appendix C. It is evident from (52) that

$$\frac{\partial w_c}{\partial \mu}\frac{\mu}{w_c} > -1 \tag{53}$$

whereas in the decentralised case we have from (24)

$$\frac{\partial w}{\partial \mu}\frac{\mu}{w} = -1 \tag{54}$$

Consequently, the following proposition can be put forward.

Proposition 4 *In the face of a tax increase the wages increase less in the centralised than in the decentralised case .*

Proof. Follows directly from (53) and (54). ■

It is noteworthy that the elasticity is not constant in the centralised case but depends on the tax rate. According to (52) also the sign of wage response to taxes is a priori ambiguous. However, it can be shown (see Appendix D) that within the plausible range of parameter values

$$\frac{\partial w_c}{\partial \tau} > 0 \tag{55}$$

In other words, tax increase leads to increase in the gross wage. What comes to working hours supplied, it follows directly from (47) and (51) that hours supplied declines in response to higher taxes

$$\frac{\partial h}{\partial \tau} < 0 \tag{56}$$

This outcome is evident also by (53). The drop in the after tax wage due to higher tax rate is not offset by a corresponding increase in the gross wage. Consequently, labour supply declines.

Finally, we are interested in response of equilibrium employment on the wage tax. Utilizing (48), we can express the elasticity of employment with respect to the wage tax as

$$\frac{\partial N^c}{\partial \mu}\frac{\mu}{N^c} = \epsilon_d\left(1 - \frac{\delta-\gamma}{\delta}\varepsilon^c_{y\mu}\right) \tag{57}$$

where

$$1 - \frac{\delta-\gamma}{\delta}\varepsilon^c_{y\mu} < 1$$

Remembering that in the decentralized case, by (30), the very same elasticity is

$$\frac{\partial N}{\partial \mu}\frac{\mu}{N} = \epsilon_d \tag{58}$$

we can conclude that

Proposition 5 *Higher wage taxes are less harmful for employment in the centralized union case.*

Proof. Follows from (57) and (58). ■

In other words, an equal proportional increase in the tax rate causes a smaller drop in employment in the centralised case. Moreover, the sign of the $\frac{\partial N^c}{\partial \tau}\frac{\tau}{N^c}$ is ambiguous and employment may even improve in the centralised case. The following condition can be derived (see Appendix E)

$$\frac{\partial N^c}{\partial \tau}\frac{\tau}{N^c} \lesseqqgtr 0 \Longleftrightarrow z_G \lesseqqgtr \frac{(1-\tau)(\delta-1)}{\delta(1-\tau)-\gamma} \equiv z_G^* \tag{59}$$

This result implies the following proposition

Proposition 6 *If the marginal utility from public good is sufficiently high, precisely $z_G > z_G^*$, a tax increase will lead into higher employment in the centralized system.*

Proof. See Appendix E. ■

In this case it is the relatively large decline in labour supply that dictates the increase in employment. In the centralised case the union is giving up some after tax wage in the face of an increased wage tax. Increase in gross wage is not enough to compensate for higher taxes and consequently, employed workers cut their labour supply. The employers, in turn, face two shocks with opposite effects on employment. Wages increase, but hours supplied per head decline. Whether employment decreases or increases depends on the relative magnitude of these shocks. For a given increase in the tax rate, the increase in the wage is inversely related to the marginal utility of public good, z_G. Thus, higher z_G leads to a more moderate gross wage increase and correspondingly to a relatively large decline in the hours due to deteriorated net wage. With high enough valuation of the public good, the supply effect dominates and employment improves. It is noteworth that according to (59) the critical level of the marginal utility of the public good, z_G^*, depends positively on the tax rate. Thus, the higher the initial level of taxation, the higher marginal utility of public good is needed for tax increases to boost employment.

5 Concluding Remarks

This paper has studied the relationship between labour taxation and the degree of centralisation in a monopoly union model with endogenous labour supply. In the model with decentralised wage formation, we showed that higher taxes increase wages and reduce employment even if unemployment benefits are taxed equally with labour income. Compared to the decentralised case, centralised wage determination exhibits wage moderation effect, which arises from internalisation of the government's budget constraint. Hours worked will be lower and employment higher in the centralised union case.

Furthermore, we show that both wages and employment are less sensitive to changes in the wage tax in the centralised case. However, wage taxes not only has smaller negative effect on employment in the centralised case, but it can even improve employment if the marginal utility from public good is sufficiently large.

Our results suggest that both the elasticity of wages as well as the elasticity of employment with respect to the wage tax are functions of the wage tax rate itself in the centralised union case. Consequently, when estimating these elasticities from the real data, our results would encourage the use of non-linear estimation methods. Possible non-linearity might partially explain the reason why for instance Kiander et al (2000) fail to find statistically significant relationship between average effective labour tax rates and unemployment in the corporatist OECD countries.

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Appendix

A Equilibrium in the centralised case

The solution can be found by solving system of the two equations (45) and (13). First, substituting (45) into (13) and solving for h gives after some manipulations

$$h = \left(\frac{\epsilon w_u \delta (1 - z_G)(1 - \tau)}{(\epsilon\delta - \delta - \epsilon)(1 - \tau) + \tau\delta z_G (\epsilon_d - 1)} \right)^{\frac{1}{\delta}} \tag{A.1}$$

Substituting this into the wage rule (45) and re-arranging yields

$$w = (1 - \tau)^{-\frac{1}{\delta}} \frac{(\epsilon w_u \delta (1 - z_G))^{1 - \frac{1}{\delta}}}{((\epsilon\delta - \delta - \epsilon)(1 - \tau) + \tau\delta z_G (\epsilon_d - 1))^{\frac{\delta - 1}{\delta}}} \tag{A.2}$$

Then multiplying the two and $(1 - \tau)$ yields the after tax income as expressed in (49)

$$\begin{aligned} y_{ec} &\equiv wh(1 - \tau) \\ &= \frac{w_u (1 - z_G)}{(1 - 1/\epsilon - 1/\delta) + \frac{z_G(\epsilon_d - 1)}{\epsilon(1 - \tau)}} \end{aligned} \tag{A.3}$$

Substituting this into (45), (13) and (5) in turn gives the expressions (46), (47) and (48) for wages, hours and employment respectively.

B Proof of result (50)

The level of employment is higher in the case of centralized unions compared to decentralized case

Proof.

$$\begin{aligned} y_{ec} &< y_e \;\forall\; \gamma < 1, \delta > 1 \\ &\Leftrightarrow \\ \frac{1 - z_G}{(1 - 1/\epsilon - 1/\delta) + \frac{\tau}{1 - \tau} z_G (\epsilon - \epsilon_s - 1)/\epsilon} &< \frac{1}{1 - 1/\delta - 1/\epsilon} \end{aligned}$$

It is enough to realize that l.h.s collapses into r.h.s when $z_G = 0$ and that l.h.s is decreasing in z_G. Therefore for all $0 < z_G < 1$, $y_{ec} < y_e$. ■

C Proof of result (51)

With the definition of after tax income (49) at hand we show that it depends negatively on the wage tax in the equilibrium.

Proof. Using the notation $\mu \equiv (1-\tau)$ we have

$$\begin{aligned} \frac{\partial y_{ec}}{\partial \mu}\frac{\mu}{y_{ec}} &= \frac{\mu}{y_{ec}}\frac{\partial}{\partial \mu}\left(\frac{w_u\left(1-z_G\right)}{\left(1-1/\epsilon-1/\delta\right)+z_G\frac{1-\mu}{\mu}\frac{\epsilon_d-1}{\epsilon}}\right) \\ &= \left(\frac{1}{\frac{\epsilon\mu((1-1/\epsilon-1/\delta)}{z_G(\epsilon_d-1)}+(1-\mu)}\right) \end{aligned}$$

Substitute for $\epsilon^d - 1 = \frac{1}{1-\gamma} - 1 = \frac{1-(1-\gamma)}{1-\gamma} = \frac{\gamma}{1-\gamma}$ and $\epsilon = \epsilon^d + \epsilon^s = \frac{1}{1-\gamma} + \frac{1}{\delta-1} = \frac{\delta-\gamma}{(1-\gamma)(\delta-1)}$ and $-1/\epsilon = -\frac{(1-\gamma)(\delta-1)}{\delta-\gamma}$ to get

$$\begin{aligned} \varepsilon_{y\mu} &\equiv \frac{\partial y_{ec}}{\partial \mu}\frac{\mu}{y_{ec}} = -z_G\frac{\delta}{-\mu\delta - z_G\delta + \mu\delta z_G + \mu} \\ &= \frac{1}{\tau + \frac{(1-\tau)(\delta-1)}{z_G\delta}} > 0 \end{aligned}$$

Also notice that this implies

$$\frac{\partial y_{ec}}{\partial \tau}\frac{\tau}{y_{ec}} = -\frac{\tau}{(1-\tau)}\frac{1}{\tau + \frac{(1-\tau)(\delta-1)}{z_G\delta}} < 0 \tag{A.4}$$

■

D Proof of result (55)

According to (55) wages always increase if the wage tax is increased.

Proof. Using (49) we can derive

$$\frac{\partial w}{\partial \mu}\frac{\mu}{w} = (1 - 1/\delta)\,\varepsilon_{y\mu} - 1$$

Substituting the formula for $\varepsilon_{y\mu} \equiv \frac{\partial y_{ec}}{\partial \mu}\frac{\mu}{y_{ec}} > 0$ as derived above yields

$$\begin{aligned}
\frac{\partial w}{\partial \mu}\frac{\mu}{w} &= \frac{(\delta - 1)}{\delta}\left(\frac{1}{\tau + \frac{(1-\tau)(\delta-1)}{z_G \delta}}\right) - 1 \\
&= \left(\frac{\delta - 1}{\delta\tau + \frac{(1-\tau)(\delta-1)}{z_G}}\right) - 1
\end{aligned}$$

In order for wages to decrease if tax rate is increased we must have

$$\begin{aligned}
\frac{\partial w}{\partial \mu}\frac{\mu}{w} &= \left(\frac{\delta - 1}{\delta\tau + \frac{(1-\tau)(\delta-1)}{z_G}}\right) - 1 > 0 \\
\left(\frac{\delta - 1}{\delta\tau + \frac{(1-\tau)(\delta-1)}{z_G}}\right) &> 1 \\
\delta - 1 &> \delta\tau + \frac{(1-\tau)(\delta-1)}{z_G} \\
(\delta - 1 - \delta\tau)\, z_G &> (1-\tau)(\delta-1)
\end{aligned}$$

First, notice that above implies that necessary condition for $\frac{\partial w}{\partial \mu}\frac{\mu}{w} > 0$ is that

$$\begin{aligned}
\delta - 1 - \delta\tau &> 0 \\
\tau &< \frac{\delta - 1}{\delta} = 1 - 1/\delta
\end{aligned}$$

and sufficient condition is that

$$z_G > \frac{(1-\tau)(\delta-1)}{\delta(1-\tau) - 1} \equiv z^*_{Gw}$$

In order for $z^*_{Gw} \leq 1$ we must have that

$$\begin{aligned}
\frac{(1-\tau)(\delta-1)}{\delta(1-\tau) - 1} &\leq 1 \\
(1-\tau)(\delta-1) &\leq \delta(1-\tau) - 1 \\
-(1-\tau) &\leq -1 \\
\tau &\leq 0
\end{aligned}$$

which is contradictory. Thus we conclude that with strictly positive tax rate, tax increase cannot lead to an increase in the wage rate unless $z_G > 1$, which we rule out by assumption. ■

E Proof of result (59)

In result (59) we argue that employment can improve in response to higher taxes if the marginal utility of the public good is high enough.

Proof. Using (48) in the main text, the elasticity can be written

$$\begin{aligned}\frac{\partial N^c}{\partial \tau}\frac{\tau}{N^c} &= \left(\frac{1}{1-\gamma}N\frac{1}{1-\tau}+\frac{\gamma-\delta}{\delta(1-\gamma)}N\frac{1}{y_{ec}}\frac{\partial y_{ec}}{\partial \tau}\right)\frac{\tau}{N}\\ &= \left(-\frac{1}{1-\gamma}\frac{\tau}{1-\tau}-\frac{\delta-\gamma}{\delta(1-\gamma)}\frac{\partial y_{ec}}{\partial \tau}\frac{\tau}{y_{ec}}\right)\end{aligned}$$

Remembering that by (A.4)

$$\frac{\partial y_{ec}}{\partial \tau}\frac{\tau}{y_{ec}} = \left(-\frac{z_G\delta\tau}{((\delta-1)(1-\tau)+z_G\tau\delta)(1-\tau)}\right) < 0$$

we can express the elasticity as

$$\frac{\partial N^c}{\partial \tau}\frac{\tau}{N^c} = \frac{1}{1-\gamma}\left(\left(\frac{(\delta-\gamma)z_G\tau}{((\delta-1)(1-\tau)+z_G\tau\delta)(1-\tau)}\right)-\frac{\tau}{1-\tau}\right)$$

Consequently,

$$\begin{aligned}\frac{\partial N^c}{\partial \tau}\frac{\tau}{N^c} &> 0\\ &\Leftrightarrow\\ \left(\frac{(\delta-\gamma)z_G\tau}{((\delta-1)(1-\tau)+z_G\tau\delta)(1-\tau)}\right) &> \frac{\tau}{1-\tau}\\ &\Leftrightarrow\\ \frac{(\delta-\gamma)z_G}{(\delta-1)(1-\tau)+z_G\tau\delta} &> 1\\ &\Leftrightarrow\\ z_G &> \frac{(1-\tau)(\delta-1)}{\delta(1-\tau)-\gamma}\equiv z_G^*\end{aligned}$$

where we assumed that $\tau < 1-\gamma/\delta$. Notice then that

$$\frac{\partial z_G^*}{\partial \tau} = \frac{(\delta-1)\gamma}{(-\delta+\delta\tau+\gamma)^2} > 0$$

In other words, the level of marginal utility of public good z_G needed for tax increases to boost employment is the higher, the higher the initial level of taxation. If the initial level of the wage tax $\tau > 1-\gamma/\delta$, tax increases cannot boost employment no matter how high z_G gets. It is noteworth that with plausible parameter values such that $0 < \tau < 1-\gamma$, z_G^* indeed lies in the interval $]0,1[$ and is within the defined range for z_G in the model. ■