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Etienne Lehmann
Claudio Lucifora
Simone Moriconi
Bruno Van der Linden

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Forschungsinstitut
zur Zukunft der Arbeit
Institute for the Study
of Labor

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Etienne Lehmann
CRED (TEPP) University Panthéon-Assas Paris 2, CREST, IRES Université Catholique de Louvain, IDEP, IZA, CESifo and IUF

Claudio Lucifora
Università Cattolica del Sacro Cuore and IZA

Simone Moriconi
Università Cattolica del Sacro Cuore and University of Luxembourg, CREA

Bruno Van der Linden
FNRS, IRES Université Catholique de Louvain, IZA and CESifo

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IZA

P.O. Box 7240
53072 Bonn
Germany

Phone: +49-228-3894-0
Fax: +49-228-3894-180
E-mail: iza@iza.org

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ABSTRACT

Beyond the Labour Income Tax Wedge: The Unemployment-Reducing Effect of Tax Progressivity*

In this paper we argue that, for a given overall level of labour income taxation, a more progressive tax schedule increases employment. From a theoretical point of view, higher progressivity increases overall employment through a wage moderating effect and also because employment of low-paid workers is more elastic to wages. We test these theoretical predictions on a panel of 21 OECD countries over 1998-2008. Controlling for the burden of taxation at the average wage, our estimates suggest that a more progressive tax schedule reduces the unemployment rate and increases the employment rate. These findings are confirmed when we account for the potential endogeneity of both average taxation and progressivity. Overall, our results suggest that policy-makers should not only focus on the detrimental effects of tax progressivity on in-work effort, but also consider the employment-enhancing effects.

JEL Classification: E24, H22, J68

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Corresponding author:

Etienne Lehmann
CREST
Timbre J360
15 boulevard Gabriel Péri
92245 Malakoff Cedex
France
E-mail: etienne.lehmann@ensae.fr

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I Introduction

Many OECD countries after the Great Crisis are confronted with the need to combine fiscal consolidation measures with policies to curb unemployment. Given that high levels of public debt prevent the implementation of tax reforms to reduce the tax burden on labour income, a better understanding of the effects of labour income taxation on the functioning of the labour market is crucial to identify policies that may alleviate unemployment without hindering public finances. In order to do this, we need to better know how the different dimensions of labour income taxation affect labour market performance and how their adverse effects on unemployment can be contained. Empirical studies have shown the existence of a positive relationship between the tax wedge on labour income and unemployment.[1] This paper investigates the effects of both average labour income taxation and tax progressivity on unemployment. It shows that, for a given overall level of labour income taxation, a more progressive tax schedule reduces unemployment, increases employment, although it decreases output per worker.

In the first part of the paper, we review arguments in the theoretical literature in support of the unemployment-reducing effect of tax progressivity. First, a more progressive tax schedule induces stronger employers' opposition to any claim for wage increase, since an increase in the after-tax wage becomes more costly for them. We call this a *wage moderating* effect, which triggers a reduction in labour cost and a rise in labour demand.[2] Second, a more progressive tax schedule reduces the tax burden on low-skilled workers relative to high-skilled workers. We call this a *composition effect* that alleviates unemployment because the employment of low-skilled workers is more responsive to taxation as compared to high-skilled workers. We also argue that these unemployment-reducing effects of tax progressivity are very likely to remain in the presence of labour supply responses. Although tax progressivity may be detrimental to incentives on in-work effort, as typically argued in public finance, tax progressivity remains beneficial for employment, with an ambiguous total effect on aggregate production.

In the second part of the paper, we test these theoretical predictions using data for 21 OECD countries over 1998-2008 period. Our empirical strategy relies on aggregate cross-country panel data to identify the causal effect of tax progressivity on unemployment. In countries where collective bargaining is important, unions are more likely to take into account changes in aggregate indicators of taxation, rather than focussing on the effect that specific changes in progressivity may have on selected group of workers. Even in the absence of collective bargaining, when labour markets are not segmented along narrowly defined groups, marginal tax rates can vary substantially across individuals whose labour market prospects remain unchanged since they search over a similar range of jobs. In other words, while individual-level micro data are conventionally used in studies seeking to assess the effects of specific changes in tax rates and social security contributions on individual behaviour, here we take the view that using aggregate data is more appropriate when the focus is on the global effect of taxation on aggregate

[1] See Nickell and Layard (1999), Daveri and Tabellini (2000), Nickell et al. (2005), Rogerson (2006) among others.
[2] See e.g. Hersoug (1984), Pissarides (1985, 1998),Lockwood and Manning (1993)

unemployment. We measure the overall level of labour income taxation by the average tax rate for a single worker paid at the average wage and tax progressivity by aggregating the Coefficients of Residual Income Progression[3] (CRIP) at wage levels between 67% and 167% of the average wage. OLS estimates confirm the usual finding that higher labour taxation increases unemployment. Moreover, they show a sizeable unemployment-reducing effect of tax progressivity: for any given level of taxation, we find that a more progressive tax schedule reduces the unemployment rate and increases the employment rate. The effect on the employment rate is mainly due to the impact on the unemployment rate and not on the participation rate.[4] We also find that progressivity reduces production per employed worker (the intensive margin). This is in line with the common wisdom on the detrimental effects of tax progressivity on in-work incentives. However, tax progressivity has no statistically significant effect on the ratio of GDP over the working age population, the negative effect on the intensive margin of the labour supply being compensated by the positive effect on employment. The design of an optimal tax schedule should thus not simply focus on the trade-off between the equity gain of a more progressive tax schedule against the adverse effects on the incentives to work harder (Mirrlees, 1971), but should also include the employment-enhancing effects of tax progressivity (see e.g. Hungerbühler et al. (2006) and Lehmann et al. (2011)).

One reason for concern with OLS estimates is the presence of omitted variables or reverse causality which may bias our results. To identify the causal impact of taxation on the unemployment rate, we implement an IV strategy which exploits exogenous variations in institutional, social and political factors that influence a country's fiscal policy. Our IV estimates confirm that the impacts of average tax rate and progressivity are statistically significant and bear the same signs as the OLS estimates. The marginal effect is found to be larger in absolute value suggesting that OLS tend to underestimate the effects of taxation on unemployment. This suggests that policy-makers tend to react to an adverse employment shock by cutting labour taxes and raising tax progressivity to sustain the labour demand.

Our paper contributes to the literature that uses cross-country panel data to explain unemployment patterns in OECD countries.[5] Empirical studies typically investigate the impact of macroeconomics shocks and (time-varying) labour market institutions on aggregate unemployment. In this literature, labour income taxation is generally considered as exogenous and is captured by a single indicator, the tax wedge for the average worker, which is found to be a key determinant of the unemployment rate (Daveri and Tabellini (2000), Nickell et al. (2005)). We contribute to this literature in two ways. First, we consider tax progressivity as an au-

[3] As defined by Musgrave and Thin (1948).

[4] The employment rate is the share of the working age population that is employed. It is thus equal to the product of the participation rate and one minus the unemployment rate.

[5] See the time series analysis on different OECD countries by Bean et al. (1986), Layard et al. (1991) and Nickell and Layard (1999) and the panel data analyses by Blanchard and Wolfers (2000), Daveri and Tabellini (2000), Algan et al. (2002), Belot and van Ours (2004), Nickell et al. (2005), Griffith et al. (2007), Bassanini and Duval (2009) among others. See also Prescott (2004), Rogerson (2006) Rogerson (2008) Rogerson and Wallenius (2009) who account for the different trends in total hours of works across OECD by difference in tax policy in calibrated macroeconomic models.

tonomous determinant of unemployment, besides the average tax wedge. Second, we address the endogeneity of taxation using instruments based on narrative records for the tax components of fiscal consolidation plans, the degree of social distrust in civil services and the political orientation of the parliament.

Our paper is also related to the literature that explores the effect of tax progressivity on wages using time series data, either at the aggregate level or for specific industries or subgroups of workers.[6] The typical result is that tax progressivity reduces the gross wage, at least for blue-collar workers.[7] Note, however, that the change in aggregate wage may confound true wage responses with heterogeneous employment responses that alter the wage distribution. Such composition effects therefore make the results hard to interpret in term of a wage moderating effect.

Finally, there is an extensive literature that uses micro-data to evaluate the effect of tax reforms and make-work-pay programs in selected countries. For example, policies such as the EITC (Earned Income Tax Credit) in the US or the WFTC (Working Families Tax Credit) in the UK have been shown to improve transitions from non employment to employment.[8] As these policies shifts the tax burden away from some disadvantaged groups (e.g. employed lone parents), we interpret them as a way to increase progressivity. As previously discussed, our approach takes a different perspective - though complementary to the above literature - as we mainly consider factors that operate at the aggregate level such as the wage-moderating effects of collective bargaining or the search efforts of workers (with similar attributes but different marginal tax rates) over the same range of jobs.

The paper is organised as follows. We review the theoretical arguments on the unemployment effects of tax progressivity in Section II. The empirical strategy is outlined in Section III, the dataset is described in Section IV and the empirical results are discussed in Section V. Finally, Section VI concludes.

II Theoretical framework

In this section, we use a matching model *à la* Diamond-Mortensen-Pissarides to discuss the effects of taxation on the steady-state unemployment rate. We provide a framework that unifies different theoretical predictions made earlier in the literature. We start with a model without labour supply responses and then introduce participation and in-work decisions into the model.

[6] Malcomson and Sartor (1987), Lockwood and Manning (1993), Holmlund and Kolm (1995). Brunello and Sonedda (2007) use panel data to estimate the effect of tax progressivity on wages. Manning (1993), uses quarterly time series for the UK, and estimates also an auxiliary unemployment equation augmented with a tax progressivity indicator. See also the surveys by Sørensen (1997) and by Røed and Strøm (2002).

[7] Hansen et al. (2000)

[8] See Eissa and Liebman (1996) and Blundell and Shephard (2012) among many others.

II.1 The model without labour supply responses

Time is continuous and discounted at the common rate $r > 0$. All agents are risk-neutral. An homogeneous consumption good is produced using labour only. Let y, L, N, δ and i denote respectively the productivity, the level of employment, the number of participants, the exogenous job destruction rate and the unemployment rate, with obviously $1 - u = L/N$. The pre-tax earnings (or labour cost) is denoted w and henceforth called the (gross) wage.

We assume congestion externalities in the matching process. Following Diamond (1982), Mortensen and Pissarides (1999) and Pissarides (1985, 2000), the flow of hirings is given by a matching function $\mathcal{M}(v, N - L)$ of the stocks v of vacant jobs and $N - L$ of unemployed. The matching function $\mathcal{M}(.,.)$ is increasing and concave in each of its arguments and exhibits constant returns to scale. The rate at which jobs are filled is a decreasing function $q(.)$ of the tightness ratio $\theta = v/(N - L)$, with $q(\theta) \equiv \mathcal{M}(1, 1/\theta)$. Symmetrically, the rate at which an unemployed finds a job is an increasing function $p(.)$ of tightness θ, with $p(\theta) \equiv \mathcal{M}(\theta, 1) = \theta\, q(\theta)$. The equality between flows out of and in unemployment provides the employment level and the unemployment rate at the steady state:

$$L = \frac{p(\theta)}{\delta + p(\theta)} N \qquad \text{and} \qquad u = \frac{\delta}{\delta + p(\theta)} \tag{1}$$

A filled job generates a profit flow $y - w$ and it provides an expected inter-temporal profit denoted J:

$$J = \frac{y - w}{r + \delta} \tag{2}$$

Firms create vacancies as long as the flow cost of search $c > 0$ is smaller than the expected returns to search. The latter is equal to the rate $q(\theta)$ at which jobs are filled times the inter-temporal value J of a filled job. As firms create more and more vacancies, tightness increases and the job filling rate decreases. This occurs until the following free-entry condition is met:

$$\frac{c}{q(\theta)} = J = \frac{y - w}{r + \delta} \tag{3}$$

Combining Equation (1) and the free-entry condition (3) defines the labour demand. The fraction $1 - u$ of participants who are employed is a decreasing function of the gross wage w. This relationship is denoted LD in Figure 1. A rise in the gross wage reduces the inter-temporal profit (2) made on a filled job. So, firms find it less profitable to create jobs, tightness decreases and the unemployment rate increases.

We consider a non-linear income tax function $T(.)$ that only depends on wages w. The average tax rate is denoted $\tau \equiv T(w)/w$ and the *net wage* is $n \equiv (1 - \tau)w$. We call $1 - \tau$ the *retention rate*. A change in the average tax rate τ does not affect job creation if it holds at a constant gross wage w. In the left panel of Figure 1 where the gross wage w is on the vertical axis, a rise in the average tax rate τ does not shift the LD curve. Conversely, keeping the net wage n fixed, a rise in the average tax rate increases labour cost w, thereby inducing firms to create less jobs. In the right panel of Figure 1 where the net wage n is on the vertical axis, a

rise in the average tax rate τ reduces the labour demand holding the net wage fixed, thereby shifting the LD curve inwards. We denote b the instantaneous value in unemployment. This

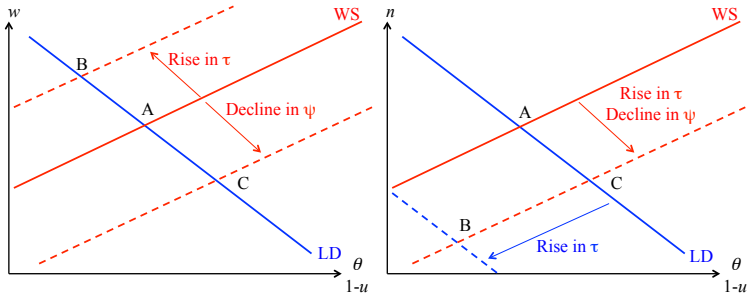

Figure 1: The effects of taxation

value sums untaxed unemployment benefits and the value of time out of work. The expected lifetime utility of an employed individual E, respectively an unemployed one U, verifies the following asset equations in steady state:

$$r\,E = w - T(w) + \delta\,(U - E) \tag{4a}$$

$$r\,U = b + p\,(\theta)\,(E - U) \tag{4b}$$

The permanent income rE of an employed worker is equal to her instantaneous utility $w - T(w)$ minus the average loss $\delta\,(E - U)$ in case of job destruction. A symmetric interpretation applies for unemployed workers. We assume Nash bargaining over the wage and denote $\gamma \in [0, 1)$ workers' bargaining power. In Appendix A we show that the first-order condition of the maximisation of the Nash product $\max_{w}\ (E - U)^{\gamma}\,(J)^{1-\gamma}$ can be written as:

$$\frac{E - U}{1 - \tau} = \frac{\gamma}{1 - \gamma}\Psi\,J \tag{5}$$

where Ψ is the Coefficient of Residual Income Progression (hereafter the *local CRIP*) at wage w defined by Musgrave and Thin (1948) as:

$$\Psi(w) \equiv \frac{1 - T'(w)}{1 - \frac{T(w)}{w}} = 1 + \frac{d\ln\left(1 - \frac{T(w)}{w}\right)}{d\ln w} \tag{6}$$

A one percent increase in the gross wage w increases the net wage n by a relative amount equals to the local CRIP $\Psi = \Psi(w)$. The latter is also equal to one plus the wage elasticity of the retention rate $1 - (T(w)/w)$. A higher local CRIP comes from a lower marginal tax rate $T'(w)$ or a higher average tax rate τ and is associated with less tax progressivity. With a lower local CRIP, a marginal increase of the gross wage remains as costly for the employer, but provides

less additional income to the worker. Consequently, the worker has less incentives to claim a higher gross wage. A more progressive tax schedule therefore affects the sharing rule (5) as does a decrease in the worker's bargaining power (Pissarides (1985, 2000), Lockwood and Manning (1993)). This is the *wage moderating effect* of a more progressive tax schedule. We then obtain the following gross and net wage setting equations, denoted WS in Figure 1 (See Appendix A):

$$w = \frac{\gamma\,\Psi}{1-\gamma+\gamma\,\Psi}\,(y+c\,\theta)+\frac{1-\gamma}{1-\gamma+\gamma\,\Psi}\,\frac{b}{1-\tau} \tag{7a}$$

$$n = \frac{\gamma\,\Psi}{1-\gamma+\gamma\,\Psi}\,(1-\tau)\,(y+c\,\theta)+\frac{1-\gamma}{1-\gamma+\gamma\,\Psi}\,b \tag{7b}$$

In the absence of taxation, Nash bargaining implies that workers extract a share γ of the total surplus $J+E-U$ while the firm extracts a share $1-\gamma$. Therefore, the worker's pay is a weighted average of the instantaneous value in unemployment on the one hand and of the productivity level y augmented with the expected hiring cost per unemployed $c\,\theta$ on the other.[9] As the latter increases when the labour marker becomes more tight, i.e. when the unemployment rate decreases, the wage Equations (7a) and (7b) are represented by upward-sloping curves labelled WS in Figure 1.

We now consider the effect of a rise in the average tax rate τ, holding tax progressivity Ψ constant. This reduces the total surplus of the match that the worker and the employer share when they bargain over the wage. The surplus J accruing to the firm decreases via a rise in the gross wage w. This corresponds in the left panel of Figure 1 to an upward shift of the WS curve (see (7a)). The surplus $E-U$ accruing to the worker shrinks via a reduction in the net wage n. This corresponds in the right panel of Figure 1 to a downward shift of the WS curve (see (7b)). Taking labour demand into account, the equilibrium shifts from A to B, where employment and the net wage are lower while the unemployment rate and the gross wage are higher. It is worth noting that if b consisted only of unemployment benefits indexed on the net wage, the tax rate would have no effect on the unemployment rate nor on the gross wage (see e.g. Pissarides (1998, 2000)). This is because a rise in the tax rate, by decreasing the net wage, also decreases the level of unemployment benefits. This effect turns out to offset the direct increasing impact of the tax rate on the gross wage.[10] Put another way, the effect of the average tax rate τ relies on an imperfect indexation of unemployment benefits on the net wage.

Second, we consider the impact of a more progressive tax schedule (a lower Ψ) holding the average tax rate τ unchanged. From (5), this affects the sharing rule as does a decrease in the relative bargaining power $\gamma/(1-\gamma)$. A locally more progressive tax schedule therefore reduces the workers' *effective bargaining power* $\gamma\Psi/(1-\gamma+\gamma\Psi)$, that is the weight of productivity in the wage Equations (7a) and (7b). The WS wage curve shifts downwards in the two

[9] For $c\,\theta = cv/(N-L)$. When a job-seeker is hired, the employer saves the cost of searching for an other applicant.

[10] Plugging $b=\rho\,(1-\tau)w$ into (7a), Equations (3) and (7a) would become a two-equation system in w and θ that does not depend on τ.

panels of Figure 1, so the equilibrium moves from A to C. Employment increases while the unemployment rate, the net and the gross wages decrease. This *wage moderating effect* of tax progressivity thus provides a first argument justifying why we expect a more progressive tax schedule to decrease the unemployment rate.

This wage moderating effect of tax progressivity is actually a very robust prediction which is common to different labour market models, such as the monopoly union model (Hersoug (1984)), the right-to-manage model, the union bargaining model (Lockwood and Manning (1993)), the competitive search equilibrium model (Lehmann et al. (2011)) or the competitive model with intensive labour supply responses (Pissarides (1998)). In all of these models, the individual level of gross wage is set to maximise an objective that is increasing in the net wage (because this triggers a rise in the worker's consumption) and decreasing in the gross wage. In the trade-union model as in the matching model, a higher gross wage reduces the employer's profit, thereby the Nash product. In the monopoly union model or in the right-to-manage model, a higher gross wage reduces employment. In the competitive search equilibrium model of Moen (1997), a higher gross wage leads to waiting longer a job offer. Finally, in the competitive labour supply model, earning a higher labour income requires more in-work effort, so pre-tax earnings are a decreasing argument of the utility function. Although the specific micro-foundations differ across these various models, labour income have to trade off the gains from a higher net wage for the workers against the costs of rising the gross wage. Therefore, a *compensated* increase in the marginal tax for a fixed level of tax liability triggers a qualitatively similar *substitution* of lower consumption for lower labour cost in all of these models.[11]

The local CRIP at a given wage w only captures progressivity in the neighbourhood of w. This raises some measurement issues illustrated by the following example. Consider a piecewise-linear tax system where two consecutive tax brackets are characterised by sizeable differences in marginal tax rates. Some measurement errors in wages could have dramatic consequences if they cause a shift from one tax bracket to the other. Furthermore, when information about taxation is based on specific worker-types, the precise choice of the type can have large effects on the marginal tax rate. To avoid such misleading idiosyncrasies, we choose to capture the progressivity of the tax system by a "global CRIP" that is equal to the (log of) the ratio of the retention rates at wages levels w_1 and w_0 with $w_1 > w_0$. The *global CRIP* between w_0 and w_1 is defined as:

$$\Psi_{w_0}^{w_1} \equiv \ln\left(\frac{1-\frac{T(w_1)}{w_1}}{1-\frac{T(w_0)}{w_0}}\right) = \int_{w_0}^{w_1}(\Psi(w)-1)\frac{dw}{w} \tag{8}$$

where the last equality is obtained by the integration of (6) between w_0 and w_1. The global CRIP aggregates the local CRIPs between w_0 and w_1 and a lower global CRIP is associated

[11] This is also the reason why the wage moderating effect of tax progressivity is robust to the introduction of risk aversion, which only complicates the formulae without adding any substantive insights.

with a globally more progressive tax schedule between wages w_0 and w_1. The equality

$$\frac{n_1}{n_0} = \frac{w_1}{w_0} \exp(\Psi_{w_0}^{w_1})$$

stresses that the global CRIP measures how the tax system reduces after-tax wage inequality between gross wage w_0 and w_1.

In addition to the *wage moderating effect*, a lower global CRIP may also reduce the aggregate unemployment rate if employment of low-paid workers at wage w_0 is more elastic to a change in the retention rate than employment for high-paid workers at wage $w_1 > w_0$. The idea that low-paid employment is more responsive than high-paid employment is quite common in the literature (see e.g. Juhn et al. (1991), Hamermesh (1993) Kramarz and Philippon (2001), Falk and Koebel (2001), Cahuc et al. (2014)). An increase in the log of the retention rate $1 - \tau_0$ at w_0 would lead to an increase in low-paid employment that outweighs the decrease in employment induced by an equivalent decrease in the log of the retention rate $1 - \tau_1$ at wage w_1. This leads to a *composition effect* according to which a lower global CRIP reduces unemployment. In addition to this mechanism, there is no way to decrease the global CRIP between w_0 and w_1 without reducing the local CRIPs in between, which also contributes to reduce unemployment trough the wage moderating effect.

Prediction 1. *In the model with exogenous labour supply, a rise in the retention rate (a decline in the average tax rate) and a more progressive tax schedule (a decline in the global CRIP) reduce the unemployment rate and increase the employment rate.*

II.2 Extensive and intensive margins of labour supply

Extensive margin. The next step introduces participation decisions in each labour market. For this purpose, we assume that individuals have different values I of being out of the labour force. When an individual enters into the labour force, she is unemployed and searches for a job. Only individuals for which $I \leq U$ choose to participate to the labour market, where:

$$U = \frac{(r+\delta)b + p(\theta)\, n}{r\,(r+\delta+p(\theta))}$$

from (4a), (4b) and $n = w - T(w)$. The value I of being out of the labour force is assumed continuously distributed according to the CDF $G(.)$. Let $\overline{N}$ denote the exogenous size of the working age population. The participation rate in the population equals $G(U)$, the size of the labour force is $\overline{N}\, G(U)$.

From Equations (1) and (3), the fraction of employed participants $1 - u$ is independent of the size of the labour force. Because of congestion externalities, firms recruit workers more easily when the size of the labour force increases. Whenever participation increases holding the gross wage w constant, firms create more jobs until tightness, thereby the unemployment rate, return to their initial values. The level L of employment thus increases in the same proportion as the size of the labour force. Consequently, total employment $\overline{N}\, G(U)\,(1-u)$ and the employment

rate $G(U)(1-u)$ are decreasing in the gross wage through labour demand and are increasing in the net wage through the participation margin.

As displayed by Figure 1, a decline in the local CRIP Ψ, holding the average tax rate τ constant, decreases the net wage n but increases the exit rate out of unemployment $p(\theta)$. The total impact on the incentives to participate is therefore theoretically ambiguous. We show in Appendix A that a decline in Ψ increases (decreases) the participation rate if the unemployment rate is inefficiently high (low). This is because a decline in the local CRIP affects the labour market outcome only by reducing the workers' effective bargaining power $\gamma\Psi/(1-\gamma+\gamma\Psi)$. For a given retention rate τ, participation is maximised whenever the effective bargaining power satisfies the Hosios (1990) condition.[12] However, the effect of tax progressivity on the unemployment rate is unchanged by the introduction of the participation decision.

Figure 1 also shows that a rise in the tax rate τ, holding progressivity Ψ constant, decreases the net wage n, increases the gross wage w and reduces the exit rate out of unemployment $p(\theta)$. Searching for a job thus becomes less interesting (i.e. U decreases), inducing pivotal individuals to exit the labour force. The participation rate decreases. The employment rate and the level of employment decrease because the size of the labour force is lower (a labour supply effect) and a smaller fraction of participating agents is employed (a labour demand effect).

The empirical literature concludes that the extensive responses (i.e. participation decisions) are concentrated on low-wage subgroups such as low-skilled workers or secondary earners (e.g. Juhn et al. (1991), Immervoll et al. (2007) or Meghir and Phillips (2010)). This suggests that increasing by 1% the retention rate $1-\tau$ on the bottom half of the wage distribution and decreasing the retention rate by 1% on the top half would increase overall participation through a composition effect on participation. From (8), such a change in the profile of the retention rate is associated with a decline in the global CRIP, that is, with a globally more progressive tax schedule.

Prediction 2. *In the model with endogenous participation, a rise in the average tax rate increases the unemployment rate and decreases the employment rate and the participation rate. A rise in tax progressivity (a decline in the global CRIP) decreases the unemployment rate. It increases (decreases) the participation rate if the unemployment rate is inefficiently high (low).*

Extensive and intensive margins in a competitive setting. The preceding predictions that tax progressivity increases employment are in deep contrast with a long tradition in public finance where tax progressivity reduces incentives to work. We argue that these two views are not contradictory as they focus on different objectives, employment on the one hand, in-work effort on the other hand.

The public finance literature typically assumes away frictions on the labour market, so full employment prevails. However, even in such a frictionless environment, one should not only consider the intensive margin of the labour supply. The empirical literature suggests that the

[12] This point was suggested by Pierre Cahuc.

extensive margin is key (e.g. Heckman (1993), Røed and Strøm (2002), Meghir and Phillips (2010)). In a competitive setting, an individual chooses to work if and only if her net income $w - T(w)$ is larger than her instantaneous value of staying out of the labour force, which is assumed continuously distributed. The extensive margin elasticity is empirically higher for low-skilled workers. An increase in the log of the retention rate $1 - \tau_0$ at w_0 would lead to an increase in low-paid participation that outweighs the decrease in participation induced by an equivalent decrease in the log of the retention rate $1 - \tau_1$ at wage w_1. This leads to a *composition effect in participation* according to which a lower global CRIP increases participation, thereby employment. In sum, we expect that a more progressive tax schedule increases employment and decreases output per worker, leading to an ambiguous impact on total production.[13]

Introducing the intensive margin in the matching framework. Turning back to environments with unemployment and wage negotiation, Sørensen (1997, 1999), Hansen (1999), Fuest and Huber (2000), Røed and Strøm (2002) and Parmentier (2006) have considered the impact of tax progressivity when in-work effort is endogenous. Increasing income tax progressivity reduces in-work effort through the traditional labour supply effect. Therefore jobs tend to become less productive, which may also be detrimental to employment. Moreover, a more progressive tax schedule still reduces the share of the surplus that accrue to the workers, which is beneficial to employment through the above-mentioned wage moderating effect. In general, the total effect on employment is ambiguous. This ambiguity can be resolved under some further specific assumptions. For instance, Cahuc and Zylberberg (2004) obtain that the wage moderating effect dominates the labour supply effect under multiplicatively separable preferences. A more progressive tax schedule then always increases employment and always decreases the unemployment rate and output per employed. The effect on total production remains ambiguous. Hansen (1999) obtains similar analytical results under different specifications. Numerical simulations under different assumptions for individual preferences find that employment is increasing in tax progressivity while output per worker is reduced (Sørensen (1999), Parmentier (2006)). The following predictions are derived in Appendix A under additively separable preferences.

Prediction 3. *In the model with bargaining over wages and in-work effort, a rise in tax progressivity (a decline in the global CRIP) reduces in-work effort. It also reduces the unemployment rate if taxation is initially not too progressive. The effect on total production is ambiguous.*

[13] Immervoll et al. (2007) use a microsimulation model with intensive and extensive labour supply responses to compute the efficiency costs of two prototypical tax reforms that increase tax progressivity. They show that their "working poor policy" which pays more attention to the disincentive effects along the participation margin entails less efficiency costs than their "demogrant policy". This suggests distortions along the extensive margin are quantitatively much more important to consider than the intensive margin.

III Empirical strategy

The arguments reviewed above convey the idea that rising tax progressivity reduces unemployment and increases employment (although it may have adverse effects on per capita productivity). Despite the theoretical relevance of these predictions, the empirical evidence that supports them is very scarce. One reason may be due to the difficulties of identifying the employment-enhancing effect of tax progressivity using individual micro-data. Typically, the literature on policy evaluation focusses on the effects of changes in taxation around a given tax threshold. This approach makes it difficult to capture the aggregate effects we address in this paper. In particular, we believe that the employment-enhancing effect of tax progressivity is better captured by the effect of the global CRIP on the aggregate unemployment rate than by the effect of an individual's local CRIP on her probability to be employed for reasons that we now provide.

First, whilst for tractability in Section II we considered a model with individual bargaining, in most OECD countries, wages are set instead through collective bargaining. Consider then a union confronted with a reform of the tax system that changes the local CRIPs of its members in various ways. It is unlikely that this union can take this diversity into account. Conversely, the tax reform will very likely trigger a common wage response, which is better predicted by the changes in the global CRIP defined above (see equation 8). Hence, it is more likely that the union will react to a change in the global CRIP than to changes in the local CRIPs faced by each individual. In this respect, focussing on the impact of a global CRIP on the unemployment rate allows us to take into account the wage moderation effect associated with collective bargaining, which is unlikely to be captured by estimates of a local CRIPs measure on individual employment probabilities.

Second, even if wages were negotiated at the individual level, when labour markets are imperfectly segmented, workers are likely to search for jobs in a range of different labour markets with different productivity levels. Hence their exit rates from unemployment depend on an aggregate of tightness levels on these different labour markets. Therefore, two "almost identical" individuals, that differ essentially by their local CRIPs may still face almost identical employment probabilities because they are searching a job in roughly the same range of labour markets.[14] Analysing the impact of the global CRIP on the unemployment rate allows us to take into account also this "aggregate tightness effect", which is unlikely to be captured by estimates of a local CRIP measure on individual employment probabilities.

Moreover, using individual data to estimate the effect of tax rates on the individual probability to be employed raises the problem of simulating the wage of non-employed individuals if they were employed.[15] The choice of country level panel data allows us to avoid this difficulty

[14]This is in line with Manning and Petrongolo (2013) who argue that "the economy cannot be divided into non-overlapping segments, as the labour market for one individual at one location overlaps with that for another individual in a different but not too distant location".

[15]This simulating step is unavoidable to compute the marginal and average tax rates an non-employed individual would face if employed. While feasible, this step rests on parametric assumptions. Note that the empirical literature

by estimating directly the effect of the global CRIP on the aggregate unemployment rate.

For the reasons stated above, we choose to rely on country level panel data to test empirically the existence of the employment-enhancing effect of tax progressivity. In practice, we use information drawn from different data sources, over the period 1997-2008 and for 21 OECD countries. Our measures of labour taxation are based on average tax rates (*ATR*) of single individuals at different points of the earnings distribution, namely: 67% of the average wage, the average wage (i.e. 100%) and 167% of the average wage, provided by the OECD tax database. These indicators are harmonised over time and across OECD countries.[16] They encompass income taxation by central and local governments and employers and employees social security contributions. From the above information, we compute tax retention rates:

$$\text{ret}j_{i,t} = 1 - \frac{T(j \times AW_{i,t})}{j \times AW_{i,t}} = 1 - ATRj_{i,t} \qquad \text{for} \qquad j \in \{67\%, 100\%, 167\%\}$$

with respect to the average wage ($AW_{i,t}$) in country i and year t. The retention rates are expressed in percentage points. The two measures of taxation that we use in the empirical analysis are: the average tax burden, measured by the logarithm of the retention rate at the average wage, $\ln(ret100)$; the *tax progressivity* indicator, which consists in the logarithm of the ratio of retention rates at 67% and 167% of the average wage, $\ln\left(\text{ret67}_{i,t}/\text{ret167}_{i,t}\right)$. Notice that the definition of the tax progressivity indicator we adopt in the empirical analysis is the inverse of the global CRIP defined in (8), where w_0 and w_1 are respectively 67% and 167% of the average wage. Since a rise in the global CRIP is associated with a less progressive tax schedule, the interpretation of empirical results is more straightforward with the tax progressivity indicator.

To the best of our knowledge, we are the first to use this comprehensive indicator of tax progressivity that includes not only the personal income tax schedule but also local taxation and social security contributions over a wide interval of the wage distribution. Unfortunately, the retention rates at different points of the wage distributions are not available prior to 1997. Moreover, we do not include years after 2008 to prevent the effects estimated to be spuriously affected by the great recession.

We adopt the following specification:

$$Y_{i,t} = \beta_1 \ln\left(\text{ret100}_{i,t-1}\right) + \beta_2 \ln\left(\frac{\text{ret67}_{i,t-1}}{\text{ret167}_{i,t-1}}\right) + \mu \cdot \mathbf{Z}_{i,t-1} + \nu \cdot \mathbf{X}_{i,t} + \alpha_i + \varphi_t + \varepsilon_{i,t} \qquad (9)$$

that estimate the extensive (participation) margin responses of labour supply (see e.g. Meghir and Phillips (2010)) need to simulate the *average* tax rates of the non-employed individuals and not their *marginal* tax rates. As the variation of the former around an income threshold separating two consecutive tax brackets is much smoother than variations of the latter, errors in simulated wage result in smaller errors in predicted average tax rate than in predicted marginal tax rates.

[16] The OECD Tax database is drawn from `http://www.oecd.org/tax/tax-policy/tax-database.htm`, Section 3.b, Table I.5. Since the OECD tax database only starts in 2000, we use the information provided by the OECD taxing wage database to extend the relevant time series back to 1997. Details on the two database and their harmonisation are given in the Data Appendix.

While the focus on singles allows us to avoid many confounding factors originating from household composition and intra-household participation decisions, it also has a drawback since we are missing the contribution of specific policies which are restricted to households with kids, as the EITC or the WFTC.

Since the wage distribution differs across countries and over time, the average tax rates computed at 67%, 100% and 167% of the average wage reflect actual taxation at different percentiles of the wage distribution.

where $Y_{i,t}$ is an indicator of labour market performance in country i and year t, $\mathbf{Z}_{i,t-1}$ and $\mathbf{X}_{i,t}$ are vectors of control variables, α_i and φ_t are, respectively, country- and time-fixed effects, and $\varepsilon_{i,t}$ is the error term. The parameters of interest for the empirical analysis are β_1 and β_2. The vector $\mathbf{Z}_{i,t-1}$ includes a baseline set of labour market institutions, namely, the average unemployment benefits replacement ratio ($UBRR$), union density ($UnionDensity$), an index of the degree of coordination in wage bargaining ($wcoord$) and a synthetic index of employment protection (EPL). The vector $\mathbf{X}_{i,t}$ includes cyclical control variables, such as the output gap ($outputgap$), the change in inflation ($inflchange$), the degree of trade openness ($Openness$) and the long term interest rate on government's bonds ($irate$).[17] More details on all the variables used in the empirical analysis are provided in the data Appendix B. These controls are usual in the literature (Blanchard and Wolfers, 2000, Nickell et al., 2005, Griffith et al., 2007, Bassanini and Duval, 2009).

Our main labour market performance indicator is the aggregate unemployment rate, measured in percentage points. As tax reforms take time to produce their effects, we enter the tax indicators with a one-year lag. According to our theoretical predictions we expect a rise in the retention rate (a decrease in the average tax rate) to reduce the unemployment rate (i.e. $\beta_1 < 0$), while a more progressive tax schedule is expected to increase unemployment (i.e. $\beta_2 < 0$). When the employment rate is considered instead, we expect $\beta_1, \beta_2 > 0$.

One matter of concern in estimating equation (9) by OLS is the potential endogeneity of the tax indicators. Changes in taxation can be driven by different economic considerations, such as (exogenous) long-term fiscal consolidation plans, (endogenous) fiscal policies induced by cyclical variation in output (and unemployment), as well as other developments in the economy affecting the choice of taxation and the level of unemployment. For example, a negative shock to unemployment that reduces the tax base and increases social expenditures can generate a decline in retention rates to balance the budget of the State. Alternatively, a government can react to an increase in unemployment by cutting taxes and reducing the CRIP to stimulate employment. In both cases, reverse causality is likely to bias the estimates. Unmeasured labour market policies or institutions can also be responsible for an omitted variable bias if they are correlated with the unemployment rate and our tax indicators.

While the macro-empirical literature on the determinants of unemployment does not generally address such endogeneity issues,[18] we take a number of steps in this direction. First, we introduce the tax indicators in Equation (9) with a one-year lag to mitigate the reverse causality bias. To be consistent, we also include the other labour market institutions in $\mathbf{Z}_{i,t-1}$ with one year lag. Second, we implement an instrumental variable estimator based on exogenous variations in institutional, social and political factors that influence a country's fiscal policy, to identify the causal effect of taxation on unemployment (and employment). We instrument the tax wedge and tax progressivity indicators using the following time-varying and country-

[17] These data are drawn from: OECD labour Force Statistics, OECD Economic Outlook, OECD Main Economic Indicators, ICTWSS database and World Bank Development Indicators.

[18] A notable exception is Nunziata (2005).

specific variables: a narrative record for the tax components of fiscal consolidation policies, an index of trust in civil services and a measure of the political orientation of the parliament.

Our first instrument is based on data on countries' fiscal consolidation plans motivated by long-term structural considerations. Devries et al. (2011) gather these data for 17 OECD countries from 1978 to 2009, using the narrative approach pioneered by Romer and Romer (2010). Devries et al. (2011) construct a variable that takes a value equal to the size of the fiscal consolidation plan legislated in country i at time t, and zero if no plan was legislated. Fiscal consolidations are reconstructed using historical records available in official documents (i.e. budget reports, central bank reports, IMF reports, OECD Economic Surveys and other country-specific sources), with the aim of identifying size, timing, and main motivation for the fiscal actions undertaken by each country. In order to guarantee the exogeneity of fiscal measures with respect to cyclical fluctuations, only long-term structural fiscal plans primarily designed to put public debt on a sustainable path are taken into account. Hence, tax hikes to choke off domestic demand are ignored. As an example, consider the fiscal consolidation efforts undertaken by European countries to access the Monetary Union. For some of them, although the requirements were agreed under the terms of the 1992 Maastricht Treaty, it was not up until the very last moment that consolidation measures were taken and implemented. The precise timing of the tax hikes provides an exogenous source of variation for labour taxation. We construct our instrument in two steps. First, since Devries et al. (2011)'s data distinguish the "tax hikes" from the "spending cuts" components of fiscal consolidation plans, we only use the former which describes the exogenous part of the (positive) *change* in the level of taxes between two consecutive years. Second, since we want an instrument for the *level* of labour taxes in a given year, we construct the country-specific (*Taxconsol*) variable in year t as an index which cumulates all the tax hike episodes that occurred up to $t-1$. In other words, the index captures the component of the level of taxes observed at time t generated by the aggregate consolidation efforts through tax increases implemented over the years. Note that the *Taxconsol* variable in the Devries et al. (2011) dataset is only available for 17 out of the 21 countries in our sample. The missing observations for Greece, New Zealand, Norway and Switzerland are set to zero. In the robustness checks section we provide additional evidence imputing the missing information on (exogenous) long-term structural changes in taxation from an external source (Guichard et al., 2007).

The share of people who report no confidence in civil services (*NoTrustCivil*) is our second instrument. It is the percentage of interviewed individuals in World Value Survey (WVS) of a given country that responded "*none at all*" to the question: "*how much confidence do you have in the civil service?*".[19] This indicator captures individuals' perception about the importance of rent-seeking behaviours in the public sector. The more people believe that public institutions are trustworthy, the more they are willing to let the State implement redistributive policies. So,

[19]The World Value Survey is available every five years. Our *NoTrustCivil* indicator is thus stepwise. Data construction is detailed in Appendix B.

we expect a higher value of *NoTrustCivil* (i.e. a lack of confidence in public services) to be negatively correlated with our indicator of tax progressivity. We also expect that *NoTrustCivil* is excludable from the unemployment equation. Available evidence supports our intuition. Sapienza et al. (2013) argue that respondents' beliefs regarding the functioning of the civil service are not directly correlated with economic activity, thus with unemployment performance. Moreover, studies that obtain a direct effect of trust on economic activity use measures of generalised trust, rather than trust in specific institutions such as public services (see e.g. Algan and Cahuc (2006, 2010) and Guiso et al. (2008)).[20] However, since we cannot exclude that generalised trust and trust in civil services are correlated, in the robustness checks section V.2, we replace *NoTrustCivil* with the share of individuals that trust other people but do not trust the civil service. Notice also that since low confidence in civil services may also affect unemployment insurance generosity, we include the unemployment benefit replacement ratio among the controls.

The difference between the shares of seats of left-wing and centrist parties minus the share of seats of right-wing parties in the parliament is our third instrument ($Leftism$).[21] This is because left-wing politicians typically support higher tax levels and more progressive taxation as opposed to right-wing parties (Summers et al. (1993), Persson and Tabellini (2002), Ardagna (2004), Nunziata (2005), among others). A long-standing literature in political economy argues however that the political orientation of parties may affect, besides taxation, also monetary and fiscal policies, as left-wing politicians, compared to right-wing ones, are more likely to implement Keynesian policies. To take this into account, we include in the controls the output gap and indicators of monetary policy such as the real interest rate and change in inflation. Also, there is no evidence in our data that elections during economic crises systematically favour left-wing governments. Out of the 35 elections occurred just after an economic downturn (defined as GDP being at least one percentage point below its potential level in a given year, or by half a point for two consecutive years), in 14 cases a right-wing parties obtained a relative majority. Conversely, there is empirical evidence suggesting that adverse economic performance may reduce the probability of re-election of incumbent politicians, whatever their political colour (Drazen, 2000). This would imply an increase in $Leftism$ after a negative shock to the economy, if the incumbent is right-wing, and the opposite if the incumbent is left-wing. This "probability of re-election channel" induces de facto a non-linearity in the effects of the business cycle on $Leftism$, which we exploit for identification.

One could argue that both distrust and leftism are correlated with the share of Active Labour Market Policies (ALMP) in GDP. However, when we add this indicator to the list of controls, it never turns out to be statistically significant while our parameters of interest remain

[20] Algan et al. (2011) construct a composite index of distrust for public institutions, which combines distrust for the civil service with distrust for the parliament and the justice system. We neglect the latter two dimensions of distrust, as we are mostly interested in describing the social propensity to finance public good provision and redistribution.

[21] The leftism variable in our first stage regression is entered with a lag. So in year t, this variable is measured at $t-2$ given that tax indicators are already lagged once in the unemployment equation.

unaffected. We therefore do not include ALMP in the main specification, while we return to it in the robustness checks section V.2.

IV Data and descriptive statistics

We assemble a unique data set which combines information drawn from different sources on taxation, other labour market institutions, labour market performance and other socio-economic characteristics for 21 OECD countries over the period 1997-2008. The countries we consider are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Norway, New Zealand, Portugal, Spain, Sweden, Switzerland, United Kingdom and the United States.

To get a broad overview of our tax data, we plot in the left panel of Figure 2, the average value by country, over the sample period, of both the retention rates at the average wage *ret100* and our progressivity indicator, namely *ret*67/*ret*167. The right panel of Figure 2 shows, for the same indicators, the country's change between the 1997-1999 and the 2006-2008 sub-periods. In the left panel of Figure 2, we also report the overall sample means (dashed horizontal and vertical lines) that partition the graph into four quadrants according to the level of OECD countries' tax burden (i.e. in terms of average taxation and tax progressivity). In the right panel of Figure 2, dashed horizontal and vertical lines are drawn at zero so that each quadrant provides the sign of the observed changes.

In terms of the levels of average tax burden and progressive taxation (left panel of Figure 2), the overall patterns suggest that countries that tax more (i.e. with lower average retention rates, *ret*100) are likely to be also characterised by a higher progressivity (i.e. a higher *ret67/ret167*). The bottom-right quadrant shows countries with a high tax burden and high tax progressivity, these are mainly Nordic and some continental European countries. In the upper-left quadrant we find mostly Anglo-Saxon and Mediterranean European countries (as well as Switzerland and Japan) characterised by a relatively lower tax burden and low progressivity.

When we focus on changes in the tax structure (the right panel of Figure 2), the majority of countries are located in the upper quadrants suggesting that many countries have reduced their tax burdens. A non negligible number of countries show a change in global progressivity: an increase occurred in France, Greece, Italy, New Zealand, Austria and Great Britain, while a decrease is observed in Australia Canada and Norway. Some countries also show substantial changes in the structure of taxation which suggest that a significant reform of the tax system occurred: Japan and The Netherlands, where the average level of taxation increased while progressivity remained relatively stable; Ireland, which decreased substantially the tax burden both in terms of average taxation and progressivity. The imperfect correlation between changes in tax burden and changes in progressivity enables us to identify the effects of tax progressivity separately from the effects of overall tax burden and reject the risk of multicollinearity.

Before turning to the empirical analysis, a brief description of the changes overtime of the

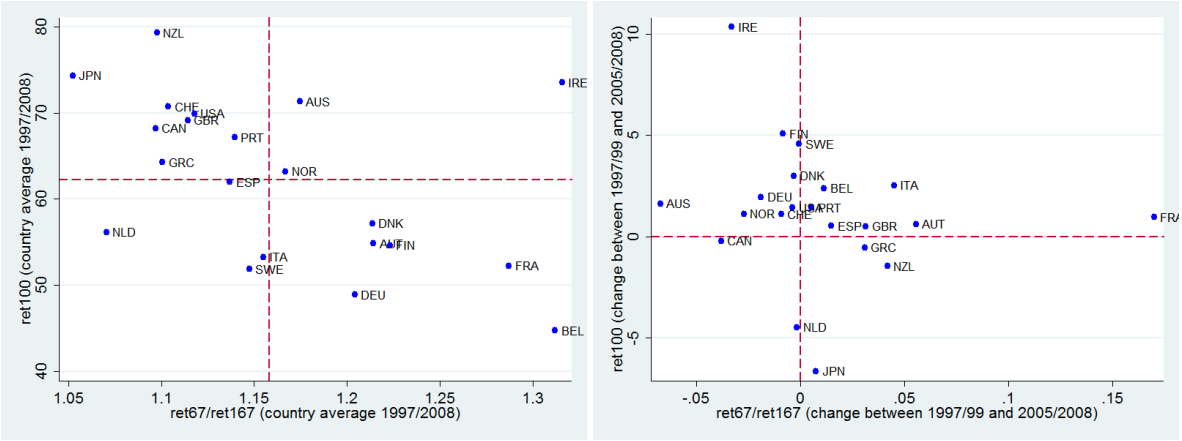

Figure 2: Tax retention rates (100% AW) and the progressivity (67% vs 167% AW) by country over the 1997-2008 period. Left: sample averages. Right: changes over the 1997-2008 periods. Sources: OECD Tax Database, OECD Taxing wages and authors' calculation.

progressivity index in countries that experienced substantial tax reforms may shed some light on our source of variation.

In the UK, the retention rate for singles paid 167% of the average wage did not change much along the period (see Figure 3). In 1999 however, the Blair government reformed the National Insurance Contributions (NICs) and the Income Tax, inducing a rise in the two other retention rates and in particular at the 67% level. Until April 1999, below a low earning limit, no NICs were due, implying that there was a jump in contributions at that level (called the "entry rate" by Stuart et al. (2010)). In April 1999, the "entry rate" was abolished. According to the Economic and Fiscal Strategy Report cited by Cloyne (2010), "it will be particularly valuable to the low paid, many of whom currently earn too little to pay income tax, but still have to pay National Insurance contributions. This move will take around 900,000 people out of N.I.C.s altogether". Furthermore in April 1999 as well, the starting rate of the income tax was cut from 20% to 10%. According to Stuart et al. (2010), in 2000-2001 nearly 3 millions people were liable of the income tax at this reduced rate. As can be seen on Figure 3, these reforms led to a sharp increase in the progressivity index. The 10% starting rate band was increased above indexation from April 2001, which led to a further rise in the progressivity index. In 2003, the government raised NICs and froze personal allowance, which led to a small decrease in progressivity.

Italy evidences a steady increase in the degree of progressivity over the sample period (see Figure 4). This was associated with successive reforms introduced by governments of different political colours, i.e. the consecutive left-wing governments by Prodi, D'Alema and Amato, the right-wing Berlusconi government, and the second Prodi government (Baldini et al., 2006). In 1998-2000, the Prodi and D'Alema governments engaged in a comprehensive reorganisation of the Personal Income Tax (PIT) system. They reduced the number of tax brackets from 7 to 5, changed the tax rates and introduced a set of progressive tax credits. These measures entailed a substantial increase of the retention rates at 67% of the average wage, thus an increase in the tax progressivity indicator between 1999 and 2000. This increase in progressivity was partially

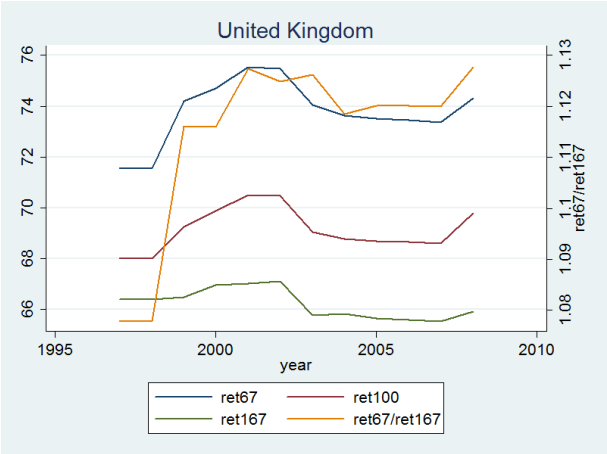

Figure 3: The experience of UK

dampened in 2001, when the new Amato government introduced tax credits for medium-high incomes, which considerably increased retention rates at 167% of the average wage (Baldini et al., 2006, Tondani and Mancini, 2006). During the 2001-2006 legislature. The new Berlusconi government carried out a new structural reforms of PIT, balancing progressivity and neutrality objectives. In 2003, it reduced the statutory tax rates on medium and low incomes, replaced tax credits with a "no-tax area" and protection clauses for specific tax payer categories.[22] Overall, these measures increased the retention rates at 67% of the average wage and decreased the retention rates at 167% of the average wage, inducing an increase in the tax progressivity indicator between 2002 and 2003. In 2005, the government further reduced the number of tax brackets from 5 to 4, revised the tax rates and introduced new exemptions for medium and high incomes. These amendments reduced the retention rates at 67% of the average wage and increased retention rates at 167% of the average wage, which reduced the degree of progressivity with respect to 2004 (see also Tondani and Mancini (2006)). In 2006, the new Prodi government partly restored the old system i.e. increased the number of tax brackets from 4 to 5, and replaced the "no-tax area" by the progressive tax credits. The government also put special effort in the reduction of employer's Social Security Contributions. Overall, these changes increased the retention rate at the 67% of the average wage and decreased the retention rate at the 167% of the average wage, inducing an increase in the tax progressivity indicator between 2006 and 2007.

According to our data, France is the country where progressivity increased the most, as shown in the right panel of Figure 2. As illustrated by the left panel of Figure 5, this is due to a large increase in the retention rate for singles paid 67% of the average wage, the two other retention rates having experienced much smaller changes over the period. This trend is a consequence of tax cuts on employers social security contributions on low paid jobs that occurred in France since 1993 (see Kramarz and Philippon (2001), Bunel and L'Horty (2012), Lehmann

[22]These clauses were especially directed to those in need of social assistance. They guaranteed that tax payers under the new regime would not pay more taxes than under the old regime.

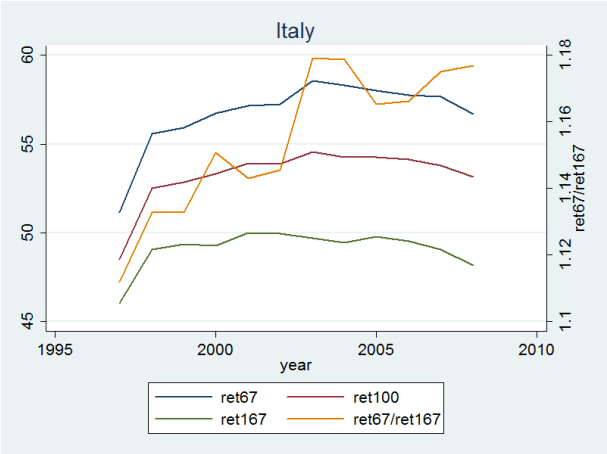

Figure 4: The experience of Italy

et al. (2013) for an overview and evaluations of these reforms). While the employers' social security contributions rate is typically around 40% of the posted wage in France, this rate was only 22% in 1997 and 14% since 2005 for workers paid at the minimum wage level. This cut in employer social security contribution is maximal at the minimum wage level and vanishes at 1.6 times the minimum wage. Simultaneously, France implemented a working tax credit targeted at low income earners called the *Prime pour l'emploi* (PPE). The PPE was launched in 2001 and progressively extended through the period (See Lehmann et al. (2013)). Unlike the EITC in the US or the WFTC in the UK, the French PPE was also generous for singles without kids. This is the reason why the extension of PPE results in a rise of our progressivity indicator.

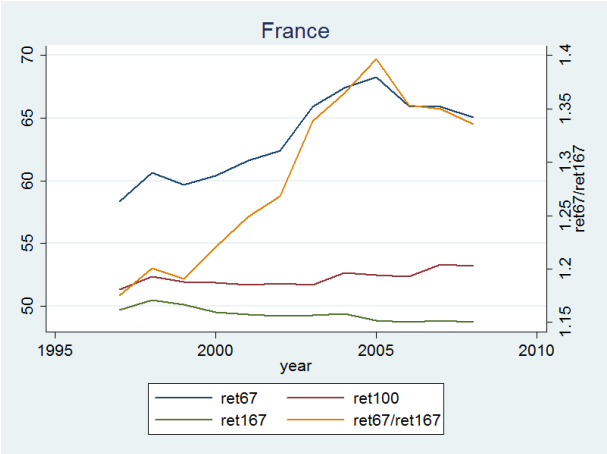

Figure 5: The French experience

While UK, Italy, and France, provide examples of progressivity increases in 1990-2008, it is also interesting to look at the case of Australia, which is the country where progressivity decreased the most in our sample as illustrated in Figure 6. It is widely acknowledged that "the 1936 Australian Income Tax Assessment Act introduced a tax system which encouraged the accumulation of wealth through borrowing and speculating, whilst penalising the accumulation of wealth through working and saving" (Eslake, 2011). The Liberal–National Coalition

led by John Howard between 1996 and 2007 introduced a set of comprehensive tax reforms, with the objective of reducing these distortions. Between 1998 and 2000 the government implemented the "New Tax System" with the objective of shifting the tax burden from labour to consumption. The new tax system reduced the average tax rates up to 14 percentage points on individuals earning between the 100% and 167% of the average production worker. It also introduced the General Sales Tax (GST) (Harding et al., 2000). The New Tax System implied a reduction of the global progressivity index between 1998-2000. This was partly offset by new tax increases on full time employees needed in 2002 and 2003 to balance the budget, alongside with problems in the actual implementation of the GST. The fine tuning of the GST and the contemporaneous reforms of corporate income taxes, allowed the government to introduce new tax cuts between 2003 and 2007. During this period, the 15% tax rate, which in 2003 was only applied to annual incomes below 20,000 AUD, was extended to incomes up to 34,000 AUD, which were previously taxed at a 30% tax rate. Overall these tax cuts implied a relative increase of the retention rates at 167% i.e. a consistent reduction of the global progressivity index during the same period (Tran-Nam and Vu, 2007, Smith, 2009).

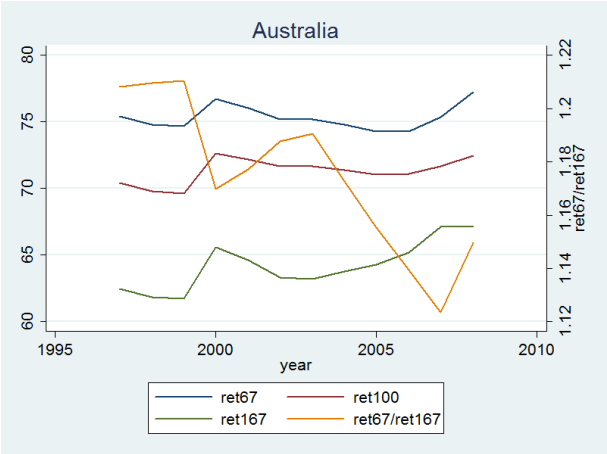

Figure 6: The Australian experience

V Empirical results

V.1 Main results

Table 1 presents results with the harmonised aggregate unemployment rate as dependent variable. OLS estimates are reported in Columns (1) and (2), IV estimates are shown in columns (3) to (5). In Column (1) we report results that are consistent with the specification typically used in the literature, whereby taxes affect the unemployment rate only through the average tax wedge (See e.g. Nickell and Layard (1999), Bassanini and Duval (2009)). We find that a one percentage point increase in the average retention rate $ret100_{t-1}$ (i.e. a one percentage point decrease in the labour tax wedge) has a favourable impact on the unemployment rate

in t, for the average OECD country and year, of about 0.11 percentage points.[23] This order of magnitude is in the range of previous findings which are between 0.1 (Nickell et al., 2005) and 0.5 (Daveri and Tabellini (2000) for Continental-European countries). In Column (2), we show results with a specification that includes tax progressivity. Consistent with Prediction 1, a lower average tax rate (a higher value of $\ln(ret100)_{t-1}$) and a more progressive tax schedule (a higher value of $\ln\left(\frac{ret67}{ret167}\right)_{t-1}$) reduce the unemployment rate. The effect of the average tax rate is statistically significant at the 1% level, the one of progressivity at the 5% level.

	OLS estimates		**IV estimates**		
	(1)	(2)	(3)	(4)	(5)
$\ln(ret100)_{t-1}$	–6.617**	–7.913***	–22.069***	–28.869***	–53.420***
	(2.716)	(2.809)	(7.835)	(9.262)	(16.302)
$\ln\left(\frac{ret67}{ret167}\right)_{t-1}$		–6.088**		–11.943***	–56.801***
		(2.534)		(4.391)	(20.544)
UBRR_{t-1}	0.055**	0.066***	0.125***	0.166***	0.315***
	(0.024)	(0.025)	(0.045)	(0.056)	(0.098)
$\text{UnionDensity}_{t-1}$	0.089	0.109*	0.005	0.020	0.085
	(0.056)	(0.056)	(0.070)	(0.073)	(0.138)
wcoord_{t-1}	–0.502**	–0.505***	–0.536***	–0.551***	–0.605**
	(0.197)	(0.193)	(0.183)	(0.191)	(0.304)
EPL_{t-1}	1.084***	1.079***	1.384***	1.457***	1.714**
	(0.369)	(0.348)	(0.405)	(0.410)	(0.674)
outputgap_t	–0.440***	–0.439***	–0.510***	–0.529***	–0.596***
	(0.066)	(0.065)	(0.079)	(0.083)	(0.114)
inflchange_t	–0.113	–0.109	–0.195*	–0.212*	–0.267*
	(0.083)	(0.084)	(0.104)	(0.110)	(0.158)
irate_t	–0.359***	–0.406***	–0.582**	–0.737***	–1.303***
	(0.134)	(0.133)	(0.232)	(0.272)	(0.442)
Openness_t	0.049***	0.052***	0.053***	0.061***	0.092***
	(0.014)	(0.014)	(0.015)	(0.017)	(0.024)
R^2	0.90	0.90	0.88	0.87	0.67
N	231	231	231	231	231
Hansen J test			0.3579	0.5513	0.6473

Table 1: Tax wedge, tax progressivity and the standardised unemployment rate *UNR*. These estimates are obtained using country-fixed effects, time-fixed effects. Robust standard errors in parentheses. Significance levels: $*$: 10%, $**$: 5%, $***$: 1%. p-values of Hansen J over-identification tests are provided. Instruments in Columns (3) and (4) are *Taxconsol* and *Leftism* (lagged twice). In Column (5), we add *NoTrustCivil* (lagged five years) defined in Appendix B.

However, as previously discussed, OLS estimates may be biased and inconsistent due to the endogeneity of the tax variables. In Columns (3), (4) and (5), we deal with those issues by implementing an instrumental variable estimator. In Column (3), we re-estimate the specification of Column (1) using the variables *Taxconsol* and *Leftism* (lagged twice) to instrument

[23]The mean of *ret*67, *ret*100 and *ret*167 over the sample are respectively 66.35%, 62.19% and 57.42%. So, when $ret100_{t-1}$ rises by one percentage point, the change in the unemployment rate amounts to $\frac{-6.617}{62.19} \cdot 1 = -0.11$ percentage points.

$\ln(ret100)_{t-1}$. In Column (4), we introduce tax progressivity $\ln\left(\frac{ret67}{ret167}\right)_{t-1}$, but consider it is exogenous and instrument $\ln(ret100)_{t-1}$ only. In Column (5), we instrument both $\ln(ret100)_{t-1}$ and $\ln\left(\frac{ret67}{ret167}\right)_{t-1}$, adding NoTrustCivil (lagged five years) to the set of instruments used in Columns (3) and (4). First-stage estimates are comforting in terms of instruments' correlation with the endogenous regressors, while the Hansen J test confirms the validity of the over-identifying restrictions.[24]

A comparison of estimated coefficients reported in Columns (3)-(5) with those in Columns (1)-(2) indicate that OLS estimates of $\ln(ret100)$ suffer from an attenuation bias. According to IV estimates, a one percentage point increase in the average retention rate implies a reduction of the unemployment rate, for the average OECD country, between 0.35 (Column 3) and 0.86 (Column 5) percentage points - i.e. an order of magnitude that is closer to the one suggested by Daveri and Tabellini (2000). As far as progressivity is concerned, let us consider the effect of a half-percentage point decrease in the average tax rate at 67% of the average wage, together with a half-percentage point increase in the average tax rate at 167% of the average wage. Such a tax reform induces a rise in tax progressivity that increases $\ln\left(\frac{ret67}{ret167}\right)_{t-1}$ by 0.016 points, thereby reducing unemployment by an amount between 0.19 percentage points[25] (Column 4, where tax progressivity is assumed to be exogenous) and 0.92 (Column 5). We interpret the contrast between the magnitude of OLS and IV estimates as evidence that reverse causality introduces an attenuation bias. A government may react to an adverse shock on unemployment by reducing average labour taxes, in particular on low-paid jobs, to curb the rise in unemployment. Such reactions generate a positive correlation between the unemployment rate and $\ln(ret100)_{t-1}$ and a positive correlation between the unemployment rate and $\ln\left(\frac{ret67}{ret167}\right)_{t-1}$ that attenuate the OLS estimates of tax indicators and may even reverse their signs. Omitted factors affecting the unemployment rate can be an additional source of attenuation.

For the other control variables we find that higher unemployment benefits increase unemployment. Union density plays no significant role. More coordination in wage bargaining has a favourable effect. The synthetic index of employment protection legislation has a statistically significant positive effect on the unemployment rate. An increase in the output gap is associated with lower unemployment, while the negative coefficients of the real interest rate on government's bonds and the change in inflation suggest that policies that guarantee prices stabilisation or raise the interest rate may be associated with higher unemployment. Finally there is a positive association between trade openness (imports plus exports relative to GDP) and the unemployment rate.

[24] First-stage estimates reported in Table 7 in Appendix show that *Taxconsol* and $Leftism$ have a strong and significant impact on $\ln(ret100)_{t-1}$, while *NoTrustCivil* is mainly correlated with $\ln\left(\frac{ret67}{ret167}\right)_{t-1}$. The F statistics are close to the critical values suggested by Stock and Yogo (2005) to restrict the bias of the IV estimator to the twenty percent of OLS bias. The Shea Partial R^2 confirm that excluded instruments explain a non-negligible part of the variance of the endogenous variables in all specifications. Moreover, the Anderson and Rubin test, which is robust to weak instruments and heteroskedasticity, always rejects the null hypothesis that the endogenous regressors have no statistically significant impact in the second stage.

[25] Namely, $\beta_2 \left(\frac{0.5}{\text{ret167}} - \frac{-0.5}{\text{ret67}}\right) = 11.9 \left(\frac{0.5}{57.4} + \frac{0.5}{66.4}\right) = 0.19$.

Overall, estimates in Table 1 yield three interesting considerations. First, omitting the role of tax progressivity leads to underestimate the impact of average taxation on unemployment. Second, IV estimates, when compared to OLS, show a considerable increase in the magnitude of coefficients, in terms of both $\ln(ret100)_{t-1}$ and $\ln\left(\frac{ret67}{ret167}\right)_{t-1}$. Last but not least, the impact of tax progressivity on unemployment is shown to be quantitatively as important as the impact of average taxation.

	OLS estimates		**IV estimates**		
	(1)	(2)	(3)	(4)	(5)
$\ln(ret100)_{t-1}$	4.260	6.778*	17.327*	26.837**	51.798***
	(3.651)	(3.787)	(10.264)	(11.719)	(19.358)
$\ln\left(\frac{ret67}{ret167}\right)_{t-1}$		11.829***		17.433***	61.884**
		(3.622)		(5.405)	(26.906)
R^2	0.97	0.98	0.97	0.97	0.95
N	231	231	231	231	231
Hansen J test			0.6264	0.9520	0.4635

Table 2: Tax wedge, tax progressivity and the employment rate *erate*. Robust standard errors in parentheses. Significance levels: $*$: 10%, $**$: 5%, $***$: 1%. p-values of Hansen J over-identification tests are provided. Instruments in Columns (3) and (4) are *Taxconsol* and $Leftism$ (lagged twice). In Column (5), we add *NoTrustCivil* (lagged five years) defined in Appendix B. These estimates are obtained using country-fixed effects, time-fixed effects and the same controls as in Table 1.

In Table 2 we replicate the same regressions as in Table 1 replacing the unemployment rate by the employment rate as the dependent variable. We only report the estimated parameters of the explanatory variables of interest. Most previous findings are confirmed also when the effects of taxation are estimated on the employment rate, though, as expected, the signs are now reversed as compared to Table 1. Focussing on our preferred specification in Column (5), we find that a one percentage point increase in the average retention rate determines an increase of the employment rate, for the average OECD country, up to 0.83 percentage points. Similarly, a one percentage point increase in $\left(\frac{ret67}{ret167}\right)_{t-1}$ - split into half a percentage point decrease in the average tax rate at 67% of the average wage and half a percentage point increase in the average tax rate at 167% - causes an increase in the employment rate up to 1.01 percentage points. Here as well, a comparison of the coefficients of $\ln(ret100)_{t-1}$ indicate that neglecting progressivity tends to underestimate the impact of the average tax wedge on employment.

In Table 3, we disentangle the effects of taxation on indicators of labour market performance on the extensive and the intensive margins. As for the extensive margin, we use as a dependent variable the logarithm of one minus the unemployment rate (Column 1), the logarithm of the participation rate (Column 2), and the logarithm of the employment rate (Column 3). In this way, adding the estimates of Column (1) and Column (2), by construction, we obtain estimates reported in Column (3).[26] As for the intensive margin, we use as a dependent variable the

[26]Note that, for consistency with the decomposition exercise, in Column (1) we use the (non-harmonised) unem-

	$\log(1-urate)_t$	$\log(prate)_t$	$\log(erate)_t$	$\log\left(\frac{GDP}{Emp}\right)_t$	$\log\left(\frac{GDP}{Pop}\right)_t$
	(1)	(2)	(3)=(1)+(2)	(4)	(5)=(3)+(4)
	OLS estimates				
$\ln(ret100)_{t-1}$	0.116***	0.010	0.126**	–0.017	0.109
	(0.037)	(0.039)	(0.061)	(0.072)	(0.088)
$\ln\left(\frac{ret67}{ret167}\right)_{t-1}$	0.135***	0.066*	0.200***	–0.118*	0.083
	(0.034)	(0.040)	(0.057)	(0.062)	(0.065)
R^2	0.88	0.98	0.97	1.00	1.00
N	231	231	231	231	231
	IV estimates				
$\ln(ret100)_{t-1}$	0.777***	0.113	0.890***	–0.508	0.382
	(0.238)	(0.143)	(0.331)	(0.406)	(0.307)
$\ln\left(\frac{ret67}{ret167}\right)_{t-1}$	0.824***	0.226	1.050**	–1.437***	–0.387
	(0.297)	(0.228)	(0.449)	(0.473)	(0.378)
R^2	0.55	0.98	0.94	0.99	1.00
N	231	231	231	231	231
Hansen J test	0.7480	0.1920	0.4353	0.1378	0.1767

Table 3: Decomposing the effects of taxation on different indicators. Robust standard errors in parentheses. Significance levels: $*$: 10%, $**$: 5%, $***$: 1%. p-values of Hansen J over-identification tests are provided. These estimates are obtained using country-fixed effects, time-fixed effects and the same controls as in Table 1. The instruments are $Taxconsol$, $Leftism$ (both lagged twice) and $NoTrustCivil$ (lagged five years).

logarithm of GDP per employed worker (Column 4). Finally we use the logarithm of GDP per individual in the working age population (Column 5). Since this is the product of the employment rate times GDP per employed worker, estimates in Column (5), which are by construction equal to the sum of estimates in Columns (3) and (4), aggregate the effects along the intensive and the extensive margins. The top panel reports OLS estimates as in Column (2) of Tables 1 and 2. The bottom panel reports IV estimates using the same identification strategy as in Column (5) of Tables 1 and 2.

Results show that a higher taxation increases the unemployment rate while more progressivity decreases it. Focusing on Column (3), we find that lower taxation and higher progressivity increase the employment rate considerably, however these effects seem to be mainly driven by the variations in the unemployment rate rather than by the changes in the participation rate. For, the latter is not statistically significantly affected in Column (2), both under OLS and under IV. These results suggest that the emphasis that is usually placed on labour supply decisions along the extensive margin to explain the employment effects of changes in taxation, instead of the unemployment-reducing effect, could be misleading.

In line with Prediction 3, results in Column 4 show that a rise in the tax progressivity indicator $\ln\left(\frac{ret67}{ret167}\right)_{t-1}$ significantly reduces GDP per employed worker. This is consistent with the

ployment rate, *urate*, instead of the standardised unemployment rate, *UNR*, provided by OECD, as in Table 1. We have checked that this change has little effects on the estimates.

common wisdom that tax progressivity has a detrimental effect on incentives to work harder. Conversely, the effect of $\ln(ret100)_{t-1}$ is never statistically significant, suggesting the absence of significant income effect on the intensive labour supply. Despite the negative impact of progressivity on output per worker shown in Column (4), we find that the overall effect on output in Column (5) is not statistically significant. This suggests that the effect of progressivity on the extensive margin (i.e. the employment rate) is large enough to offset its negative impact on the intensive margin (i.e. GDP per employed worker). Hence, once unemployment responses are taken into account, rising tax progressivity is not necessarily detrimental to output. To summarise, Table 3 reconciles our view that tax progressivity reduces unemployment (Column (1)) and increases employment (Column (3)) with the traditional view that it generates negative incentives in terms of in-work effort (Column (4)). It also shows that the total effect on production is ambiguous (Column (5)).

	Skill		**Age**	
	Low-skilled	High-skilled	Young	Adults
	OLS estimates			
$\ln(ret100)_{t-1}$	–11.531***	–5.866*	–20.966***	–10.027***
	(3.915)	(3.419)	(6.572)	(3.091)
$\ln\left(\frac{ret67}{ret167}\right)_{t-1}$	– 12.518***	–10.755***	–21.465***	–12.090***
	(3.592)	(3.111)	(7.454)	(2.796)
R^2	0.87	0.78	0.92	0.88
N	231	231	231	231
	IV estimates			
$\ln(ret100)_{t-1}$	–70.765***	–54.549**	–124.102***	–64.722***
	(24.795)	(23.816)	(37.135)	(18.796)
$\ln\left(\frac{ret67}{ret167}\right)_{t-1}$	–97.487***	–64.506**	–118.986**	–65.948***
	(29.585)	(28.173)	(47.110)	(24.142)
R^2	0.52	0.44	0.78	0.58
N	231	231	231	231
Hansen J test	0.4212	0.3426	0.9320	0.8251

Table 4: Effects on the unemployment rates of different subgroups. Significance levels: $*$: 10%, $**$: 5%, $***$: 1%. p-values of Hansen J over-identification tests are provided. These estimates are obtained using country-fixed effects, time-fixed effects and the same controls as in Table 1. The instruments are $Taxconsol$, $Leftism$ (both lagged twice) and $NoTrustCivil$ (lagged five years).

Estimates in Tables 1, 2 and 3 implicitly assume that the effects of taxation are homogeneous across the whole labour force. In Table 4, we report estimates where we distinguish unemployment rates by skill and by age. The top panel reports OLS estimates while the bottom panel shows IV estimates. Some caution is needed when interpreting these results, since the distribution of wages can vary a lot between these groups, while the retention rates we use are not specific to each sub-population considered. Still, a rough comparison of the magnitude of the coefficients of $\ln(ret100)_{t-1}$ and $\ln\left(\frac{ret67}{ret167}\right)_{t-1}$ can improve our understanding of the diverse ef-

fects of taxation on unemployment across different groups of workers. Estimates in Columns (1) and (2) suggest that the impact of taxation and progressivity is larger (and statistically more robust) for low-skilled workers than for high-skilled ones.[27] Results reported in Columns (3) and (4) show a similar pattern, whereby the impact of taxation and progressivity on unemployment is larger for younger workers (i.e. age group 15-24), as compared to prime-age workers (i.e. age group 25-54). That the effects on the prime-age workers remains significant is however striking, given the common wisdom that difference in employment across countries are essentially due to differences in employment at the two extremities of the life cycle.

V.2 Robustness checks

In this section, we carry out a number or robustness checks on the main set of estimates, for the impact of taxation on the unemployment rate and the employment rate. In Table 5, we check the robustness of our results to alternative identification strategies based on different sets of instruments. To ease comparisons, in Columns (1a) and (1b), we reproduce our results from the baseline specification (Column (5) of Table 1, for the unemployment rate *UNR*; Column (5) of Table 2 for the employment rate *erate*). The bottom part of Table 5 shows first-stage results (note these are identical whether the dependent variable in the second stage is the unemployment or the employment rate).[28] In Columns (2a) and (2b), we fill in the missing information for Greece, New Zealand, Norway and Switzerland in the *Taxconsol* instrument from the Devries et al. (2011) dataset using an alternative OECD dataset on fiscal consolidation provided by Guichard et al. (2007). Although the information in this dataset relies on a statistical algorithm (i.e. based on countries' structural changes in the cyclically adjusted primary balance), rather than on the narrative approach, the sequence of tax hikes show a rather similar pattern in both dataset.[29] In Columns (3a) and (3b), we use the ratio of public debt over GDP ($t-2$) as an instrument instead of the tax consolidation indicator. This captures the idea that highly indebted governments need to use fiscal policy to consolidate their budget (Galí and Perotti, 2003). To mitigate the risk of reverse causality, we lag the variable twice. Moreover, the inclusion of cyclical controls is expected to account for any effect of public debt on unemployment going through the channels of demand-management policies.[30] Results reported in Table 5 show that the IV estimates are robust to theses changes in the instruments. Finally, we account for the possible correlation of *NoTrustCivil* with measures of generalised trust, which have a direct effect on economic activity (see e.g. Algan and Cahuc (2006, 2010) and Guiso et al. (2008)). In Columns (4a) and

[27] These two skill categories are based on educational attainment. Low-skilled workers completed up to secondary education, while high-skilled workers completed tertiary education or more. The inclusion of individuals with a high school degree into the low-skilled category can be disputed. However, this aggregation choice is unavoidable due to the switch from the ISCED76 to the ISCED97 classification, which recoded lower-secondary education from level 1 (primary) to level 2 (secondary).

[28] Column (1a) displays the Shea Partial R^2 and the F statistic of the significance test of excluded instruments for the first-stage estimation of $\ln(ret100)$; Column (1b) provides the same statistics for $\ln(\frac{ret67}{ret167})$.

[29] We checked the consistency of the two indicators - i.e. narrative and statistical - for the countries in which information on both approach was available.

[30] Note that in the textbooks IS-LM and AS-AD models, aggregate demand depends on public *deficits*, not on public *debt*.

(4b), we substitute in the list of instruments *NoTrustCivil* by the share of individuals that trust other people but do not trust the civil service. The effect of progressivity on unemployment remains negative (Column (4a)), but is now only significant at the 10% level, while the effect on employment remains positive but is no longer statistically significant.

In Table 6, we run a set of more traditional robustness checks. We experiment a different set of control variables, alternative specifications of the baseline equation, various estimation methods to control for unobserved country-specific shocks, as well as a different clustering of the error term to account for common unobserved effects. For each sensitivity check, we report the estimated coefficients of the tax variables and the Hansen test of the over-identifying restrictions. The various robustness checks experimented are discussed hereafter. With partial exceptions of Rows (4), (10) and (18), robustness checks leave our results almost unaffected. In our baseline equation, we use the output gap to control for overall business cycle conditions, assuming that output fluctuations are exogenous with respect to the unemployment rate. As the inclusion of output gap in the list of controls may trigger a simultaneity bias, we omit this variable in Row (1). Similarly, in Row (2) we omit from the baseline equation the trade-to-GDP ratio to account for the potential endogeneity of trade flows with respect to labour market performance. In Row (3) we omit all cyclical controls. Next, while in our baseline specification all the tax variables are assumed to be pre-determined and entered with a year lag, in Row (4) we instead take contemporaneous tax indicators.[31] The estimates remain similar but the Hansen test is now rejected. This suggests that reverse causality is an important concern to take into account. In Row (5) we add to the set of controls the OECD ratio of expenditures in active labour market policies over GDP, to account for confounding factors, as discussed at the very end of Section III. We further experiment how results are altered by considering only country-fixed effects (i.e. excluding the time dummies; Row (6)), replacing country-fixed effects and time dummies with country-specific time trends (Row (7)), and including in the specification both time dummies and country-specific trends (Row (8)). To account for the presence of cross-section correlated error terms, in Row (9), we replace the time-fixed effects with a Correlated Common Effect Pooled (CCEP) estimator (Pesaran, 2006). In Row (10), we use the differences estimator instead of the country fixed effects. The sign of the estimated coefficients are unchanged, while significance falls as a result of short-term noise, which typically arises when taking first or longer differences.[32] In Row (11) we implement the Newey-West HAC estimator that delivers heteroskedasticity and autocorrelation consistent estimates. In Rows (12) to (16), we exclude from our sample the countries that show the largest changes in the structure of taxation (i.e. France, Ireland, Japan and The Netherlands), as illustrated in the right panel of Figure 2. In Row (17), we exclude the years 1997 and 1998, to focus on data coming from the

[31] In this specification, since we want to isolate the effect of contemporaneous tax indicators, we still enter control variables for labour market institutions with a one-year lag and instruments with a two-years lag.

[32] This type of noise is associated with transitory and idiosyncratic shocks, e.g. changes in the generosity of the welfare state. This noise increases when the differences become shorter. For this reason, we take three years' differences rather than first differences.

OECD Tax Database.[33] In Row (18), finally, to capture the medium-run effects and to partially smooth the year-to-year variations, we replicate the estimates using three years averages. In this case the sign of the estimated coefficients are unchanged, while significance falls as a result of the reduction in the number of observations.

VI Conclusion

This paper argues that tax progressivity has unemployment-reducing and employment enhancing effects. We develop a simple theoretical model in which tax progressivity may be detrimental to labour supply along the intensive margin, while the overall effects on employment and unemployment are beneficial for overall labour market performance. We empirically test the effects of tax progressivity on employment and unemployment using a panel data of 21 OECD countries gathered for the 1997-2008 period. We propose a new measure of global tax progressivity based on a comparison between the fiscal wedges at 67% and 167% of the average wage. We find that tax progressivity has a significant unemployment-reducing impact of a similar order of magnitude as the unemployment-increasing effect of average labour taxation. These effects are more concentrated among low-skilled workers and among young workers. These results are in line with theories claiming that tax progressivity reduces unemployment because it generates a wage moderating effect that boosts the labour demand and because it shifts the tax burden away from groups of workers whose employment is the most responsive to taxation. We also find that a more progressive tax schedule increases the employment rate, but decreases production per worker. The net impact on total production is statistically non-significant. Our central result that tax progressivity increases employment (and decreases unemployment) thus comes hand in hand with the standard disincentive effect of tax progressivity on the intensive margin of the labour supply as commonly argued in the public finance and macroeconomic literatures.

Consequently, we add a new effect to be taken into account in the optimal design of labour income taxation. Optimal progressivity not only trades off the equity gain of a higher progressivity against the efficiency loss due to the disincentive effect along the incentive margin. One should also take into account the efficiency gains of a more progressive tax schedule on labour market performance through a reduction in unemployment and a rise in employment. In the European context where many countries are plagued with a high public debt to GDP ratio and high unemployment rates, our results suggest that a rise in tax progressivity should be part of governments' policy agenda, at least in countries with low tax progressivity.

[33] In principle we should only look at the period 2000-2008. We retain the 1999 to guarantee that *NoTrustCivil* exhibits enough time variation.

A Theoretical model

We here consider the general model with an intensive labour supply margin. Let ℓ be the effort provided by employed individuals and the money-equivalent of this disutility.[34] One can think of ℓ as hours of work or as the intensity of in-work effort. We assume that providing effort ℓ leads to a flow of output $f(\ell)$, with $f'(.) > 0 > f''(.)$ and a flow of disutility ℓ. Denoting w the total gross wage (and not the wage rate), Equation (4a) becomes:

$$r\,E = w - T(w) - \ell + \delta\,(U - E) \tag{10}$$

The case without the intensive margin is retrieved by setting the disutility $\ell = 0$ and $f(\ell) = y$. Equations (2) and (10) imply respectively:

$$J = \frac{f(\ell) - w}{r + \delta} \qquad \text{and} \qquad E - U = \frac{w - T(w) - \ell - r\,U}{r + \delta} \tag{11}$$

Maximising the (log of) the Nash product with respect to the wage and in-work effort leads to:

$$\frac{\gamma\,(1 - T'(w))}{E - U} = \frac{1 - \gamma}{J} \qquad \text{and} \qquad \frac{\gamma}{E - U} = \frac{(1 - \gamma)\,f'(\ell)}{J}$$

Using (6) and $\Psi = \Psi(w)$, the first of these two equations gives the sharing rule (5). The second of these equations imply the labour supply condition:

$$\big(1 - T'(w)\big)\,f'(\ell) = 1 \tag{12}$$

which determines effort ℓ as a decreasing function of the marginal tax rate, independently of any other variable. Combining the sharing rule (5) with (11) leads to:

$$\gamma\,\Psi\,(f(\ell) - w) = (1 - \gamma)\left(w - \frac{\ell + r\,U}{1 - \tau}\right)$$

Moreover, we get from (4b) and the sharing rule (5):

$$\frac{r\,U}{1 - \tau} = \frac{b}{1 - \tau} + p(\theta)\frac{\gamma\,\Psi}{1 - \gamma}J = \frac{b}{1 - \tau} + c\frac{\gamma\,\Psi}{1 - \gamma}\,\theta \tag{13}$$

where the second equality uses the free-entry condition (3). The (gross) wage equation is

$$w = \frac{\gamma\,\Psi}{1 - \gamma + \gamma\,\Psi}\,(f(\ell) + c\,\theta) + \frac{1 - \gamma}{1 - \gamma + \gamma\,\Psi}\frac{b + \ell}{1 - \tau}$$

which gives (7a) in the case of exogenous labour supply by taking $\ell = 0$ and $f(\ell) = y$. Equation (7b) follows directly. Combining this wage equation with the free-entry condition (3) leads to:

$$\left(1 + \frac{\gamma\,\Psi}{1 - \gamma}\right)\frac{r + \delta}{q\,(\theta)} + \frac{\gamma\,\Psi}{1 - \gamma}\theta = \frac{1}{c}\left(f\,(\ell) - \frac{b + \ell}{1 - \tau}\right) \tag{14}$$

Equation (14) determines implicitly equilibrium tightness θ as a decreasing function of the average tax rate τ and of the CRIP Ψ, while the sign of the relationship with in-work effort ℓ is ambiguous. Using (1), it also determines the fraction $1 - u$ of participants that are employed.

With an endogenous labour supply margin, productivity is a function of effort and the disutility of effort plays a role similar to the value in unemployment b. For a given level of effort ℓ, a rise in progressivity (a decrease in the CRIP Ψ) increases employment through the same

[34] Introducing a more complex increasing and convex expression for this disutility leads to more cumbersome expressions without adding any new insight.

wage moderating. Moreover, a rise in tax progressivity decreases effort ℓ. This reduction has two opposite effects on the total surplus of a match. On the one hand, production decreases. On the other hand, the disutility of work also decreases. The net effect of effort ℓ on employment depends on how the term $f(\ell) - (b+\ell)/(1-\tau)$ in the left-hand side of (14) varies with ℓ. Using (12) a reduction in effort ℓ increases (decreases) this term whenever taxation is regressive (progressive) i.e. when $\Psi > 1$ (i.e. $\Psi < 1$). Therefore, by continuity, and provided that the taxation is not too progressive so that the labour supply effect of tax progressivity remains dominated by the wage moderating effect, a rise in tax progressivity (a reduction in the CRIP Ψ) increases employment and decreases the unemployment rate.

Let us denote $X \equiv \frac{\gamma\,\Psi}{1-\gamma}$. From (14), the effect of the CRIP Ψ on tightness happens only through a change in X. A rise in the CRIP Ψ holding the average tax rate τ constant increases participation only if it increases the value of unemployed. Rewriting (13) as:

$$r\,U = b + c\,X\,\theta(1-\tau)$$

implies that a rise in the CRIP for a fixed τ increases participation if and only if $X\,\theta$ is increasing in X. Denoting the elasticity of the job filling rate by $\eta(\theta) \equiv -\theta q'(\theta)/q'(\theta)$ and differentiating (14) in θ and in $X = \frac{\gamma\,\Psi}{1-\gamma}$ gives:

$$\frac{d\theta}{\theta} = -\frac{X\,\frac{r+\delta}{q(\theta)} + X\,\theta}{\eta(\theta)(1+X)\,\frac{r+\delta}{q(\theta)} + X\,\theta}\,\frac{dX}{X} \quad \Rightarrow \quad \frac{d(\theta\,X)}{\theta\,X} = \frac{[\eta(\theta)(1+X) - X]\,\frac{r+\delta}{q(\theta)}}{\eta(\theta)(1+X)\,\frac{r+\delta}{q(\theta)} + X\,\theta}\,\frac{dX}{X}$$

Hence, $X\,\theta$ is increasing in X, thereby participation is decreasing in progressivity, if and only if $X > \eta(\theta)(1+X)$. Given the definition of X, the latter condition is equivalent to:

$$\frac{\gamma\,\Psi}{1-\gamma+\gamma\,\Psi} > \eta(\theta)$$

that is to effective bargaining power being higher than the efficient one prescribed by the Hosios (1990) condition (see Pissarides (2000)), i.e. by unemployment rate being inefficiently high.

B Data Appendix

Main variables used in the analysis

UNR: unemployed persons divided by the labour force (harmonised; OECD economic outlook).

Urate: unemployed persons divided by the labour force (non harmonised; OECD Employment Database based on National Labour Force Surveys).

Erate: persons in employment divided by the working age population (non harmonised; OECD Employment Database based on data from National Labour Force Surveys).

Prate: persons in the labour force divided by the working age population (non harmonised; OECD Employment Database based on data from National Labour Force Surveys).

ATR, 67, 100, 167 AW: average tax rates (ATR) including taxes, social security contributions (net of cash benefits received) for the average worker (single person, no child) at 67%, 100% and 167% of average earnings. These data are drawn from the OECD tax Database for the years 2000-2008 and extended back to 1997, using information from OECD Taxing Wages (historical model B). The two datasets are constructed using the same methodology, the only difference being that computations from Taxing Wages historical model B use as a benchmark the average production worker (APW) rather than the average worker (AW). We used the common support of the two datasets (i.e. the years 2000-2004) to rescale the ATRs from OECD Taxing Wages to the corresponding ATRs from the OECD Tax Database. This allowed us to exploit the yearly

variation of OECD Taxing Wages' ATRs between years 1999/2000, 1998/1999, and 1997/1998 to extend the relevant time series from the OECD Tax Database back to 1997.

Instruments

NoTrust: percentage of respondents that give answer 4 (i.e., 'none at all') to questions *E*069_8 in WVS1-5, V212 in EVS4, V207 in EVS3, q553i in EVS2, v546 in EVS1 (how much confidence in civil service). The period is as follows:

1980-89: coverage by EVS1/WVS1 but for CHE, covered by EVS2. Surveys carried in 1981 for AUS, BEL, DEU, DNK, ESP, FIN, FRA, GBR, IRE, JPN, NLD; 1982 for CAN, NOR, NOR, SWE, USA;

1990-94: coverage by EVS2/WVS2. Surveys carried in 1990 for AUT, BEL, CAN, DEU, DNK, ESP, FIN, FRA, GBR, ITA, JPN, NLD, NOR, PRT, SWE, USA. Notice that we have two observations for ESP (in year 1990) corresponding to both WVS2 and EVS2 being carried that year.

1995-99: coverage by EVS3/WVS3. Surveys carried in 1995 for AUS, ESP, JPN, USA; 1996 for CHE, FIN, NOR, SWE; 1997 for DEU; 1998 for GBR, BEL, GBR, NZL; 1999 for AUT, BEL, DEU, DNK, ESP, FRA, GBR, GRC, IRE, ITA, NLD, PRT, SWE, USA. Notice that we have two observations for ESP (1995 and 1999), DEU (1997 and 1999), GBR (1998, 1999), and USA (1999), corresponding to both WVS3 and EVS3 being carried in those countries.

2000-04: coverage by WVS4 but for FIN and NZL, covered by EVS3 and WVS5, respectively. This period is generally not covered by any EVS wave, thus the majority of European countries is not surveyed. Surveys carried in 2000 for CAN, ESP, FIN, JPN; 2004 for NZL.

2005-08: coverage by EVS4/WVS5. Surveys carried in 2005 for AUS, FIN, ITA, JPN; 2006 for CAN, DEU, FRA, GBR, NLD, SWE, USA; 2007 for CHE, ESP; 2008 for AUS, CHE, DEU, DNK, ESP, FRA, GRC, IRE, NLD, NOR, PRT. Notice that we have two observations for AUS (2005 and 2008), CHE (2007 and 2008), DEU (2006, 2008), ESP (2007, 2008), FRA (2006, 2008), NLD (2006, 2008), POL (2005, 2008), corresponding to both WVS5 and EVS4 being carried.

Observations were averaged out by country and period thus obtaining an unbalanced panel of 21 countries covering the period 1990-2008 in five years averages. Missing observations were obtained by linear interpolation. The initial observation covering the period 1980-89, has not been used in the empirical analysis, but provided the basis to obtain the observation for the period 1990-94 by linear interpolation for countries where observations were missing for this period.

Leftism: Difference between the shares in legislative seats of left-wing and centrist parties minus the share in legislative seats of right-wing parties. Authors' calculations using data from "Electoral, Legislative, and Government Strength of Political Parties by Ideological Group in Capitalist Democracies, 1950-2006: A Database", by Duane Swank. See `http://www.marquette.edu/polisci/faculty_swank.shtml`.

Taxconsol: Cumulated sum of documented tax increases drawn by historical sources and records based on the methodology developed by Romer and Romer (2010), drawn by Devries et al. (2011) (see `http://www.imf.org/external/pubs/cat/longres.aspx?sk=24892.0`).

For estimates presented in Table 5 (columns 2a and 2b), observations for the missing countries (Greece, Norway, New Zealand, Switzerland) have been reconstructed applying the methodology by Guichard *et alii* 2007 to the cyclically adjusted current receipts, general government, as a percentage of potential GDP (OECD Economic Outlook).

Pcdebt: General government gross financial liabilities, as a percentage of GDP (OECD Economic Outlook).

Other variables used in the analysis

Unemployment rates by skill level: Unemployed persons divided by the labour force by

age group and educational attainment. Low skilled workers completed up to secondary education, while high skilled workers completed tertiary education or more. Young workers have an age comprised between 15 and 24 years. Old workers have an age comprised between 25 and 54 years. These are authors' calculation based on World Bank's Development Indicators.

EPL: Unweighted sum of the OECD synthetic index of employment protection legislation (OECD Employment Outlook).

UnionDensity: union density (% of unionised workers; OECD Employment Outlook).

UBRR: average unemployment benefit replacement rates (average of replacement rates across various earnings levels, family situations and durations of unemployment; OECD Benefits and Wages Database).

Wcoord: coordination of wage bargaining (classification is based on Kenworthy's 5-point classification of wage-setting coordination scores; ICTWSS Database).

Irate: Long-term interest rate on government bonds (OECD Economic Outlook).

Outgap: Percentage deviation of output from trend (OECD Economic Outlook).

Inflchange: Change in the inflation between two consecutive years (authors' calculation using data from the OECD Economic Outlook).

Openness: The trade-to-GDP ratio is the sum of exports and imports of goods and services relative to GDP (OECD International Trade Indicators database).

References

Algan, Y. and P. Cahuc (2006). Civic Attitudes and the Design of Labour Market Institutions: Which Countries Can Implement the Danish Flexicurity Model? Technical Report 5489, CEPR Discussion Papers.

Algan, Y. and P. Cahuc (2010). Inherited Trust and Growth. *American Economic Review 100*(5), 2060–92.

Algan, Y., P. Cahuc, and M. Sangnier (2011). Efficient and Inefficient Welfare States. Technical Report 5445, IZA Discussion Papers.

Algan, Y., P. Cahuc, and A. Zylberberg (2002). Public employment and labour market performance. *Economic Policy 17*(34), 7–66.

Ardagna, S. (2004). Fiscal stabilizations: When do they work and why. *European Economic Review 48*(5), 1047–1074.

Baldini, M., M. Marcello, and S. Toso (2006). Chi ha beneficiato delle riforme del nostro sistema di tax-benefit? le ultime due legislature a confronto. In B. Andrea and S. Chiara (Eds.), *Rapporto sulle disuguaglianze economiche in Italia*. il Mulino.

Bassanini, A. and R. Duval (2009). Unemployment, institutions, and reform complementarities: re-assessing the aggregate evidence for oecd countries. *Oxford Review of Economic Policy 25*(1), 40–59.

Bean, C. R., P. R. G. Layard, and S. J. Nickell (1986). The Rise in Unemployment: A Multi-country Study. *Economica 53*(210), S1–22.

Belot, M. and J. C. van Ours (2004). Does the recent success of some OECD countries in lowering their unemployment rates lie in the clever design of their labor market reforms? *Oxford Economic Papers 56*(4), 621–642.

Blanchard, O. and J. Wolfers (2000). The Role of Shocks and Institutions in the Rise of European Unemployment: The Aggregate Evidence. *Economic Journal 110*(462), C1–33.

Blundell, R. and A. Shephard (2012). Employment, Hours of Work and the Optimal Taxation of Low-Income Families. *Review of Economic Studies 79*(2), 481–510.

Brunello, G. and D. Sonedda (2007). Progressive taxation and wage setting when unions strategically interact. *Oxford Economic Papers 59*(1), 127–140.

Bunel, M. and Y. L'Horty (2012). The effects of reduced social security contributions on employment: An evaluation of the 2003 french reform. *Fiscal Studies 33*(3), 371–398.

Cahuc, P., S. Carcillo, and T. L. Barbanchon (2014). Hiring subsidies in bad times: do they work? *mimeo*.

Cahuc, P. and A. Zylberberg (2004). *Labor Economics*. The MIT Press.

Cloyne, J. S. (2010). Discretionary tax shocks in the United Kingdom 1945-2009: a narrative account and dataset. Technical Report 34913, MPRA Paper.

Daveri, F. and G. Tabellini (2000). Unemployment, growth and taxation in industrial countries. *Economic Policy 15*(30), 47–104.

Devries, P., J. Guajardo, D. Leigh, and A. Pescatori (2011). A New Action-based Dataset of Fiscal Consolidation. Technical Report 11/128, IMF Working Papers.

Diamond, P. A. (1982). Wage Determination and Efficiency in Search Equilibrium. *Review of Economic Studies 49*(2), 217–27.

Drazen, A. (2000). *Political Economy in Macroeconomics*. Princeton University Press.

Eissa, N. and J. B. Liebman (1996). Labor Supply Response to the Earned Income Tax Credit. *The Quarterly Journal of Economics 111*(2), 605–37.

Eslake, S. (2011). Australia's tax reform challenge. *Australian Parliamentary Library Lecture, Parliament House, Canberra*.

Falk, M. and B. Koebel (2001). A dynamic heterogeneous labour demand model for German manufacturing. *Applied Economics 33*(3), 339–348.

Fuest, C. and B. Huber (2000). Is tax progression really good for employment? A model with endogenous hours of work. *Labour Economics 7*(1), 79–93.

Galí, J. and R. Perotti (2003). Fiscal policy and monetary integration in Europe. *Economic Policy 18*(37), 533–572.

Griffith, R., R. Harrison, and G. Macartney (2007). Product Market Reforms, Labour Market Institutions and Unemployment. *Economic Journal 117*(519), C142–C166.

Guichard, S., M. Kennedy, E. Wurzel, and C. André (2007). What Promotes Fiscal Consolidation: OECD Country Experiences. Technical report, OECD Economics Department Working Papers.

Guiso, L., P. Sapienza, and L. Zingales (2008). Long Term Persistence. Technical Report 14278, NBER Working Papers.

Hamermesh, D. S. (1993). *Labor Demand*. Princeton University Press.

Hansen, C. T. (1999). Lower tax progression, longer hours and higher wages. *Scandinavian Journal of Economics 101*(1), 49–65.

Hansen, C. T., L. H. Pedersen, and T. Sløk (2000). Ambiguous effects of tax progressivity – theory and Danish evidence. *Labour Economics 7*(3), 335–347.

Harding, A., N. Warren, M. Robinson, and S. Lambert (2000). The distributional impact of year 2000 tax reforms in australia. *Agenda 7*(1), 17–32.

Heckman, J. J. (1993). What has been learned about labor supply in the past twenty years? *The American Economic Review 83*(2), pp. 116–121.

Hersoug, T. (1984). Union wage responses to tax changes. *Oxford Economic Papers 36*(1), 37–51.

Holmlund, B. and A. S. Kolm (1995). Progressive taxation, wage setting and unemployment: theory and swedish evidence. *Swedish Economic Policy Review 2*, 423–460.

Hosios, A. J. (1990). On the Efficiency of Matching and Related Models of Search and Unemployment. *Review of Economic Studies 57*(2), 279–98.

Hungerbühler, M., E. Lehmann, A. Parmentier, and B. Van der Linden (2006). Optimal redistributive taxation in a search equilibrium model. *Review of Economic Studies 73*(3), 743–767.

Immervoll, H., H. J. Kleven, C. T. Kreiner, and E. Saez (2007). Welfare reform in European countries: a microsimulation analysis. *Economic Journal 117*(516), 1–44.

Juhn, C., K. M. Murphy, and R. H. Topel (1991). Why Has the Natural Rate of Unemployment Increased over Time? *Brookings Papers on Economic Activity 22*(2), 75–142.

Kramarz, F. and T. Philippon (2001). The impact of differential payroll tax subsidies on minimum wage employment. *Journal of Public Economics 82*(1), 115–146.

Layard, R., S. Nickell, and R. Jackman (1991). *Unemployment: Macroeconomic Performance and the Labour Market*. Oxford University Press.

Lehmann, E., F. Marical, and L. Rioux (2013). Labor income responds differently to income-tax and payroll-tax reforms. *Journal of Public Economics 99*(1), 66–84.

Lehmann, E., A. Parmentier, and B. Van der Linden (2011). Optimal income taxation with endogenous participation and search unemployment. *Journal of Public Economics 95*(11), 1523–1537.

Lockwood, B. and A. Manning (1993). Wage setting and the tax system theory and evidence for the United Kingdom. *Journal of Public Economics 52*(1), 1–29.

Malcomson, J. M. and N. Sartor (1987). Tax push inflation in a unionized labour market. *European Economic Review 31*(8), 1581 – 1596.

Manning, A. (1993). Wage Bargaining and the Phillips Curve: The Identification and Specification of Aggregate Wage Equations. *Economic Journal 103*(416), 98–118.

Manning, A. and B. Petrongolo (2013). How local are labor markets? Evidence from a spatial job search model. London school of economics.

Meghir, C. and D. Phillips (2010). Labour supply and taxes. In J. Mirrlees, S. Adam, T. Besley, R. Blundell, S. Bond, R. Chote, M. Gammie, P. Johnson, G. Myles, and J. Poterba (Eds.), *Mirrlees Review: Reforming the tax system for the 21st century*, Volume Dimensions of Tax design, Chapter 3, pp. 202–274. Oxford University Press.

Mirrlees, J. A. (1971). An exploration in the theory of optimum income taxation. *Review of Economic Studies 38*, 175–208.

Moen, E. R. (1997). Competitive Search Equilibrium. *Journal of Political Economy 105*(2), 385–411.

Mortensen, D. T. and C. A. Pissarides (1999). New developments in models of search in the labor market. In O. Ashenfelter and D. Card (Eds.), *Handbook of Labor Economics*, Volume 3 of *Handbook of Labor Economics*, Chapter 39, pp. 2567–2627. Elsevier.

Musgrave, R. A. and T. Thin (1948). Income tax progression, 1928-48. *Journal of Political Economy 56*, 498–514.

Nickell, S. and R. Layard (1999). Chapter 46 labor market institutions and economic performance. Volume 3, Part C of *Handbook of Labor Economics*, pp. 3029 – 3084. Elsevier.

Nickell, S., L. Nunziata, and W. Ochel (2005). Unemployment in the OECD Since the 1960s. What Do We Know? *Economic Journal 115*(500), 1–27.

Nunziata, L. (2005). Institutions and Wage Determination: a Multi-country Approach. *Oxford Bulletin of Economics and Statistics 67*(4), 435–466.

Parmentier, A. (2006). The effects of the marginal tax rate in a matching model with endogenous labor supply. Discussion papers, Université catholique de Louvain, Département des Sciences Economiques.

Persson, T. and G. Tabellini (2002). *Political Economics: Explaining Economic Policy*. The MIT Press.

Pesaran, M. H. (2006). Estimation and Inference in Large Heterogeneous Panels with a Multifactor Error Structure. *Econometrica 74*(4), 967–1012.

Pissarides, C. A. (1985). Taxes, subsidies and equilibrium unemployment. *Review of Economic Studies 52*(1), 121–134.

Pissarides, C. A. (1998). The impact of employment tax cuts on unemployment and wages; The role of unemployment benefits and tax structure. *European Economic Review 42*(1), 155–183.

Pissarides, C. A. (2000). *Equilibrium Unemployment Theory, 2nd Edition*, Volume 1 of *MIT Press Books*. The MIT Press.

Prescott, E. C. (2004). Why do Americans work so much more than Europeans? *Quarterly Review* (Jul), 2–13.

Røed, K. and S. Strøm (2002). Progressive Taxes and the Labour Market: Is the Trade-Off between Equality and Efficiency Inevitable? *Journal of Economic Surveys 16*(1), 77–110.

Rogerson, R. (2006). Understanding Differences in Hours Worked. *Review of Economic Dynamics 9*(3), 365–409.

Rogerson, R. (2008). Structural Transformation and the Deterioration of European Labor Market Outcomes. *Journal of Political Economy 116*(2), 235–259.

Rogerson, R. and J. Wallenius (2009). Micro and macro elasticities in a life cycle model with taxes. *Journal of Economic Theory 144*(6), 2277–2292.

Romer, C. D. and D. H. Romer (2010). The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks. *American Economic Review 100*(3), 763–801.

Sapienza, P., A. Toldra-Simats, and L. Zingales (2013). Understanding trust. *The Economic Journal 123*(573), 1313–1332.

Smith, G. (2009). Australian tax reforms: Past and future. Unpublished.

Sørensen, P. B. (1997). Public finance solutions to the european unemployment problem? *Economic Policy 25*, 223–264.

Sørensen, P. B. (1999). Optimal tax progressivity in imperfect labour markets. *Labour Economics 6*, 435–452.

Stuart, A., B. James, and H. Christopher (2010). Taxation in the UK. In J. Mirrlees, S. Adam, T. Besley, R. Blundell, S. Bond, R. Chote, M. Gammie, P. Johnson, G. Myles, and J. Poterba (Eds.), *Mirrlees Review: Reforming the tax system for the 21st century*, Volume Dimensions of Tax design, Chapter 1, pp. 1–77. Oxford University Press.

Summers, L. H., J. Gruber, and R. Vergara (1993). Taxation and the Structure of Labor Markets: The Case of Corporatism. *The Quarterly Journal of Economics 108*(2), 385–411.

Tondani, D. and P. Mancini (2006). Gli effetti redistributivi delle riforme dell'imposizione personale nella XIV Legislatura. SIEP Working Paper 479.

Tran-Nam, B. and L. Vu (2007). Personal income tax reform in australia: a specific proposal. *37*(2), 163–186.

	Baseline Identification		Using Guichard et al. (2007)		Using Public Debt		Using Normalised *NoTrustCivil*	
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)
	Second-stage results							
	UNR	erate	UNR	erate	UNR	erate		
$\ln(ret100)_{t-1}$	–53.420**	51.798**	–53.578*	55.010*	–56.535***	58.393***	–57.793**	32.144**
	(16.302)	(19.358)	(21.789)	(26.371)	(14.151)	(17.255)	(18.538)	(12.199)
$\ln\left(\frac{ret67}{ret167}\right)_{t-1}$	–56.801**	61.884*	–64.397**	74.531*	–63.523**	71.713*	–72.402*	32.156
	(20.544)	(26.906)	(23.437)	(32.208)	(23.186)	(31.723)	(35.473)	(23.524)
R^2	0.67	0.95	0.63	0.94	0.62	0.94	0.56	0.97
N	231	231	231	231	231	231	231	231
Hansen J test	0.6473	0.4635	0.8837	0.5448	0.8142	0.7471	0.9136	0.2876
	First-stage statistics							
	$\ln(ret100)$	$\ln\left(\frac{ret67}{ret167}\right)$	$\ln(ret100)$	$\ln\left(\frac{ret67}{ret167}\right)$	$\ln(ret100)$	$\ln\left(\frac{ret67}{ret167}\right)$		
F of Excluded	6.214	8.678	6.351	6.028	17.812	7.672	8.12	3.36
Shea Partial R^2	0.0840	0.0623	0.0761	0.0493	0.1226	0.0486	0.1062	0.0413
KP under	0.0003		0.0004		0.0004		0.0078	
KP weak	4.87		4.59		4.96		3.39	

Table 5: Robustness checks about instruments. Significance levels: $*$: 10%, $**$: 5%, $***$: 1%. p-values of Hansen J over-identification tests and of Anderson and Rubin F test of significance of endogenous regressors are provided. These estimates are obtained using country-fixed effects, time-fixed effects and the same controls as in Table 1. The instruments for Columns (1 a, b) are $Leftism$, *NoTrustCivil* and *Taxconsol*. In columns (2 a, b), *Taxconsol* is extended for the missing countries by Guichard et al. (2007). In Columns (3 a, b) *Taxconsol* is replaced by Public debt. In Columns (4 a, b), *NoTrustCivil* is computed as the share of individuals that trust other people but do not trust the civil service.

	Unemployment rate *UNR*			Employment rate *erate*		
	$\ln(ret100)_{t-1}$	$\ln\left(\frac{ret67}{ret167}\right)_{t-1}$	Hansen J test (pvalue)	$\ln(ret100)_{t-1}$	$\ln\left(\frac{ret67}{ret167}\right)_{t-1}$	Hansen J test (pvalue)
1. no output gap	–51.26 **	–76.24***	0.12	50.18**	82.03***	0.006
	(21.76)	(24.54)	(0.727)	(24.33)	(30.42)	(0.936)
2. no trade openness	–64.39***	– 62.73***	0.04	66.74**	70.23**	0.006
	(21.6876)	(25.03)	(0.952)	(25.73)	(32.73)	(4.941)
3. no cyclical controls	–51.18*	–93.42***	0.29	53.14*	100.01**	0.13
	(26.29)	(31.75)	(0.58)	(28.93)	(39.12)	(0.71)
4. contemporaneous tax indicators	–46.23***	–44.61**	6.22	41.98**	45.89**	4.788
	(16.87)	(18.27)	(0.02)	(17.39)	(23.20)	(0.029)
5. control for ALMP	–53.77***	–63.24***	0.204	51.91**	65.21**	0.521
	(17.39)	(23.20)	(0.651)	(19.90)	(28.13)	(0.470)
6. country fixed effects, only	–53.91***	–65.63***	0.067	61.44***	92.73***	2.401
	(16.95)	(18.50)	(0.796)	(23.40)	(28.81)	(0.121)
7. country specific trends, only	–53.53**	–66.53***	0.184	52.09***	68.45***	0.455
	(16.97)	(21.70)	(0.685)	(19.60)	(27.54)	(0.499)
8. country specific trends and time dummies	–53.11***	–56.84***	0.213	51.57***	62.30***	0.477
	(16.21)	(20.42)	(0.644)	(19.28)	(26.81)	(0.489)
9. country fixed effects and CCEP estimator	–51.83***	–59.46***	0.368	58.93***	99.31***	0.329
	(15.42)	(19.84)	(0.544)	(26.13)	(33.52)	(0.566)
10. three years differences and time dummies	–32.15*	-42.49*	0.25	32.55**	25.62	0.566
	(16.63)	(22.72)	(0.62)	(16.13)	(25.94)	(0.452)
11. HAC standard errors	–53.42***	–56.80**	0.177	51.79**	61.89**	0.439
	(20.15)	(22.61)	(0.674)	(24.57)	(33.05)	(0.507)
12. France excluded	–65.50***	–67.05**	0.055	66.60***	77.49**	0.002
	(18.59)	(22.83)	(0.814)	(23.11)	(31.00)	(0.965)
13. Ireland excluded	–44.01***	–43.28**	0.353	46.01***	55.82**	0.716
	(21.09)	(15.66)	(0.552)	(16.71)	(23.65)	(0.397)
14. Japan excluded	–71.79**	–51.93**	0.490	66.34**	60.36**	0.381
	(29.84)	(22.24)	(0.483)	(34.22)	(26.90)	(0.537)
15. Netherlands excluded	–61.04**	–62.76**	0.147	63.41**	73.57**	0.524
	(21.97)	(25.19)	(0.701)	(26.50)	(32.66)	(0.469)
16. France, Ireland, Japan and Netherlands excluded	–137.38**	–61.89*	0.009	151.67*	87.77*	0.000
	(68.82)	(35.54)	(0.924)	(91.66)	(47.15)	(0.997)
17. 1999-2008 only	–39.50**	-73.62**	0.867	29.37	72.48**	0.564
	(18.51)	(28.29)	(0.351)	(18.29)	(35.17)	(0.453)
18. Three years averages	–43.23**	–31.13	1.129	–42.27*	32.08**	2.377
	(18.79)	(22.59)	(0.288)	(24.16)	(32.76)	(0.123)

Table 6: Robustness checks. IV estimates with robust standard errors. The instruments are *Taxconsol*, *Leftism* (both lagged twice) and *NoTrustCivil* (lagged five years). Hansen *J* provides the p-value of the Hansen test for over-identification. Significance levels: $*$: 10%, $**$: 5%, $***$: 1%

	[C1]	[C2]	[C3]	
	$\ln(ret100)_{t-1}$	$\ln(ret100)_{t-1}$	$\ln(ret100)_{t-1}$	$\ln\left(\frac{ret67}{ret167}\right)_{t-1}$
$Taxhike_{t-2}$	–0.0148**	–0.0146**	–0.0141**	0.0027
	(0.0071)	(0.0070)	(0.0071)	(0.0058)
$Leftism_{t-2}$	–0.0455***	–0.0380**	–0.0440***	0.0405**
	(0.0136)	(0.0150)	(0.0139)	(0.0162)
$NoTrust_{t-2}$			–0.0797	–0.2126***
			(0.0772)	(0.0658)
$\ln\left(\frac{ret67}{ret167}\right)_{t-1}$		–0.2064**		
		(0.0901)		
$UBRR_{t-1}$	0.0048***	0.0050***	0.0047***	0.0004
	(0.0009)	(0.0009)	(0.0009)	(0.0006)
$UnionDensity_{t-1}$	–0.0061***	–0.0050***	–0.0062***	0.0048***
	(0.0015)	(0.0016)	(0.0015)	(0.0016)
$wcoord_{t-1}$	–0.0012	–0.0015	–0.0016	–0.0024
	(0.0060)	(0.0060)	(0.0060)	(0.0029)
EPL_{t-1}	0.0172	0.0157	0.0197*	–0.0010
	(0.0112)	(0.0113)	(0.0105)	(0.0076)
outputgap	–0.0033*	–0.0033*	–0.0033*	–0.0004
	(0.0018)	(0.0018)	(0.0018)	(0.0013)
inflchange	–0.0050**	–0.0047**	–0.0051**	0.0011
	(0.0023)	(0.0022)	(0.0023)	(0.0018)
irate	–0.0094	–0.0110	–0.0097	–0.0085***
	(0.0070)	(0.0068)	(0.0071)	(0.0028)
Openness	0.0005	0.0006*	0.0005	0.0005**
	(0.0003)	(0.0003)	(0.0003)	(0.0002)
R^2	0.98	0.99	0.98	0.93
F Test of Excluded instruments	8.641	6.692	6.214	8.678
Shea Partial R^2	0.118	0.0953	0.0840	0.0623
Kleibergen-Paap under-identification test	0.0000	0.0002	0.0003	
Kleibergen-Paap weak-identification test	8.64	6.69	4.87	
Anderson Rubin F test	0.0269	0.0095	0.0000	
N	231	231	231	231

Table 7: Columns [C1], [C2], and [C3] report the first stage results for estimates in Tables 1 and 2, Columns [3], [4], and [5], respectively. Robust standard errors in parentheses. Significance levels: $*$: 10%, $**$: 5%, $***$: 1%. p values of Kleibergen-Paap rank LM test for under-identification test are provided. The p-values of Anderson and Rubin F tests of significance of endogenous regressors in the second stage of Table 1 are also provided.