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Summary

Public finance solutions to high unemployment in Europe have often been advocated during the past years. With unemployment concentrated among the young and unskilled, it has been suggested that the reduction of social security contributions for low wage earnings, financed by a carbon tax, could yield a double dividend, the reduction of unemployment and the abatement of pollution. A decline in average labor taxes reduces unemployment if it generates lower pretax wages. Pretax 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 in a unionized economy, lower average labor taxes reduce the replacement ratio, and unions are willing to accept lower pretax wages because the net income loss from employment increases. 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.When labor taxation is nonlinear, another opportunity is to vary the degree of labor tax progressivity. Economic theory suggests that higher progressivity could reduce unemployment. Suppose that wages are bargained over by unions. When a union contemplates the possibility of a wage hike, it has to consider that say for a 1% increase in the after tax wage the pretax wage increases by $1/\nu$, where ν denotes the coefficient of residual income progression. This implies that the expected employment loss associated to the higher after tax wage is ε/ν, where ε is the elasticity of labor demand. Since $\nu<1$ with progressive taxation, this loss is higher with progressive than with proportional taxation. It follows that, when labor markets are not perfectly competitive, a certain degree of tax progressivity can be desirable because it makes wage increases less attractive to unions, with positive consequences on the unemployment rate.

This empirical paper adds to the existing literature additional evidence based on Italian data. We use both panel and grouped data to study the effects of average and marginal (payroll and income) tax rates on wage pressure, and investigate whether these effects vary by skill, age group and region of residence.

Our empirical findings are summarized as follows:

a) changes in average payroll taxes are not fully absorbed by offsetting changes in the after tax wage and affect both pretax wages and employment;

b) the estimated effects of changes in average income taxes on pretax wages are mixed but on balance the evidence suggests that after tax wages do not fully offset these changes;

c) higher tax progressivity *increases* pretax wages;

d) there are significant differences in the relationship between labor taxes and pretax wages by age group but not by region of residence or skill.

We also find that the estimated elasticity of pretax wages to changes in marginal tax rates, given average rates, is large and ranges between 0.919 and 1.131, depending on the specification being used. It is difficult to explain this large positive elasticity exclusively with the argument that the labor supply effect prevails over the wage moderation effect. Therefore, we add an additional mechanism, the relative wage effect, and describe how it can contribute to producing the above results. Briefly put, when individuals and unions care about relative wages and an increase in tax progressivity

reduces the own wage via the wage moderation effect, this reduction translates into lower relative wages, which can only be avoided by increasing wage pressure.

Keywords: Progressive taxation, wage determination, Italy

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1 Introduction

Public finance solutions to high unemployment have often been advocated in the past years. 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 clearly pointed out that a decline in average labor taxes reduces unemployment if it generates 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] and Sonedda [2001]).

Another result in this literature is that changes in tax progressivity, holding average labor taxes constant, can affect wage pressure. 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. Somewhat different results are obtained by Lockwood et al. [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 skill) and positive for high levels of income (and skill)[2].

These authors 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. This allows the union to buy more employment through wage moderation, because

[2] See also Hansen et al [1999].

a given fall in the pre-tax wage leads to a smaller change in the after tax wage (see Sørensen [1997], p.228). 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. This could be the case of unskilled workers if they are heavily unionized and if their hours supply function is flatter than that of skilled workers.

Sonedda [2001] develops an overlapping generations model of a unionized economy where hours of work are allowed to vary endogenously. The model is calibrated for Italy, a country where unskilled workers are highly unionized and can use overtime to vary their supply of hours. Her quantitative results show that an increase in income tax progressivity raises union wages, and that the labor supply effect prevails over the wage moderation substitution effect.

In this paper, we add to the wage moderation and labor supply effects another mechanism, *the relative wage effect*, and show how it influences the relationship between tax progressivity and pre-tax wage in unionized labor markets. Briefly put, when individuals and unions care about relative wages and an increase in tax progressivity reduces the own wage via the wage moderation effect, this reduction translates into lower relative wages, which can only be avoided by increasing wage pressure. The idea that unions are concerned not only with the absolute wage of union members but also with its relative purchasing power goes back at least to Keynes (see Gylfason and Lindbeck [1984]). A relative wage concern can also be justified either by "fairness" (Fehr and Schmidt [1999], Agell and Lundborg [1995], Akerlof and Yellen [1990] and Oswald [1980]) or by "envy" considerations (Clark and Oswald [1996]).

We model a two sector economy with unionized labor markets and competitive product markets, where workers and unions care about their relative wages, and show that the presence of a relative wage concern reinforces the labor supply effect and could help in generating a positive relationship between tax progressivity and wage pressure. We also

conduct an empirical analysis of the relationship between labor taxation and pre-tax wages in Italy and study whether such relationship varies significantly by skill and age group. To preview our results, we find that higher tax progressivity increases pre-tax wages, which suggests that the combination of the labor supply and the relative wage effect dominates the wage moderation effect in this specific context. There is also evidence that changes in payroll taxes are not fully absorbed by offsetting changes in the pre-tax wage and affect labor costs and employment. The evidence on the effect of the average income tax rate on pre-tax wages is more mixed, but it also points to the presence of some degree of real wage resistance. Finally, we find significant differences in the relationship between labor taxes and pre-tax wages by age group but not by skill.

The paper is organized as follows. Section 1 presents the model and its implications. Section 2 introduces the empirical analysis and Section 3 presents the data. The empirical results are discussed in Section 4. Conclusions follow.

2 The Model

Consider a closed economy characterized by two sectors and composed of three economic agents: households, unions and firms. Skilled workers are employed in one sector ("the skilled workers' sector") and unskilled workers work in the other sector ("the unskilled workers' sector"). Each sector is fully unionized and for simplicity we assume that both unions have monopoly power over wage setting[3]. The labor force is constant and individuals earn only wage income.

This economy is populated by a fixed number of identical competitive firms, indexed by j. Their technology is described by the following production function:

[3]The assumption of a monopoly union is made for the sake of simplicity. If we rule out the possibility that wages may be strategic substitutes à la Padilla et al [1996] (this should be sensible given that in our case the product market is competitive), the signs of the comparative statics of interest in the monopoly union framework correspond to those of the right to manage model of wage bargaining.

$$Y_{ji} = \alpha_i L_{ji}^{\sigma_i} \tag{1}$$

where $i = u, s$ stands for "unskilled" and "skilled" respectively and α_i is a productivity parameter. By assumption $\alpha_u < \alpha_s$ and both σ_u and σ_s are lower than 1.

In both sectors the labor input L_{ji} is homogeneous and hours of work are fixed and normalized to 1. Therefore, provided that the goods market is competitive, labor demand can be obtained by inverting the first order condition of the profit function:

$$L_{ji} = N_{ji}(w_{ji}) = \left[\frac{w_{ji}}{\alpha_i \sigma_i}\right]^{\frac{1}{\sigma_i - 1}} \tag{2}$$

Risk neutral skilled and unskilled individuals care about their consumption and their relative position in the distribution of income. They have homothetic preferences described by a utility function, separable over consumption and the wage differential between their own wage and the wage of the other group.

The utility function is linear in both arguments and takes the following form[4]:

$$U^{i,m} = c_i + a_i \left[w_i (1 - t_i) - w_k (w_i)(1 - t_k)\right] \tag{3}$$

where $k \neq i = u, s$; $m = e\,(employed)\,,\ un\,(unemployed)$; c_i denotes consumption, the term $[w_i(1 - t_i) - w_k(w_i)(1 - t_k)]$ is the wage differential and $t_i = t_u, t_s$ denotes the average personal income tax rate of unskilled and skilled workers respectively. Finally a_i is a parameter that measures the marginal utility of the wage differential[5]. Since each agent internalizes the effect of changes in the own wage on the other wage, the term $w_k(w_i)$ in the utility function captures the conjecture on how

[4] Our results hold also when we use the relative wage in place of the wage differential in the utility function. The proof is available from the authors upon request.

[5] It is clear that when $a = 0$ there is no relative wage concern. We believe that the introduction of the wage differential in the utility function cannot be considered as arbitrary since fairness or envy motives truly affect behaviour. See Fehr and Schimdt [1999], who refer to a more general context than the labor market.

the other wage is expected to respond. We assume that the conjectural variation $\frac{dw_k}{dw_i}$ is equal to a positive constant $\varphi_i > 0$.

There is no saving and households face the following budget constraint:

$$\omega_i^m = c_i^m \tag{4}$$

where

$$\omega^m = \begin{cases} w_i - T(w_i, z) & if \quad employed \\ b_i & if \quad unemployed \end{cases}$$

with $w_i - T(w_i, z)$ as the income net of taxes and b_i as unemployment benefits, which are determined by some political-economy mechanism outside the model and are not taxable by assumption[6]. As in Lockwood and Manning (1993), $T(w_i, z)$ is for personal labor income taxes and z is a vector of parameters (marginal tax rates, tax brackets...) which takes into account any non-linearities in the tax system.

Each sector is characterized by the presence of a monopolistic union which sets the sector wage by taking into account the effects of its own decision on the other sector wage. Following Dowrick [1989], we interpret the parameter $0 < \varphi_i < 1$ as a measure of the degree of centralization in the wage setting process. When $\varphi = 0$ ($\varphi = 1$) wage determination is fully decentralized (fully centralized). Since the output price index is normalized to unity, setting nominal (pre-tax) wages is equivalent to setting real wages. Unions are unable to affect fiscal policy decisions and their aim is to maximize the expected utility of members subject to (2). Notice that an interior solution to the maximization problem is guaranteed by the presence of unemployed union members. The union optimization problem is:

$$\max_{w_i} N_i(w_i) \left[U_i^e - U_i^{un}\right] \tag{5}$$

Following Lockwood and Manning (1993), we express (5) in logs and define the first order condition ψ as:

[6] If unemployment benefits are taxable, changes in the parameter z of the taxation system would affect net benefits. Then, when evaluating the effect of changes in taxation on wages one should also consider this effect. However, since benefits are conceived as unemployment benefits only and since individuals can only earn labor income, it is quite likely that unemployment benefits would be below the minimum threshold and therefore remain untaxed.

$$\psi_i = 0 = \frac{\frac{\partial N_i(w_i)}{\partial w_i}}{N_i\left(w_i\right)} + \frac{\frac{\partial\left[U_i^e - U_i^{un}\right]}{\partial w_i}}{\left[U_i^e - U_i^{un}\right]} \tag{6}$$

where $\frac{\partial\left[U_i^e - U_i^{un}\right]}{\partial w_i} = \frac{\partial\left[U_i^e - U_i^{un}\right]}{\partial w_i} + \frac{\partial\left[U_i^e - U_i^{un}\right]}{\partial wj}\frac{\partial w_j}{\partial w_i}$. We can use (3) and rewrite (6) as

$$\psi_i = \begin{cases} w_u - \frac{b_u}{1-t_u} M_u = 0 & if \quad i{=}u \\ w_s - \frac{b_s}{1-t_s} M_s = 0 & if \quad i{=}s \end{cases} \tag{7}$$

with M_i as the union markup in sector i, defined as

$$M_i = \begin{cases} \left[(1+a_u)(\nu_u(\sigma_u - 1)+1) - \frac{(1-t_s)}{(1-t_u)}(\sigma_u - 1)a_u\nu_s\varphi_s - \frac{a_u}{RW}\right]^{-1} & if \quad i{=}u \\ \left[(1+a_s)(\nu_s(\sigma_s - 1)+1) - \frac{(1-t_u)}{(1-t_s)}(\sigma_s - 1)a_s\nu_u\varphi_u - a_s RW\right]^{-1} & if \quad i{=}s \end{cases}$$

In the above expression ν is the coefficient of residual income progression $\left(\nu_i = \frac{1-\tau_i}{1-t_i}\right)$; the marginal tax rate τ_i is equal to $\frac{\partial T(w_i)}{\partial w_i}$and RW is the relative post tax wage $\frac{w_u(1-t_u)}{w_s(1-t_s)}$.

Sectorial wages in the two reaction functions defined by (7) are increasing functions of unemployment benefits and of the union markup[7]. We can decompose this markup into three components. The first term, $\left((1+a_i)\left(\nu_i(\sigma_i - 1)+1\right)\right)$, is the well know wage moderation effect; the second term, $\left(\frac{(1-t_k)}{(1-t_i)}\left(\sigma_i - 1\right)a_i\nu_k\varphi_k\right)$, is generated by the presence of conjectural variations, and we define the last term as the relative wage concern. The markup is increasing in the first term, decreasing in the second term and either decreasing (M_u) or increasing (M_s) in the relative wage. An equilibrium of this game requires that each union achieve positive utility. This condition is guaranteed if each sectorial wage is higher than unemployment benefits. The second order conditions of the optimization problem (5) are met if $\left(1+a_i\right)\left(1-\tau_i\right) > a_k\left(1-\tau_k\right)\varphi_k$, which surely holds when a and τ are not too different.

2.1 Qualitative Analysis

In this section we study how changes in the labor tax parameters affect equilibrium skilled and unskilled pre-tax wages. In order to do so, it is convenient to re-write (7) in implicit form as follows

$$\psi_u = \psi_u(w_u, w_s(w_u), \nu_u, \nu_s, X_u) = 0 \tag{8}$$

[7] As expected, reaction functions are upward sloping.

$$\psi_s = \psi_s(w_u(w_s), w_s, \nu_s, \nu_u, X_s) = 0 \tag{9}$$

where $X_i \in (a_i, \sigma_i, b_i, t_i)$. Total differentiation of (8) and (9) and the application of Cramer's rule allows us to establish the following

Proposition 1 *Given the average tax rate and with fixed hours, an increase in tax progressivity v_u has both a wage moderation effect and a relative wage effect, with an ambiguous overall effect on the unskilled wage w_u.*

Proof.

$$\frac{dw_u}{d\nu_u} = -\frac{\left[\frac{\partial\psi_u}{\partial\nu_u}\frac{\partial\psi_s}{\partial w_s} + \frac{\partial\psi_u}{\partial\nu_u}\frac{\partial\psi_s}{\partial w_u}\frac{\partial w_u}{\partial w_s}\right] - \left[\frac{\partial\psi_s}{\partial\nu_u}\frac{\partial\psi_u}{\partial w_s} + \frac{\partial\psi_s}{\partial\nu_u}\frac{\partial\psi_u}{\partial w_u}\frac{\partial w_u}{\partial w_s}\right]}{|J|} \gtreqless 0 \tag{10}$$

where $\frac{\partial\psi_s}{\partial w_s} < 0$; $\frac{\partial\psi_u}{\partial\nu_u} > 0$; $\frac{\partial\psi_u}{\partial w_u} < 0$; $\frac{\partial w_s}{\partial w_u} > 0$; $\frac{\partial\psi_u}{\partial w_s} > 0$; $\frac{\partial\psi_s}{\partial w_u} > 0$; $\frac{\partial w_s}{\partial\nu_u} < 0$; $\frac{\partial\psi_s}{\partial\nu_u} < 0$; $\frac{\partial w_u}{\partial\nu_u} > 0$ ■

As usual, the sign of (10) depends on the numerator since the sign of the denominator corresponds to the sign of the determinant of the Jacobian matrix J, which must be positive to guarantee the stability of the system. Following Padilla, Bentolila and Dolado [1996], we distinguish between a direct effect (shift of the reaction curve), captured by the terms in the former bracket in the numerator, and a strategic effect (movement along the reaction curve), represented by the terms in the latter bracket.

The relative wage effect on the reaction curve associated to unskilled workers is captured by the second term in the first bracket in the numerator. In the absence of this effect and of the strategic effect, given by the first term in the second bracket, the sign of the derivative is positive, which suggests that an increase in tax progressivity should reduce the unskilled pre-tax wage. This is the well known wage moderation effect discussed in the Introduction. The presence of a relative wage concern combined with a certain degree of centralization in the wage determination process adds to this the relative wage effect. On the one hand, the union in the unskilled sector, aware of the fact that a decline in the unskilled wage induced by higher tax progressivity in the unskilled

sector will reduce its relative wage, reacts by increasing its wage pressure. On the other hand, the union in the skilled sector realizes that the other union could avoid the (expected) reduction in its relative wage by bargaining for a higher wage (or by going for lower wage moderation). In order to prevent the deterioration of its own relative wage, the union in the skilled sector will also react by increasing its own wage pressure. These effects are amplified by the strategic complementarity between the two wages and generate an increase in wage pressure. Therefore, the wage moderation and the relative wage effect have opposite influences on the unskilled wage. The overall effect is ambiguous and depends on the parameters of the model.

Notice that this result is robust to different model specifications. If we rule out conjectural variations and consider instead a framework where the employers' association determines the employment level in either sector and the two unions are completely collusive, an increase in tax progressivity raises (reduces) the unskilled wage w_u if and only if $a_u > 1+a_s$ $(a_u < 1+a_s)$. The main difference with the model presented above relies on the asymmetric effects on the two sectorial wages . That is, $a_u > 1+a_s$ $(a_u < 1+a_s)$ implies $a_s < 1+a_u$ $(a_s > 1+a_u)$ and therefore an increase in tax progressivity in the skilled sector would lead to lower (higher) skilled wage pressure. It is worth noting that empirical results for Denmark presented by Lockwood et al [2000] could be interpreted in terms of this framework even though working hours are fixed. Furthermore, the ambiguous effect on wage determination could also be obtained in a simple Bertrand-Nash game under the assumption that skilled and unskilled wages bear equal marginal and average tax rates (e.g when tax brackets are quite large).

Proposition 2 *Given the average tax rate and with fixed hours, the effect of an increase in tax progressivity ν_s on the unskilled wage is ambiguous.*

Proof.

$$\frac{dw_u}{d\nu_s} = -\frac{\left[\frac{\partial\psi_u}{\partial\nu_s}\frac{\partial\psi_s}{\partial w_s} + \frac{\partial\psi_u}{\partial\nu_s}\frac{\partial\psi_s}{\partial w_u}\frac{\partial w_u}{\partial w_s}\right] - \left[\frac{\partial\psi_s}{\partial\nu_s}\frac{\partial\psi_u}{\partial w_s} + \frac{\partial\psi_s}{\partial w_u}\frac{\partial\psi_u}{\partial w_u}\frac{\partial w_u}{\partial w_s}\right]}{|J|} \gtreqless 0 \qquad (11)$$

where $\frac{\partial \psi_s}{\partial w_s} < 0; \frac{\partial \psi_u}{\partial \nu_u} > 0; \frac{\partial \psi_u}{\partial w_u} < 0; \frac{\partial w_s}{\partial w_u} > 0; \frac{\partial \psi_u}{\partial w_s} > 0; \frac{\partial \psi_s}{\partial w_u} > 0; \frac{\partial w_s}{\partial \nu_u} < 0; \frac{\partial \psi_s}{\partial \nu_u} < 0; \frac{\partial w_u}{\partial \nu_u} > 0.$ ■

In the absence of a relative wage concern, an increase in tax progressivity in the skilled sector ν_s has no impact on the unskilled wage. When wages are strategic complements and conjectural variations are introduced, the presence of a relative wage effect implies that the wage moderation effect on the skilled wage spills over to the unskilled wage, with uncertain overall effects.

The effect of changes in tax progressivity on the skilled wage are symmetric:

Proposition 3 *Given the average tax rate and with fixed hours, an increase in tax progressivity v_s has both a wage moderation effect and a relative wage effect, with an ambiguous overall effect on the skilled wage w_s.*

Proof.

$$\frac{dw_s}{d\nu_s} = -\frac{\left[\frac{\partial \psi_s}{\partial \nu_s}\frac{\partial \psi_u}{\partial w_u} + \frac{\partial \psi_s}{\partial \nu_s}\frac{\partial \psi_u}{\partial w_s}\frac{\partial w_s}{\partial w_u}\right] - \left[\frac{\partial \psi_u}{\partial \nu_s}\frac{\partial \psi_s}{\partial w_u} + \frac{\partial \psi_u}{\partial w_s}\frac{\partial \psi_s}{\partial w_s}\frac{\partial w_s}{\partial w_u}\right]}{|J|} \gtreqless 0 \qquad (12)$$

where $\frac{\partial \psi_s}{\partial w_s} < 0; \frac{\partial \psi_u}{\partial \nu_u} > 0; \frac{\partial \psi_u}{\partial w_u} < 0; \frac{\partial w_s}{\partial w_u} > 0; \frac{\partial \psi_u}{\partial w_s} > 0; \frac{\partial \psi_s}{\partial w_u} > 0; \frac{\partial w_s}{\partial \nu_u} < 0; \frac{\partial \psi_s}{\partial \nu_u} < 0; \frac{\partial w_u}{\partial \nu_u} > 0.$ ■

Proposition 4 *Given the average tax rate and with fixed hours, the effect of an increase in tax progressivity ν_u on the skilled wage is ambiguous.*

Proof.

$$\frac{dw_s}{d\nu_u} = -\frac{\left[\frac{\partial \psi_s}{\partial \nu_u}\frac{\partial \psi_u}{\partial w_u} + \frac{\partial \psi_s}{\partial \nu_u}\frac{\partial \psi_u}{\partial w_s}\frac{\partial w_s}{\partial w_u}\right] - \left[\frac{\partial \psi_u}{\partial \nu_u}\frac{\partial \psi_s}{\partial w_u} + \frac{\partial \psi_u}{\partial w_s}\frac{\partial \psi_s}{\partial w_s}\frac{\partial w_s}{\partial w_u}\right]}{|J|} \gtreqless 0 \qquad (13)$$

where $\frac{\partial \psi_s}{\partial w_s} < 0; \frac{\partial \psi_u}{\partial \nu_u} > 0; \frac{\partial \psi_u}{\partial w_u} < 0; \frac{\partial w_s}{\partial w_u} > 0; \frac{\partial \psi_u}{\partial w_s} > 0; \frac{\partial \psi_s}{\partial w_u} > 0; \frac{\partial w_s}{\partial \nu_u} < 0; \frac{\partial \psi_s}{\partial \nu_u} < 0; \frac{\partial w_u}{\partial \nu_u} > 0.$ ■

To summarize, our simple model suggests that, in unionized labor markets where unions care about the wage differential and make conjectures about the effects of changes in their own wages on the other wages, changes in tax progressivity have ambiguous effects on wage pressure. There are two important mechanisms at work: a) a union wage moderation effect; b) a relative wage effect. To these we should also add the hours supply effect, that was not included in the model for the sake of simplicity. While the former effect reduces wage pressure in the presence of an increase in tax progressivity, the other two effects increase it. The overall effect cannot be signed using the restrictions imposed by economic theory and can only be determined in the empirical analysis, to which we now turn.

3 The Empirical Specification

The first order conditions (8) and (9) can be solved to yield equilibrium wages

$$w_u^* = w_u(\nu_u, \nu_s, X_u, X_s) \tag{14}$$

$$w_s^* = w_s(\nu_u, \nu_s, X_u, X_s) \tag{15}$$

Notice that each equilibrium wage depend on the entire tax structure, described by the tax parameters t_s, t_u, ν_s and ν_u. In the empirical specification we impose the restriction that the cross effects of changes in the parameters and variables associated to one wage on the other wage are small and can be disregarded as a first approximation. To add realism, we also assume that wage settlements are determined by bilateral bargaining between unions and employers rather than by a monopolistic union. It is also reasonable to expect that the relative bargaining power of unions vary with changes in labor market conditions, captured by the unemployment rate.

With these additional assumptions, a log-linear approximation of (14) and (15) yield the following empirical model

$$\ln w_i - \ln q_i = f_i + \alpha_1 \ln(1+t_e) + \alpha_2 \ln(1-t) + \alpha_3 \ln v + \alpha_4 \ln u + \epsilon_i \tag{16}$$

where u is unemployment, q is the output price, t_e is the payroll tax

wedge, defined as the ratio of payroll taxes to pre-tax wages, $(1-t)$ is the average income tax retention rate and ν is the measure of tax progressivity, i is for the individual, f_i is an individual fixed effect and ϵ_i is the random error term. This specification has the advantage of having been used in previous empirical work, most notably by Holmlund and Kolm [1995] and by Lockwood et al. [2000]. This facilitates the comparison of our results with theirs.

In the current setup, w_i is the pre-tax wage net of payroll taxes. This wage is related to the total labor cost c_i by the following identity: $\ln c_i = \ln w_i + \ln(1+t_e)$. Changes in labor taxes, both average and marginal, do not affect per capita labor costs and employment when the following restrictions hold:

$$\alpha_1 = -\frac{t_e}{1+t_e}; \quad \alpha_2 - \alpha_3 = 0; \ \alpha_3 = 0 \tag{17}$$

When the former two restrictions hold, we say that there is no real wage resistance to change in labor taxes.

4 The Data

We investigate the relationship between labor taxes and pre-tax wages using two data sets: a panel drawn from the 1993 and 1995 waves of the survey on the income and wealth of Italian households, carried out by the Bank of Italy ($SHIW$), and grouped data covering a longer period, from 1979 to 1995, obtained by collapsing data from $SHIW$ and by merging the results with other sources of information. Genuine longitudinal information is available from $SHIW$ only from 1989, and we choose the 1993 - 1995 window to minimize attrition in the data. The main advantage of the grouped data from 1979 to 1995 is that they allow us to use the time variation in average and marginal tax rates to study how these variables affect the pre-tax wage.

The $SHIW$ survey covers most years from 1979 to 1989 and the years 1991, 1993, 1995 and 1998. Individual earnings in this data-set are net of taxes and social security contributions. For each year and for each individual in the sample, we compute pre-tax wages by using the information on income tax rates, tax brackets and tax allowances

from the relevant tax legislation and information on the composition of the household (whether the individual has a dependent spouse and / or children, whether he is employed or self - employed) from $SHIW$. Given pre-tax and net wages, we compute for each individual the relevant average and marginal tax rate. These rates are based on labor income only, and do not take into account additional income from capital and self - employment. Since there is no individual information on social security contributions paid by the employer and by the employee, we use regional data from the Regional Accounts, that cover the period 1979-1995.

Grouped data are obtained by combining information from different sources: gross wages and income tax rates from $SHIW$, unemployment rates from the Labor Force Survey and payroll taxes from the Regional Accounts. Each cell in the data contains the average value of these variables by gender, educational attainment, age group, macro area of residence and year. We classify educational attainment into two categories, at least upper secondary education (the skilled) and less than upper secondary education (the unskilled). We also group individuals into two age groups, the young (20-29) and the adults (30-59) and in three macro areas of residence (North, Center and South).

While information on unemployment rates and payroll taxes is available for the entire period 1979 - 1995, gross wages and tax rates are missing in the years when the $SHIW$ was not carried out. We take care of these missing values in two ways: first, average and marginal tax rates are linearly interpolated using the available data points; second, gross wages in the missing years are estimated by using the rate of growth of regional gross wages, which are available for the full period. The Appendix at the end of the paper provides additional technical details.

Figure 1 provides a summary description of the data. The first panel of the figure shows that the unemployment rate has increased during the sample period, especially among the unskilled. As a consequence, the relative unskilled unemployment rate has risen from less than 0.5 in 1979 to about 1 in 1995. Nominal gross wages by skill have also increased (see panel 2), and the absolute gap between skilled and unskilled wages is

higher in 1995 than it was in 1979. Panel 3 shows that average income taxes have increased sharply in the early eighties and only mildly thereafter. Clearly, the skilled have higher average tax rates, and the absolute gap with the unskilled has slightly increased in the 1990s. Finally, the evolution of tax progressivity is illustrated in the last panel of the figure. Progressivity increased sharply up to 1982, partially bounced back in the mid 1980 only to increase again in the rest of the period, with the exception of the last two years in the sample, when it decreased mildly.

Income tax rates in Italy were almost proportional before the sweeping fiscal reform of 1974, which introduced steeply rising marginal tax rates. This reform was followed by a significant cut in the payroll tax wedge, that declined by close to 10 percentage points in the second part of the seventies[8]. In the early 1980s, two-digits inflation increased significantly the average tax rate and tax progressivity. As remarked by Giavazzi and Spaventa [1988]

"..the inflation induced increase in the average tax rate was such that the wedge between the cost of labor for enterprises and take-home pay actually increased in the period, in spite of the substantial cut in contributions...." (p.147)

Since fiscal drag was responsible of a sharp increase in the tax burden of employees, unions started to negotiate with the government both the restitution of the drag and measures that could reduce the progressivity of income taxation. These measures were eventually implemented in the early 1980s. Tax progressivity was loosened again during the last part of the 1980s, only to be increased in the early 1990s.

Figure 2 presents similar evidence by age group. We notice that youth unemployment is much higher than adult unemployment over the entire sample period. A high gap in the unemployment rate has been accompanied by an increasing gap in the wage differential between the adults and the young. While income tax progressivity does not vary significantly across the two groups, average income taxes paid by the young have declined since the late 1980s and their gap with the tax

[8] See Brunello et al [2001] for a detailed discussion.

rates paid by the adults have increased. Finally, Figure 3 shows the evolution of the average payroll tax wedge. With the exclusion of the few years at the start of the sample, the wedge has increased by close to 10 points from about 0.45 to about 0.55.

5 Results

We start our empirical analysis by estimating (16) on the longitudinal data for the years 1993 and 1995. First, we eliminate the individual fixed effect f_i by taking first differences; second, we add to the explanatory variables additional controls, including gender, marital status, age, education. We also include occupation, sector of activity, firm size and region of residence in 1993. The inclusion of sector, occupation, firm size and regional dummies captures all the variation in local labor market conditions, including changes in the unemployment rate. Since payroll taxes in these data are only available at the regional level, their effects on individual wages cannot be identified and are captured by regional dummies.

The dependent variable is the change in the (log) hourly wage w_h, obtained by dividing the annual wage by total hours worked (weekly hours by number of weeks by number of months of employment). By construction, shocks to individual pre-tax hourly wages affect both tax progressivity and the average income tax retention rate $(1 - t)$. The endogeneity of the current changes in tax progressivity and in the retention rate requires that we use instrumental variables. Our selected instruments include the 1991 to 1993 changes in both variables, computed from grouped data. We also add the changes in the presence of a dependent spouse in the household, the changes in a dummy indicating whether the household has purchased a life insurance, a private health insurance or a private pension scheme, and a dummy indicating whether the individual has had medical or college expenses in 1993. These variables are selected because they affect tax deductions and the tax rates without any obvious effect on the hourly wage.

Instrument validity is tested with the Sargan Criterion, a misspecification test of whether additional instruments can be omitted from the

vector of explanatory variables. The quality of instruments is tested with the Bound test, an F test of the additional instruments in the regression of each endogenous variable on the full list of instruments.

Our main results are reported in Table 1, which shows both the estimated coefficients and the implied elasticities associated to the tax variables[9]. The Sargan criterion clearly rejects the hypothesis of misspecification. Not reported in the table, the Bound tests suggest that the selected instruments are significantly correlated with each endogenous variable.

We find that higher marginal taxes, given the retention rate, significantly *increase* the pre-tax wage. A similar result holds also for average taxes, given tax progressivity. The estimated coefficients associated to the average tax retention rate and to tax progressivity are not significantly different from zero (P-value of the test: 0.68). Therefore, and conditional on marginal taxes, changes in average labor tax rates do not significantly affect pre-tax hourly wages. On the other hand, changes in the marginal tax rate, given average taxes, have a large and significant positive effect on hourly wages (the elasticity is equal to 1.131).

The evidence in Table 1 is based on the cross - sectional variation of changes in taxation and changes in hourly wages. These changes cover a short period of time (two years) characterized by relatively small changes in the tax rates. The longitudinal data-set could be extended backward to 1989 and forward to 1998 at the price of significant attrition[10]. A more appealing alternative is to use grouped annual data from 1979 to 1995. We have information on real gross and net annual wages[11], the unemployment rate, the average and the marginal personal income tax rate, and each cell contains average values of data classified by year, gender, age group, macro area of residence and educational attainment.

We estimate a version of (16) where the subscript i is now for the cell rather than for the individual. Rather than taking first differences, we capture the cell specific fixed effect with gender, education, age and

[9] These elasticities are computed using the sample averages of τ and t in 1995.

[10] The inclusion of 1991 would reduce the sample size from 2233 to 1650 individuals.

[11] Since hours of work are not available in the first part of the sample, we prefer to use annual wages.

Table 1: IV estimates of (16) based on panel data (1993-95). Dependent variable: two - year change in log hourly gross wage $\Delta \ln w_h$

	Coefficient
$\Delta \ln(1 - T_a)$	-2.693
	(.818)
$\Delta \ln V$	-2.612
	(.877)
η_1	.017
η_2	1.131
$Nobs$	2233
R^2	.285
SC	.336

Note: Each regression includes a constant, individual age and marital status, plus gender, part time, education, region, occupation, firm size, sector dummies. Additional instruments are the changes in the average retention rate between 1991 and 1993, in tax progressivity between 1991 and 1993 and between 1989 and 1991, computed from grouped data, the changes in the number of dependent children, in a dummy indicating whether the spouse is dependent, in dummies indicating whether the household has purchased a life insurance, a private health insurance or a private pension scheme, and in a dummy showing medical and college expenses in 1993. Robust standard errors within parentheses. η_1 : average income tax elasticity of the gross wage; η_2 : marginal income tax elasticity of the gross wage. SC : P- value of the Sargan test for the validity of instruments.

area dummies and estimate two alternative empirical specifications. In the former specification we regress cell - specific annual wages on cell - specific retention rates, tax progressivity and unemployment rates and model aggregate, region, age and skill specific effects with time dummies and interactions of these dummies with region of residence, educational attainment and age. Since payroll taxes are available only at the regional level, these dummies capture also the impact of payroll taxes on pre-tax wages.

In the latter specification, we add lagged payroll tax rates[12] to the list of regressors and model the remaining aggregate, region, age and skill specific effects with a linear and a quadratic trend and with the interactions of these trends with region, educational and age dummies. The second specification allows us to identify the effect of payroll taxes at the price of imposing restrictions on the shape of aggregate, region, age and skill specific effects.

By construction, income tax rates and cell - specific unemployment rates u are endogenous. A disadvantage of the longer span of time is that most of the variables used as instruments in Table 1 are not available. An advantage is that we have a richer lag structure. We exploit this advantage by selecting as additional instruments the first and second lags of the average income tax retention rate, the first lag of log tax progressivity and the first and second lag of log regional unemployment.

Table 2 shows our estimates for the full sample, with the former specification in the first column and the latter specification in the second column. Since the payroll tax is defined at a higher level of aggregation than the annual wage, Column (2) reports IV estimates with standard errors corrected for the lack of independence of errors within regions of residence. The Sargan criterion always rejects the hypothesis of misspecification. Both columns show that a higher average income tax retention rate and a lower rate of tax progressivity significantly reduce pre-tax wages. These findings broadly confirm the results in Table 1. Compared to that table and conditional on marginal tax rates, we find that changes in average income taxes have a positive and significant

[12] We use lagged rather than current values to avoid endogeneity issues.

effect on the pre-tax wage, thereby suggesting the presence of real wage resistance. We also find that the impact of marginal taxes on wage pressure, given average taxes, is positive and quantitatively similar to that found in Table 1.

Moreover, a one percentage point increase in payroll taxation is estimated to increase labor costs per head by 0.427[13]. Overall, this evidence suggests that increases in average income and payroll taxes are only partially absorbed by reductions in take home pay and affect pre-tax wages, labor costs per head and (un)employment.

Next we ask whether the impact of marginal and average taxes on pre-tax wages vary by skill and age, where skill is measured by educational attainment. This is done by selecting the empirical specification in the second column of Table 2 and by interacting the main regressors either with the dummy $UNSK$, equal to one for cells of individuals with less than upper secondary education and to zero otherwise, or with the dummy $YOUNG$, equal to 1 if the cell consists of individuals younger than 30 and to zero otherwise. Table 3 illustrates the results. The Wald test in the table shows that only the interactions with $YOUNG$ are (jointly) significantly different from zero. Therefore, and in contrast with the findings by Lockwood and at [2000], there is evidence in our data that the relationship between taxation and pre-tax wages varies significantly by age group but not by skill.

We find that the elasticity of the pre-tax wage to changes in tax progressivity is significantly lower in the younger (0.377) than in the older age group (0.747). On the other hand, the elasticity of the pre-tax wage to changes in the income tax retention rate and in the payroll tax is higher among the young (0.741 and 0.406 respectively) than among the adults (0.569 and 0.123 respectively). Only for payroll taxes, however, the observed difference in the elasticities is significantly different from zero. The higher real wage resistance to changes in payroll taxes among

[13]This elasticity is computed as follows

$$\frac{\partial \ln c}{\partial \ln t_e} = (1 + \frac{\partial \ln w}{\partial \ln t_e})\frac{t_e}{1 + t_e}$$

Table 2: IV estimates of (16) based on grouped data. Dependent variable: log annual gross wage $\ln W$

	(1)	(2)
$\ln(1-T_a)$	-4.656	-5.895
	(.431)	(.411)
$\ln V$	-2.857	-2.735
	(.495)	(.493)
u	-.060	-.029
	(.011)	(.009)
$\ln(1+T_e)_{-1}$	-	1.002
		(.194)
η_1	.298°	.524°
η_2	.960	.919
η_3	-	.324†
η_4	-	.427
$Nobs$	408	408
R^2	.986	.965
SC	.315	.374
$Regressors$	time dummies	trends

Note: Additional instruments include first and second lags of the average retention rate, first lag of log tax progressivity, first and second lag of log regional unemployment. Robust standard errors in Column (1) and cluster adjusted robust standard errors in Column (2) within parentheses. η_1 : average income tax elasticity of the gross wage; η_2 : marginal income tax elasticity of the gross wage; η_3: payroll tax elasticity of the gross wage; η_4: payroll tax elasticity of the labor cost; SC : P- value of the Sargan test for the validity of instruments. $^\circ$ and † if the estimated elasticity is significantly different from zero and one respectively at the 10 percent level of confidence.

Table 3. IV estimates of (16) based on grouped data. Dependent variable: log annual gross wage $\ln w$. With age and skill interactions.

	(1)	(2)
$\ln(1-T_a)$	-5.708	-5.655
	(.770)	(.426)
$\ln V$	-1.988	-2.222
	(.515)	(.541)
u	-.035	-.047
	(.010)	(.011)
$\ln(1+T_e)_{-1}$	1.020	.381
	(.169)	(.375)
$UNSK * \ln(1-T_a)$	-.361	–
	(.409)	
$UNSK * \ln V$	-.736	–
	(.371)	
$UNSK * u$	.006	–
	(.002)	
$UNSK * \ln(1+T_e)_{-1}$	−.129	–
	(.059)	
$YOUNG * \ln(1-T_a)$	–	.067
		(.366)
$YOUNG * \ln V$	–	1.099
		(.424)
$YOUNG * u$	–	.064
		(.008)
$YOUNG * \ln(1+T_e)_{-1}$	–	.876
		(.348)
$Nobs$	408	408
$Wald\ Test\ -Skill$	.176	-
$Wald\ Test\ -Age$	-	.025
SC	.321	.564
R^2	968	.975
$Regressors$	trends	trends

Note: Additional instruments include first and second lags of the average retention rate, first lag of log tax progressivity, first and second lag of log regional unemployment plus all interactions with the dummies $UNSK$ and $YOUNG$. Cluster adjusted robust standard errors within parentheses. η_1 : average income tax elasticity of the gross wage; η_2 : marginal income tax elasticity of the gross wage; η_3: payroll tax elasticity of the gross wage. SC : P- value of the Sargan test for the validity of instruments.

the young could be explained with the fact that the wages of this group have been relatively close to sectorial wage floors set by collective bargaining in an economic environment characterized by increasing payroll taxes. As a consequence, the take home pay of this group could not adjust downward as much as in the case of adult workers to compensate for the higher payroll taxes. An alternative explanation is that unionized young workers have had a higher emphasis than unionized adults on wage gains relative to employment gains.

We can further illustrate our results in this section by considering the following policy experiment. Marginal income taxes in our sample have increased from 1979 to 1995 by close to 39%, and the relative employment of the young has fallen during the same period by close to 25%. Suppose that the government decides to reduce the marginal income tax rate borne by the young by 10% and to increase it by the same amount for the adults. Given that the young earn on average lower annual wages, this can be accomplished by reducing progressivity for the low wage income group and by increasing it for the high wage income group. According to our estimates in the second column of Table 3, and assuming that the estimated wage pressure equation is invariant to this policy experiment, the relative pre-tax wage of the young would fall as a consequence by 11.2%, a substantial reduction. Following Katz and Autor [1999], we have estimated that the long run elasticity of relative employment to relative labor costs is 0.903. Using these estimates, this policy experiment would increase the relative employment of the young by 10.11%, from 0.279 to 0.307, close to the value taken in 1992 but still far from 0.372, the 1979 value.

6 Conclusions

We have found that higher tax progressivity increases pre-tax wages. There is also evidence that changes in payroll taxes are not fully absorbed by offsetting changes in the pre-tax wage and affect labor costs and employment. The evidence on the effect of the average income tax rate on pre-tax wages is more mixed and varies with the data set being used, but on balance it also points to the presence of some degree of real

wage resistance. Finally, we have found significant differences in the relationship between labor taxes and pre-tax wages by age group but not by skill.

The finding that there is some degree of real wage resistance in the relationship between labor taxes and pre-tax wages is not surprising in the Italian institutional environment. Income from unemployment in this country includes both ordinary unemployment benefits and more generous unemployment subsidies paid to dismissed employees from large firms. Provided that income is above a given threshold, both are subject to income taxes, but the latter are exempt from taxation after the first year of unemployment[14]. Neither is subject to payroll taxes, that constitute the largest share of the overall tax wedge. When income from unemployment is only partially taxed, changes in average taxes (both payroll and income) affect wage pressure by influencing the reservation wage.

This result is also consistent with previous research. Daveri and Tabellini [2000] find that taxes affect unemployment relatively more in countries like Italy with an intermediate degree of centralization of the wage bargain. Brunello et al. [2001] show that the long term relationship between the average labor tax wedge and regional unemployment is significant and large.

The positive and relatively large effect of higher marginal income tax rates, given average rates, on the pre-tax wage is not in line with the previous empirical literature, which typically finds a negative effect. We interpret it as evidence that both the labor supply *and* the relative wage effects have dominated the wage moderation effect in the specific institutional context and time period. As illustrated at the end of the previous section, a switch of tax progressivity from the young to the adults could help reduce the relative unemployment of the young. A message of this paper is not only that this tax instrument can be effective, but also that is should be used in the same direction as the other tax

[14]Dismissed workers from large firms are enrolled in "mobility lists" and can draw subsidies for longer than one year if they live in the South or are older than 40. See Brunello and Miniaci [1997] for details.

instruments (average income and payroll taxes).

7 Appendix

The Bank of Italy [2000] supplies information on net income for each individual in the interviewed household. Income can be from employment, self - employment and welfare (pensions and other benefits). For each household, there is also information both on the number of individuals earning income and on the number of dependents (spouse or children). This information is available by gender, educational attainment, occupation, sector of activity, region of residence and age. The survey covers the years from 1977 to 1989 (with the exclusion of 1985), 1991, 1993, 1995 and 1998. In the longitudinal panel, we use the 1993 and the 1995 wave. In the grouped data, we focus on the period 1979-1995.

For each year, gross wages w are calculated from the available information on net wages nw and tax legislation as follows

$$w = \frac{(nw - basdet)}{(1 - T_{mi})} + \frac{[max_1 * (T_{m1} - T_{m2}) + ... + max_{i-1} * (T_{mi-1} - T_{mi})]}{(1 - T_{mi})} \tag{A1}$$

where w is the gross wage, nw the net wage, *basdet* are tax deductions, which vary with the type and level of income, with the number of dependent children and with whether the individual is single or have a dependent spouse, and max_i is the upper bound of each income bracket relevant to each individual. In (A1) T_{mi} is the marginal tax rate and T_{mk}, $k = 1..i$ are the marginal tax rates associated to each tax bracket. Finally, individual tax rates are defined as $T_a = \frac{(w-nw)}{w}$.

Grouped data for the period 1979-95 are obtained by collapsing individual data by gender, age group, area of residence and educational attainment. Since a few years are missing, we linearly interpolate marginal and average tax rates and gross wages. Missing gross wages are computed by applying to the available data the rate of change of regional gross wages in the missing years[15].

Data on employment, unemployment and active population by age group, gender, region of residence and educational attainment are

[15] Holmlund and Kolm [1995] use a similar method.

Table A1. Summary statistics.

	Mean	St.D.
Annual wage	31764.48	17588.2
Hourly wage	18.86	10.4
Payroll tax rate	0.48	0.07
Average tax retention rate	0.83	0.06
Tax progressivity	0.85	0.04
Gender	0.38	0.48
Age	40.62	9.52
Part time	0.04	0.20
Marital status	0.73	0.44
Educational attainment	0.56	0.49
Unemployment rate	0.15	0.14

from the Labor Force Survey (Istat [2000]). This survey underwent a number of minor changes over the sample period and a major change in 1992. Starting from October 1992, the Statistical Office uses new weights to expand the sample data to the universe and implements a restricted definition of unemployment. In order to reduce the risk of structural jumps in the data, we restrict our attention to two age categories (20-29 = young and 30-59 = adult), two educational levels (elementary plus middle school = unskilled, and high school plus university degree = skilled), three macro areas (north, centre and south). For each group, we work with the pre-1992 definition of unemployment and extend it forward to 1995, using the data provided on line by Fondazione Brodolini[16].

Finally, grouped data from $SHIW$ and the Labor Force Survey are merged with regional account data, that include information on the payroll tax rate. Table A1 presents the summary statistics for 1995 of the main variables used in the paper.

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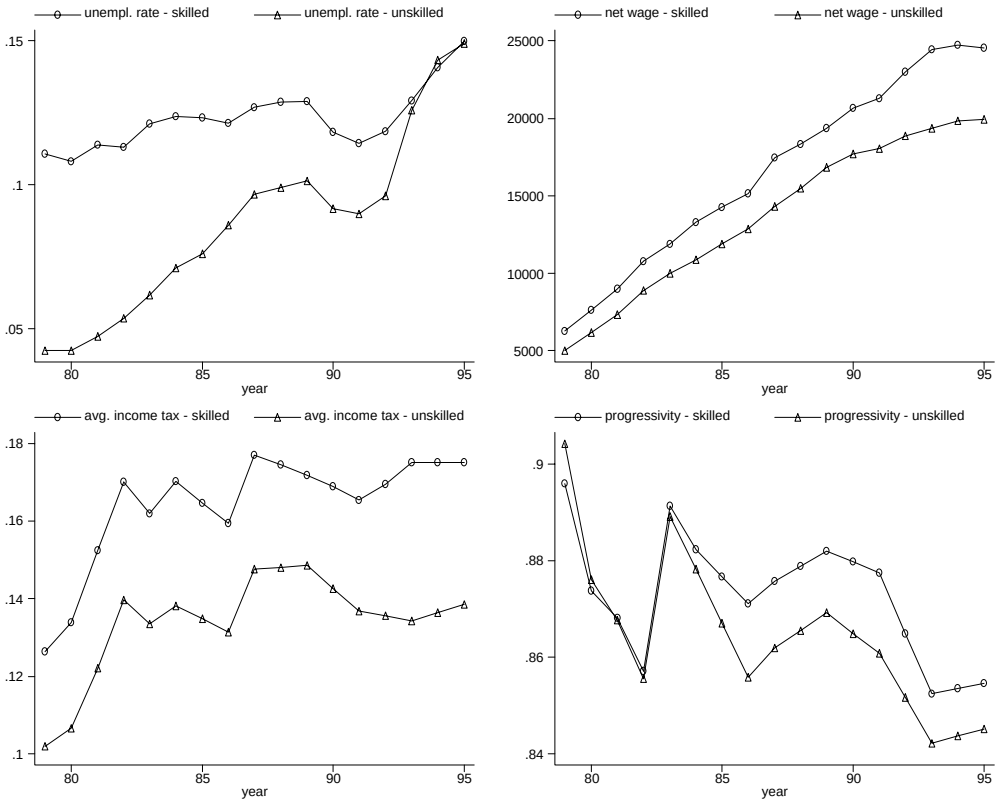

Figure 1: By skill

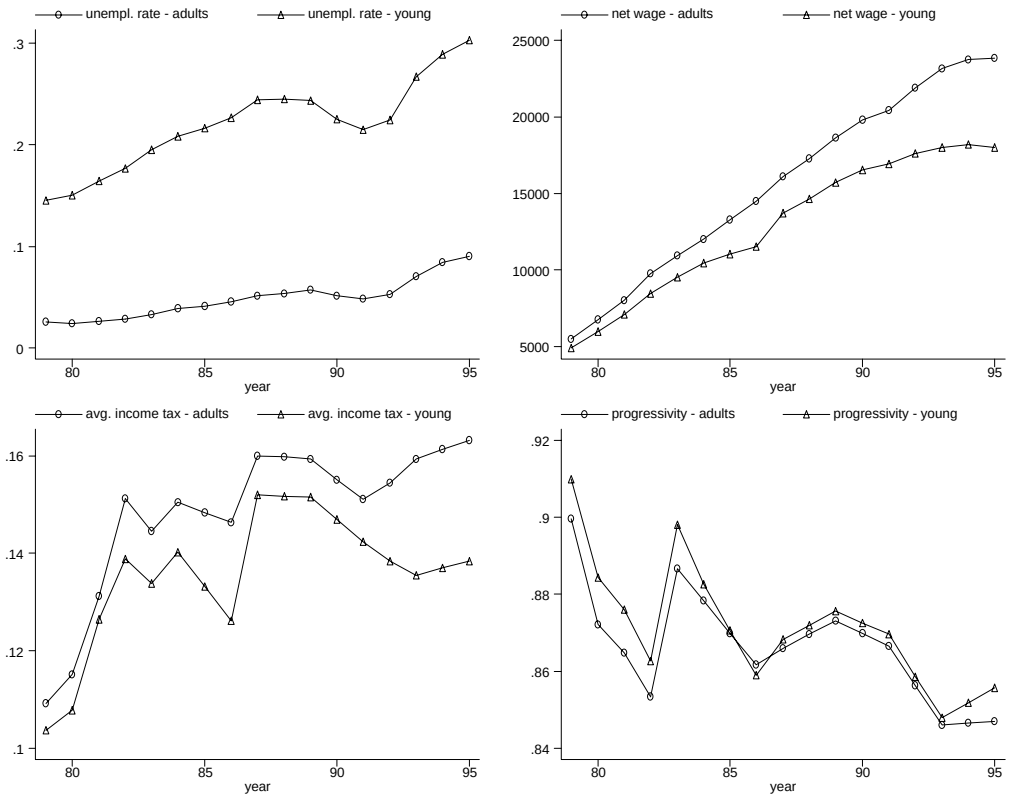

Figure 2: By age

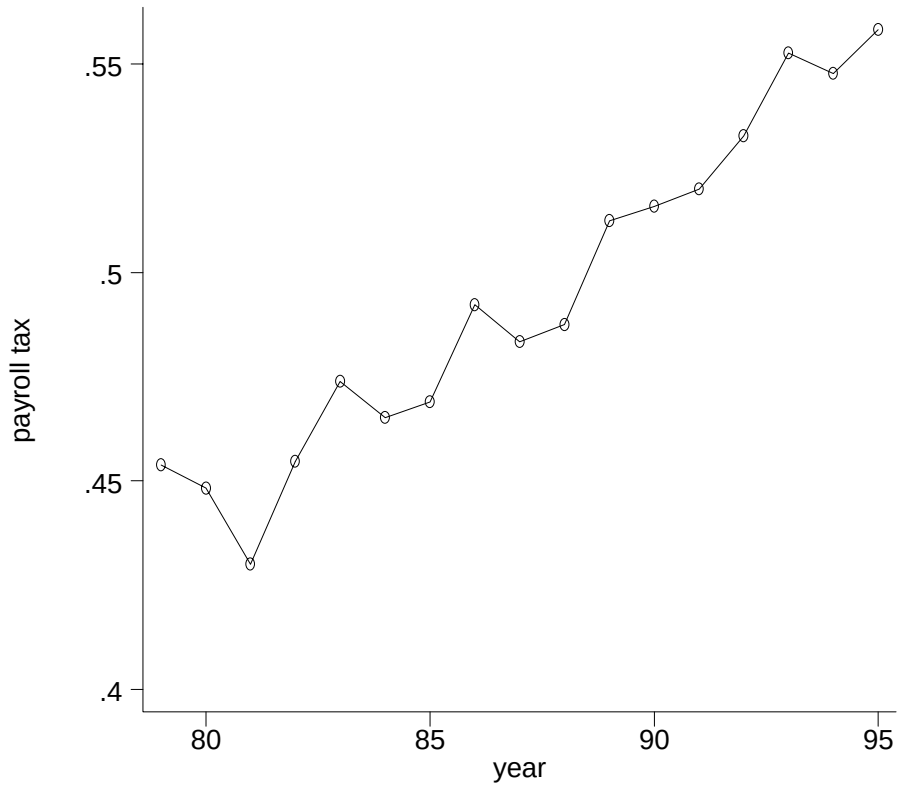

Figure 3: The average payroll tax rate

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