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PROGRESSIVE TAXATION AND WAGE SETTING WHEN UNIONS STRATEGICALLY INTERACT

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Progressive Taxation and Wage Setting when Unions Strategically Interact[1]

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Abstract

In a multisector economy with unionized labor markets, the interdependence of union wage claims - typical of industrial bargaining - affects the relationship between tax progressivity and wage pressure, which varies in a non-linear fashion with the nature of the wage bargain, and can be hump-shaped. Our empirical analysis of 20 OECD countries for the period 1997-2004 shows that higher tax progressivity increases pre-tax wages (and unemployment) in countries characterized by industry level wage bargaining, and reduces them in countries with local or fully centralized bargaining.

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Introduction

Public finance solutions to high unemployment have often been advocated. With unemployment concentrated among the young and unskilled, a fairly popular suggestion has been that a reduction of the social security contributions borne by low wage earnings, financed by a carbon tax, could yield a double dividend, the reduction of unemployment and the abatement of pollution (see Sørensen [1997]).

The literature in this area has pointed out that a decline in average labor taxes reduces unemployment if it yields lower pre-tax wages. Pre-tax wages fall if real after tax income from unemployment and leisure is not affected or only partially affected by the change in average taxes. When unemployment benefits are not taxed, for instance, lower average labor taxes reduce the replacement ratio, and unions are willing to accept lower pre-tax wages because the net income loss from employment increases (see Pissarides [1998], Lockwood and Manning [1993], Daveri and Tabellini [2000]).

Changes in labor taxation do not necessarily require that average labor taxes vary. In principle, a switch from payroll to income taxes, given average rates, could affect wage pressure and unemployment. The empirical evidence to date, however, does not support this possibility (see Nickell and Layard [1999] for a review)[2].

When labor taxation is nonlinear, another opportunity to reduce unemployment is to vary the degree of labor tax progressivity. Most studies of the effects of tax progressivity on wages (and employment) consider unionized labor markets and decompose the impact of tax progressivity on pre-tax wages into a *wage moderation effect* and a *labor supply effect.* The wage moderation effect occurs because, when the marginal tax rate increases, the price in terms of foregone employment of a higher take - home pay goes up (see Lockwood and Manning [1993]). This allows the union to buy more employment through wage moderation, because a given fall in the pre-tax wage leads to a smaller change in the after tax

[2]Koskela and Schöb [1999] show that the equivalence between personal income tax rates and payroll taxes fails in the presence of tax allowances.

wage (see Sørensen [1997], p.228).

To better illustrate this effect, consider the case when a union contemplates the possibility of a net wage hike. In such case, it has to consider that say for a 1% increase in the utility of each employed union member the pre-tax wage increases by $\frac{1}{\nu}$, where ν denotes the coefficient of residual income progression[3]. The expected employment loss associated to the higher after tax wage is $\frac{\varepsilon}{\nu}$, where ε is the elasticity of labor demand (see Calmfors [1995]). When progressivity increases (ν declines), the employment cost of a higher take home wage increases, and this higher cost induces the union to moderate its wage claims.

The labor supply effect can generate higher wage pressure when an increase in tax progressivity reduces the supply of working hours, because the income effect is dominated by the substitution effect. If the wage moderation effect prevails over the labor supply effect, higher labor tax progressivity reduces pre-tax wages and increases employment[4].

So far this literature has focused either on decentralized (see Lockwood and Manning [1993]) or on centralized (see Alesina and Perotti [1997]) wage bargaining and has ignored the interdependence between union wage claims. Typical examples of interdependence are imitative union behavior and union rivalry over "fair" wage differentials across firms or industries (see Oswald [1979] and Gylfason and Lindbeck [1984]).

In this paper we argue that the explicit consideration of the interdependence of unions adds to the wage moderation and the labor supply effects a third effect, which we call the *strategic interaction effect*. This effect is relevant when the degree of centralization of the wage bargain is intermediate- as in the case of industrial bargaining - and irrelevant with local and fully centralized bargaining. We show that strategic interaction reinforces the labor supply effect and contrasts the wage moderation effect. The reason is that the industrial union expects that an increase

[3]The coefficient of residual income progression suggested by Musgrave and Musgrave [1976] is defined as

$$\nu = \frac{1-\tau}{1-t}$$

where τ (t) stands for the marginal (average) personal income tax rate.

[4]This could be the case of unskilled workers if they are heavily unionized and if their hours supply function is less responsive to taxes than that of skilled workers.

in the own wage will increase the average wage. Such expectation leads to higher wage pressure in the industry, as the union strives to maintain the utility of its members relative to their outside option.

When wages are strategic complements, there is an additional amplifying effect: if higher tax progressivity increases the pre-tax wage - because the sum of the strategic interaction effect and the labor supply effect prevails on wage moderation - strategic complementarity amplifies this increase. Conversely, when the wage moderation effect prevails on the sum of the strategic interaction and the labor supply effect, the pre-tax wage falls with higher progressivity, and this reduction is amplified by strategic complementarity.

A closely related strand of literature shows that the institutions regulating wage bargaining have important effects both on equilibrium unemployment and on the relationship between labor taxation and unemployment. Calmfors and Driffill [1988] have shown that the relationship between the degree of centralization of the wage bargain and equilibrium unemployment is hump - shaped and highest in countries with an intermediate degree of centralization. On the other hand, Daveri and Tabellini [2000] have argued that the negative impact of higher (average) labor taxes on unemployment is strongest in Continental Europe, where unions are powerful than in the Nordic or the Anglo-Saxon countries.

We contribute to this literature by presenting empirical evidence showing that the impact of higher tax progressivity on pre-tax wages (and unemployment) varies with the degree of centralization of the wage bargain and can be hump-shaped - stronger with industrial bargaining and weaker with central and local bargaining.

Our empirical strategy exploits the variability of wage bargaining institutions in OECD countries. There are two key results. On the one hand, we find that the relationship between the coefficient of residual income progression and pre-tax wages is *negative* and statistically significant in countries with industrial bargaining. On the other hand, there is evidence that this relationship is *positive* and much smaller in absolute terms in countries where the wage bargaining is either local or centralized.

These findings suggest that, in the former group of countries, the sum of the labor supply and the strategic interaction effect prevails over the wage moderation effect, and is amplified by strategic complementarity. They also indicate the presence of a hump-shaped relationship between the responsiveness of the pre-tax wage to tax progressivity and the degree of centralization of the wage bargain: this responsiveness is positive in countries where the wage bargain takes place at the industrial level and negative when the bargain is either local or centralized.

The paper is organized as follows. We set the stage with an illustrative model, which clarifies how the relationship between tax progressivity and pre-tax wages is affected by wage bargaining institutions. The core of the paper is the empirical analysis in the second section. Conclusions follow.

1. An Illustrative Model

Consider a closed and fully unionized economy[5] composed of S sectors, and inhabited by three economic agents: individuals, unions and firms. The number of firms is given and equal to fS, with $f \geq 1$. The number of unions is equal to the number of sectors. Each sector j is populated by a fixed number of monopolistic competitive firms, indexed by i, which face the following inverse product demand function:

$$p_{ij} = \left(\frac{K_j}{y_{ij}}\right)^{\frac{1}{\sigma}} \tag{1}$$

where p and y stand for price and output respectively; K_j denotes nominal expenditure in sector j and σ measures the output elasticity with respect to the price.

Since each firm is small with respect to the economy, it takes K_j as given. Labor L consists of employment N and hours of work h, and the

[5] We consider a fully unionized economy since the received literature on the labor market effects of tax progressivity points out that beneficial employment effects are present in unionized economies - in competitive labor markets we only have the labor supply effect.

two are perfect substitutes in production. The technology is described by the following production function:

$$y_{ij} = L_{ij}^{\lambda_j} \tag{2}$$

where $L_{ij} = N_{ij}h_{ij}$, and $\lambda_j \in (0,1)$[6].

Firms set prices and employment by taking wages and hours as given. Profit maximization yields

$$N_{ij} = h_{ij}^{-1} C_j w_{ij}^{-\epsilon_j} (1+s)^{-\epsilon_j} \tag{3}$$

where s is the average payroll tax rate, w is the pre-tax hourly wage, $\epsilon_j = \frac{\sigma}{\sigma - \lambda_j(\sigma-1)}$ and $C_j = \left[\frac{\lambda_j(\sigma-1)}{\sigma} K_j^{\frac{1}{\sigma}}\right]^{\epsilon_j}$.

We assume symmetry within sectors. Therefore, in a symmetric equilibrium, the firm - specific labor demand and wage are equal to their industrial averages and the subscript i can be omitted.

Risk neutral ex-ante identical individuals care about their take home pay[7] and have homothetic preferences described by an indirect utility function, separable over the post-tax wage and hours of work. This function is linear in earnings and convex in leisure and takes the following form:

$$U_j = \omega_j - d\frac{h_j^{\beta}}{\beta} \tag{4}$$

where post-tax earnings are defined as $\omega_j = w_j h_j - T(w_j h_j, Z)$. As in Lockwood and Manning [1993], $T(\cdot, Z)$ is the personal labor income tax function and Z is a vector of parameters (marginal tax rates, tax bands) which captures any non-linearities in the tax system.

Standard utility maximization[8] yields the number of hours worked

$$h_j = \left[\frac{(1-\tau)\, w_j}{d}\right]^{\frac{1}{\beta-1}} \tag{5}$$

[6] Since the parameter λ is sector - specific, the labor input is ex-ante homogenous but ex-post heterogeneous.

[7] Since the consumer price index P_c is normalized to 1, nominal and real wages are equivalent.

[8] An alternative modeling strategy would allow unions and employers to bargain over working hours. We prefer the current specification because individuals can always increase their working hours over the bargained level by doing overtime.

where the marginal tax rate τ is equal to $\frac{\partial T(w_j h_j)}{\partial w_j h_j}$.

The wage in each sector is the outcome of the bargain between the union and the firms. We characterize the institutional differences in the wage bargain with the parameter S, the number of sectors in the economy. When this number tends to infinite, each union is small with respect to the labor market and takes the average wage as given. This situation corresponds to local bargaining. On the other hand, when S is equal to 1, there is only one union in the economy, so the own wage is equal to the average wage. This is the case of centralized wage bargaining. Between these two polar cases there is the case of a small number of sectors, which corresponds to industrial bargaining.

With more than one sector, the wage bargain occurs simultaneously in all industries. Following Lockwood and Manning [1993], the union utility function in sector j is

$$V_j = N_j^{\gamma} \left[U_j - \bar{U} \right]^{1-\gamma} \tag{6}$$

where U_j corresponds to equation (5) and $\bar{U}$ is the expected alternative utility available to an employed union member who is laid off or quits, given by

$$\bar{U} = (1 - x)\, \chi + xb \tag{7}$$

where the term $\chi = zh_z - T(zh_z, Z)$ defines average post-tax earnings, z is the average hourly wage, h_z the average hours of work, b is unemployment benefits, which are assumed to be constant and not taxable, and x is a weight[9].

With a small number of sectors, each union is large enough to take into account the responses of other unions and of the average wage to changes in its own wage. As a convenient shortcut, we model this interdependence by assuming that $\frac{d\chi}{d\omega} = \frac{\partial z h_z (1-t_z)}{\partial w h (1-t)} \approx \frac{\partial z h_z}{\partial w h} = \frac{1}{S}$, where the conjectural variation of union j, $0 \leqslant \frac{1}{S} \leqslant 1$, is inversely proportional to the number of sectors in the economy. Following Dowrick [1989], we in-

[9] Lockwood and Manning [1993] and Holmlund and Kolm [1995] use a similar assumption. Our key results do not depend on it. Equation (6) is a fairly general objective function. When $\gamma = 1/2$, it describes the preferences of an utilitarian union, whereas when $\gamma = 0$ it reflects the preferences of insiders.

terpret $\frac{1}{S}$ as the degree of union coordination in the wage setting process: when $S \to \infty$ the single union is very small compared to the labor market and bargaining is fully decentralized; when $S \to 1$ the bargain is fully centralized.

The Nash maximand is defined as

$$\underset{w_j}{Max} V_j^{\rho_j} \Pi_j^{1-\rho_j} \tag{8}$$

where ρ_j measures the union's bargaining power in sector j. With a small number of sectors, each union bargains with the firms in the relevant sector simultaneously with the other unions in the economy, by considering the impact of the bargained wage on hours and employment, as detailed by (5) and (3), and by taking nominal expenditure in sector j, K_j, prices in sector j, P_j, and consumer prices P_c as given. The latter assumption - which rules out cross-substitution effects - is very convenient but, we admit, strong in a context where each union internalizes the response of other unions and of the average wage to changes in its own wage[10].

The optimal earnings function corresponds to[11]

$$\omega_j = \frac{xb + (1-x)\chi}{1 - v\left[\frac{1}{\beta} + \frac{1}{m_j} - \frac{\beta}{\beta - 1}\frac{1}{m_j}(1-x)\frac{1}{S}\right]} \tag{9}$$

where $m_j = \frac{\rho_j \gamma\left(\epsilon_j + \frac{1}{\beta - 1}\right) - (1-\rho_j)(1-\epsilon_j)}{\rho_j(1-\gamma)}$.

A sufficient condition for the denominator in (9) to be positive is $\nu\left(\frac{1}{\beta} + \frac{1}{m_j}\right) < 1$, which we assume to hold. Equation (9) shows that post-tax earnings in each sector are a markup over the weighted average of unemployment benefits and the average wage, with weights which depend on the parameter x.

Using (5) to substitute hours of work in (9) we obtain

[10] We are grateful to a referee for pointing this out to us. In results available from the authors upon request, we show that the relaxation of the strong assumption made in the text does not change our qualitative results for plausible parameter configurations.

[11] The second order conditions associated to the optimization problem (8), both when $\omega_j > \chi$ and when $\omega_j < \chi$, are always satisfied given that $\frac{xb}{\frac{1}{S}(\omega_j - \chi)} > 0$ and $1 - (1-x)\frac{1}{S} > 0$.

$$w_j = \left[\frac{1}{1-t}\frac{xb}{A\left(\nu,\beta,m_j,x,\frac{1}{S}\right)}\right]^{\frac{\beta-1}{\beta}}\left[\frac{d}{1-\tau}\right]^{\frac{1}{\beta}}+\left[\frac{1}{1-t}\frac{(1-x)}{A\left(\nu,\beta,m_j,x,\frac{1}{S}\right)}\right]^{\frac{\beta-1}{\beta}} z \tag{10}$$

where $A\left(\nu,\beta,m_j,x,\frac{1}{S}\right) = 1 - v\left[\frac{1}{\beta}+\frac{1}{m_j}-\frac{\beta}{\beta-1}\frac{1}{m_j}(1-x)\frac{1}{S}\right]$.

We can prove the following

Result *Given the average tax rate and a common tax bracket for the industrial wage and the average wage, the labor supply effect reinforces the strategic interaction effect and contrasts the wage moderation effect. If the strategic interaction effect is stronger than the wage moderation effect (e.g.* $\frac{\beta}{\beta-1}\frac{1}{m_j}(1-x)\frac{1}{S} > \frac{1}{\beta}+\frac{1}{m_j}$*), an increase in* v *(lower progressivity) reduces the pre-tax hourly wage* w_j*.*

Proof.

$$\frac{\partial \ln w}{\partial \ln v} = \frac{\beta}{\beta-1}\frac{v\left[\frac{1}{\beta}+\frac{1}{m_j}-\frac{\beta}{\beta-1}\frac{1}{m_j}(1-x)\frac{1}{S}\right]}{1-v\left[\frac{1}{\beta}+\frac{1}{m_j}-\frac{\beta}{\beta-1}\frac{1}{m_j}(1-x)\frac{1}{S}\right]} - \frac{1}{\beta} \tag{11}$$

This derivative is negative if $\frac{\beta}{\beta-1}\frac{1}{m_j}(1-x)\frac{1}{S} > \frac{1}{\beta}+\frac{1}{m_j}$. ■

The term $\nu\left[\frac{1}{\beta}+\frac{1}{m_j}\right]$ in the numerator of (11) is the wage moderation effect, and we call the term $\nu\left(-\frac{\beta}{\beta-1}\frac{1}{m_j}(1-x)\frac{1}{S}\right)$ the strategic interaction effect, because it relies on the positive interdependence between the industrial wage and the average wage. That is, the union in sector j expects positive interdependence among sectoral wages and reacts to the expected increase in the average wage by rising its own wage in order to maintain its relative utility U_j with respect to the alternative $\bar{U}$. Finally, the term $\left(\frac{1}{\beta}\right)$ in (11) identifies the negative labor supply effect.

Since the reaction function defined by (10) is upward sloping, pre-tax wages are strategic complements. When the union in sector j bargains over its own wage, it considers the effect of its decision on the other wages in the economy and on the average wage. At the same time, however, the unions operating in the other sectors of the economy bargain by considering the impact of their own decision on the wage in sector j, which is affected because of the strategic complementarity linking wages in different sectors. If we take this additional effect into account, we

can show that, under plausible assumptions, strategic complementarity amplifies the effect of an increase in v on earnings[12].

In summary, this illustrative model highlights how the relationship between tax progressivity and pre-tax wages can be affected by the institutions regulating the wage bargain. OECD countries differ markedly in these institutions, and in the next section we exploit such variability to investigate such relationship from an empirical standpoint.

2. Tax Progressivity and Wage Bargaining in a Sample of 20 OECD Countries

Our reading of the empirical literature on the relationship between tax progressivity and pre-tax wages (and unemployment) is that there is no broad consensus. On the one hand, Lockwood and Manning [1993] find that an increase of tax progressivity reduces wage pressure in the UK. In empirical studies of Italy and Sweden, Malcomson and Sartor [1984] and Holmlund and Kolm [1995] also find evidence of a negative relationship between tax progressivity and wage pressure. Sørensen [1997] provides further evidence on the positive employment effects of reduced tax progressivity.

On the other hand, Newell and Symons [1993] find that the change in unemployment between the 1970s and the 1980s is an *increasing* function of the change in marginal tax rates over the same period[13]. Somewhat different results are obtained by Lockwood, Sløk, and Tranaes [2000], who study the Danish case and show that the relationship between tax progressivity and pre-tax wages is negative for low levels of income (and unskilled) and positive for high levels of income (and skill)[14].

Most of these studies are country specific, and none considers whether the relationship between changes in tax progressivity and wages varies across countries with different wage bargaining institutions. The illustrative model presented in the previous section of the paper predicts that these institutions matter, and that the impact of higher tax progressivity

[12] Further details are available from the authors upon request.
[13] See Nickell and Layard [1999], p.3061.
[14] See also Hansen et al [1999].

on pre-tax wages can be hump shaped - stronger with industrial bargaining and weaker with central or local bargaining. In this section, we verify such prediction by using OECD data for 20 countries, 8 years - 1997 to 2004 - and 8 household types. Following Lockwood and Manning [1993], we estimate a log-linearized version of (9), defined as

$$\ln w = \text{constant} + \vartheta_1 X + \vartheta_2 \ln v + \vartheta_3 C \ln v + \vartheta_4 \ln(1-t) \qquad (12)$$

where X is a vector of country specific and time varying effects, which includes hours of work, income from unemployment and the unemployment rate, $(1-t)$ is the retention rate, and C is a dummy equal to 1 when wage bargaining takes place at the industry level, and to 0 otherwise. We classify countries according to the degree of centralization of the wage bargain using the international empirical study by Golden, Lange and Wallerstein [2004]. These authors distinguish between three levels of the bargain, local, industrial and central. Based on their classification, the countries with industrial bargaining in our sample are Australia, Austria, France, Germany, Japan, The Netherlands, Portugal, Spain and Switzerland[15].

The parameter ϑ_2 is positive when the wage moderation effect dominates the labor supply effect, and negative otherwise. On the other hand, the parameter ϑ_3 captures the differences in the sensitivity of pre-tax wages to changes in tax progressivity associated to industrial wage bargaining, relative to both local and centralized wage setting. These differences can be due to differences in the wage moderation and labor supply effects, and/or to the presence of the strategic interaction effect.

2.1 The Data

We estimate (12) using OECD data which cover 20 countries over the period 1997-2004. Since marginal and average tax rates vary signif-

[15]The other countries in our sample are Belgium, Canada, Denmark, Finland, Ireland, Italy, New Zealand, Norway, Sweden, the UK and the US. The data in "Union Centralization among Advanced Industrial Societies", Version 3.1, by Golden and others, do not include Portugal, Ireland and New Zealand. For these countries we use the Nickell and Nunziata [2000] databank.

icantly across households within each country, we take into account this additional source of variation by considering, for each country, 8 household types, characterized by different family status - single/married, 0-2 children, economic status - one/two earner family, and wage level - as a percent of the annual gross earnings of the average production worker (see OECD, [2004])[16]. More in detail, the selected types are: 1) single, no children, with a wage equal to 67% of average; 2) single, no children, with a wage equal to 100% of the average; 3) single, no children, with a wage equal to 167% of the average; 4) single, two children, with a wage equal to 67% of average; 5) married, two children, principal earner with a wage equal to 100% of average; no other earner; 6) married, two children, principal earner with a wage equal to 100% of average; second earner with a wage equal to 33% of average; 7) married, two children, principal earner with a wage equal to 100% of average; second earner with a wage equal to 67% of average; 8) married, no children, principal earner with a wage equal to 100% of average; second earner with a wage equal to 33% of average.

Table 1 shows for the 20 countries in the sample the average tax rate - gross of social security contributions - and the coefficient of residual income progression, both for the year 2004, and the dummy C, based on the Golden, Lange and Wallerstein measure of centralization of the wage bargaining in 2000. There is substantial cross country variation in the selected indicators: the average tax rate ranges from .117 in Ireland to .338 in Belgium, and the coefficient of residual income progression ranges from .715 in Australia to .930 in Japan.

Table 2 shows the same indicators by household type. The average tax rate ranges from .151 for households with a single parent, two children and a wage equal to 67% of average earnings to .327 for households with a single individual, no children and a wage equal to 167% of average earnings. The former household type has also the lowest coefficient of residual income progression, .626, which is highest for households with

[16] We measure pre-tax earnings using gross wage earnings before taxes expressed in US dollars using PPP exchange rates. These data are provided by the OECD, Taxing Wages Statistics, Vol. 2004, release 01.

Table 1. Average tax rate, coefficient of residual income progression and value of the dummy C, by country

Country	t	v	C
Australia	.234	.715	1
Austria	.254	.677	1
Belgium	.338	.620	0
Canada	.217	.776	0
Denmark	.403	.830	0
Finland	.283	.745	0
France	.226	.856	1
Germany	.307	.697	1
Ireland	.117	.730	0
Italy	.233	.730	0
Japan	.162	.930	1
Netherlands	.284	.732	1
Norway	.206	.816	0
New Zealand	.270	.815	0
Portugal	.142	.857	1
Spain	.148	.855	1
Sweden	.306	.845	0
Switzerland	.186	.861	1
United Kingdom	.172	.722	0
United States	.171	.831	0

Source: OECD, [2004]

Table 2. Average tax rate, coefficient of residual income progression and value of the dummy C, by household type

Household type	t	v
single, no children, wage=67%	.222	.824
single, no children, wage=100%	.268	.864
single, no children, wage=167%	.327	.827
single, two children, wage=67%	.151	.626
married, two children, first wage=100%	.207	.715
married, two children, first wage=100%; second wage=33%	.216	.776
married, two children, first wage=100%; second wage=67%	.236	.785
married, no children, first wage=100%; second wage=33%	.234	.836

Note: percentages refer to average earnings; Source: OECD, [2004]

single individuals, no children and average earnings.

2.2 The Estimates

We capture the influence of the variables included in the vector X in (12) on log pre-tax wages with the lagged unemployment rate and with type, country and time dummies. The first column in Table 3 reports the OLS estimates of the coefficients associated to the log retention rate, the log of the index of residual income progression and the interaction of this latter variable with the dummy C. These estimates show that the coefficient of residual income progression attracts a positive and statistically significant sign in countries where the wage bargain is either plant-level or centralized. Since the interaction of the coefficient with the dummy C for industry level bargaining is negative, statistically significant, and larger in absolute value than the former coefficient, there is evidence that, given the retention rate, higher marginal tax rates when the wage bargaining is industry-level increase pre-tax earnings.

Before reaching hasty conclusions, however, we need to recognize that the coefficient of residual income progression v, its interaction with the indicator of industry level bargaining C, and the income tax retention rate $(1-t)$ are endogenous variables. By construction, shocks to earnings

affect both tax progressivity and the income tax retention rate $(1-t)$. Moreover, as discussed by Gruber [1995], measurement errors in the annual wage can generate a spurious correlation between the dependent variable, the average and the marginal tax rate. In particular, positive innovations to the measurement error rise the measured annual wage and reduce the average tax rate.

Table 3. OLS and GMM Estimates. Dependent variable: log pre-tax earnings

	OLS	GMM
log retention rate	-0.010	-0.033**
	(0.012)	(0.016)
log residual income progression	0.013***	0.011**
	(.003)	(.005)
log residual income progression	−0.047***	−0.131***
interacted with the dummy C	(.006)	(.023)
$Nobs$	1104	1104
R^2	.99	.99
Hansen J (2)		0.184 (p-value)

Note: Robust standard errors within parentheses. Each regression include the unemployment rate, country, type and year dummies. The instruments used in the second column are the first lag of the log index of tax progressivity, its interaction with the dummy C, the lagged log retention rate, the lagged cyclically adjusted government deficit as a percentage of GDP and the percentage of individuals older than 64 in the population. $J(2)$: P- value of the Hansen J test for the validity of instruments, with 2 degrees of freedom.

We re-estimate the model by using the Generalized Method of Moments (GMM) and by instrumenting the endogenous variables with their first lag, the percentage of individuals aged 65 or older in the population and the lagged cyclically adjusted government deficit as a share of GDP. Lags are used by Lockwood and Manning [1993], who estimate a similar equation. The share of older individuals in the population affect government expenditure - because of health and pensions - and tax rates because of the need to raise revenue, but has no obvious effect on the pre-tax wage. A similar argument can be used for the lagged structural government deficit.

The results reported in the second column of the Table confirm the positive relationship between the coefficient of residual income progression and earnings in countries where the wage bargaining does not take place at the industry level, and the negative - and much larger - relationship when the bargain is industry specific. If anything, the difference in the response of the two groups of countries increases when we use the GMM estimator. Importantly, the Hansen J test for instrument validity cannot reject the null hypothesis of no misspecification at the 5% level of confidence.

Our findings confirm the previous evidence - reviewed above - of a negative correlation between tax progressivity and pre-tax wages in Italy, the UK and Sweden, all countries with either local or centralized wage setting according to the classification by Golden, Lange and Wallerstein, [2004], and add evidence of a positive correlation in the countries with industrial bargaining.

How do we explain the uncovered contrast between countries with different degrees of centralization of the wage bargain? It is plausible to assume that the labor supply effect does not vary much across countries with different bargaining regimes. Moreover, this effect is likely to be small, especially for male unskilled labor (see Lockwood et al [2000]). With small labor supply effects and in the absence of strategic interaction effects, the much larger and positive correlation between tax progressivity and pre-tax wages in countries with industrial bargaining requires a much smaller wage moderation effect. This stringent requirement is not necessary once we are prepared to take into account the strategic interaction effect identified in this paper.

Conclusions

In this paper, we have shown that the explicit consideration of the interdependence among wages in unionized labor markets magnifies the net impact of the wage moderation and the combined labor supply and strategic interaction effects on the relationship between tax progressivity and pre-tax wages (or unemployment). In our empirical study of 20 OECD countries, we have found that higher tax progressivity increases

pre-tax wages in the countries characterized by an intermediate degree of centralization of the wage bargain, and reduces them in the countries where the wage bargain is either local or central. This evidence gives support to the existence of a hump - shaped pattern in the relationship between tax progressivity and pre-tax wages, highest when the wage bargain is at the industrial level and lowest when it is either local or centralized. A potentially important policy message of this paper is that the effectiveness of policies aimed at reducing unemployment by changing the degree of labor tax progressivity can vary significantly with the institutions regulating the wage bargain.

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