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PROGRESSIVE
TAXATION UNDER
CENTRALISED
WAGE SETTING

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Abstract: The study reconsiders the effects of tax progression in imperfectly competitive labour markets. Allowing for the individual supply of working hours, we show that the results derived in the standard model of decentralised wage bargaining do not hold if the wage setting is centralised or highly co-ordinated. We show that increased progression is more likely to harm employment if either i) the initial tax system is progressive or ii) the wage setting is centralised or co-ordinated. If the wage setting institutions are centralised or strongly co-ordinated, increased progression may be bad for employment even when departing from a proportional tax system.

Keywords: Tax progression, wage setting, employment.

Tiivistelmä: Tutkimuksessa tarkastellaan työtulojen progressiivisen verotuksen vaikutuksia olettaen, että palkoista päätetään kollektiivisesti ja työtuntien tarjonta perustuu yksilöiden päätöksiin. Osoittautuu, että veroprogressiolla on todennäköisemmin negatiivinen vaikutus työllisyyteen jos i) lähtötilanteessa vallitsee progressiivinen verotus tai ii) palkanmuodostus on keskitettyä tai koordinoitua. Keskitetyn palkanmuodostuksen tapauksessa progression lisääminen saattaa heikentää työllisyyttä, vaikka lähtötilanteen vero olisi proportionaalinen.

Asiasanat: Veroprogressio, palkanmuodostus, työllisyys.

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1 Introduction

Progressive labour income taxation has traditionally been justified by distributional goals, in particular achievement of vertical equity. When designing a tax system, the gains in equity would then need to be balanced against the losses in efficiency caused by the increased progression. More recently, advances in the study of imperfect labour markets has shown that tax progression is likely to bring about wage moderation and thereby reduce the involuntary unemployment. This result - arising in both trade union and efficiency wage models - suggests that in the economies showing high rates of unemployment, increased tax progression could be desirable even on the efficiency grounds.

The present paper challenges this view by arguing that increased progression is unlikely to improve employment in unionised labour markets if two plausible features of real economies is allowed for: We show that increased progression is likely to harm employment if either i) the initial tax system is progressive or ii) the wage setting is either centralised or well co-ordinated.

The employment effects of progressive labour taxation can be conveniently described with the help of two opposite effects: the *labour supply effect* and the *union effect*¹. In the competitive model, where only the former is present, higher progression causes a decrease in the individual as well as aggregate labour supply and consequently, an increase in the equilibrium wage. In a trade union model with fixed labour supply, the sole effect in work is the union effect: progressive taxation reduces the net gain to the union from a wage hike and therefore induces wage moderation. A trade union model with endogenous working hours provides a framework where the two effects can be analysed simultaneously.

These two effects facilitates the understanding of the existing literature on the effects of progressive taxation in unionised labour markets. In his pioneering work Herzoug (1984) finds a positive employment effect of progression in a monopoly union model with fixed working hours. A similar result is extended to the right-to-manage framework by Koskela and Vilmunen (1996). Holm et al (1997) show in monopoly union model with individual supply of hours that if utility is separable between consumption and leisure, an increase in progression departing from a proportional tax system improves employment. In other words, they suggest that under reasonable conditions, the

¹See e.g. Hansen et al (2000).

union effect is likely to dominate. This result is generalised to the right-to-manage model with individual supply of hours by Fuest and Huber (2000). Fuest and Huber (2000) and Hansen et al (2000) also show that the positive employment effect does not necessarily arise if bargain is over both wages and hours².

A completely separate branch of literature has analysed the implications of centralised or co-ordinated wage setting in unionised labour markets. In their pioneering work Calmfors and Driffill (1988) show that centralisation in the wage setting can potentially mitigate the adverse effects of imperfectly competitive labour markets through the internalisation of various externalities such as the effect of wages on the general price level. Summers, Gruber and Vergara (1993) operationalise this idea by identifying centralisation with the wage setting institutions' ability to perceive the linkage between labour taxes and the public provision of goods. This structure is suggested to bring about a more moderate response of wages to taxes and a better employment performance in the countries with centralised wage setting³. The findings of Summers et al (1993) are generalised to a union model with endogenous working hours by Kilponen and Sinko (2001), who also show that centralised wage setting is likely to lead to less working hours per employee.

To our knowledge, the implications of progressive taxation has not been analysed in the context of centralised wage setting, so far. This is somewhat surprising in the light of the fact that many countries with a relatively progressive income taxation also tend to be characterised by rather centralised labour market structures, as demonstrated in section 2 of this paper. From this point of view it seems interesting to combine the two branches of literature in an effort to find out whether the results on tax progression derived in the models with decentralised corporatism survive in the framework with centralised wage setting. Perhaps somewhat surprisingly, we show that they necessarily don't: the conditions under which progressive taxation improves employment are stricter in the case of centralised wage setting and may not be satisfied at all. Therefore, our results suggest that progressive taxation is less likely to be good for employment in countries with relatively centralised wage setting institutions.

²The wage moderation effect of tax progression has gained support in a number of empirical studies e.g. Lockwood and Manning, (1993), Holmlund and Kolm (1995), Aronsson et al (1997). However there is less evidence on positive employment effects.

³These findings are supported by the recent empirical studies on OECD economies. See e.g. Daveri and Tabellini (2000) and Kiander et al (2004).

We also utilise the same set up to review the results derived in the standard decentralised bargaining framework. Our findings emphasise the fact - to a large extent neglected in the existing literature - that even for the decentralised wage setting, positive employment effects may not arise if the initial tax system is already progressive. The importance of this notion is emphasised by the fact that of the 30 OECD countries reviewed in the next section only one had non-progressive labour taxation at the earnings level of an average production worker in the latter half of the 1990's.

The structure of the paper is as follows: In section 2 we review some stylised facts on the labour taxation and the structure of wage bargaining in the OECD countries and suggest an empirical measure for the inter-country comparison of tax progressivity. Section 3 introduces the basic model and re-establishes the results concerning progressive taxation under decentralised wage setting. Section 4 extends the framework to allow for centralisation in the wage setting and derives some new results. Concluding remarks are presented in section 5. A detailed derivation of some of the results can be found in the Appendices A-C.

2 Stylised Facts on Tax Progression and Centralised Wage Setting

Although the concept of progressive taxation is widely understood as a setting where the tax payments increase (more than proportionally) with the earned income, there is no unequivocal definition for tax progression. A prominent definition frequently used in the tax literature (e.g. Holmlund and Kolm, 1995, Sørensen, 1999) is based on the *coefficient of residual income progression* (CRIP) defined as

$$v \equiv \frac{1 - \tau_m}{1 - \tau_a} \quad (1)$$

where τ_a is the average tax rate and τ_m the marginal tax rate facing an individual. The tax schedule is said to be progressive (regressive) if $v < 1$ ($v > 1$). The special case of a proportional tax implies $v = 1$. It can be shown that comparing any two tax schedules, the one with lower v is more redistributive in the sense that the implied after-tax Lorenz curve lies everywhere inside the corresponding curve implied by the less redistributive tax schedule (Jakobsson, 1976).

The micro-based data from the member countries collected by the OECD suggests a convenient way to make the formula (1) operational. OECD reports the measures of the so called tax wedge at the income level of an average production worker (APW) in different countries. The tax wedge includes all taxes on labour income: the general income tax plus payroll taxes levied on both the employees and the employers. Most importantly, both average and marginal tax rates are reported. Utilising this information to calculate the coefficient of residual income progression provides a straightforward way to approximate the progressivity of labour taxation in different countries at the income level of a representative worker or employed union member.

	ta	tm	1/v		ta	tm	1/v
<i>Ireland</i>	29.8	49.7	1.41	<i>United Kingdom</i>	30.7	39.4	1.14
<i>Germany</i>	51.7	63.9	1.34	<i>Switzerland</i>	29.7	37.8	1.13
<i>Belgium</i>	56.2	67.0	1.33	<i>Greece</i>	35.7	43.0	1.13
<i>Finland</i>	47.3	58.9	1.28	<i>Spain</i>	38.2	45.1	1.12
<i>Luxembourg</i>	34.1	48.1	1.27	<i>Slovak Republic</i>	41.8	47.7	1.11
<i>Canada</i>	31.3	45.7	1.27	<i>Portugal</i>	33.3	39.9	1.11
<i>Netherlands</i>	42.4	53.9	1.25	<i>France</i>	48.1	53.1	1.11
<i>Austria</i>	45.3	56.1	1.25	<i>New Zealand</i>	20.0	27.5	1.10
<i>Iceland</i>	25.0	39.5	1.24	<i>Czech Republic</i>	43.0	48.1	1.10
<i>Norway</i>	34.4	45.9	1.2	<i>Japan</i>	22.8	28.3	1.08
<i>Australia</i>	24.3	36.5	1.19	<i>United States</i>	30.6	34.7	1.06
<i>Hungary</i>	49.9	57.9	1.19	<i>Poland</i>	43.1	45.4	1.04
<i>Italy</i>	47.5	55.8	1.19	<i>Korea</i>	15.4	18.8	1.04
<i>Denmark</i>	44.1	52.9	1.18	<i>Sweden</i>	49.6	51.1	1.03
<i>Mexico</i>	17.1	28.8	1.17	<i>Turkey</i>	39.5	36.6	0.96

Table 1: The 1997-2002 average of total tax wedge by country for APW100 single person on average (ta), at the margin (tm) and the inverse of CRIP (1/v). Source: OECD.

Table 1 shows the average and marginal tax wedge at the income level of an average production worker for an unmarried person⁴. The measure of

⁴OECD provides tax wedge data for alternative level of income as well as for different marital status. The choice of the variables affects the value of CRIP derived from the data and may change the ranking order of the countries. Nevertheless, the broad picture remains the same.

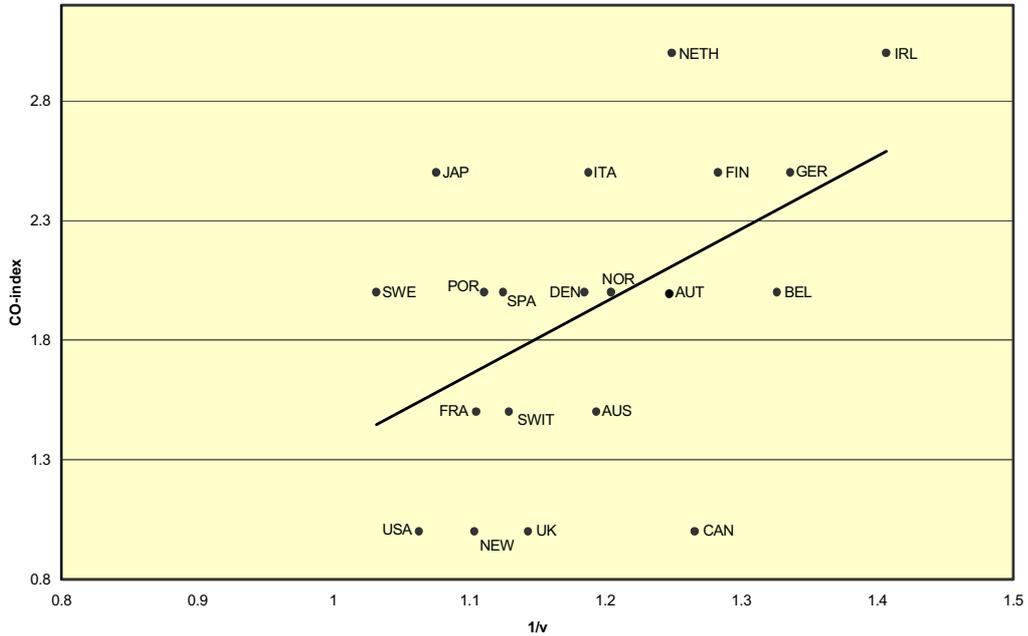


Figure 1: The correlation between progressivity of labour taxation and degree of co-ordination within the wage setting institutions. The figure shows a scatter diagram of the labour market co-ordination index for 1995-99 (Nickell, 2003) and the 1997-2002 average of the inverse of coefficient of residual income progression ($1/v$) calculated at the income level of an average production worker in a selection of 20 OECD countries.

tax progression $1/v$ is shown in the third column and is *increasing* with the progressivity of taxation. The table indicates that out of the 30 OECD countries included, only Turkey seems to have non-progressive labour taxation at this income level.

The empirical measurement of the degree of co-ordination within the wage setting behaviour is not a simple task. Nevertheless, a branch of literature has developed around the efforts to produce numerical indices that would capture the essential aspects and country differences in the workings of the wage setting institutions. A recent survey and some comparative analysis of the available indices describing wage-setting behaviour is provided by Kenworthy (2001). The empirical indices usually make distinction between

centralisation and co-ordination: whereas co-ordination is a key behavioural mechanism that leads to internalisation of the economy wide effects of wage decisions, centralisation can be seen as one possible way to achieve it. Thus, centralisation is sufficient rather than necessary for the co-ordination.

Nickell (2003) provides observations by country of a summary index that reflects a variety of aspects related to the co-ordination of the wage setting⁵. In Figure 1 we have cross-plotted this index for years 1995-1999 against the measure of tax progression at the APW income level calculated from the data for 20 OECD countries. The measure of tax progression is the average of $(1/v)$ for years 1997-2002, also reported in Table 1. According to Figure 1, there seems to be a tendency of countries with centralised or co-ordinated wage setting to also exhibit a more progressive labour taxation and vice versa⁶.

These observed tendencies, the progressivity of the existing tax systems (when measured by the concept of CRIP) and the tendency of coexistence of progressive tax schedules and centralised wage setting form the empirical motivation of the theoretical analysis that we now turn to.

3 The Model

3.1 Individual labour supply

Individuals in the model are either employed or unemployed. The total number of the individuals is normalised to unity, out of which N are employed and $1 - N$ are unemployed. For the employed, salaries are proportional to hours worked and subject to an income tax. Working also causes disutility that is increasing in working hours. Once unemployed, the disutility of work is zero and income consists of the public unemployment benefit. Following Summers et al (1993) and Kilponen and Sinko (2001), we assume that both employed and unemployed receive some utility from the provision of public goods and services denoted by G .

⁵See Nickell (2003) for co-ordination index 2, which is based on the original work of Ochel (2000).

⁶The solid line in Figure 1 depicts an OLS prediction ($b=3.0$, $t=2.35$, $R^2 = 0.235$). The positive slope is statistically significant at the 5 per cent level.

More specifically, the utility of the unemployed individuals is given by

$$U_u = b + z(G) \quad (2)$$

where b is the unemployment benefit and $z(G)$ is the subutility defined over the public provision G . Both unemployment benefits and the provision of public goods are financed by the revenues of the income tax as follows

$$TN = G + b(1 - N) \quad (3)$$

where $T = T(wh)$ is the taxes paid by an employed individual. Once employed individuals decide how many hours to work so as to maximise their instantaneous utility

$$U_e = y_e - v(h) + z(G) \quad (4)$$

where $v(h)$ is the disutility of work and

$$y_e = wh - T(wh) \quad (5)$$

is the after tax income. Maximising (4) subject to (5) taking G as given yields the standard first order condition

$$w(1 - T') = v' \quad (6)$$

which equates the marginal income from an extra hour worked to the marginal disutility. For some of the results below, we specify the following simple functional form for the disutility of labour (see e.g. Sørensen, 1999)

$$v(h) = \frac{1}{\delta} h^\delta, \quad \delta > 1 \quad (7)$$

With this specification (6) can be solved for the supply of working hours as follows

$$h = (w(1 - \tau_m))^{\frac{1}{\delta-1}} \quad (8)$$

where $\tau_m \equiv \frac{\partial T}{\partial y}$ is the marginal tax rate. It is clear from (8) that for a given wage rate, the supply of working hours is decreasing in the marginal tax rate, i.e. $\partial h / \partial \tau_m < 0$. It is noteworthy that the supply of working hours only depends on the marginal tax rate and not on the average tax rate. This is a well known property of the quasi linear utility structure, which is widely used in the tax literature. Also notice that utilising (8), the elasticity of the working hours with respect to wages can be defined as $\epsilon^s \equiv \frac{1}{\delta-1}$.

3.2 Demand for labour

The labour demand is derived from the behaviour of profit maximising firms that employ the effective labour input $L = Nh$ to produce an output. The firms are competitive in the sense that they take prices given in both labour and output markets⁷. Normalising the output price to unity, the profits of a representative firm is given by

$$\Pi = f(N, h) - whN \quad (9)$$

For analytical simplicity, we assume that the number of workers N and working hours per employee h are perfect substitutes in production and that production function takes the following simple form

$$f(N, h) = (Nh)^\gamma, \quad \gamma < 1 \quad (10)$$

The production technology exhibits decreasing returns for the labour input, which gives rise to pure profits in the equilibrium. These profits can be interpreted as the return to a fixed capital input. Under this structure, the first order condition of the profit maximising problem can be solved for the number of workers to yield

$$N(w, h) = \left(\frac{wh^{1-\gamma}}{\gamma} \right)^{-\frac{1}{1-\gamma}} \quad (11)$$

which is the demand for labour with $N_w < 0$, $N_h < 0$. In what follows we make the standard assumption that the firms are not rationed in the labour market and employment always equals labour demand. Utilising (11) we can define the *wage elasticity of employment for fixed working hours*

$$\epsilon^d \equiv -\frac{\partial \log N}{\partial \log w} = \frac{1}{1-\gamma} > 1 \quad (12)$$

Also, it is worth noticing that according to (11) the elasticity of employment with respect to working hours equals unity. For further purposes, we substitute (11) into (9) and (10) to derive

$$\Pi = (1-\gamma) \left(\frac{\gamma}{w} \right)^{\frac{\gamma}{1-\gamma}} \quad (13)$$

which expresses the maximum attainable profits as a function of wages.

⁷Allowing for some monopolistic power in the output market similar to e.g. Sørensen (1999) would not change the results.

3.3 Wage bargaining

Besides the supply and demand decisions, the labour market equilibrium is characterised by a non-competitive wage setting mechanism. Following the widely used right-to-manage approach (see e.g. Booth, 1995) we assume that the wage rate is determined in a Nash bargain between the workers' unions and the firms' representatives as follows

$$\max_w \Omega = (V - V_0)^\beta (\Pi - \Pi_0)^{1-\beta} \quad (14)$$

where V and Π are the objectives of the union and firms respectively and V_0 and Π_0 are the corresponding fall-back positions. Parameter β reflects the bargaining power of the workers. Firms' objective is the profits as defined in (13). The corresponding fall-back position is assumed to be zero. Objective of an utilitarian union is to maximise the expected utility of its members

$$V = NU_e + (1 - N)U_u \quad (15)$$

and the corresponding fall-back position is U_u . With these premises the problem becomes

$$\max_w \Omega = (N(U_e - U_u))^\beta (\Pi)^{1-\beta} \quad (16)$$

Taking logarithms and differentiating with respect to the wage rate then yields the following first order condition for the optimal wage

$$\frac{\beta wh(1 - \tau_m)}{U_e - U_u} - \beta\epsilon - \frac{1 - \beta}{1/\gamma - 1} = 0 \quad (17)$$

where $\epsilon \equiv \epsilon^d + \epsilon^s$ refers to the total elasticity of employment with respect to wages when the indirect effect through working hours is allowed for.

3.4 Decentralised equilibrium

Substituting (4), (2) and (7) into (17) we can rewrite the wage equation in the form

$$\frac{\beta wh(1 - \tau_m)}{wh(1 - \tau_a) - \frac{1}{\delta}h^\delta - b} - \beta\epsilon - \frac{1 - \beta}{1/\gamma - 1} = 0 \quad (18)$$

that determines the labour market equilibrium together with the supply of working hours (8) and labour demand (11) equations. The equilibrium solution for the endogenous variables h, w and N is given by (see Appendix A for more details)

$$h = (y_m)^{\frac{1}{\delta}} \quad (19)$$

$$w = (1 - \tau_m)^{-1} (y_m)^{1 - \frac{1}{\delta}} \quad (20)$$

$$N = (\gamma(1 - \tau_m))^{\frac{1}{1-\gamma}} (y_m)^{-\frac{\delta-\gamma}{\delta(1-\gamma)}} \quad (21)$$

where

$$\begin{aligned} y_m &\equiv (1 - \tau_m) wh \\ &= b \left[\frac{1 - \tau_a}{1 - \tau_m} - \frac{1}{\delta} \left(1 + \left(\epsilon + \frac{\gamma/\beta\delta - 1}{1 - \gamma} \right)^{-1} \right) \right]^{-1} \end{aligned} \quad (22)$$

is the "marginal after tax income" related to an extra efficiency unit of labour and $\tau_a \equiv T/wh$ is the average tax rate of an employed individual.

To find out about the employment effects of increased tax progression, differentiate (21) with respect to (one minus) the marginal tax rate τ_m holding the average tax rate τ_a fixed to get

$$\begin{aligned} \frac{dN}{d(1 - \tau_m)} &= \frac{\gamma^{\frac{1}{1-\gamma}}}{1 - \gamma} (1 - \tau_m)^{\frac{1}{1-\gamma} - 1} (y_m)^{-\frac{\delta-\gamma}{\delta(1-\gamma)}} \\ &\quad \times \left[1 - \frac{\delta - \gamma}{\delta} \frac{\partial y_m}{\partial (1 - \tau_m)} \frac{(1 - \tau_m)}{y_m} \right] \end{aligned} \quad (23)$$

Utilising (22) we then have the following condition for the right hand side of (23) being positive

$$1 - \frac{(\delta - \gamma)}{\delta v} \left(\frac{1}{v} - \frac{1}{\delta} \left(1 + \left(\epsilon + \frac{\gamma/\beta\delta - 1}{1 - \gamma} \right)^{-1} \right) \right)^{-1} > 0 \quad (24)$$

where, for notational convenience, we have defined $v \equiv \frac{1 - \tau_m}{1 - \tau_a}$ which is the coefficient of residual income progression as defined above in (1). After the

notion that the left hand side of (24) is decreasing in v , it is straightforward to show that (24) implies

$$v < \gamma \left[1 + \left(\frac{\gamma}{1-\gamma} (1 - 1/\beta\delta) - \epsilon \right)^{-1} \right] \quad (25)$$

Expression (25) defines the condition under which a pure increase in tax progression has a negative impact on employment. Notice that setting $\beta = 1$ produces the corresponding condition in the case where the wage rate is unilaterally determined by a monopolistic union. In the latter case the condition reads

$$v < \frac{\gamma}{1 + \delta/\epsilon} \quad (26)$$

The essence of the two conditions (25) and (26) can be summarised by the following proposition:

Proposition 1 *Higher progression is good for employment if either*
i) labour supply is fixed or
ii) initial tax system is proportional or regressive

Proof. The case of fixed labour supply is captured by letting $\delta \rightarrow \infty$ in (25), then the condition implies $\frac{dN}{d(1-\tau_m)} > 0 \implies v < 0$ which is contradictory and the opposite must be true. As for the second conjecture, it can be shown (see Appendix B) that the term within the square brackets on the right hand side of (25) is less than unity. Thus, for a proportional or regressive initial tax with $v \geq 1$ a contradiction follows and the opposite is true. ■

It is noteworthy that a fixed supply of working hours and non-progressive initial tax system are both sufficient conditions for a pure increase in progression to have a positive employment effect⁸. Proposition 1 generalises the findings of a number of earlier studies. Herzoug (1984) finds a positive employment effect of progression in monopoly union model with fixed hours. Koskela and Vilmunen (1996) extend his result to the right-to-manage framework. Holm, Kiander and Koskela (1997) show in monopoly union model and Fuest and Huber (2000) in a right-to-manage model with individual supply of hours that tax progression improves employment if the initial tax system is proportional ($v = 1$).

⁸Notice that this does not guarantee that the amount of effective labour input $L \equiv Nh$ increases, since the hours worked decline.

Corollary 1 *Higher progression may be bad for employment if initial tax system is progressive and the labour supply is elastic. Negative employment effect is more likely the more progressive is the initial tax system, the more elastic is labour supply and the lower is the union bargaining power.*

Proof. Follows from the notion that the right hand side of (25) is decreasing in β and v is the lower the more progressive is the initial tax system.

■

The implications of the corollary are to a large extent overlooked in the existing literature that restricts the analysis mainly to the case where the initial tax is proportional (e.g. Holm et al, 1997, Fuest and Huber, 2000). The essence of the corollary is that if the starting point of a reform is already progressive - which does not seem to be that unrealistic when thinking about actual tax systems (see the evidence of Table 1) - we do not know whether the employment effects of increased progression are positive or negative. The possibility of a negative response is particularly likely, if the bargaining power of the unions is low, which is to some extent inherent in the set up with decentralised, non-coordinated unions.

4 Centralised wage setting

In above we derived the effects on employment of a pure increase in tax progression in the standard model of decentralised wage setting. In that set up, there are numerous wage setting institutions operating in the economy, each taking the actions of the others as given. Therefore, it is natural to assume that the wage setters do not take account of effects of wage policy on economy wide variables such as the fiscal balance. In this section we turn to an alternative model, which assumes that wage setting is relatively centralised or well co-ordinated and the economy wide consequences of the wage choice are taken into account ⁹.

To model such a framework, we rely on the formulation suggested by Summers *et al* (1993) and define the centralised wage setting as unions' ability to perceive the government budget constraint. When deciding over the wage rate, the wage setting institutions realise that since a wage hike tends to increase unemployment, it also puts an extra pressure on public

⁹For further discussion on the centralisation vs. the degree of co-ordination in the wage setting and the empirical indicators see e.g. Nickell (1997).

finances and is likely to reduce tax revenues and thereby the provision of public goods and services. We believe that this is a particularly relevant formulation for economies such as the Nordic countries where a large part of the services are publicly provided¹⁰. The formulation seems to fit well especially the case of Finland where the government is involved in the so called tripartite co-operation with the wage setting institutions and typically provides incentives for the wage moderation by using tax and social policy instruments¹¹.

With these premises, the case of centralised wage setting can be operationalised in the present framework by assuming that the government budget (3) is included as an extra constraint in the wage setting problem (14). For analytical tractability, we consider the case where $\beta = 1$ i.e. the union can monopolistically decide the wage rate. Consequently, the first order condition of the wage setting problem becomes

$$(U_e - U_u) \frac{dN}{dw} + N \left(\frac{dU_e}{dw} - \frac{dU_u}{dw} \right) + \frac{dU_u}{dw} = 0 \quad (27)$$

Different from the standard decentralised case, the utility level experienced by the unemployed individuals is no longer constant, but depends on the wage rate chosen. This link from wages to benefits is recognised in the wage setting process by the inclusion of the term $\frac{dU_u}{dw}$ in left hand side of (27). In the present set up we have simply

$$\frac{dU_u}{dw} = z_G \frac{dG}{dw} \quad (28)$$

The effect of wage hike on the utility of an unemployed worker is equal to the (constant) marginal utility of the public provision z_G times the marginal change in the level of public provision. Substituting this into (27) yields, after some manipulation, a more convenient version of the first order condition

$$-(U_e - U_u)\epsilon + w \frac{\partial U_e}{\partial w} + z_G \frac{dG}{dw} \frac{w}{N} = 0 \quad (29)$$

Solving the government budget constraint for G and differentiating with respect to the wage rate amounts to

$$\frac{dG}{dw} \frac{w}{N} = wh \left[\tau_m (1 + \epsilon^s) - \left(\tau_a + \frac{w_u}{wh} \right) \epsilon \right] \quad (30)$$

¹⁰For an alternative approach where a centralised union takes into account the link between wages and general price level see e.g. Driffill and van der Ploeg (1993).

¹¹The Finnish system of wage setting is described in more detail by Vartiainen (1998).

which describes the sensitivity of public provision to changes in the level of employment. Then substitute (4), (2) and (30) into (29) and utilise $\partial U_e/\partial w = h(1 - \tau_m)$ to get

$$-(wh(1 - \tau_a) - v(h) - b)\epsilon + wh(1 - \tau_m) + z_G \left[wh\tau_m(1 + \epsilon^s) - wh\epsilon \left(\tau_a + \frac{w_u}{wh} \right) \right] = 0 \quad (31)$$

which implicitly defines the optimal wage rate in the case of centralised wage setting. Substituting $v(h) = \frac{1}{\delta}h^\delta$ into (31) and combining it with the supply of working hours equation (8) and the labour demand equation (11) yields the set of three equations that determine the equilibrium in the centralised case. With some manipulation (see Appendix C) these can be solved for the equilibrium values of wages, hours and employment as follows

$$\begin{aligned} h_c &= (y_{mc})^{\frac{1}{\delta}} \\ w_c &= (1 - \tau_m)^{-1} (y_{mc})^{1 - \frac{1}{\delta}} \\ N_c &= (\gamma(1 - \tau_m))^{\frac{1}{1-\gamma}} (y_{mc})^{-\frac{\delta-\gamma}{\delta(1-\gamma)}} \end{aligned} \quad (32)$$

where

$$y_{mc} = \frac{eb\delta(1 - \tau_m)(1 - z_G)}{\epsilon\delta - (\delta + \epsilon)(1 - \tau_m) - \delta z_G \tau_m(1 + \epsilon^s) - \delta\epsilon\tau_a(1 - z_G)} \quad (33)$$

is again the marginal after tax income defined as $y_{mc} \equiv (1 - \tau_m)w_ch_c$. Notice that setting $z_G = 0$ makes (33) equal to (22). To derive the effect of increased progression on employment, we differentiate (32) with respect to (one minus) the marginal tax rate τ_m holding the average tax rate τ_a fixed to get

$$\begin{aligned} \frac{dN}{d(1 - \tau_m)} &= \frac{\gamma^{\frac{1}{1-\gamma}}}{1 - \gamma} (1 - \tau_m)^{\frac{1}{1-\gamma}-1} (y_{mc})^{-\frac{\delta-\gamma}{\delta(1-\gamma)}} \\ &\quad \times \left[1 - \frac{\delta - \gamma}{\delta} \frac{\partial y_{mc}}{\partial(1 - \tau_m)} \frac{(1 - \tau_m)}{y_{mc}} \right] \end{aligned} \quad (34)$$

The sign of (34) is determined by the term within the square brackets, that we now turn to. Differentiating (33) yields

$$\frac{\partial y_{mc}}{\partial(1 - \tau_m)} \frac{(1 - \tau_m)}{y_{mc}} = \left(\frac{\epsilon - z_G(1 + \epsilon^s) - \epsilon\tau_a(1 - z_G)}{(1 - \tau_m)\epsilon(1 - z_G)b} \right) y_{mc} \quad (35)$$

Substituting into (34) we get the following condition for the right hand side of (34) being positive

$$1 - \left(\frac{\delta - \gamma}{\delta} \right) \left(\frac{\epsilon - z_G(1 + \epsilon^s) - \epsilon\tau_a(1 - z_G)}{(1 - \tau_m)\epsilon(1 - z_G)b} \right) y_{mc} > 0 \quad (36)$$

which defines the condition under which a pure increase in progression reduces employment in the centralised case and thus corresponds to (24) above in the standard model with decentralised wage setting. It can be shown (see Appendix D) that imposing $z_G = 0$ in (36) reproduces condition (26). Thus, in the special case where the private marginal valuation of the publicly provided goods is zero, the model collapses to the standard model with decentralised wage setting and the results derived above in section 2 hold.

To analyse the case $0 < z_G < 1$ corresponding to the centralised wage setting, let us consider the special case $\tau_m = \tau_a = \tau$ i.e. the case where the initial tax system is proportional. Substituting for $\epsilon^s = \frac{1}{\delta-1}$, $\epsilon^d = \frac{1}{1-\gamma}$ and $\epsilon = \epsilon^s + \epsilon^d$ and rearranging, (36) may be rewritten as

$$\frac{(\delta - \gamma)(1 - \tau(1 - z_G)) - z_G\delta(1 - \gamma)}{\gamma(\delta - 1)(\delta - \gamma)^{-1}[\delta z_G\tau + (1 - \tau)(\delta - 1)]} < 1 \quad (37)$$

To capture the case of fixed labour supply let $\delta \rightarrow \infty$. Taking the limit of the left hand side, (37) becomes

$$(1 - \tau)(1 - \gamma)(1 - z_G) < 0 \quad (38)$$

where the left hand side is positive suggesting that for fixed hours an increase in progression - when departing from proportional system - always improves employment even in the case of centralised wage setting.

Next, consider the general case with $0 < z_G < 1$ and $\delta < \infty$. First notice that the left hand side of (37) is decreasing in τ if and only if

$$\delta < \frac{1}{1 - z_G} \quad (39)$$

which holds if δ is low enough i.e. the labour supply is elastic enough. Under this assumption (37) holds if and only if¹²

$$z_G > \frac{(1 - \gamma)(1 - \tau)(\delta^2 - \gamma)}{(\delta - \gamma)(\delta(1 - \gamma) + \tau\gamma) - \tau\delta^2(1 - \gamma)} \equiv z_G^* \quad (40)$$

¹²Solve (37) for z_G to verify.

i.e. a pure increase in progression - departing from a proportional tax - reduces employment if the marginal utility of public provision is higher than some critical level z_G^* . More formally,

Proposition 2 *In the model with centralised wage setting and individual supply of working hours, a pure increase in progression - departing from a proportional tax - leads to lower (higher) employment if the marginal utility of public provision is high (low) enough.*

Proof. Follows directly from (40). ■

Proposition 2 asserts that the result of a positive employment effect derived in the models with decentralised wage setting (Holm et al 1997, Fuest and Huber, 2000) does not hold in the present set up¹³. If the wage setting institutions perceive the link from higher tax burden to the increased public provision, the wage moderation effect of increased tax progression is mitigated. Intuitively, while progressive tax still has the effect of reducing the net gain of higher wage to a worker, it also tends to counteract the reduction of revenues induced by a wage hike and thereby weaken the mechanism that causes the wage moderation effect under centralised wage setting. Thus, the effectiveness of progressive taxation as a means to lower the equilibrium unemployment is weaker than in the case of decentralised wage setting. It is possible to show that for some plausible parameter values, the critical value z_G^* is monotonically declining in the tax rate τ i.e.

$$\frac{\partial z_G^*}{\partial \tau} < 0 \quad (41)$$

which shows that - other things equal - the higher the initial tax rate τ , the more likely is the adverse effect on employment of a pure increase in progression.

In above, we have interpreted z_G as the marginal utility of public provision. An alternative interpretation, more in the spirit of Summers et al (1993), would be to think z_G as measuring the degree of centralisation or co-ordination in the wage setting¹⁴. From this point of view we can conjecture that the negative employment effect of increased progression are the more likely the more centralised is the wage setting process.

¹³As noted above, we have only considered the case $\beta = 1$ with a monopolistic union. However, based on the findings in section 3, allowing for $\beta < 1$, is not likely to change the result qualitatively, but would rather make a negative employment effect more probable.

¹⁴Summers et al (1993) refer to z_G as "the degree of encompassment".

5 Concluding remarks

We have employed a trade union model with endogenous working hours to study the implications of progressive labour income taxation. We showed that the results derived in the standard model of decentralised wage bargaining do not hold when the wage setting is centralised or highly co-ordinated.

To start with, we derived a stylised model with decentralised Nash bargaining over wages and showed that in this set up, a sufficient condition for a positive employment effect of a pure increase in progression is that either labour supply is fixed or the initial tax system is non-progressive. Consequently - a fact less emphasised in the existing literature - higher progression may be bad for employment if labour supply is elastic and initial tax system is progressive. Under these circumstances, a negative employment effect is more likely the more progressive is the initial tax system, the more elastic is labour supply and the lower is the union bargaining power.

We then proceed to introduce a model with centralised wage setting following the approach suggested by Summers et al (1993). Using a model with centralised wage setting and individual supply of working hours, we show that the conditions under which progressive taxation improves employment are stricter than under the decentralised wage setting. If marginal utility of the public provision is high enough, increased progression leads to lower employment even when departing from a proportional tax system. Increased tax progression tends to mitigate the wage moderation mechanism related to centralised wage setting and therefore is less likely to be good for employment in the countries with centralised or well co-ordinated wage setting institutions.

Our findings cast some doubts on the widely held view that progressive taxation could be used to reduce structural unemployment in the unionised labour markets. As for the decentralised wage setting, the results suggest that some progression is better than none. However, since we do not know how much progression is needed to reach the best outcome in terms of employment, great caution is needed with respect to the policy implications. If the wage setting institutions are centralised or act strongly coordinated, there seems to be even less scope for increased tax progression.

The analysis presented has focused solely on the effects of tax progression on the wage formation and aggregate employment. There are, of course, other justifications for progressive income taxation, that cannot be addressed within the present framework. For example, progressive taxation may be de-

sirable in order to promote the inclusion of the low-skilled workers to the labour market. As for the centralised wage setting, our model has focused on one relevant margin - that of public finance - while other aspects of centralised corporatism are abstracted from. Nevertheless, our analysis has pointed out another possible reason why the positive employment effects of tax progression found in the aggregate models may not be that robust¹⁵.

¹⁵Fuest and Huber (2000) show that the positive employment effects may not arise if working hours are negotiated along with wages or if consumption is not separable from leisure.

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A Decentralised equilibrium

Equation (18) in the main text can be developed to

$$\frac{\beta(1-\tau_m)}{(1-\tau_a) - \frac{1}{\delta}w^{-1}h^{\delta-1} - b/wh} = \beta\epsilon + \frac{1-\beta}{1/\gamma-1}$$

Then substituting the labour supply condition (8) for h and some manipulation yields the following expression for wage rate

$$w = (1-\tau_m)^{-1}b^{1-\frac{1}{\delta}} \left[\frac{1}{v} - \frac{1}{\delta} - \frac{\beta(1-\gamma)(\delta-1)}{\gamma(\delta-1) + \beta\delta(1-\gamma)} \right]^{-\left(1-\frac{1}{\delta}\right)} \quad (42)$$

where $v \equiv \frac{1-\tau_m}{1-\tau_a}$ and we utilised $\beta\epsilon + \frac{1-\beta}{1/\gamma-1} = \frac{1}{1/\gamma-1} + \beta\frac{1}{1-1/\delta}$. Substituting this into (8) and some manipulation then gives

$$h = b^{\frac{1}{\delta}} \left[\frac{1}{v} - \frac{1}{\delta} - \frac{\beta(1-\gamma)(\delta-1)}{\gamma(\delta-1) + \beta\delta(1-\gamma)} \right]^{-\frac{1}{\delta}} \quad (43)$$

Equations (42) and (43) imply

$$\begin{aligned} y_m &\equiv (1-\tau_m)wh \\ &= b \left[\frac{1}{v} - \frac{1}{\delta} \left(1 + \left(\epsilon + \frac{\gamma/\beta\delta - 1}{1-\gamma} \right)^{-1} \right) \right]^{-1} \end{aligned}$$

which is (22) in the main text and where we utilised the fact that

$$\frac{\beta(1-\gamma)(\delta-1)}{\gamma(\delta-1) + \beta\delta(1-\gamma)} = \frac{1}{\delta} \left(\epsilon + \frac{\gamma - \beta\delta}{\beta\delta(1-\gamma)} \right)^{-1}$$

B Centralised equilibrium

Substituting $v(h) = \frac{1}{\delta}h^\delta$ into the first order condition (31) and solving explicitly for the wage rate gives, after some manipulation

$$w = \frac{\epsilon(h^\delta + b\delta(1-z_G))}{\delta h(\epsilon - 1 + \tau_m(1-z_G(1+\epsilon^s)) - \epsilon\tau_a(1-z_G))}$$

Substituting this into (8) and solving for the working hours then yields

$$h_c = \left[\frac{\epsilon b \delta (1 - \tau_m) (1 - z_G)}{\epsilon \delta - (\delta + \epsilon) (1 - \tau_m) - \delta z_G \tau_m (1 + \epsilon^s) - \delta \epsilon \tau_a (1 - z_G)} \right]^{1/\delta} \quad (44)$$

which defines equilibrium hours in terms of the exogenous parameters in the centralised case. Substituting (44) back to (8) and solving for the wage rate then gives

$$w_c = (1 - \tau_m)^{-1} \left[\frac{\epsilon b \delta (1 - \tau_m) (1 - z_G)}{\epsilon \delta - (\delta + \epsilon) (1 - \tau_m) - \delta z_G \tau_m (1 + \epsilon^s) - \delta \epsilon \tau_a (1 - z_G)} \right]^{1-1/\delta} \quad (45)$$

Utilising (44) and (45) we can derive

$$\begin{aligned} y_{mc} &\equiv (1 - \tau_m) w_c h_c \\ &= \frac{\epsilon b \delta (1 - \tau_m) (1 - z_G)}{\epsilon \delta - (\delta + \epsilon) (1 - \tau_m) - \delta z_G \tau_m (1 + \epsilon^s) - \delta \epsilon \tau_a (1 - z_G)} \end{aligned}$$

Equations (45), (8) and (11) then imply the expressions used in (32) the main text.

C The equivalence of conditions (36) and (26)

Under $z_G = 0$ (33) becomes

$$y_{mc} = \frac{\epsilon b \delta (1 - \tau_m)}{\epsilon \delta - (\delta + \epsilon) (1 - \tau_m) - \delta \epsilon \tau_a}$$

which can be shown to equal (22) after substituting $\epsilon = \epsilon^d + \epsilon^s = \frac{\delta - \gamma}{(\delta - 1)(1 - \gamma)}$ and setting $\beta = 1$. Under $z_G = 0$ (36) becomes

$$\begin{aligned} 1 - \left(\frac{\delta - \gamma}{\delta} \right) \left(\frac{\epsilon (1 - \tau_a)}{(1 - \tau_m) \epsilon b} \right) y_{mc} &> 0 \\ \Leftrightarrow \left(\frac{\delta - \gamma}{v \delta} \right) \left(\frac{1}{\frac{1}{v} - \frac{\epsilon + \delta}{\epsilon \delta}} \right) &< 1 \end{aligned}$$

which is equivalent to (26) after solving for v and rearranging.

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