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DOES CENTRALISED WAGE SETTING LEAD INTO HIGHER TAXATION?

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Abstract: This paper studies implications of centralised wage setting for the level of taxation and public expenditure in an analytical model with unionised labour markets. We extend the previous studies by allowing for both demand and supply effects of labour. Also, in addition to the standard social planner approach, we consider a political economy set up, where the tax rate is chosen to maximise the welfare of a median voter. Our results suggest that when working hours are endogenous, the relationship between the degree of centralisation and the labour tax rate is ambiguous. In particular, if the marginal utility from public provision is sufficiently low, centralised wage setting implies lower optimal tax rate on labour. This is due to a "budgetary discipline effect", which reduces the optimal tax rate preferred by the median voter under centralised wage setting.

Keywords: Taxation, wage setting, public expenditure.

Tiivistelmä: Tutkimuksessa tarkastellaan keskitetyn palkanmuodostuksen vaikutusta verojen ja julkisten menojen määräytymiseen. Tarkastelukehikko on ammattiliittomalli, jossa sekä työn kysyntä että työtuntien tarjonta määräytyvät endogeenisesti. Veroasteen määräytyminen perustuu vaihtoehtoisesti joko ns. suunnittelijan ongelman ratkaisuun tai mediaaniäänestäjän hyödyn maksimointiin. Tulosten mukaan keskitetyn palkanmuodostuksen vaikutus veroasteeseen riippuu olennaisesti työn tarjontaa, veron määräytymistä ja julkista hyödykettä koskevista oletuksista. Jos julkisen kulutuksen rajahyöty on alhainen, liittotasolle hajautettu palkanmuodostus voi johtaa korkeampaan veroasteeseen. Tämä on seurausta keskitetyn järjestelmän aiheuttamasta ”budjettikurivaikutuksesta”, joka pyrkii alentamaan mediaaniäänestäjän preferoimaa veroastetta.

Asiasanat: Verotus, palkanmuodostus, julkiset menot.

Contents

1 Introduction

A large body of political economy literature, ranging from basic median voter models to the models of comparative politics and political constitutions, provides a variety of theoretical explanations to the observed country differences in the structure of public spending and taxation[1]. At the same time, much less attention has been paid to the role of wage setting mechanism and labour market institutions in explaining these differences. This is somewhat surprising given the importance of labour taxes in financing the welfare spending in today's developed economies and the remarkable role of wage setting institutions in transmitting the effects of labour taxation to employment and efficiency.

This paper studies specifically whether the centralisation of wage setting affects the society's prefered level of labour taxes. In closely related paper, Summers, Gruger, and Vergara (1993) argue that centralised wage setting causes the "social planner" to prefer higher tax rate on labour income when compared to decentralised wage setting. The argument is based on the result that centralised wage setting internalises the government's budget constraint and thus makes labour taxation less distorting with respect to labour demand decisions [2]. Exploiting the same principle, Kilponen and Sinko (2001) show that the latter result also arises in a more realistic setup where both labour supply and demand effects are allowed for. In their model, labour supply is endogenised through individual choice of working hours, the monopoly union decides upon wages and the level of employment is determined by the profit maximising firms.

In this paper, we extend the analysis of Kilponen and Sinko (2001) by focusing on endogenous determination of the tax rate. The approach is novel in that we allow for endogenous supply of working hours and compare the results from the two alternative mechanisms of tax determination. In particular, we model the choice of optimal tax rate using two widely known alternatives: In the first one, a benevolent social planner chooses the optimal tax rate by maximising social welfare of the economy. In the second one, the optimal tax rate is decided by the median voter.

It turns out that the assumptions on labour supply and determination of taxes are decisive for the model's predictions on the preferred level of wage taxation. When the tax rate is chosen by the social planner and labour supply

[1] See for instance Persson and Tabellini (1999) for a review.

[2] This prediction has found support in a number of empirical studies suggesting that adverse employment effects of labour taxation are smaller in countries with centralised wage setting (Elmeskov (1998), Daveri & Tabellini, (2000), Kiander, Kilponen & Vilmunen (2000), Everaert & Heylen (2002)).

is exogenously fixed, the optimal tax rate is unambiguously higher in the centralised case in accordance with Summers *et al* (1993). This holds subject to some minor qualifications even if unemployment benefits are financed with tax revenues and labour supply decision by individual workers is allowed for.

In the median voter regime with endogenous labour supply, the relationship between the degree of centralisation in the wage setting and the optimal tax rate on wages is generally ambiguous. In fact, it is perfectly plausible that the median voter prefers a lower tax rate when wage setting is centralised. This result seems to be in line with the recent stylised facts on wage bargaining institutions and public finance: The average effective labour tax rate and public consumption in the countries with industry level wage bargaining structure have been somewhat higher when compared to countries with centralised wage setting during the last three decades.[3]

Rest of the paper is organised as follows. Section 2 sets up the model. Section 3 analyses the decision of optimal tax rate and section 4 concludes.

[3]For further discussion and empirical evidence, see Kiander *et al* (2000).

2 The Model Preliminaries

In this section, we briefly introduce the model equations that are utilised in section 3 to discuss the determination of optimal tax rate and the level of public spending[4]. We start by considering the following broad model of labour markets: Individuals choose working hours h taking the wage w as given; firms choose employment N taking wages and working hours as given; and, a monopoly union sets wages allowing for the response of both workers and firms.[5] Within this framework, the equilibrium wages, working hours and employment are sensitive to a number of assumptions that can be made on institutional structure of the economy, such as determination of taxes, unemployment benefits, other public expenditure and, not least, the degree of centralisation in the wage setting.

In the present set up, the question of the degree of centralisation boils down to the question of whether the monopolistic unions recognise the connection between wages and government budget.[6] If the unions operate mainly at industry level and there is no co-operation among the unions of different industries, it maybe plausible to assume that the unions treat the provision of public good as given. This is likely to characterize most of the advanced economies, except US, Canada and Great Britain, where a majority of workers are covered by industry level agreements (Wallerstein and Western, 2000). On the contrary, in some countries centralised wage contracts extend to several industrial sectors and cover almost entire private sector. In such countries[7], it is reasonable to assume that unions "see beyond the budget constraint of the government" and thus take account of the effects of wages on public finances, in particular on the provision of public good. This is particularly plausible if the government is either implicitly or explicitly involved in the wage setting process through the so called tripartite co-operation. In tripartite co-operation government typically provides incentives for wage moderation using tax and social policy instruments (See e.g. Vartiainen (1998)). In what follows, we refer to these two institutional setups as decentralised and centralised case, respectively.

[4] A more detailed derivation of the equations can be found in Kilponen & Sinko (2001)

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

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

[7] The Scandinavian countries and the Netherlands are examples of economies where such centralised contracts have been used for substantial periods of time (See for instance, Checci *et al* (2002), Golden (2002) and Wallerstein and Western (2000)).

2.1 Firm behaviour

The level of employment is determined by the competitive profit maximising firms, that solves the following problem

$$\max_{N} \Pi = f(Nh) - whN \tag{2.1}$$

For analytical simplicity, we assume that workers and hours are perfect substitutes in production so that our production function takes the form

$$f(Nh) = (Nh)^{\gamma} \ , \gamma < 1 \tag{2.2}$$

Under this assumption, the first order condition for profit maximisation can be solved for N to yield

$$N(w,h) = \left(\frac{\gamma}{w}\right)^{\frac{1}{1-\gamma}} h^{-1} \tag{2.3}$$

which is the demand for labour with $N_w < 0$, $N_h < 0$. Firms are not rationed in the labour market and employment always equals labour demand. From (2.3) we define

$$\epsilon^d \equiv -\frac{\partial \log N}{\partial \log w} = \frac{1}{1-\gamma} > 1 \tag{2.4}$$

which is the wage elasticity of employment with fixed working hours. Finally,

$$\frac{\partial \log N}{\partial \log h} = -1 \tag{2.5}$$

is the elasticity of employment with respect to working hours.

2.2 Individual behaviour and labour supply

As for the individuals, we normalise their total number to unity, out of which N are employed and $1-N$ are unemployed. The utility of employed individuals is evaluated by quasi-linear utility function

$$U_e = y_e - v(h) + z(G) \tag{2.6}$$

where y_e denotes after tax income (to be defined below) and $v(h)$ is some convex function denoting disutility from work with $v_h > 0, v_{hh} > 0, v(0) = 0$ and $v(1) < \infty$. We normalise total time endowment to unity, thereby $(1-h)$ is the time spent on other non-productive activities, such as leisure. $z(G)$ is a function, denoting utility from the publicly provided good, G. Throughout the paper we assume that public good has a constant positive marginal utility

less than one $0 < z_G < 1$. The assumption that the marginal utility of public good is less than unity implies that the marginal utility of private income is always higher than that of public good for the individual. The utility of unemployed individuals is given by

$$U_u = y_u + z(G) \tag{2.7}$$

Net labour incomes for employed (y_e) and unemployed (y_u) are defined as

$$\begin{aligned} y_e &= wh(1-\tau) \\ y_u &= w_u \end{aligned} \tag{2.8}$$

where w is the wage set by the union, w_u is an exogenous unemployment benefit net of taxes and h is hours worked. Finally, τ is the proportional tax rate on wages. For later use we note that the utility difference between the employed and unemployed can be expressed as

$$U_e - U_u = wh\,(1-\tau) - w_u - v(h) \tag{2.9}$$

We assume throughout the paper that $U_e - U_u$ is positive i.e. employed are better off than the unemployed and unemployment is thus involuntary. Once employed, individuals solve the following problem

$$\begin{aligned} & \max_h U_e \\ & s.t. \\ y_e &= wh(1-\tau) \end{aligned} \tag{2.10}$$

This yields the first order condition

$$(1-\tau)w - v'(h) = 0 \tag{2.11}$$

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

$$v(h) = \frac{1}{\delta}h^{\delta},\ \delta > 1 \tag{2.12}$$

Consequently, (2.11) yields

$$h = ((1-\tau)w)^{\frac{1}{\delta-1}} \tag{2.13}$$

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

$$\epsilon^s \equiv \frac{\partial \log h}{\partial \log w} = \frac{1}{\delta - 1} \tag{2.14}$$

Notice that our model encompasses the model with fixed working hours when $\delta \to \infty$. At this point, individual workers disutility from labour approaches zero and workers would supply fixed ($h = 1$) amount of labour as implied by (2.12) and (2.13).

2.3 Government budget

We assume that the government collects taxes on wages at rate τ. Tax revenues are then used to finance costs of the unemployment benefits w_u and a publicly provided good, G.[8] Consequently, the government budget constraint takes the following simple form

$$\tau whN = G + w_u(1 - N) \tag{2.15}$$

where w, h and N are wages, hours worked and employment as defined above. For simplicity, we do not allow the government to balance its budget by debt. With fixed unemployment benefit per capita, the level of public good is endogenous and adjusts to satisfy the budget constraint.

2.4 Labour market equilibrium

Traditionally, in similar models wages are set by a decentralised utilitarian monopoly union, which is small enough not to take into account the consequences of their wage policy on aggregate economy. The unions have been granted a right to negotiate the wages of their members but not hours. They act as Stackelberg leaders, setting the wage of their members and letting the firms and individuals decide over employment and hours, respectively. This implies that union considers the provision of public good as given.

Formally, the decentralised utilitarian union solves the following maximisation problem:

$$\begin{aligned} \max_{w} V &= NU_e + (1 - N)\, U_u \\ & \quad s.t. \\ N &= n(w, h(w)) \\ U_e &= u\,(w, h\,(w)) \end{aligned} \tag{2.16}$$

[8] We abstract from the effects on labour market of the production of G. Therefore, G can be interpreted as income transfers not related to labour market status.

The first order condition is

$$\frac{dV}{dw} = (U_e - U_u)\frac{dN}{dw} + N\frac{dU_e}{dw} = 0. \tag{2.17}$$

Expressing the first order condition conveniently in the elasticity form, applying the envelope theorem, using the total elasticity of labour demand with respect to wage ($\epsilon \equiv \epsilon^d + \epsilon^s$), and finally solving for the wage at given h, we find that

$$w(h) = \frac{1}{(1-1/\epsilon)}\left[\frac{w_u}{(1-\tau)\,h} + \frac{v\,(h)}{(1-\tau)\,h}\right] \tag{2.18}$$

Equation (2.18) decomposes the wage rate to that prevailing in the conventional monopoly union model with zero disutility of labour and inelastic labour supply ($h = 1$, $v(1) = 0$), 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 monopoly union wage is, in other words, 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 (2.18), depends on the elasticity of labour demand, but also on tax rate. With an endogenous labour supply the reservation wage, captured by the term within square brackets, consists of unemployment benefit paid per hour and the value of lost leisure gross of tax.

Given the decision rules for wages (2.18), hours supplied (2.13) and employment (2.3) the labour market equilibrium can be written as

$$w^* = (1-\tau)^{-1} y_e^{\frac{\delta-1}{\delta}} \tag{2.19}$$

$$h^* = y_e^{\frac{1}{\delta}} \tag{2.20}$$

$$N^* = ((1-\tau)\,\gamma)^{\frac{1}{1-\gamma}}\, y_e^{-\frac{\delta-\gamma}{\delta(1-\gamma)}} \tag{2.21}$$

where we have used an assumption that $v(h) = \frac{1}{\delta}h^\delta$ and where

$$y_e \equiv wh(1-\tau) = \frac{w_u}{1-1/\delta-1/\epsilon} \tag{2.22}$$

is the after tax earnings of an employed worker. Noticing from (2.22) that $\partial y_e/\partial\tau = 0$, equilibrium formulas directly imply that

$$\frac{\partial w^*}{\partial \tau} > 0 \tag{2.23}$$

$$\frac{\partial h^*}{\partial \tau} = 0 \tag{2.24}$$

$$\frac{\partial N^*}{\partial \tau} < 0 \tag{2.25}$$

In the face of tax change, optimal response of the monopoly union is to keep the after tax wage constant (2.19). 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 tax wage determines supply of hours, the latter is unaffected by changes in taxes in equilibrium.

2.5 Centralised Union

The previous case of decentralised wage setting characterises the labour market situation where wage setting takes place at industry level, without explicit or even de facto co-ordination among the unions. In this section, we turn to the alternative case, where an exclusive control over wages has been granted to confederation of unions or wage setting is well co-ordinated across industrial sectors. As already discussed above, in such a setup it is reasonable to assume that unions "see beyond the budget constraint of the government" and thus take account of the effects of wages on public finances, in particular on the provision of public good.[9]

Formally, the union's problem can be expressed as

$$\begin{aligned} \max_{w} V &= NU_e + (1-N)\,U_u \\ & \quad s.t. \\ N &= n(w, h(w)) \\ U_e &= u\left(w, h\left(w\right), G\right) \\ U_u &= u\left(w_u, G\right) \\ G &= g(w, h(w), N) \end{aligned} \tag{2.26}$$

Following a similar procedure as in the decentralised union case, but internalising the effect of wages on the provision of public good and differentiating the government's budget constraint, it is possible to derive the equations corresponding to (2.19)-(2.21) for the centralised case as follows

[9] 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.

$$w_c^* = (1-\tau)^{-1}(y_{ec})^{\frac{\delta-1}{\delta}} \tag{2.27}$$

$$h_c^* = (y_{ec})^{\frac{1}{\delta}} \tag{2.28}$$

$$N_c^* = (\gamma(1-\tau))^{\frac{1}{1-\gamma}}(y_{ec})^{-\frac{\delta-\gamma}{\delta(1-\gamma)}} \tag{2.29}$$

where net labour income y_{ec} now is

$$y_{ec} \equiv w_c h_c(1-\tau) = \left(\frac{w_u(1-z_G)}{(1-1/\epsilon-1/\delta)+z_G\frac{\tau}{1-\tau}\frac{\epsilon_d-1}{\epsilon}}\right) \tag{2.30}$$

Notably, (2.30) collapses into gross labour income in the decentralised union case (2.22) when $z_G = 0$. It is immediately clear that with $0 < z_G < 1$

$$y_{ec} < y_e \tag{2.31}$$

In other words, the after tax income is lower in the centralised union case[10]. It is indeed easy to show that w_c in (2.27) is decreasing in z_G. This represents a wage moderation effect of public good. The centralised union realises that higher wages and the consequent drop in employment imply a lower supply of public good. The wage moderation effect is larger, the higher is the marginal utility from public good.

With the notation adopted above, the levels of wages, hours, and employment in the decentralised and centralised case can be conveniently compared by evaluating the net labour incomes, y_e and y_{ec}, in the two cases. It immediately follows from (2.31) that the gross wage and the individual workers' labour supply will be lower while the level of employment will be higher in the centralised case when compared to decentralised case i.e. $w_c^* < w^*$, $h_c^* < h^*$ and $N_c^* > N^*$. Moreover, the after tax income (2.30) now depends negatively on the tax rate on wages, τ. Formally

$$\frac{\partial y_{ec}}{\partial \tau} < 0 \tag{2.32}$$

implying the dependency of wages and hours supplied on the tax rate as follows

$$\frac{\partial w_c^*}{\partial \tau} > 0 \tag{2.33}$$

$$\frac{\partial h_c^*}{\partial \tau} < 0 \tag{2.34}$$

[10] For a formal proof see Kilponen and Sinko (2001), Appendix B)

Noteworthy, the supply of hours now depends negatively on the tax rate. As suggested by Kilponen and Sinko (2001), this is due to the fact that the centralised union does not fully compensate the tax increase by higher wages and therefore supply of labour by individuals drops. This effect is essential for some of the results derived in the next section.

3 Endogenous tax rate

In the previous section, we have followed the model of Kilponen and Sinko (2001) and suggested that more centralised bargaining leads into lower wages and higher employment *at a given level of taxes*. In this section, we analyse the determination of labour tax rate within the model. In particular, we ask whether the degree of centralisation in the labour market affects the preferred level of taxation and public spending in the economy.

Generally, the government's problem may be expressed as one of choosing the optimal level of taxation when the tax revenue is used to finance the provision of some public goods. The specified model then implies a mapping from tax rate to tax revenue and the level of public provision. Since the tax is distortionary, individuals (and unions) tend to change their behaviour to avoid tax payments. Eventually, at high enough tax rate, say τ_L, this reaction becomes so strong that further increases in the tax rate will reduce the revenue and consequently, the amount of publicly provided goods.[11]

Extending this argument, it seems natural to assume that the public provision of goods and services is financed as a residual after the mandatory expenditure such as the unemployment benefits (see e.g. Sinko, 1999). In such set up, lower employment has two separate effects on the public provision: On the one hand, tax revenues are reduced. On the other hand, unemployment expenditures are increased. Both of the effects tend to narrow government's possibilities to provide other transfers, goods and services. One would expect that the public provision of these starts falling at a tax rate lower than the one which maximises tax revenue. This can indeed be demonstrated within our model, too.

In what follows we refer to the mapping from the tax rate τ to the public provision G as *the net Laffer curve*, which reaches the peak at some tax rate $\tau_G < \tau_L$. It seems reasonable to conjecture that the optimal tax rate in the model cannot exceed τ_G and thus must lie in the interval $[0, \tau_G]$.[12] For rates lower than τ_G, the government must balance the gains in terms of higher provision of public good against the losses in private welfare caused by the increased tax distortion.

The optimal choice of the labour tax rate then crucially depends upon the way the most preferred tax rate is chosen. The traditional choice is a view point of an all-encompassing social planner, that aims to maximise social welfare. However, this is not necessarily the only relevant alternative. It

[11] The hump-shaped relation between tax rate and revenue is known as "Laffer curve" according to Professor Arthur Laffer.

[12] With endogenous working hours, there might exist a special case where it would be optimal to choose $\tau^* > \tau_G$, provided that labour supply effect was strong enough.

might be reasonable to assume that the government objective would be to maximise the welfare of a "median voter", which is a common approach in the political economy literature. In what follows we develop both approaches, starting from the social planner case.

3.1 Social planner approach

In the framework of this paper, consider an all encompassing social planner, who maximises the social welfare of the economy (S). Social welfare consists of total output minus the disutility of labour devoted in its production, and any additional welfare due to the provision of public good. Formally,

$$S = f(N, h) - Nv(h) + (Pz_G - 1)G \tag{3.1}$$

where introduction of parameter P allows social marginal valuation of public good to differ from that of private. In particular, we are interested in the case $P > 1$, where social valuation of public provison exceeds its private valuation. Such a situation is likely to arise if the publicly provided good creates positive externalities or bears features of the so called merit goods. Given (3.1) changes in total welfare due to taxes can be expressed as

$$\frac{\partial S}{\partial \tau} = \frac{\partial f}{\partial \tau} - \frac{\partial [Nv(h)]}{\partial \tau} + (Pz_G - 1)\frac{\partial G}{\partial \tau} \tag{3.2}$$

According to this, taxation has two separate effects on welfare. First, taxation affects the level of total output and hours worked, reflected by the first two terms in the right hand side of (3.2). Second, taxation determines the share of total output devoted to provision of public good. This in turn affects welfare to the extent that marginal valuation of public provision differs from that of private consumption, $Pz_G \neq 1$. This effect is captured by the last term in the right hand side of (3.2).

For simplicity, consider first the case where supply of hours is exogenously fixed and unemployment benefits are financed from external sources. [13]With these simplifying assumptions, we are able to solve the first order condition analytically. Setting the right hand of (3.2) equal to zero, the first order condition for the optimal tax rate is

$$\frac{\partial f}{\partial \tau} + (Pz_G - 1)\frac{\partial G}{\partial \tau} = 0 \tag{3.3}$$

[13]The case of fixed working hours can be easily derived as a special case by letting $\delta \to \infty$ in the model's equations. Then $h = 1$ and $v(h) = 0$. Assuming that unemployment benefits are financed from external sources amounts to writing the government budget as $G = \tau whN$.

Notice that when $\frac{\partial f}{\partial \tau} \leq 0$, assuming $Pz_G > 1$ ensures that $\frac{\partial G}{\partial \tau} \geq 0$ i.e. that net Laffer curve is not downward sloping. Substituting for the corresponding variables from previous sections, we can derive (see Appendix A1 for details) the following expression for the optimal tax rate in the *decentralised* case:

$$\tau_d^* = \frac{Pz_G(1-\gamma)+\gamma-2}{Pz_G-1} \tag{3.4}$$

which is positive if $Pz_G > \frac{2-\gamma}{1-\gamma}$. Similarly (see Appendix A1), we can derive optimal tax rate in the *centralised* case as follows

$$\tau_c^* = \frac{2-z_G(1+P(1-\gamma))-\gamma}{(1-z_G)(1-Pz_G)} \tag{3.5}$$

which is positive if $Pz_G > \frac{2-(z_G+\gamma)}{1-\gamma}$. This implies that lower social valuation of the public good is needed to make the social planner's utility maximising tax rate positive in the centralised case. Finally, with the above formulas it is straightforward to derive the difference between the tax rate in the centralised and decentralised case

$$\tau_c^* - \tau_d^* = \frac{z_G(1-\gamma)}{1-z_G} > 0 \tag{3.6}$$

Thus the optimal tax rate in the centralised case is unambiguously higher for the given parameters. This difference is increasing in private marginal valuation of public good z_G, and as expected, when $z_G = 0$ the difference disappears. The following proposition can be stated:

Proposition 1 *If the supply of hours is fixed and unemployment benefit is financed from external resources, the optimal tax rate chosen by the social planner is higher under centralised wage setting* ($\tau_c^* > \tau_d^*$).

The result stated in proposition (1) in fact corresponds to the findings of Summers *et al.* (1993). As we add more realism to the model and let the unemployment benefits be financed from the tax revenue as well as allow endogenous working hours, derivations become more complicated. By relaxing the assumption of external financing of benefits, we can show that the prerequisite for a positive tax rate to emerge in centralised or decentralised case is that labour demand is not too elastic (see Appendix A2). Intuitively, if labour demand is very elastic, higher tax rate causes such a strong increase in unemployment spending that no positive tax rate can be optimal. Excluding this case, we can derive the following formula for the difference of the optimal tax rates in the two cases

$$\tau_{cu}^* - \tau_{du}^* = \frac{(1-2\gamma)z_G}{(1-\gamma)(1-z_G)} \tag{3.7}$$

which is positive for all $0 < \gamma < 0.5$. Condition $\gamma < 0.5$ implies labour demand elasticity being less than two, $\epsilon^d < 2$, which is also a necessary condition for positive optimal tax rates to emerge. Consequently, provided that labour demand is not too elastic, proposition (1) still holds. If labour demand elasticity is very high, implying $\gamma > 0.5$, then zero (or negative) tax rates would be optimal.

Finally, let us consider the general formulation with working hours determined by individual supply as defined in (2.13). In the centralised case, introduction of endogenous hours tends to reduce the welfare loss implied by a higher tax rate and therefore, *ceteris paribus*, increases the optimal tax rate chosen by the social planner. However, in the decentralised case, the equilibrium supply of hours is invariant to changes in the tax rate as can be seen from (2.24) and the optimal tax rate τ_d^* is not affected by the introduction of endogenous hours. Combining these notions, the gap between optimal tax rates in the two cases is a priori likely to be increased.

Since finding an analytical solution for the general formulation proved cumbersome, we had to rely on numerical simulations. It turned out that the relationship between the optimal tax rates in the two case critically depends on the elasticity of labour supply as well as the difference between social and private valuation of public good. Nevertheless, resticting the analysis to positive tax rates, decentralised wage setting leads into lower taxation than centralised one. Consequently, the proposition (1) holds even when labour supply is endogenous and unemployment benefits are financed from tax revenues and thus the result of Summers *et al* (1993) carries over to the present set up.

3.2 The "median voter" approach

In the previous section we assumed that taxes were determined to maximise the social welfare. Perhaps more realistically, we next study the determination of taxes and public good in the political economy set up, where the taxes are set to satisfy the median voter. For reasonable unemployment rates then, the optimal labour tax rate will be determined by an employed worker. Formally, recall first that the utility of an employed worker is

$$U_e = wh(1-\tau) - v(h) + z(G) \tag{3.8}$$

where $y_e = wh(1-\tau)$[14]. Totally differentiating (3.8) and using the fact that $v'(h) = w(1-\tau)$, the first order condition can be expressed conveniently as

$$z_G \frac{\partial G}{\partial \tau} = \frac{\delta - 1}{\delta} \frac{\partial y_e}{\partial \tau} \tag{3.9}$$

Notice that employment does not enter expression (3.9). This is due to the fact that an employed individual does not care about increased unemployment as long as his/her own job is secured. The only possible cost implied by higher taxation is the reduction in the take home pay, y_e. Optimal tax rate is set equal to the level at which private utility from marginal increase in public expenditure equals marginal loss in take-home-pay and marginal change in the value of leisure. The latter is due to endogenous labour supply.

Notice, however, that in the decentralised case the union keeps after tax wage constant i.e. $\frac{\partial y_e}{\partial \tau} = 0$. Therefore, the median voter's preferred tax rate in the decentralised case will be the one that maximises the public provision, as can be seen from (3.9).

In the centralised case $\frac{\partial y_e}{\partial \tau} < 0$ and higher taxes are reflected in a lower take home pay among the employed (since the union wage policy does not fully compensate the loss due to higher taxes). This brings about a "budgetary discipline effect" among employed workers, who are no longer willing to increase taxation to the level where public good provision is maximised. Consequently, we cannot say *a priori* whether the optimal tax rate for the median voter is higher or lower in the centralised case in comparison to the decentralised case.

Moreover, the most general case with endogenous working hours and unemployment benefits financed from the tax revenues proves cumbersome to be solved analytically. We therefore start with the most simple case where hours are fixed and unemployment benefits are financed from external sources. In this case, appendix A.3 shows that the optimal tax rate in the centralised and decentralised cases respectively reads as

$$\tau^*_{dm} = 1 - \gamma \tag{3.10}$$

$$\tau^*_{cm} = \frac{1-\gamma}{1-z_G} \tag{3.11}$$

Proposition 2 *When hours are fixed and unemployment benefits are financed from external sources, the median voter prefers higher tax rate under centralised wage setting* ($\tau^*_{cm} > \tau^*_{dm}$).

[14]Noteworthy, we follow the standard convention of trade union models that workers receive no capital income. The profits accrue to capital owners that do not supply working hours.

In other words, the principle stated in proposition (1) holds true also in the median voter case. Furthermore, from (3.11) we notice that the difference between optimal tax rates in the two cases is increasing in z_G. Utility gain from marginal increase in the public provision is proportional to its private marginal valuation. The centralised union takes this into account in its wage policy and thus the median voter's preferred tax rate will be increasing in the private marginal valuation of public provision, z_G.

In order to analyse the most general case with endogenous working hours and unemployment benefits financed with tax revenues, we rely on numerical simulations. We start with the benchmark where the uncompensated labour supply elasticity is $\epsilon^s = .25$, and wage elasticity of employment for fixed hours is $\epsilon^d = 1.7$. The unemployment benefit w_u is set equal to 0.1[15].

	τ^*	G/Y
Decentralised	40.1	15.4
Centralised	44.0	16.0

Table 1: Baseline simulations

Table 1 summarises the main results from the baseline simulations, where we have set $z_G = .57$. With this value of marginal utility of public good, we find out that optimal tax rate preferred by the employed worker in the centralized case would be around 4 percentage points higher than that in the decentralised case. In this simulation, the labour demand effect dominates the supply effect and due to low wage rate, the economy with centralised wage setting exhibits both higher employment and total production. Moreover, optimal tax rate and the public provision per total output is clearly higher in the centralised case.

Given that median voter preferred tax rate will be determined solely by the net Laffer curve in the decentralised case, it is of some interest to plot this curve for alternative values of labour supply elasticity. Figure (1) draws the net Laffer curves in the decentralised case with tax rate on the horizontal axis and public provision in excess of unemployment benefits on the vertical axis. The curves have the familiar inverted U-shape form. The preferred

[15] Although the rate of unemployment does not affect the optimal level of taxation in our model, it does affect the public good provided through the government's budget constraint. We have therefore calibrated the model such that at each given optimal tax rate, unemployment rate is roughly 10 per cent.

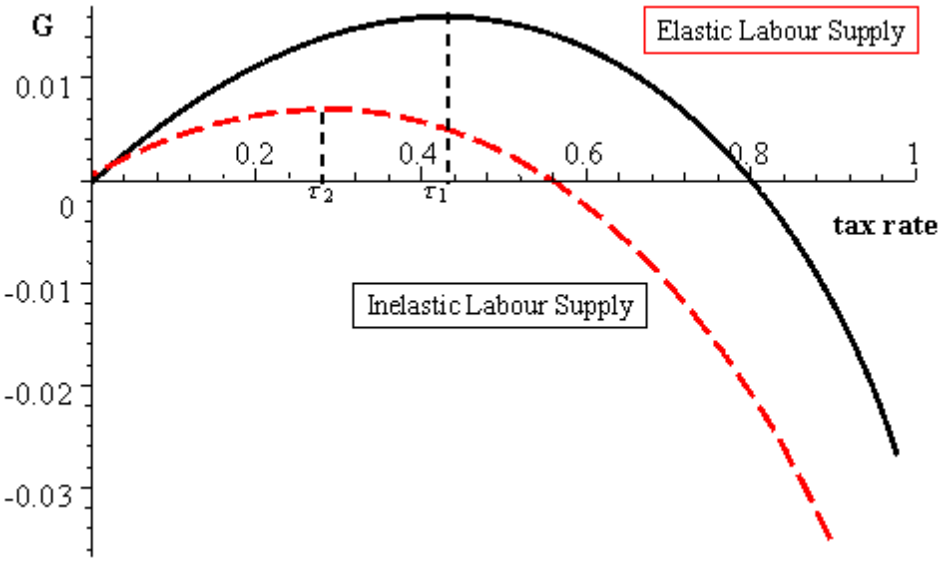

Figure 1: The net Laffer curves under elastic and inelastic labour supply in the decentralised case.

tax rate in the median voter case can be read on the horizontal axis directly beneath the stationary point of the curves. The figure reveals that more elastic labour supply makes the median voter prefer higher tax rate. When labour supply is very elastic ($\epsilon^s = 0.33$), the median voter preferred tax rate would be $\tau_1 = 0.43$, while with practically fixed working hours, the preferred tax rate would be at $\tau_2 = 0.28$.

Net Laffer curves in the centralised case have a similar inverted U-shape, but as can be seen from (3.9), the median voter does not choose the tax rate so as to maximise the public provision. We therefore need to rely on more specific simulations in this case.

In table 2, we simulate the centralised case for three alternative values of labour supply elasticity and for a range of values of private marginal valuation of public provision.

Recalling that the tax rates preferred by the median voter with inelastic, - semi-elastic and elastic labour supply are given by 0.28, 0.41 and 0.43 respectively, we see that in each case, it is possible that the median voter would actually prefer a lower tax rate in the centralised wage bargaining situation. The table also reveals that depending upon the private marginal valuation of public good, more elastic labour supply may either decrease or increase the tax rate preferred by the median voter in the centralised case.

This is in contrast to decentralised wage bargaining situation, where more

	Inelastic L. Supply $\varepsilon^s = 0.01$	Semi-Elastic L. Supply $\varepsilon^s = 0.25$	Elastic L. Supply $\varepsilon^s = 0.33$
z_G	τ_c^*	τ_c^*	τ_c^*
0.1	0.05	0.01	0
0.3	0.1	0.04	0.02
0.5	0.22	0.35	0.30
0.7	0.64	0.61	0.62
0.9	0.84	0.63	0.65
$\boldsymbol{\tau_d^*}$	**0.28**	**0.41**	**0.43**

Table 2: Optimal tax rate preferred by the median voter with alternative values of labour supply elasticity (ϵ^s) and marginal valuation of public good (z_G).

elastic labour supply monotonically increases the tax rate preferred by the median voter. Consequently, the more elastic labour supply, the less likely it is that the median voter would prefer higher tax rate in the centralised wage bargaining case when compared to decentralised one. In particular, the combination of relatively low private marginal valuation of public provision and elastic labour supply, is likely to lead to higher optimal tax rates in the decentralised case. These findings can be summarised by the following proposition:

Proposition 3 *When working hours are determined by individual supply, labour supply elasticity is high and private valuation of public goods is low, the median voter is likely to prefer a lower tax rate under centralised wage setting* ($\tau_{cm}^* < \tau_{dm}^*$).

4 Concluding remarks

If the unions are large enough to recognize a linkage between taxes and benefits received, they internalise the government's budget constraint in their wage policy and hence bear the cost of a wage hike in terms of reduced public provision of goods and services. This leads into more moderate wage responses to labor taxes and higher employment at a given level of taxation. Moreover, tax rates and the institutional setting of wage bargaining are likely to be inter-dependent. The seminal analysis by Summers *et al.* (1993) suggest that centralised wage setting is likely to encourage the provision of public goods and the use of labour taxes for financing public outlays. The authors then conjecture, that countries with centralised wage setting are likely to post higher tax rates on labour.

In this paper, we have extended this discussion into two directions. First, we have relaxed the assumption on exogenous labour supply and studied the decision on optimal labour tax rate in the model which allows both labour demand and supply effects. Second, in addition to traditional social planner approach, we have considered the determination of taxes in the political economy set up, where the tax rate is chosen to maximise the welfare of the median voter.

It turned out that endogenous labour supply and assumptions concerning the determination of tax rates are decisive for the model's predictions on the preferred level of labour taxation. The results derived under fixed labour supply and social planner regime do not necessarily carry over to more realistic set ups. In particular, our model suggests that under the median voter regime, the relationship between the degree of centralisation of wage bargaining and the optimal tax rate is ambiguous. Furthermore, it is perfectly plausible that the median voter prefers a lower tax rate when wage setting is centralised. This is due to the "budgetary discipline" effect that arises if wage setting is centralised: wage response to higher taxes is incomplete so that net labour income of median voter declines. This causes median voter to prefer a lower tax rate. This prediction of higher optimal tax rate in the case of decentralised wage setting seems to be in line with the stylised facts on wage bargaining institutions and public finance presented in Kiander *et al.* (2003). The average effective labour tax rate and public consumption in the countries with industry level wage bargaining structure have been somewhat higher when compared to countries with centralised wage setting institutions during the last three decades.

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A Derivations of optimal tax rates

A.1 Social planner

First consider the social welfare function in the case of exogenous working hours

$$S = f + (Pz_G - 1)\,G \tag{A.1}$$

with ue-benefits financed from external resources, the formula for the public good derived from (2.15) simplifies to

$$\begin{aligned} G &= \tau w N \\ &= \tau \gamma f \end{aligned} \tag{A.2}$$

where the second equality follows from utilising the first order condition of profit maximisation (2.3) and conveniently expresses the share of total production devoted to provision of the public good. Substituting into (A.1) and differentiating with respect to the tax rate yields the following first order condition for the optimal tax rate

$$\frac{f_\tau}{f} = -\frac{(z_G P - 1)\gamma}{1 + (z_G P - 1)\gamma\tau} \tag{A.3}$$

The left hand side can be developed to a more useful form by utililising the definition of the production function (2.2) implying $f = N^\gamma$ and $f_\tau = \gamma N^{\gamma-1}\left(\partial N/\partial\tau\right)$. Substituting this for $\frac{f_\tau}{f}$ and rearranging yields the following expression of the first order condition

$$\frac{\partial N}{\partial \tau}\frac{\tau}{N} = -\frac{\tau(z_G P - 1)}{1 + (z_G P - 1)\gamma\tau} \tag{A.4}$$

where the left hand side is the elasticity of equilibrium employment with respect to the tax rate and depends on the degree of centralisation in the wage formation. In particular, for the decentralised case

$$\frac{\partial N}{\partial \tau}\frac{\tau}{N} = -\frac{\tau}{(1-\tau)\,(1-\gamma)} \tag{A.5}$$

Substituting (A.5) into (A.4) and solving for τ then yields the optimal tax rate for the decentralised case

$$\tau_d^* = \frac{z_G P\,(1-\gamma) + \gamma - 2}{z_G P - 1}$$

As for the centralised case the elasticity formula is somewhat more complicated and reads as

$$\frac{\partial N}{\partial \tau}\frac{\tau}{N} = \frac{1}{1-\gamma}\left(\frac{\tau(1-z_G)}{\tau\left(1-z_G\right)-1}\right) \tag{A.6}$$

Again, substituting above into (A.4) and solving for τ yields the optimal tax rate in the centralised case

$$\tau_c^* = \frac{2 - z_G\left(1 + P\left(1-\gamma\right)\right) - \gamma}{\left(1-z_G\right)\left(1-z_G P\right)}$$

A.2 Derivation of result (45)

With UI benefits financed with taxes, we have

$$\tau_{cu}^* = \frac{2 - z_G\left(P+1\right) - 2\gamma\left(1-z_G P\right)}{\left(1-z_G\right)\left(1-z_G P\right)\left(1-\gamma\right)} \tag{A.7}$$

$$\tau_{du}^* = \frac{z_G P\left(2\gamma-1\right) + 2\left(1-\gamma\right)}{\left(1-\gamma\right)\left(1-z_G P\right)} \tag{A.8}$$

Set τ_{cu}^* to zero and solve for γ

$$\begin{aligned} \tau_{cu}^* &= 0 \\ &\Longleftrightarrow \\ \gamma &= \frac{z_G\left(P+1\right)-2}{2Pz_G-2} \end{aligned} \tag{A.9}$$

notice that

$$\frac{\partial \tau_{cu}^*}{\partial \gamma} = -\frac{z_G\left(P-1\right)}{\left(1-z_G\right)\left(z_G P-1\right)\left(\gamma-1\right)^2} < 0 \tag{A.10}$$

i.e. optimal tax rate in the centarlised case is decreasing in γ. For $\tau_{cu}^* > 0$ we must have

$$\gamma < \frac{z_G\left(P+1\right)-2}{z_G 2P-2} \equiv \gamma_{cc} \tag{A.11}$$

Similarly, for the decentralised case we have

$$\begin{aligned} \tau_{du}^* &= 0 \\ &\Longleftrightarrow \\ \gamma &= \frac{Pz_G-2}{2Pz_G-2} \end{aligned} \tag{A.12}$$

and

$$\frac{\partial \tau_{du}^{*}}{\partial \gamma} = -\left(z_G P - 1\right)^{-1} \frac{\partial}{\partial \gamma}\left(\frac{z_G P\left(2\gamma - 1\right)}{\left(1-\gamma\right)}\right) < 0 \tag{A.13}$$

i.e. optimal tax rate in the centarlised case is decreasing in γ. Therefore, for a positive tax rate to emerge we must have

$$\gamma < \frac{P z_G - 2}{2P z_G - 2} \equiv \gamma_{cd} = \gamma_{cc} - \frac{1}{2}\frac{z_G}{z_G P - 1} \tag{A.14}$$

Thus, for positive tax rates to emerge in both decentralised and centralised case we must have

$$\gamma < \gamma_{cd} \tag{A.15}$$

But can we somehow derive a restriction $\gamma < 0.5$? Let us impose the restriction

$$P > \frac{2}{z_G} \tag{A.16}$$

which is sufficient for both γ_{cd} and γ_{cc} being positive i.e. that there exist $0 < \gamma < 1$ such that $\tau_{iu}^{*} > 0 \ \forall \gamma < \gamma_{ci}$. Then notice that $\frac{\partial \gamma_{cc}}{\partial P} > 0$, $\frac{\partial \gamma_{cd}}{\partial P} > 0$ and

$$\begin{aligned} \lim_{P\to\infty} \gamma_{cc} &= \lim_{P\to\infty}\left(\frac{z_G\left(P+1\right)-2}{z_G 2P - 2}\right) \\ &= \frac{1}{2} \end{aligned} \tag{A.17}$$

and

$$\begin{aligned} \lim_{P\to\infty} \gamma_{cd} &= \lim_{P\to\infty}\left(\frac{P z_G - 2}{2P z_G - 2}\right) \\ &= \frac{1}{2} \end{aligned} \tag{A.18}$$

So, with this restriction we effectively confine ourselves within the interval $\gamma \in]0, \frac{1}{2}[$ where

$$\tau_{cu}^{*} - \tau_{du}^{*} = \frac{\left(1-2\gamma\right) z_G}{\left(1-\gamma\right)\left(1-z_G\right)} > 0 \tag{A.19}$$

A.3 Median voter

First notice that $\frac{\partial y_e}{\partial \tau} = 0$ in the decentralised case. This implies that the median voter preferred tax rate will be implicitly determined by the condition

$\frac{\partial G}{\partial \tau} = 0$. Utilising the first order condition of profit maximisation and rewriting the government's budget constraint as $G = \tau\gamma f$ when unemployment benefits are exogenously financed, we can write

$$\frac{\partial G}{\partial \tau} = 0 \tag{A.20}$$

$$\Leftrightarrow$$

$$\gamma f + \tau\gamma f_\tau = 0 \tag{A.21}$$

Furthermore, recall that $f = N^\gamma$ and $f_\tau = \gamma f/N(\frac{\partial N}{\partial \tau})$, when hours are fixed. Then (A.21) simplifies to

$$\frac{\partial N}{\partial \tau}\frac{\tau}{N} = -\frac{1}{\gamma} \tag{A.22}$$

Using $\frac{\partial N}{\partial \tau}\frac{\tau}{N} = -\frac{\tau}{(1-\tau)(1-\gamma)}$ in (A.22) and solving for τ, we find that

$$\tau^*_{dm} = 1 - \gamma \tag{A.23}$$

which is the optimal tax rate preferred by the median voter with exogenous labour supply and unemployment benefits financed from external sources in the decentralised case.

In the centralised case with exogenous working hours, we utilise the first order condition of the workers, which states that $(1-\tau)w = v'(1) = 1$. Consequently, when working hours are fixed the optimal tax rate preferred by the median voter will be implicitly determined by the condition $\frac{\partial G}{\partial \tau} = 0$ also in the centralised case. When unemployment benefits are financed from external sources, the condition (A.22) still holds with the difference that in the centralised case right hand side reads as $\frac{\partial N}{\partial \tau}\frac{\tau}{N} = \frac{\gamma}{1-\gamma}\left(\frac{(1-z_G)\tau}{\tau(1-z_G)-1}\right)$. Using this and solving (A.22) for τ delivers

$$\tau^*_{cm} = \frac{1-\gamma}{1-z_G}$$

which is the optimal tax rate preferred by the median voter in the centralised case with fixed working hours and unemployment benefits financed from external sources.

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