Tax Progressivity, Labour Markets and Growth

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Caelum non Animum mutant
Qui trans Mare currunt.
(Oratius, Epistola XI)
To my Parents
I wish to thank my supervisor Gianluca Violante for his useful suggestions and comments. I am particularly indebted to Gianni Amisano for his constant support. I have also benefitted from discussions with Gianni Amisano, Guido Ascari, Rinaldo Brau, Giorgio Brunello, Gianluca Fusai, Aldo Goia, Fabrizio Iacone, Matteo Lippi Bruni and Michele Santoni. Imperfections and errors are mine.

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I am grateful to my parents for more than I can say.
Abstract of the Thesis:

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Public finance solutions to high unemployment in Europe have often been advocated during the past years. When unemployment benefits are not taxed, for instance, lower average labor taxes reduce the replacement ratio, and unions are willing to accept lower pre-tax wages because the net income loss from employment increases (see Pissarides [1998], Lockwood and Manning [1993]). However, as many argue (see for example Sorensen [1997]), several potential distortions such as human capital formation and disincentives to work effort are related to a strongly progressive taxation system. Indeed, with the so called "skilled-biased technological change" and the consequent increase in wage (income) inequality, governments in charge pay more attention to the growth effect of redistributive policy.

The first two chapters of this thesis focus on the relationship between labour tax progressivity and the labour market. The third chapter analyses the growth's effects of a progressive labour taxation system.

In the first chapter we present a general equilibrium, overlapping generations (OLG) model in which labour supply is endogenous and the labour market is fully unionised. The theoretical model and a calibration exercise for Italy and the US, cast some doubt on the view that powerful unions are able to shift the tax burden onto firms. However, our policy experiments find also some evidence in favour of the Daveri and Tabellini's [2000] hypothesis according to which an economy's poor employment performance can be related to labour taxation.

The second chapter presents a theoretical model and an empirical investigation over Italy on the relation between progressive labour taxation and wage determination. We add to the current literature another economic mechanism which builds on the strategic interactions among unions and which helps generating a positive relationship between wage determination and changes in the marginal tax rates. The empirical evidence indeed shows that higher tax progressivity increases pre-tax wages in Italy.

Finally, the third chapter of this thesis models the individuals' investment in physical capital and education decisions in presence of borrowing constraints and a progressive taxation system. The empirical evidence for 15 OECD countries suggests that higher redistribution affects growth conditioning on the degree of tax progressivity and the taxation level.
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Introduction

Public finance solutions to high unemployment in Europe have often been advocated during the past years. When unemployment benefits are not taxed, for instance, lower average labour taxes reduce the replacement ratio, and unions are willing to accept lower pre-tax wages because the net income loss from employment increases (see Pissarides [1998], Lockwood and Manning [1993]).

However, as many argue (see for example Sørensen [1997]), several potential distortions such as human capital formation and disincentives to work effort are related to a strongly progressive taxation system. Indeed, with the so called “skilled-biased technological change” and the consequent increase in wage (income) inequality, governments in charge pay more attention to the growth effect of redistributive policy.

On the one hand, the first two chapters of this thesis aim at analysing the relationship between a progressive taxation system and the labour market. On the other, the third chapter will focus on the growth’s effects of a redistributive policy such as an increase in the personal income tax progressivity.

The view that labour taxation was the main source of high European unemployment was particularly popular in the mid-1980s. However, the study conducted by Bean, Layard and Nickell [1986] succeed only partially. As recently argued by Daveri and Tabellini [2000], this pessimistic result could be explained by the fact that Bean and co-authors used cross-section data and ignored the correlation of these variables over time. More recent studies by Scarpetta [1996], Nickell and Layard [1999], Daveri and Tabellini [2000] and Brunello, Lupi, Ordine and Parisi [2001], that use time varying data, have
documented a significant positive relationship between unemployment rates and average labour taxes.

Malcomson and Sartor [1987] developed the relationship between wage determination and tax progressivity which shows that, within imperfect labour markets, if labour taxation is progressive, following an increase in the sole marginal tax rate, unions reduce pre-tax wages on the basis of a "union wage moderation (substitution) effect". This substitution effect weighs the increasing wage pressure in terms of the cost of foregone employment. Under the assumption of a progressive taxation system, the post-tax wages elasticity with respect to pre-tax wages is smaller than one. This implies that following an increase in the marginal tax rate holding constant the average, the marginal benefit of increasing the wage is reduced whereas the marginal cost is invariant. That is, when a union contemplates the possibility of a net wage hike, it has to consider that say for a 1% increase in the utility of each employed union member the pre-tax wage increases by \( \frac{1}{\nu} \). This implies that the expected employment loss associated to the higher after tax wage is \( \frac{\varepsilon}{\nu} \), where \( \varepsilon \) is the elasticity of labour demand (see Calmfors [1995]). When progressivity increases (\( \nu \) declines), the employment cost of a higher take home wage increases, and this higher cost induces the union to moderate its wage claims.

Drawing on the contribution of Malcomson and Sartor, Lockwood and Manning [1993] further discuss the implications of a progressive taxation system on unions' wage-setting behaviour. Koskela and Vilmunen [1996] derive the effects on wages and employment of a revenue neutral increase in tax progressivity by using three popular models of trade union behaviour: the Monopoly Union, the "Right to Manage" and the Efficiency Bargaining model. They show that a revenue neutral increase in tax progressivity unambiguously decreases the wages and increases employment. Further, Koskela and Schöb [1999] show that the equivalence between personal income tax rates and payroll taxes ceases when the two tax bases differ because of the presence of tax allowances\(^1\). In particular, under

\(^1\)The presence of tax allowances implies that the employee's tax base is narrower than the employer's tax base.
the assumption of a "right to manage" wage bargaining process, a revenue neutral tax
reform which raises the marginal personal income tax rate and reduces the payroll tax
rate decreases the gross wage and leads to higher employment.

Number of papers within this literature present static, partial equilibrium models
and assume that labour supply is exogenous. Therefore, given wage determination, they
basically derive employment effects as residuals from the labour demand.

More recently, several contributions have gone forward in considering the implications
of tax progressivity on wage setting and employment when labour supply is endogenous.
Holmlund and Kolm [1995], Calmfors [1995], Fuest and Huber [2000] and Hansen, Ped­
ersen and Slok [1999] show that, with an endogenous labour supply, a sole increase in the
marginal tax rate has also a "labour supply (income) effect" that may result in increasing
wage pressure given the lower incentive to supply labour services. In particular, Aron­
sson, Lofgren and Sjögren [2002], by developing a dynamic general equilibrium model
with infinitely lived agents, show that an increase in the sole marginal tax rate leads to
a higher real wage and to a lower employment rate.

The first chapter of this thesis considers a general equilibrium, overlapping genera­
tions (OLG) model in which labour supply is endogenous and the labour market is not
competitive. By providing both qualitative and quantitative analyses, this chapter as­
sesses the robustness of existing propositions in an OLG general equilibrium framework
that has not been previously used to address the tax progressivity issue. Furthermore,
moving from a partial to a general equilibrium framework, this chapter will point to the
importance of the "general equilibrium interest rate effect" and its strict dependency on
the OLG structure of the model.

Following a tax shock, inter-temporal decisions of individuals change as well as their
opportunity cost, the real interest rate. As long as the real interest rate changes, firms
modify their decisions on the input choices. This kind of transmission mechanism can
also be found in a Ramsey type model. However, within a Ramsey model the steady
state net of tax real interest rate and capital stock are determined solely by individuals'
rate of time preference and therefore the golden rule of capital is satisfied. In contrast, within an OLG framework this does not necessarily hold. Thus, effects on consumption, savings, output and therefore employment of changes in tax progressivity differ across the two frameworks. The current OLG setup may amplify the effects of firms' decisions on the input choices through its linkage with the supply of capital. Thereby, this chapter will focus on the interactions among three main transmission mechanisms: a "union wage moderation (substitution) effect," a "labour supply (income) effect" and a "general equilibrium interest rate effect".

Since the qualitative analysis of the model seems to suggest that wage and employment effects of progressive taxation are likely to be ambiguous, we run some policy experiments for two countries, Italy and the USA, in order to determine their direction and quantify their size. Italy was chosen since it is characterised by the presence of strong unions and a high unemployment rate, and it is meant to represent a typical European Continental country. The USA, given their low-unemployment experience and their tradition of weaker unions represent the Anglo-Saxon group.

Our policy experiments find also some evidence in favour of the Daveri and Tabellini's [2000] hypothesis according to which an economy's poor employment performance can be related to labour taxation. In particular, a 1% decrease in the average personal income and payroll tax rates has a relevant impact on employment (namely, 0.43% and 0.83%, respectively, for Italy; 0.60% and 0.57%, respectively, for the US). These effects are strongly related to the interest rate mechanism and to the initial taxation level.

In spite of its popularity, the empirical support of the view that unemployment can be reduced by cutting average labour taxes has not been overwhelming. Lockwood and Manning [1993] find that an increase of tax progressivity reduces wage pressure in the UK. In empirical studies of Italy and Sweden, Malcomson and Sartor [1984] and Holmlund and Kolm [1995] also find evidence of a negative relationship between tax progressivity and wage pressure. Sørensen [1997] provides further evidence on the positive employment effects of reduced tax progressivity.
On the other hand, Newell and Symons [1993] find that the change in unemployment between the 1970s and the 1980s is a significantly increasing function of the change in marginal tax rates over the same period. Hansen, Pedersen and Sløk [1999] present empirical evidence based on Danish data and distinguish between blue and white collar workers. They find that a reduction of tax progressivity increases the pre-tax wages of blue collars but have no significant effects on the pre-tax wages of white collar employees. Lockwood, Sløk, and Tranaes [2000] also study the Danish case and show that the relationship between tax progressivity and pre-tax wages is negative for low levels of income (unskilled workers) and positive for high levels of income (skilled workers).

The second chapter of this thesis presents an empirical analysis which adds to the existing literature further evidence based on Italian data. We use two datasets. The first set is a panel of individuals observed before and after the personal income tax reform of 1998, which reduced tax bands and changed tax allowances. The second set is a pseudo panel of cells, with each cell identified by the industrial sector, gender, age and education, which covers a much longer time span and includes several tax reforms. Using this second dataset, we estimate our relation of interest for both the earnings and the hourly pre-tax wage equations.

With regard to evidence using the panel of individuals, we find that higher marginal taxes, given the retention rate, significantly increase the pre-tax wage. In the full sample a 1 percent increase in the marginal tax rate leads to a close to 2 percent increase in annual earnings. This elasticity is lower for blue collar workers than for white collars. An increase in average taxes, given marginal taxes, also increases annual earnings, but the elasticity is significantly lower. In the full sample, a 1 percent increase in the average tax rate leads to a 0.417 percent increase in earnings. This elasticity is higher among blue collar workers.

Using instead the pseudo panel dataset, we find that a higher average income tax retention rate and a lower rate of tax progressivity significantly reduce pre-tax annual wages, thereby confirming the results drawn from panel data. However, the impact of
changes in average income taxes and in marginal taxes is significantly lower. In particular, we estimate that a 1 percent increase in the marginal and in the average tax rates increase real annual earnings by 0.454 and by -0.016 percent respectively. The hourly pre-tax wage regression clearly supports the previous findings. In Italy, a country with an intermediate degree of centralization of the wage bargain, higher tax progressivity increases pre-tax wages, with negative consequences for employment and unemployment.

In all cases the negative coefficient attracted by tax progressivity on pre-tax wages is not in line with the previous empirical literature, which typically finds a negative effect. Further it suggests that it is difficult to explain this elasticity exclusively with the argument that the labour supply effect prevails over the wage moderation effect.

Therefore, this chapter presents further a theoretical framework which adds to the literature an additional mechanism which builds on the strategic interactions among unions.

So far this literature has focused either on decentralized (see Lockwood and Manning [1993]) or on centralized (see Alesina and Perotti [1997]) wage bargaining and has ignored the interdependence between union wage claims. Typical examples of interdependence are imitative union behaviour and union rivalry over "fair" wage differentials across firms or industries (see Oswald [1979] and Gylfason and Lindbeck [1984]). In this chapter we show that the explicit consideration of the interdependence of unions adds to the wage moderation and the labour supply effects a third effect of a change in tax progressivity on pre-tax wages, which we call a "strategic interaction" effect. When unions are large enough to take into account the consequences of a change in their own wage on the average wage, the average wage affects the utility of a union member who quits or is laid off and individuals care about their relative wage, this strategic interaction effect goes in the same direction as the labour supply effect and reduces the likelihood that an increase in tax progressivity can benefit employment and reduce unemployment.

To provide some economic intuition, consider the simplest described above case where only the wage moderation effect exists. Recalling that in this case, the expected employ-
ment loss associated to the higher after tax wage is \( \frac{\epsilon}{\rho} \), where \( \epsilon \) is the elasticity of labour demand (see Calmfors [1995]). When progressivity increases (\( \rho \) declines), the employment cost of a higher take home wage increases, and this higher cost induces the union to moderate its wage claims.

In the presence of interdependence between union wage claims, we show that the increase in the employment cost of a higher take home pay when progressivity increases is lower the more important is the relative wage effect, the higher the weight of the average wage in the expected outside opportunities available to union members and the stronger the interaction between the union wage in a given industry and the average wage.

Provided all these results on the relationship between tax progressivity and the labour market, the third chapter of this thesis considers how an increase in tax progressivity affects the economic performance. Indeed, if we wish to advocate a public finance solution to high unemployment, we need to know the growth’s implications of such a policy.

There is no broad consensus neither on the analysis of the relationship between inequality and growth nor on the relationship between redistribution and growth. Though, this third chapter will focus on this latter issue, it is useful to have a look at the former.

Conventional textbook view suggests that equality has a negative impact on growth. According to this literature, a more unequal distribution of income is good for incentives and therefore growth-enhancing. Furthermore, under the assumption of a rising in income marginal propensity to save, savings, and possibly growth, are positively related to wealth inequality (see for example, Bourguignon [1981]).

A new challenging literature supports the view that equality may affect growth positively. The “Fiscal Policy” approach emphasises that more equal societies require less redistribution. Since redistributive government expenditures as well as distortionary taxation reduce the economy’s rate of growth, more equal economies grow faster. (see Alesina and Rodrick [1994], Bertola [1993], Perotti [1993] and Persson and Tabellini [1994]).

The “socio-political Instability” approach, posits a positive relationships between
equality and growth given that economic growth increases if the socio-political instability is reduced and more equal societies are more politically stable. (see Alesina and Perotti [1996], Benhabib and Rustichini [1996], Fay [1993], Gupta [1990] and Svensson [1994]).

The “Endogenous Fertility” approach implies that fertility decreases as the income dispersion is reduced. That is, more equal societies are less fertile. Lower fertility implies that there are more resources to be allocated within each family. For instance, a lower fertility rate allows more children to be able to attend school. This leads to a higher human capital accumulation and therefore to a higher growth rate. Then, the economy grow faster as fertility decreases (see Barro and Becker [1989], Becker, Murphy and Tamura [1990]).

Finally, the “Borrowing constraints-investment in education and physical capital” approach is related to the trickle-down effects of growth (See among the others, Galor and Zeira [1993], Aghion and Bolton [1997]). Aghion and Bolton [1997] show that in presence of some imperfections in the capital market derived by moral hazard with wealth constraints, redistribution allows more people to have access to the capital market leading to an improvement of the production efficiency an to a higher speed of the trickle-down process. However, these effects are temporary if the redistribution policy is one-shot. Indeed, given that economies characterised by a high enough rate of capital accumulation converges to a unique invariant wealth distribution, only permanent redistribution policies may have permanent effects. Notice that the interaction between credit market imperfections and the dynamics of the wealth distribution can also be matter of concerns of business cycle analysis as shown by Aghion, Banerjee and Piketty [1999]. By focusing on short-run fluctuations, however, this latter study points to the importance of inequality between savers and investors rather than the rich, the middle income class and the very poor. As the authors point out, there is no reason why the savers are necessarily poor (or middle class agent). As a consequence, at least for a short run point of view, policies targeted to the savers may not reduce overall inequality.
Galor and Zeira [1993] develop a model where output and investment in human capital depend on the initial distribution of wealth. The combined presence of an imperfect capital market and some indivisibilities in the human capital investment function implies that output and investment are temporarily and permanently related to the initial distribution. Thus, the importance of having a more equal society since the initial distribution of wealth affects growth through the percentage of individuals who are wealthy enough to invest (self or bank financed) in human capital. Given that output is affected both in the short and in the long-run, their framework provides an explanation on the persistent differences in per capita output across countries. Furthermore, their study helps accounting for the cross-countries differences in the adjustment process to exogenous shocks as long as the latter depend upon the initial distribution of wealth. Notice, however, that developed economies characterised by similar percentages of individuals investing in human capital might converge to a common steady state.

Inter-generational earnings mobility, inequality and growth is instead matter of concern of Owen and Weil [1998]. According to their model, even if the economies present identical taste and technology, different initial wealth distributions can lead to different steady states with, respectively, high and low output levels.\(^2\) Equilibria characterised by higher income levels also have higher inter-generational mobility and lower wealth and earnings inequality. Fiscal policies do not have permanent effects on growth but have permanent effects on the output level. Finally, the causal relationship between inter-generational mobility and growth in per capita income runs both ways. Consider for instance a fiscal policy which reduces wealth inequality leading to a higher steady state output level and then focus on the transitional dynamics towards this new steady state. As long as the economic growth raises and the wage gap between educated and uneducated workers reduces, the probability that more children of uneducated workers may have access to the education system increases, leading to more inter-generational

\(^2\)This implies that their model does not belong to the endogenous growth model category. That is, their framework does not allow for different steady state income growth rates unless one endogenises the technological progress.
mobility. This higher inter-generational mobility is at least in the short run growth enhancing since resources are allocated more efficiently. And so on so forth until the new steady state is reached.

Benabou [2002] presents a dynamic heterogenous agent model with endogenous effort and missing credit and insurance markets. He evaluates the costs and benefits of redistributive policies defined as progressive income taxes or progressive education finance. The costs of these policies derive from the distortions in agents' labour supply and/or savings decisions. Consumptions taxes and investment subsidies are introduced to correct for the distortions in the savings decision and therefore savings are restored to their optimal level. The benefits of these policies are expressed in terms of higher insurance against the risk of negative shocks and lower credit constraints which do not allow certain investments. He shows that in order to achieve a higher growth rate, an education finance redistributive policy always dominates income tax progressivity and transfers. This is due to the fact that the former policy implies smaller distortions to agents' effort. The opposite holds from an insurance point of view.

Further, he develops a new measure of economic efficiency builds on the sum of consumption-certainty equivalents instead of either aggregating individual incomes and consumptions (eliminating thus the idiosyncratic uncertainty) or summing up individuals utilities (introducing then a bias toward the egalitarian allocations). This new efficiency measure instead can be conceived as a risk-adjusted GDP measure and it is shown to be maximised at some strictly positive rate of redistribution. This positive rate depends on the elasticity of labour supply, the variance of the idiosyncratic shocks and on the credit constraints on investments. Finally, the author also provides some simulations based on a calibration exercise using empirical parameters estimates. Similar findings are obtained when considering a redistributive income tax policy or a redistributive school finance policy: the richest 30% families subsidize the education of the remaining 70%.

Much research has further pointed to the importance of the link between redistribution and either/both the skill-biased technical change or/and education. For instance, Rehme
[2002] presents a model where human capital drives economic growth and simultaneously determines income inequality. He shows that the relationship between growth and pre-tax and post-tax income inequality is inverted U shaped. Then, a more efficient education technology determines a higher growth rate and less income redistribution (a higher post-tax income inequality).

The "two-way" interaction between the labour market and the credit market in presence of asymmetric information is matter of concern of Ghatak, Morelli and Sjöstrom [2001]. They present a static and dynamic economy which generates multiple equilibria: one characterised by high wages and output and another one where the opposite holds. Heterogenous in terms of talent economic agents decide the amount to invest on the extent of the credit rationing. This investment level affects the wage rate on which in turn depend the individuals' occupational choice decisions. Therefore, by endogenising the wage rate as the outside option to bank-financed entrepreneurs, they show that the amount of collateral required to prevent untalented agents from being attracted by an entrepreneurial activity is decreasing in the wage rate. Under such assumption one can obtain an equilibrium characterised by a high wage rate (given a greater labour demand and a higher amount of investments) and low collateral. The high wage rate encourages the untalented to become a worker rather than an entrepreneur. The low collateral allows more talented poor agents to try their luck in the credit market.

Their framework differs from pure coordination failure models (see for instance Murphy, Shleifer and Vishny [1989]) by allowing for some conflicting elements. These elements in particular depend on the political power of the rich to block the economy in one equilibrium rather than the other. Under such circumstances it is not longer possible to rank the Pareto equilibria. However, the potential role of redistributive policies might be quite huge. In the short run, small changes in the wealth distribution may lead to large effect on efficiency given that the positive effects on the credit market (e.g. more talent individuals may have access to the bank loans) and the labour market (e.g. the higher supply of entrepreneur implies higher investments and wages) reinforces each other.
Briefly recapping, ambiguous growth effect of a redistributive policy can be easily generated by introducing in a framework similar to Aghion and Bolton [1997] and Galor and Zeira [1993] one feature of the Persson and Tabellini [1994] approach such as a distortionary taxation system.

The same result can be found in Benabou [1996] where greater redistribution leads to two conflicting effects: on the one hand, it discourages the individuals' investment rate. On the other, it relaxes the credit constraints faced by the poor and given the assumption of decreasing returns to investments allows the less wealthy to earn a higher return. That is, the economy faces a trade off between costs and benefits of the redistributive policy.

The costs of redistributive policies derive from the distortions in agents' labour supply and/or savings decisions. The benefits of these policies are expressed in terms of lower credit constraints which do not allow certain investment. According to the author, the growth maximizing tax rate of redistribution is positive and depends on the degree of pre-tax inequality.

If liquidity constraints are impeding investment by the poor or lower middle class any form of progressive transfer contributes to relax them. Further, ambiguous growth effects can be easily obtained by introducing some elements to the model presented in the first chapter of this thesis.

The main objective of the third chapter of this thesis is to present some empirical evidence on the growth effects of higher redistribution, proxied by changes in labour tax progressivity.

Briefly put, most of these papers posit a negative relationship between growth and inequality suggesting that a redistributive policy might be beneficial for growth\(^3\). Of course, the opposite would hold if the this relationship is instead positive\(^4\). Empirical evidence on the effects of redistribution on growth is not clear-cut. For instance, Perotti [1993], Alesina and Rodrick [1994] and Persson and Tabellini [1994] find that redistrib-

\(^3\)Notice that the "Fiscal Policy" approach claims for a positive relationship between growth and equality but suggests a negative effect of redistribution on growth.

\(^4\)The caveat of the previous note still applies.
bution affects growth negatively whereas empirical analyses presented by Easterly and Rebelo [1993] and Perotti [1994] support the opposite view.

Further, a number of papers have considered the theoretical implications of human capital on growth by suggesting a permanent positive relationship between them. Nevertheless, empirical evidence is mixed. For instance, micro-econometrics findings based on Mincerian human capital earnings functions (e.g. Card [1999]) and growth accounting exercises (e.g. Jorgenson and Stiroh [1987]) posit significant growth effects of human capital (education). In contrast, macro-econometrics studies fail to show any statistical link between human capital and the output growth (See among the others Topel [1999] for a review).

Drawing on this issue, Bassanini and Scarpetta [2001] have gone forward in presenting empirical support. They exploit the time as long as the cross-countries variation by using a novel panel data technique (the Pooled Mean Group Estimator) for a sample of 21 OECD countries over the period 1971-1998. Allowing short-terms adjustments and convergence speeds to differ across-countries but imposing a common long-run relationship, they find a robust positive link between the output growth and human capital measured as the average number of years of schooling of the population from 25 to 64 years of age. Their findings are quantitatively consistent with the micro-econometrics evidence and with theoretical framework of endogenous growth model à la Uzawa-Lucas.

By comparing pre-tax and post-tax income inequality as measured by the Gini coefficient Rehme [2002] evaluates the impact of redistribution on growth. Using income data from the Luxembourg Income Study for a sample of 13 rich countries, the author finds a negative relationship between pre-tax and post-tax income inequality. As a consequence, as long as economic growth is negatively related to pre-tax income inequality, long-run growth might be enhanced by more redistribution. Further, the author’s empirical evidence on the link between education (measured as secondary and tertiary education or overall education spending) and growth appears to be positive but weak. Higher government spending on all levels of education determines more redistribution, lower pre-tax
and post-tax income inequality. After controlling for the dropout rate (as a proxy of a
less efficient use of resources for education), higher education expenditure is negatively
related to redistribution, pre-tax and post-tax income inequality but affects the growth
rate positively. According to Rehme, then, these findings support the view that in a
developed economy higher growth combined with a lower degree of inequality can result
from an increase in education spending.

Empirical evidence based on the growth effects of taxation, among the others fiscal
policy indicators, is presented by Easterly and Rebelo [1993]. Further, Mendoza, Milesi-
Ferretti and Asea [1997] test the Harberger's superneutrality hypothesis according to
which changes in taxes affect the investment rate but have insignificant long-run effect
on growth. This view is supported by their findings, relative to panel regressions of quin-
quennial averages for 18 OECD countries from 1965 to 1991. Some numerical simulations
built on the class of endogenous growth models driven by human capital accumulation
confirm the negligible long run growth effects of changes in the tax structure. Therefore,
this analysis concludes by pointing to the importance of tax reforms as a welfare gains
device (in terms of efficiency gains on the levels of consumption, investment and output)
rather than as a growth enhancing policy instrument. However, it is interesting to note
that using a panel of annual data, the authors do find some evidence on the growth
effects of changing taxes. This latter result is interpreted as some short-run variability
of growth determinants which would be consistent with stochastic endogenous growth
models or as the existence of short run effects. Then, it might be case that changes in
taxes may affect growth in the short but not in the long run unless the fiscal policy is
permanently implemented.

In the third chapter of this thesis, we conduct an empirical analysis on the relation-
ships between redistribution and growth by using an original data set on marginal and
average tax rates in 15 OECD countries for the period 1974-1997. We expect that the
relationship between taxation and growth is hump shaped [Barro, 1990]. Our further a
priori prediction is that the relationship between redistribution and growth is hill shaped
[Benabou, 1996]. We, then, impose and test the identifying assumption that the sign of the growth effect depends on the taxation level and the degree of tax progressivity of the economy. To preview our results, we find statistical support to these imposed restrictions. Redistribution, measured as a higher tax progressivity, has a positive (negative) effect on growth in those countries characterized by a low (high) degree of tax progressivity and a low (high) taxation level.

This thesis is organized as follows. The first chapter presents an analysis on the employment effects of a progressive taxation system in a unionised economy; the second considers the relationships between progressive taxation and wage setting when unions strategically interact and further provides an empirical analysis for Italy; the third chapter focuses on the growth’s effects of a redistributive policy such as an increase in tax progressivity and finally some conclusions follow.
Chapter 1

Employment Effects of Progressive Taxation in a Unionised Economy

1.1 Introduction

The effect of labour taxation on unemployment differentials across countries was one of the issues widely discussed in the mid-eighties following the Bean, Layard and Nickell [1986] effort to organise a multicountry study. According to them, labour taxation is only partially responsible for the unsatisfactory employment performance of European countries. Their empirical evidence shows a negative but weak relationship between labour taxation and employment. This seems to confirm the labour economists' common view that the tax burden is fully passed onto real wages.

After almost two decades, Daveri and Tabellini [2000, DT henceforth], have put such a view into question. Inspired by some data correlations, DT suggest that the combined effect of monopolistic and decentralised trade unions and high labour taxation can provide an explanation for the high unemployment and slow growth of European continental countries relative to the US and UK. In other words, labour taxation affects unemployment only in those countries where the labour market is unionised. In interpreting their empirical results, DT primarily refer to a model of the economy characterised by propor-
tional labour taxation and exogenous labour supply.

When the labour tax structure is nonlinear, it is possible to identify several policy instruments. The tax burden could be passed from the employers onto the employees in order to affect the wage pressure and the employment. However, as reviewed by Nickell and Layard [1999], empirical evidence suggests that this latter policy does not prove to be successful. Then, a Government could change the degree of tax progressivity.

Malcomson and Sartor [1987] developed the relationship between wage determination and tax progressivity which shows that, within imperfect labour markets, if labour taxation is progressive, following an increase in the sole marginal tax rate, unions reduce pre-tax wages on the basis of a "union wage moderation effect". This wage moderation effect is a substitution effect since unions weight the increasing wage pressure in terms of the cost of foregone employment and therefore they prefer to substitute higher wages for employment. Under the assumption of a progressive taxation system, the post-tax wages elasticity with respect to pre-tax wages is smaller than one. This implies that following an increase in the marginal tax rate holding constant the average, the marginal benefit of increasing the wage is reduced whereas the marginal cost is invariant. More specifically, when a union contemplates the possibility of a wage hike, it has to consider that say for a 1% increase in the after tax rate the pre-tax wage increases by \( \frac{1}{\nu} \), where \( \nu \) denotes the coefficient of residual income progression\(^1\). This implies that the expected employment loss associated to the higher after tax wage is \( \frac{\varepsilon}{\nu} \), where \( \varepsilon \) is the elasticity of labour demand. Since \( \nu < 1 \) with progressive taxation, this loss is higher with progressive than with proportional taxation (\( \nu = 1 \)). It follows that, when labour markets are not perfectly competitive, a certain degree of tax progressivity can be desirable because it makes wage increases less attractive to unions, with positive consequences on

\[^{1}\text{The coefficient of residual income progression, } \nu, \text{ suggested by Musgrave and Musgrave [1976] is defined as} \]

\[ \nu = \frac{1 - \tau}{1 - \lambda} \]

\( \tau (\lambda) \) stands for the marginal (average) personal income tax rate. Further, this coefficient corresponds to the elasticity of the after tax wage with respect to the pre tax wage.
the unemployment rate.

Lockwood and Manning [1993, LM] further discuss the implications of a progressive taxation system on unions' wage-setting behaviour. Koskela and Vilmunen [1996] derive the effects on wages and employment of a revenue neutral increase in tax progressivity by using three popular models of trade union behaviour: the Monopoly Union, the "Right to Manage" and the Efficiency Bargaining model. They show that a revenue neutral increase in tax progressivity unambiguously decreases the wages and increases employment. Many of these papers present static, partial equilibrium models and assume that labour supply is exogenous. Therefore, given wage determination, they derive employment effects as residuals from the labour demand.

More recently, a number of papers have considered the implications of tax progressivity on wage setting and employment when labour supply is endogenous. Holmlund and Kolm [1995], Calmfors [1995], Fuest and Huber [2000] and Hansen, Pedersen and Skøk [1999] show that, with an endogenous labour supply, a sole increase in the marginal tax rate has also a "labour supply effect". This labour supply effect is an income effect in wage determination. When marginal tax rates raise the incentive to supply labour services is reduced because the income effect is dominated by the substitution effect. This reduction in the supply of working hours (i.e. the labour supply effect) generates higher wage pressure.

If the wage moderation effect prevails over the labour supply effect, higher labour tax progressivity reduces pre-tax wages and increases employment. This could be the case of unskilled workers if they are heavily unionized and if their hours supply function is flatter than that of skilled workers.

To the best of our knowledge only Aronsson, Löfgren and Sjögren [2002], by developing a dynamic general equilibrium model with infinitely lived agents, investigate over the general equilibrium implications of an increase in tax progressivity. They show that a higher marginal tax rate leads to a higher real wage and to a lower employment rate.

This chapter considers a general equilibrium, overlapping generations (OLG) model
in which labour supply is endogenous and the labour market is not competitive. For a
given, labour market structure, the current analysis aims at evaluating quantitatively the
effects of progressive labour taxation on wage determination and employment by focusing
on the role played by each of the four relevant tax parameters of a progressive taxation
system (namely, marginal and average rates related to the personal income and the payroll
taxation systems). Determining the role played by each of the four labour tax parameters
is an important issue as long as actual fiscal reforms involve contemporaneous changes
in marginal and average tax rates. For example, as shown by Wagstaff et al [1999] in
several OECD countries, fiscal reforms on personal income taxes have often led to fewer
brackets (e.g. lower marginal rates) and lower average rates.

Moreover, it is largely recognised that payroll taxes may affect employment (see for
example Kolm [1999], to name but one). According to LM, agents’ optimising behaviour
implies that marginal and average personal income tax rates influence employment in
the same manner as marginal and average payroll taxes. This chapter will show that
if labour supply is endogenous this is not necessarily true. Notice that, Koskela and
Schöb [1999] show that the equivalence between personal income tax rates and payroll
taxes ceases when the two tax bases differ because of the presence of tax allowances. In
our framework, payroll taxes do not have any direct effect on labour supply and for this
reason the changes in union markup are not equivalent when either we observe a variation
in the degree of tax progressivity of the personal income taxation system or in the payroll
taxation system. To provide some economic intuition, also in our case we can conceive
the failure of the tax equivalence as the result of different tax bases. Indeed, for a given
change in the degree of personal income tax progressivity the tax base of reference for
the union is the earnings function whereas for the same change in the degree of payroll
tax progressivity the tax base of reference is the sole wage rate.

Although some of these questions have already been analysed, the answers provided

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2 The presence of tax allowances implies that the employee's tax base is narrower than the employer's
tax base.
by the current literature are quite controversial. By providing both qualitative and quantitative analyses, this chapter assesses the robustness of existing propositions in an OLG general equilibrium framework that has not been previously used to address the tax progressivity issue. Furthermore, moving from a partial to a general equilibrium framework, the current analysis will point to the importance of the "general equilibrium interest rate effect" and its strict dependency on the OLG structure of the model.

Following a tax shock, inter-temporal decisions of individuals change as well as their opportunity cost, the real interest rate. As long as the real interest rate changes, firms modify their decisions on the input choices. This kind of transmission mechanism can also be found in a Ramsey type model. However, within a Ramsey model the steady state net of tax real interest rate and capital stock are determined solely by individuals' rate of time preference and therefore the golden rule of capital is satisfied. In contrast, within an OLG framework this does not necessarily hold. Thus, effects on consumption, savings, output and therefore employment of changes in tax progressivity differ across the two frameworks. The OLG setup may amplify the effects of firms' decisions on the input choices through its linkage with the supply of capital. The importance of the supply of capital as a leading mechanism is therefore straightforward.

Thereby, this chapter will focus on the interactions among three main transmission mechanisms: a "union wage moderation (substitution) effect," a "labour supply (income) effect" and an "general equilibrium interest rate effect". Notice that the OLG framework does not affect the nature of the wage moderation (substitution) effect and the labour supply (income) effect. Indeed, these two effects could be explained in a static model without loss of generality (See for instance the model presented in the second chapter of this thesis).

The current qualitative results, based on an OLG framework, can be compared to the results obtained by Aronsson et al. [2002], the only work in the literature which refers to a dynamic general equilibrium setting. This work extends the DT paper by introducing a progressive taxation system and it extends all the previous static partial
equilibrium analyses such as LM. Furthermore, this work extends both by endogenising labour supply. It also generalises Aronsson et al. [2002], by considering the employment effects of all labour tax shocks and by quantifying these effects. Finally, the current chapter will show that the policy used for changing tax progressivity matters for the final effects on equilibrium wages and employment.

Since the qualitative analysis of the model seems to suggest that wage and employment effects of progressive taxation are likely to be ambiguous, we run some policy experiments for two countries, Italy and the USA, in order to determine their direction and quantify their size. Italy was chosen since it is characterised by the presence of strong unions and a high unemployment rate, and it is meant to represent a typical European Continental country. The USA, given their low-unemployment experience and their tradition of weaker unions represent the Anglo-Saxon group.

The rest of the chapter is organised as follows. Section 2 presents the basic model. Section 3 describes the equilibrium solution. Section 4 illustrates the qualitative effects of progressive taxation on wage setting and employment. Section 5 reports the calibration and the policy experiments. Finally some conclusions follow.

### 1.2 The Economy

Consider a closed economy characterised by two periods overlapping generations and composed of four main economic agents: households, unions, firms and the government.

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3 As Aronsson et al. [2002] point out, their results are consistent only with an increase in the marginal tax rate holding the average tax rate constant.

4 The Anglo-Saxon countries and in particular the USA are largely recognised as countries where labour market is almost competitive. However, empirical evidence of the presence of non-competitive forces can be found in papers such as Brunello and Wadhwani [1989] and Holmlund and Zetterberg [1991] where the estimates of the insider weight is quite high for the US (0.3).

5 We believe that the representative agent's hypothesis is a useful simplifying assumption that may be consistent with the stylised facts of trade unions' wage setting under a progressive tax system. In fact, it is quite likely that unionised workers within the manufacturing sector present similar characteristics. Furthermore, by determining one single wage for the entire sector, unions primarily refer to one income bracket within the taxation system.
Population is constant, there is no altruism, individuals earn only wage income when young and capital income when old. At the end of the first period individuals retire.

### 1.2.1 Household

Economic agents have homothetic preferences described by an inter-temporal Constant Relative Risk Aversion utility function, separable over consumption and hours of work when the individual is young and employed and over consumption only when old.\(^6\) Hence, it takes the following form:

\[
U^i = \frac{1}{1 - \theta} \left( c_y^{1-\theta} + g_y^{1-\theta} \right) - \varphi \frac{h^2}{\gamma} + \frac{\beta}{1 - \theta} \left( c_o^{1-\theta} + g_o^{1-\theta} \right)
\]

(1.1)

where \( i = e (employed), u (unemployed) \); \( "y" \) and \( "o" \) stands for young and old respectively; the second term takes the value of zero if the individual is unemployed; \( \beta \) is a discount factor which is as usual less than \(|1|\) and that can be positive or negative according to the weight on the two periods given by the household; \( c_y \) denotes household consumption when young and \( c_o \) when old; \( g_y \) and \( g_o \) represent government consumption\(^7\) in the two generations; \( \theta > 0 \) measures the households' attitude to substitute consumption between the two periods and the parameter \( \varphi > 0 \) measures the individual's evaluation of leisure; finally \( \frac{1}{\gamma-1} (\gamma > 1) \) is the elasticity of marginal disutility of hours worked. Further, it is assumed that \( g_y^e = g_o^u = g_o^e = g_o^u \). Households face the following budget constraints when young and old respectively:

\[
\omega^i_y = c^i_y + s^i_y
\]

(1.2)

\[
(1 + r) s^i_y = c^i_o
\]

(1.3)

---

\(^6\)This specification generalises the cases of a log-linear utility function where \( \theta \) is equal to 1 (e.g. Holmlund and Kolm [1995]) and a linear utility function where \( \theta \) is equal to 0 (e.g. Sørensen [1997b]). Further, it examines the relationship between the intertemporal elasticity of substitution between consumption and changes in labour taxation.

\(^7\)For government consumption it is meant here the provision of public goods.
where

\[ \omega^i = \begin{cases} \omega_{wh} - T(wh, z) & \text{if employed} \\ b & \text{if unemployed} \end{cases} \]

and \( wh - T(wh, z) \) is the income of workers net of taxes; \( b \) denotes unemployment subsidies, \( r \) is the rate of return on capital, and finally \( s^i \) indicates the individual savings.

Following LM, \( T(wh, z) \) labels the personal labour income taxes, \( z \) is a vector of parameters (marginal tax rates, tax bands...) which takes into account any non-linearities within the tax system. Unemployment subsidies are determined by some political-economy mechanism outside the model and are not taxable by assumption.® Combining 1.2 and 1.3, through a standard utility maximisation procedure, it is possible to derive the general solutions for employed and unemployed hours worked, consumption and savings:

\[
h^i = \begin{cases} r \left[ 1 - \beta (1 + r) \right] & \text{if employed} \\ 0 & \text{if unemployed} \end{cases}
\]

\[
c^i_y = \frac{\omega^i}{1 + \mu(r)}
\]

\[
c^i_o = \frac{\omega^i}{1 + \mu(r)} [\beta (1 + r)]^{\frac{1}{\gamma}}
\]

\[
s^i = \frac{\mu(r)}{1 + \mu(r)} \omega^i
\]

where \( \mu(r) = \beta^{\frac{1}{\gamma}} (1 + r)^{\frac{1}{\gamma}} \). We introduce the parameter \( \nu \), suggested by Musgrave and Musgrave [1976], which measures the personal income tax progressivity and corresponds

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® If unemployment benefits are assumed taxable, then changes in the parameter \( z \) of the taxation system would affect the marginal and average rate of the benefits' brackets. Then, in evaluating the effect of changes in taxation on wages one should also consider this effect. Notice, however, that this further effect would not change our basic results. (see also Lockwood and Manning, [1993] pp. 8) Moreover, since benefits are conceived as unemployment subsidies only and since individuals can not earn other income rather than wages, it is quite likely that these unemployment subsidies would be below the income threshold and therefore untaxed.
to the value of \((1 - \tau)/(1 - \lambda)\), given that \(\tau\) and \(\lambda\) represent respectively the marginal and the average personal income tax rates.\(^9\) It should be noted that \(\nu\) is inversely related to tax progressivity.\(^10\) Finally, given the budget constraint and under the assumption of full capital depreciation, savings of the young at time \(t\) set the capital stock at time \(t + 1\) that, combined with the labour supplied by the next young generation, produces output at time \(t + 1\). Hence, savings depend on the income net of taxes, the return on savings, the discount factor and the inter-temporal elasticity of substitution between consumption.\(^11\)

According to equations 1.4, 1.5 and 1.6 the effect of a change in the interest rate on the supply of hours of work and consumption of young and old is ambiguous since it depends on an income and a substitution effect. If the parameter \(\theta\) is bigger than one (the inter-temporal elasticity of substitution between consumption is lower than one), an increase in the interest rate is negatively correlated with the supply of working hours. Under the same assumption the consumption of the young (old) increases (decreases). Indeed, an inter-temporal elasticity of substitution between consumption lower than one implies that individuals prefer to consume more today rather than tomorrow and therefore the income effect is stronger.

In symmetric equilibrium, for a given wage rate the household’s specific hours worked, consumption and savings are equal to the aggregate ones. Henceforth, the subscript “\(i\)” is then omitted.

1.2.2 Firms

There exists a measure one identical competitive firms indexed by \(j\). Their technology is described by a Cobb-Douglas production function formalised as follows:

---

\(^9\) As usual, we define \(\tau\) and \(\lambda\) as equal to \(\frac{\partial T(\cdot)}{\partial w_h}\) and \(\frac{T(\cdot)}{w_h}\) respectively.

\(^10\) The parameter \(\nu\) is well-known in the literature as the coefficient of residual income progression and it corresponds to the elasticity of the after-tax wage with respect to an increase in the pre-tax wage.

\(^11\) This is strictly related to the functional form of the utility function.
\[ y_j = A k_j^\alpha l_j^{1-\alpha} \]  

(1.8)

Let's define \( l \), the labour input, as the number of workers times the hours of work. Since the goods market is competitive, the firms' optimisation problem consists of maximising the following profit function:

\[
\max_{l_j, k_j} \pi_j = y_j - l_j(w_j + D(w_j, z')) - r k_j
\]

(1.9)

where \( D(w_j, z') \) represents the payroll tax function and \( z' \) is a vector of parameters of the payroll tax system. Labour demand can thus be obtained by inverting the first order conditions with respect to labour:

\[
l_j(w_j) = \left[ \frac{(1-\alpha) A k_j^\alpha}{w_j + D_j(w_j, z')} \right]^\frac{1}{\alpha} \]

(1.10)

Finally, since capital markets are competitive, for the first order condition with respect to capital, the equilibrium rate of return on capital is equal to the marginal productivity of capital:

\[ r = \alpha A \left( \frac{K}{L} \right)^{\alpha-1} \]

(1.11)

1.2.3 Government

The aim of the government is to keep the following budget constraint balanced:

\[ twhN + dwhN = (1 - N)b + G \]

(1.12)

where \( d \) stands for the average payroll tax rate\(^\text{12}\) and \( G \) represents government consumption. The balanced budget constraint 1.12 is guaranteed by the condition that

\(^\text{12}\)The average payroll tax rate corresponds to \( \frac{D(w)}{w} \)
changes in public consumption counterbalance the changes of tax rates.\textsuperscript{13}

1.2.4 Unions

The labour market is characterised by the presence of monopolistic unions at firm level which set wages. The aim of the paper is to derive the general equilibrium employment effects of tax progressivity for a given labour market structure characterised by the presence of strong unions. For this reason, we choose the extreme case of a monopoly union rather than a Right to Manage framework. We do not expect this choice to affect our qualitative results\textsuperscript{14}. Indeed, Koskela and Vilmunen [1996] show that the effects on wages and employment of a revenue neutral increase in tax progressivity do not differ between the Monopoly Union and the "Right to Manage" model.

Since output prices are normalised to unity, setting nominal (pre-tax) wages is equivalent to setting real wages. Unions are unable to affect fiscal policy decisions and their aim is to maximise the expected utility of members subject to the labour demand 1.10 and household hours supply function 1.4. Note that an interior solution to the maximisation problem is guaranteed by the presence of some unemployed among union members. The unions’ optimisation problem takes the form:\textsuperscript{15}

\begin{equation}
\max_{w_j} N_j (w_j) [U^e - U^u] + U^u = \max_{w_j} \frac{l_j (w_j)}{h_j (w_j)} [U^e - U^u] + U^u \tag{1.13}
\end{equation}

It is possible to obtain an explicit solution for 1.13:

\begin{equation}
(w h (1 - t))_j = b M^*_j \tag{1.14}
\end{equation}

\textsuperscript{13}To simplify the exposition, indirect taxation (e.g. VAT), is not taken into account for two main reasons. Firstly, each firm produces an identical good and prices are taken as given. Secondly, they are proportional and therefore their coefficient of progression is equal to 1. This implies that their changes do not affect unions’ markup. Further, for simplicity in order to focus on labour taxes only, it is assumed that capital income is not taxable.

\textsuperscript{14}For the quantitative implications see Section 5.

\textsuperscript{15}Notice that we are considering a one sector unionised economy. Therefore, the unemployment benefits can be either conceived as equal to the competitive wage or as the only alternative income.
The post-tax real earnings \((w_h (1 - t))\) is an increasing function of the unemployment benefit \((b)\) and "the union markup relevant to changes in payroll taxes" \((M_{\tilde{\nu}})\).\(^{16}\)

The union markup \((M_{\tilde{\nu}})\) is equal to:

\[
M_{\tilde{\nu}} = \left[ 1 - (1 - \theta) \left( \frac{\alpha \nu^*}{(1 + \alpha \nu^* h)} + \frac{\nu}{\gamma} \right) \right]^{-\frac{1}{1 - \theta}}
\]  

\[(1.15)\]

where \(\varepsilon_h\) labels the constant \((\frac{1 - \theta}{\theta + \gamma - 1})\) elasticity of hours of work with respect to a wage rate and \(\nu^*\) corresponds to the product of \(\nu\) and \(\tilde{\nu}\). The latter parameter, \(\tilde{\nu}\), measures the payroll tax progressivity and corresponds to the ratio \([(1 + d) / (1 + \delta)]\) where \(d\) and \(\delta\) denotes the average and marginal payroll tax rate respectively.\(^{17}\) Indeed, defining the labour cost as \(LC = w + D(w)\), \(\tilde{\nu}\) corresponds to the inverse of the elasticity of labour costs.

Since the union markup \(M_{\tilde{\nu}}\) is higher than 1, the post-tax real wage is higher than the unemployment benefits and changes in union markup imply changes in the ratio between the post-tax wage and the alternative wage.\(^{18}\)

Further, union markup \(M_{\tilde{\nu}}\) is increasing in \(\nu\). When the marginal tax rate increases, the price in terms of foregone employment of a higher take-home pay goes up. This allows the union to buy more employment through wage moderation, because a given fall in the pre-tax wage leads to a smaller change in the after tax wage. Indeed, recall that \(\nu\) corresponds to the elasticity of the after-tax wage with respect to the pre-tax wage and

\(^{16}\)Notice that equation \((1.14)\) can be re-written as:

\[w = \frac{bM_{\tilde{\nu}}}{h (1 - t)}\]

Since according to our assumption \((h = \frac{1}{N})\) we have:

\[w = \frac{bM_{\tilde{\nu}}}{L (1 - t) N}\]

That is, the wage rate is an increasing function of the employment level.

\(^{17}\)As usual, we define \(\delta\) and \(d\) as equal to \(\frac{\partial D(\cdot)}{\partial w}\) and \(\frac{D(\cdot)}{w}\) respectively.

\(^{18}\)Notice that \(\frac{\partial (w_h (1 - t))}{w} = M_{\tilde{\nu}}\).
that \( \nu < 1 \) with progressive taxation (\( \nu = 1 \) with proportional taxation). This produces
the well known wage moderation substitution effect which reduces wage pressure.

Though unions care about post-tax wages, they set pre-tax wages. Rearranging
equation 1.14, and substituting the hours of work supply function 1.4, one obtains the
optimal solution for the wage set by the unions \( w_j \):

\[
w_j = \frac{b^{\sigma+\lambda-1}}{(1 - t)} M^* \tag{1.16}
\]

where:

\[
M^* = \frac{1}{\left(\frac{\nu}{\phi}\right)^{\frac{1}{\delta}} \left(1 + \mu (r)^{\frac{1}{\delta}}\right)^{\frac{\nu}{\delta}}} M
\]

the union markup relevant to changes in personal income taxes \( M \),
and some other parameters that enter into the hours supply function.
According to equation 1.14, pre-tax wage is an increasing function of unemployment
benefits and the union markup \( M^*_\nu \) but it is decreasing in hours of work. That is, labour
supply endogenisation introduces an income effect (that is, the term \( \frac{1}{\left(\frac{\nu}{\phi}\right)^{\frac{1}{\delta}} \left(1 + \mu (r)^{\frac{1}{\delta}}\right)^{\frac{\nu}{\delta}}} \) in
\( M^*_\nu \)) according to which it is no longer possible to identify a "pure" substitution effect
on wage determination when we change the degree of personal income tax progressivity.
The labour supply effect can generate higher wage pressure when an increase in tax
progressivity reduces the supply of working hours (recall that the wage function 1.14 is
decreasing in working hours). In contrast, if the wage moderation effect prevails over the
labour supply effect, higher labour tax progressivity reduces pre-tax wages and increases
employment. This could be the case of unskilled workers if they are heavily unionized
and if their hours supply function is flatter than that of skilled workers.

Since a change in payroll taxes does not produce this labour supply income effect,
clearly the tax equivalence between personal income and payroll taxes does not longer
hold. Notice further that decentralised unions take the interest rate as given when they
set the wage. However, according to equation 1.16 the general equilibrium wage is affected by changes in the endogenous interest rate.

In symmetric equilibrium, the firm specific wage and labour demand are equal to the aggregate ones. Henceforth, the subscript "j" is then omitted.

### 1.3 The Equilibrium

The equilibrium condition in the goods market is given by:

$$K_{t+1} = S_t$$

where $K_{t+1}$ indicates the economy's capital stock at time $t + 1$ and $S_t$ denotes the savings of the economy. Equation 1.17 states that investments are equal to net savings given the hypothesis of full capital depreciation. The expression for savings is then the following:

$$S = ns^s + (1 - n)s^w = \frac{\mu(r)}{1 + \mu(r)} wh (1 - t) (n + (1 - n)\sigma)$$

where $n$ represents the proportion of young employed within the labour force and $\sigma$ denotes the replacement ratio which is assumed to be a function of per capita real net wage ($\sigma = \frac{b}{wh(1-t)}$). Substituting 1.18 into 1.17 one obtains:

$$K_{t+1} = \frac{\mu(r)}{1 + \mu(r)} wh(1 - t) [n + (1 - n)\sigma]$$

The stock of capital at time $t+1$ depends on the marginal propensity to save, the post-tax wage and the employment rate. From equation 1.19 one can easily analyse the dynamics of the system. Defining the capital/ labour ratio as $k_t = (\frac{K_t}{L_t})$ and since $w_t = f(k_t) - k_t f'(k_t)$\(^{19}\) equation 1.19 can be re-written as:

\(^{19}\)This formula applies here since employment is entirely determined by the firm and the wage set by the union is on the labour demand curve.
\[ k_{t+1} = \frac{\mu(r)}{1 + \mu(r)} \frac{1}{1 + l} \left[ Ak_t^\alpha (1 - \alpha) (1 - t) + \frac{(1 - n_t) b}{L} \right] \]  
(1.19a)

where \( l \) defines the rate of growth of the labour input.

The existence and uniqueness of the steady state equilibrium depend on the shape of the savings locus. That is, they depend on the total differential \( \frac{dk_{t+1}}{dk_t} \) whose sign is not clear on a priori grounds in our model (see for instance the next subsection which shows that there is not a closed-form solution for the interest rate). For the same reason analytically we are not able to prove the stability of the equilibrium \( \left( \frac{dk_{t+1}}{dk_t} < 1 \right) \). However, the following section will present a quantitative analysis according to which it is shown that numerically the steady state equilibrium exists and it is stable.

Finally dividing both sides for \( k_t \) we obtain:

\[ \frac{k_{t+1}}{k_t} = \frac{\mu(r)}{1 + \mu(r)} \frac{1}{1 + l} \left[ \frac{1 - \alpha}{\alpha} r (1 - t) + \frac{(1 - n) b}{K^*} \right] \]  
(1.19b)

Within the labour market, the equilibrium level of employment \( N^* \) can be derived combining the aggregate wage equation 1.14 and the aggregate labour demand determined by the firms 1.10:20

\[ N^* = \frac{(1 - \alpha) r s^u}{\alpha (1 + d) wh - (1 - \alpha) r (s - s^u)} \]  
(1.20)

All these results allow standard interpretations. Thereby, the economy’s equilibrium is determined by all the following conditions:

1) The individual quantities \((c_t, k_t, h_t)\) are derived from the representative agent’s optimisation problem given \((r, w, b)\);

2) The real interest rate \( r \) is equal to the marginal product of capital from the firm’s optimisation problem;

3) The wage at firm level \((w_j)\) is set by the decentralised trade unions’ optimisation problem given \((r, n, c, b, h)\);

---

20To be more precise, note that this refers to the aggregate version of equations 1.14 and 1.10.
4) Employment at firm level \( n_j \) is set by the representative firm given \((r, w, b)\);

5) The goods market and the capital market clear;

6) The government budget constraint is satisfied;

7) The consistency condition guarantees that \( c_i = c, \ k_i = k, \ h_i = h \) and \( w_j = w \)

### 1.3.1 General Equilibrium Implications of the endogenous interest rate

Clearly, according to equation 1.19, the economy supply of capital is affected by changes in the interest rate. Moreover, by considering equation 1.19 and equation 1.11, it is possible to obtain the steady state value of the endogenous interest rate which corresponds to:

\[
1 = \frac{\mu(r)}{1 + \mu(r)} \frac{1}{1 + \frac{1 - \alpha}{\alpha} r (1 - t) + \frac{(1 - n)}{K^*} b}
\]

where \( K^* \) defines the steady state capital stock.

The above equation does not present a closed form but it is clear that it is quite unlikely that the golden rule of capital holds in this context. This implies that the general equilibrium effects of a change in tax progressivity in our OLG framework do differ from those derived in a Ramsey type model.

Further, consider, for instance, the case of a small open economy where the real interest rate still equalises the marginal product of capital but has to be taken as given. Under this hypothesis, a change in tax progressivity affects the inputs’ price ratio (via a change in the sole wage rate). Therefore, given our Cobb-Douglas production function, firms substitutes the more expensive input factor with the less costly one. In our framework, this effect may be amplified by the influence on the supply of capital of a change in the interest rate. Indeed, here a change in tax progressivity affects both the real interest and the wage rate.
1.4 The qualitative analysis.

The purpose of this section is to analyse the effect of changes in each of the four labour tax parameters of interest on union’s wage setting and employment.\(^{21}\)

1.4.1 Tax progressivity and wage determination.

Remark 1 The effect on union’s wage determination of a rise in marginal personal income tax rate is ambiguous and depends on a “union (wage moderation) substitution effect” and on a “labour supply income effect.” A higher average personal income tax rate induces an increase in wages.

Proof.

\[
\frac{dw}{dt} = \frac{\partial w}{\partial h} \frac{\partial h}{\partial t} + \frac{\partial w}{\partial M_v} \frac{\partial M_v}{\partial t} + \frac{\partial w}{\partial t} > 0
\]

\(^{21}\)Henceforth, except when explicitly stated, each rise in tax rates is allowed keeping constant all the others tax parameters.
\[ \eta_{h,t} = \frac{\theta}{\theta + \gamma - 1} \frac{t}{1-t} \text{ and } \eta_{w,t} = \frac{t}{1-t} \text{ where } \frac{\theta}{\theta + \gamma - 1} < 1 \text{ which implies that } \frac{dw}{dt} > 0 \text{ where } \eta_{h,t} \text{ defines the hours of work elasticity with respect to the average tax rate and } \eta_{w,t} \text{ the wage rate elasticity with respect to the average tax rate for a given degree of tax progressivity.} \]

Equation [1.22] shows that the endogenous hours supply function introduces an income effect \(-\frac{1}{\gamma'} M^2 \nu \) that contrasts the "union substitution effect" \( \left[ \frac{\theta + \gamma - 1}{\theta} \left( \frac{\partial \nu}{1 + \alpha \bar{v} \bar{h}} + \frac{1}{\gamma} \right) \right] \) on union's wage determination. Then, the sign of the overall effect is ambiguous. This result can not be conceived as properly novel since the implications of an endogenous labour supply have already been a matter of concern of other papers. (see for instance Fuest and Huber [2000]).

By expressing the implicit total differential [1.23a] in elasticities' terms since \( \frac{\theta}{\theta + \gamma - 1} \) is less than one, we clearly have that an increase in the average tax rate leads to a higher wage. That is, the unions' attempt to protect wages from the taxation increase (the terms \( \frac{\partial w}{\partial M} \frac{\partial M}{\partial \nu} \frac{\partial \nu}{\partial t} + \frac{\partial w}{\partial h} \frac{\partial h}{\partial \nu} \frac{\partial \nu}{\partial t} \)) dominates the opposite effect due to changes in hours worked \( \left( \frac{\partial w}{\partial h} \frac{\partial h}{\partial \nu} \frac{\partial \nu}{\partial t} \right) \). Indeed, notice that a higher average tax rate increases the supply of working hours and this has a negative effect on the wage. This counterbalancing labour supply effect in wage determination appears to be a good reason to cast some doubts on LM's result of a more than 100% wage shift.\(^{22}\) This means, that the burden of labour taxation is not shifted completely onto firms even though unions have monopolistic power.

The amount of tax burden transferred to firms depends on the initial taxation level \( \left( \frac{t}{1-t} \right) \) and on the worked hours elasticity with respect to the average tax rate \( \left( \frac{\theta}{\theta + \gamma - 1} \right) \). Hence, following a rise in the average personal income tax rate, the monopolistic union increases the wage pressure as suggested by DT but the strength of this claim does not depend on unions' power but on the initial taxation level. If the taxation level is extremely high, a further increase in the tax rate implies an heavy cost for the workers, thus the compensating rise in the wage would be higher than what required for a lower

\(^{22}\) The more than 100% shift is due to the combined effect of a complete pre-tax wage recovery from the increase in taxation and a further increase triggered by the union markup variation.
initial taxation level.

Finally, notice that all the above comparative statics refers to the wage determined by the monopoly union. If one aims at analyzing the effect on the general equilibrium wage of a change in tax progressivity a further mechanism should be added. Consider for instance the case of an increase in the marginal personal income tax rate:

$$\frac{dw}{d\tau} = \frac{\partial w}{\partial M_v} \frac{\partial v}{\partial \tau} + \frac{\partial w}{\partial r} \frac{\partial v}{\partial \tau} > 0$$

This general equilibrium effect is clearly unsigned since $\frac{\partial w}{\partial \tau} \leq 0$ according to $\theta \leq 1$. Moreover, according to equation 1.21 also the sign of $\frac{\partial w}{\partial v}$ is not known on a priori grounds as long as feedback mechanisms are quite relevant (that is, the sign of $\frac{\partial v}{\partial \tau}$ depends both on the unemployment rate and the capital stock which in turn are affected by a change in the wage rate).

**Remark 2** An increase in the marginal (average) payroll tax rate lowers (increases) the real wage.

**Proof.**

$$\frac{dw}{d\delta} = \frac{\partial w}{\partial \tilde{v}} \frac{\partial \tilde{v}}{\partial \delta} = \frac{\partial w}{\partial M_v} \frac{\partial v}{\partial \delta} < 0 \quad (1.24)$$

$$\frac{dw}{d\delta} = -\frac{b}{h(1-t)} \frac{M_v^{-1}}{\left(1+\alpha v^2\right)} \frac{\tilde{v}}{1+\delta} < 0$$

$$\frac{dw}{dd} = \frac{\partial w}{\partial \tilde{v}} \frac{\partial \tilde{v}}{\partial d} = \frac{\partial w}{\partial M_v} \frac{\partial v}{\partial \delta} > 0 \quad (1.25)$$

$$\frac{dw}{dd} = \frac{b}{h(1-t)} \frac{M_v^{-1}}{\left(1+\alpha v^2\right)} \frac{1}{1+\delta} > 0$$

According to all the above equations, payroll taxes could affect wage setting differently from personal income taxes. That is, the tax equivalence between personal income and payroll taxes does not hold. This result contrasts what suggested by LM but it is
consistent with Koskela and Schöb [1999], though the framework differs. Koskela and Schöb [1999] assume an exogenous labour supply but a specific tax structure that allows them to show that when the taxation system is progressive the employee's tax base does not correspond to the employers' tax base. In our framework, payroll taxes do not have any direct effect on labour supply and for this reason the changes in union markup are not equivalent when either we observe a variation in the degree of tax progressivity of the personal income taxation system or in the payroll taxation system. To some extent, also in our case we can conceive the failure of the tax equivalence as the result of different tax bases. Indeed, for a given change in the degree of personal income tax progressivity the tax base of reference for the union is the earnings function whereas for the same change in the degree of payroll tax progressivity the tax base of reference is the sole wage rate.

Then, the union markup $M_{\pi}$ is increasing in $\tilde{\nu}$. That is, a higher marginal tax rate, keeping the average tax rate constant, reduces the marginal benefit of increasing the pre-tax wage, whereas the marginal cost is invariant. This raises the cost in terms of foregone employment of an increase in the post-tax wage and produces the well known substitution effect which reduces wage pressure.

However, as above, when analyzing the effect on the general equilibrium wage of a change in payroll tax progressivity, one should consider all the feedbacks at work. That is, we might take into account both the effects of changes in the supply of hours of work (via the change in the wage rate) and the variation of the real interest rate.

1.4.2 Tax progressivity and employment

Remark 3 Employment effects of changes in personal income taxes depend on an “general equilibrium interest rate effect” and a “union (wage moderation) substitution effect.” An increase in the average personal income tax rate implies lower employment.

23 For this reason we denote the union's markup relevant to changes in payroll taxes differently from that relevant to changes in personal income taxes.
Proof.

\[
\frac{dn}{dr} = \frac{\partial n}{\partial r} \frac{\partial \nu}{\partial r} + \frac{\partial n}{\partial M^\nu} \frac{\partial \nu}{\partial r} \leq 0 \tag{1.26}
\]

where: \( \frac{\partial n}{\partial r} > 0, \frac{\partial \nu}{\partial r} < 0, \frac{\partial n}{\partial M^\nu}, \frac{\partial \nu}{\partial r} < 0 \)

\[
\frac{dn}{dt} = \frac{\partial n}{\partial r} \frac{\partial \nu}{\partial t} + \frac{\partial n}{\partial M^\nu} \frac{\partial \nu}{\partial t} + \frac{\partial n}{\partial t} \leq 0 \tag{1.27}
\]

where: \( \frac{\partial n}{\partial r} \leq 0, \frac{\partial n}{\partial t} > 0, \frac{\partial \nu}{\partial t} > 0, \) and \( \frac{\partial n}{\partial t} < 0 \)

By looking at equation 1.20 one can easily recognise that a change in personal income tax progressivity affects the employment level basically from two mechanisms: the earnings function \((w_h)\) and the real interest rate. Further, from equation 1.14 we observe that the earnings function basically depends on the union markup \(M^\nu\) which produces the well known union wage moderation substitution effect and thus has a positive impact on employment. It is clear that the real interest rate effect, due to the general equilibrium framework, is novel to all the partial equilibrium literature. Being the user cost of capital, at a given wage, the real interest rate influences the firms' decisions on the input choices. Furthermore, the real interest rate influences the labour market also through the hours supply of work since it changes the opportunity cost of working today. On a priori grounds the sign of the employment effects of a change in tax progressivity are not clear. Indeed, if the elasticity of inter-temporal substitution is higher than 1 (i.e. \( \theta < 1 \)) unambiguously the partial effect of a change of the real interest rate on employment is positive\(^{24}\). This result might hold even if \( \theta > 1 \). This implies that we can exclude the possibility that the effect of a change in the interest rate on the supply of capital is enough negative to reduce output and employment. How a change in the degree of tax progressivity influences the real interest rate relies upon all the feedback mechanisms but is consistent with this plausible story. Suppose that following an increase in the marginal personal income tax rate, the labour supply income effects dominates and unions push for

\(^{24}\text{Indeed, we have: } \frac{\partial n}{\partial e} = \frac{(1-\alpha)e^\alpha}{\alpha(1+d)w_h(1-\alpha)r(s^e-s^o)} + \frac{(1-\alpha)e^\alpha \left\{ (1-\alpha)[w_h(1-t)-b] \frac{(1-t)\mu(\alpha)}{1+\mu(\alpha)} + \frac{1}{1+\mu(\alpha)} \mu(\alpha)(\frac{\partial \nu}{\partial M^\nu})^2 \right\}}{\alpha(1+d)w_h(1-\alpha)r(s^e-s^o)^2}.\)
a higher wage. Under this hypothesis firms should substitute labour for capital. Further, we should observe a higher unemployment rate. If this is the case, the supply of capital of the still employed increases since the wage rate is higher. However, since there is more unemployment a portion of the supply of capital from the employment is lost. Therefore, we cannot say whether the economy supply of capital increases or not. However, if it raises then the real interest rate diminishes and firms substitute labour for capital even further (that is employment decreases even more or in other words the real interest rate amplifies the former effect of a higher wage rate).

A novel implication of this general equilibrium framework is that we can not exclude the possibility of a positive correlation between changes in real wage and changes in employment.\(^{25}\) We can then conceive a change in tax progressivity that increases both wages and employment. This is, for example, what was observed in a Scandinavian country like Norway where the correlation between changes in real wages and employment for the period 1978-1997 was positive. Of course, there could be other possible explanations of this result. For instance a labour demand shock is perfectly consistent with this fact. However, both all the other explanations and our suggestion (a general equilibrium effect driven by the change in the interest rate) have in common a shift of the labour demand. By definition, this shift in the labour demand can not be captured by a partial equilibrium analysis.

An increase in the average personal income tax leads has an ambiguous effect on employment. However, since we know from Remark 1 that unions' wage claims rises and all the three transmission mechanisms \(\left(\frac{\partial n}{\partial M}, \frac{\partial M}{\partial \psi}, \frac{\partial \psi}{\partial \sigma}\right)\) work in the same direction determining lower employment. Given the increase in the wage rate, the argument is similar as above. Though, because of the endogenous labour supply, the wage pressure is lower than 100% and the impact on employment could be weaker than what expected by LM or it could be stronger because of the presence of the interest rate.

\(^{25}\)Note that a positive correlation between changes in wages and employment can hardly be explained only in terms of movement on the labour demand but can be easily conceived as a labour demand shift.
Remark 4. The employment effects of an increase in the marginal (average) payroll tax rates are ambiguous.

Proof.

\[
\frac{dn}{d\delta} = \frac{\partial n}{\partial r} \frac{\partial r}{\partial v} \frac{\partial v}{\partial \delta} + \frac{\partial n}{\partial M_v} \frac{\partial M_v}{\partial \tilde{v}} \frac{\partial \tilde{v}}{\partial \delta} \leq 0
\]

(1.28)

\[
\frac{dn}{d\tilde{d}} = \frac{\partial n}{\partial r} \frac{\partial r}{\partial \tilde{v}} \frac{\partial \tilde{v}}{\partial \tilde{d}} + \frac{\partial n}{\partial M_v} \frac{\partial M_v}{\partial \tilde{v}} \frac{\partial \tilde{v}}{\partial \tilde{d}} + \frac{\partial n}{\partial \tilde{d}} \leq 0
\]

(1.29)

\[
\frac{\partial r}{\partial \tilde{v}} > 0, \frac{\partial n}{\partial r} > 0, \frac{\partial n}{\partial M_v} < 0, \frac{\partial M_v}{\partial \tilde{v}} > 0, \frac{\partial \tilde{v}}{\partial \delta} < 0, \frac{\partial \tilde{v}}{\partial \tilde{d}} > 0, \frac{\partial n}{\partial \tilde{d}} < 0. \]

As before, the sign of \(\frac{\partial r}{\partial \tilde{v}}\) is not clear cut on a priori grounds. We clearly know that following an increase in the marginal payroll tax rate unions reduce their wage pressure. How this affect the economy's supply of capital is not obvious at all: on the one hand there should be more employment, on the other the wage rate is lower. Moreover, Remark 2 points to the importance of the wage set by the decentralised union which is not able to internalise the effect of a change in the interest rate. In other words, despite of the reduction in the union wage pressure, the general equilibrium wage which depends on the interest rate and whether or not the inter-temporal elasticity of substitution between consumption is greater or not than 1 could also increase. Thus we can not sign the employment effect of a change in the marginal payroll tax rate.

Following an increase of the average payroll tax rate according to Remark 2 the unions' wage pressure increases. If the general equilibrium wage increases as well, then it may be the case that the economy's supply of capital increases, the real interest rate decreases and the three relevant channels, namely the general equilibrium real interest rate effect \(\left(\frac{\partial n}{\partial r} \frac{\partial r}{\partial \tilde{v}} \frac{\partial \tilde{v}}{\partial \delta}\right)\) and the union wage moderation substitution effect \(\left(\frac{\partial n}{\partial M_v} \frac{\partial M_v}{\partial \tilde{v}} \frac{\partial \tilde{v}}{\partial \delta}\right)\), and the direct effect on the labour demand \(\left(\frac{\partial n}{\partial \tilde{d}}\right)\) work in the same direction. Thereby, an increase in the average payroll tax rate ends up in lower employment. Finally, the
magitude of the employment effect depends on the initial taxation level.\footnote{This statement can easily be proved by showing that the absolute value of the elasticity of the labour demand with respect to the average payroll tax rate is equal to $\frac{d}{\alpha (1+\delta)}$ whereas that of the general equilibrium employment level corresponds to $\frac{\delta}{(1+\delta) \frac{d}{\alpha} (\sigma - \psi)}$.}

Table 1.1 summarises the basic results.

We conclude that from a qualitative point of view, we are not able to identify unambiguously the sign of the effect on the general equilibrium wages and employment.

### 1.5 The Quantitative Analysis

#### 1.5.1 Calibration

The calibration procedure offers two main advantages. The first is to solve numerically the model which does not present a closed form solution for all the steady state equations. The second is to establish the direction and quantify the effects of changes in the tax parameters of our interest through the identification of all the deep parameters.

The model described in the previous sections is characterised by 10 parameters $(\theta, \varphi, \beta, b, \alpha, \gamma, \tau, \delta, d)$ of which the four tax parameters $(\tau, t, \delta, d)$ are taken from independent data source and all the others are calibrated from the model's steady state equations. Before describing the calibration procedure in details, it is worth introducing the two countries over which we carried out our policy experiments: Italy and the US. The choice is made aiming at comparing a European Continental country such as Italy
with an Anglo-Saxon country with a low unemployment experience like the US.

The two countries of interest are characterized by the presence of unions whose strength is quite different. In particular, their institutional wage settings are both classified as decentralized but Italian unions are traditionally stronger. Then, one could also argue that changes in labour taxation affect the two countries differently because of a different labour market structure. Under such view, our theoretical model should be considered appropriate only for Italy whereas a competitive labour market might better represent the US.

This chapter aims at analysing the general equilibrium effects of a change in tax progressivity for a given labour market structure. Indeed, according to our qualitative results, the effects of changes in tax progressivity may be related to the taxation level or in other words to the taxation structure. At this stage, by modelling both a monopoly union and a competitive labour market, we would not be able to separate differences in the structure of the labour market from those of the taxation system. We also conduct a policy experiment according to which we consider a counterfactual country “ITA_{ustax}” with all the Italian parameters values apart from the tax parameters which are equal to the US. Then, although the model better refers to Italy, we carry out our policy experiments also for the US by capturing the countries’ unions’ strength through the union markup parameter. Notice that even when modelling a ”Right to Manage” model differences in unions’ strength are captured by the union markup which would include the bargaining power parameter.

We start by setting the period equal to 20 years and by assuming that the following expressions hold within the data $Y_{kp} = (r + \delta_{kp})K_p$, $Y_{kd} = (r + \delta_{kd})K_d$, and $Y_{kg} = (r + \delta_{kg})K_g$, where $r$ denotes the real interest rate, $\delta$ represents the capital depreciation rate which is equal to 0.025 per quarter, $K_p$, $K_d$ and $K_g$ denote respectively the sum of gross fixed capital formation and inventories stock, consumption of private and public durable goods.\(^{27}\) Country specific real interest rate is calculated from Fisher’s identity.

\(^{27}\) A 2.5% per quarter depreciation rate is consistent with the assumption of full capital depreciation
\( r \equiv i - \pi^e \) where the expected inflation is set equal to a five-year average of lagged inflation. Data are provided by the Bank of Italy and the Federal Reserve. The capital share, \( \alpha \), is then calibrated according to the following expression:

\[
\alpha = \frac{Y_{kp} + Y_{kd} + Y_{kg}}{GNP + Y_{kd} + Y_{kg}}
\]

(1.30)

On the basis of equation [1.30] we obtain that for Italy the capital share is equal to 0.36 while for the US the parameter takes the value of 0.33. These two values are consistent with observed data according to which during the last decades the capital share has been higher in the European Continental countries than in the Anglo-Saxon group.

The parameter \( \theta \), the inverse of the inter-temporal elasticity of substitution for consumption, is an important parameter. The value refers to that suggested by Attanasio and Jappelli (1998) on the basis of Attanasio and Weber's (1993) estimates of the inter-temporal elasticity of substitution (0.8). Thus, \( \theta \) is set equal to 1.25 for both countries. Since \( \theta \) is an important parameter in the Appendix we present some robustness checks of our analysis obtained by identifying an upper and lower bound (± 30%) of this \( \theta \) value.

Given a value for \( \theta \), we calibrate the parameters \( \beta \) and \( \gamma \). The former is calculated from the Euler Equation:

\[
\beta = \left( \frac{c_0}{c_y} \right)^\theta \frac{1}{1 + r}
\]

(1.31)

where the ratio between old and young people's consumption is equal to 0.92 and 0.69 for Italy and the US respectively.\(^{28}\) The latter derives from Pencavel's estimates of men worked hours elasticity with respect to a wage rate:

\[ \varepsilon_h = \frac{1 - \theta}{\theta + \gamma - 1} = -0.094 \quad (1.32) \]

It should be noted that in both cases the condition that \( \gamma \) might be higher than unity holds. Taking the tax parameter \( \lambda \) from the data, the parameter \( b \) is instead calibrated from the identity:

\[ b \equiv \sigma wh(1 - \lambda) \quad (1.33) \]

where the replacement ratio value, \( \sigma \), corresponds to the inverse of the union markup as implied by the theoretical model and the hours of work proportion over total hours is constructed from the data.\(^{29}\) The average weekly hours of work in the manufacturing sector (1978-97) is divided to 96 hours (e.g. 16 hours times 6 working days). Moreover, as implied by the Cobb-Douglas production function \( w \) is equalised to:

\[ w = r \frac{(1 - \alpha) K}{\alpha L} \quad (1.34) \]

where real interest rate and the ratio \( K/L \) values are taken from the data and the capital share is equal to the calibrated values, 0.36 and 0.33. Finally, given \( \theta, b, \gamma \) and \( M_\varphi \), the parameter \( \varphi \) is calibrated from the FOC for the hours of work in the utility maximisation process, that is:

\[ \varphi = \nu \left( b M_\varphi \right)^{1 - \theta} \frac{(1 + \mu)^\theta}{h^\gamma} \quad (1.35) \]

Table 1.2 summarises the calibration.

Table 1.3 instead shows the tax parameters that are taken from independent data sources. The tax rates refer to those burdened onto a single income couple which earns an average wage in the manufacturing sector and has two children and onto his employer.

\(^{29}\)Eurostat and Bureau of Labour Statistics provide the data.
Although it might seem restrictive, the use of a specific category of workers is consistent with the theoretical model. The model is built in a unionised framework. Therefore, what is relevant is whether or not this specific category of workers is representative of unions’ members rather than if it is representative of the median worker.

Note that at this income level, the personal income taxes are higher in the US where this taxation system is also more progressive. In contrast, payroll tax rates are much higher in Italy and the Italian payroll taxation system is progressive whereas the American one is regressive. Further evidence that the personal income tax system is more progressive in the USA rather than Italy can be found in Wagstaff et al [1999]. In their paper progressivity refers only to the personal income taxes and it is measured, using different data sources, by the Kakwani index.

Illustrated by Table 1.4 are the “three” countries’ steady state characteristics implied by the calibration procedure. Within the Table, in order to be able to express our employment effects in terms of the unemployment rate we conceive the employment rate as the ratio between the employment and the labour force. This can not be regarded as a strong assumption since in our model the whole population is allowed to participate.

\(^\text{30}\) The literature on this issue has widely proved that the wage (substitution) moderation effect is entirely due to the presence of the unions.
Results presented in Table 1.4 are quite consistent with some empirical characteristics of the two real countries. For example, Italy presents a higher savings rate, a higher real interest rate, a higher union markup and a higher government expenditure ratio. Moreover, the comparison of the steady state results for Italy and the counterfactual country "ITA^{ustax}" may provide an indication of the direction towards the Italian economy would move if the Italian Government would switch from its tax parameters to the US one.

### 1.5.2 Policy Experiments

Before describing our policy experiments, it is worth looking at the actual labour tax variations in Italy and the US during the period 1978-1997 to have a more precise idea on the empirical relevance of our model. According to Table 1.5, personal income taxes changes have been larger in Italy than in the US, though the increase in the progressivity of this taxation system is bigger in the US (|\frac{\%\nu_{us}}{\%\nu_{it}}|). In both countries the payroll tax system seems to be quite unchanged. Our policy experiments will help to shed some light on the single and combined effect of labour tax rate changes in the two economies. A different set of policy experiments is run for both countries. Initially, aiming at quantifying the single effect of labour tax parameters on wages and employment, each of them is allowed to vary keeping constant all the others. After that, we will take as a benchmark tax changes illustrated in Table 1.5.\textsuperscript{31} Note that, since these policy

\textsuperscript{31}We also ran some experiments where the restriction of a constant overall level of tax progressivity is imposed. Under this assumption the employment effects are quite negligible. This is consistent with our findings of different effects associated to different tax parameters and the importance of changing tax progressivity. Then, for ease of exposition these results are not reported but are available upon request.
Table 1.5: Labour Taxes and Unemployment changes 1978-1997

<table>
<thead>
<tr>
<th>Country</th>
<th>%λ</th>
<th>%τ</th>
<th>%δ</th>
<th>%ν</th>
<th>%μ</th>
<th>%μ*</th>
<th>%u</th>
</tr>
</thead>
<tbody>
<tr>
<td>Italy</td>
<td>19.3</td>
<td>3.99</td>
<td>0.15</td>
<td>0.16</td>
<td>-0.33</td>
<td>0.1</td>
<td>-0.21</td>
</tr>
<tr>
<td>USA</td>
<td>0.65</td>
<td>2.61</td>
<td>1.06</td>
<td>1.59</td>
<td>-1.00</td>
<td>0.13</td>
<td>-0.65</td>
</tr>
</tbody>
</table>

experiments are meant to be a comparison between different steady state equilibria, we focus only on the long-run implications of changes in taxation without considering short-run and transitional dynamics.\(^32,33\)

**Marginal Personal Income Tax Rate Effects**

Figure 1.1, illustrates the implications for Italy (the blue line) and the US (the pink line)\(^34\) of the sole change in the marginal personal income tax rates, \(\tau\).

![Figure 1-1: Marginal Personal Income Tax Rates and Wages](image)

In Figure 1.1, we read for both countries that changes in \(\tau\) are always positively correlated to changes in wages. This suggests that the "labour supply income effect" always dominates "the union (wage moderation) substitution effect". The size of the final effect on wages appears to be strongly related to the initial taxation level. Indeed,

\(^32\)This seems not to be a strong limit of the calibration with regard to the theoretical model given that there exists only two overlapping generations.

\(^33\)Note further, it is like saying that changes in taxation are permanent.

\(^34\)Henceforth, when it is not explicitly stated, Italy and the US are represented by the blue and the pink line respectively.
the wage variation is larger in the US (-0.14% against -0.10% for Italy when we impose a 1% reduction in \( \tau \)) where the actual marginal tax rate and the personal income tax progressivity are higher.

![Figure 1-2: Marginal Personal Income Tax Rates and Employment](image)

![Figure 1-3: Changes in the Marginal Personal Income Tax Rates](image)

Figure 1.2 shows further that the general equilibrium interest rate effect is stronger than the union (wage moderation) substitution effect leading to a negative correlation between \( \tau \) and employment even though union markup is decreasing in \( \tau \). As expected, the coefficient is bigger for the US and for the counterfactual country “ITA\textsubscript{ustax}” where

51
Table 1.6: Effects of Changes Of Marginal Personal Income Tax Rates

The effects of changes in marginal personal income tax rates are shown in Table 1.6. The table measures the impact of changes in tax rates on various economic indicators such as consumption, savings, real interest rates, and government expenditures.

The initial level of taxation is higher. Note that the presence of this general equilibrium mechanism is quite important since the union substitution effect alone does not appear to be strong enough to suggest this kind of fiscal reform as a solution to unemployment. By affecting inter-temporal decisions of individuals, it appears that labour taxation could be harmful to capital accumulation as much as capital taxation.

Table 1.6 provides more evidence in this regard.

For both countries changes in $\tau$ are negatively correlated to changes in consumption (cfr Figure 1.3 graph on the left in the first row), savings (cfr Figure 1.3 graph on the right in the first row), real interest rate (cfr Figure 1.3 graph on the left in the second row) and government expenditures (cfr Figure 1.3 graph on the right in the second row). Two main points are worth noting here. First, because of the increase in the employment rate, even though the marginal tax rate is lower, government expenditure

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35 The union's markup change is equal to 0.05% for Italy and 0.07% for US following a 1% reduction in $\tau$. 

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is increasing since total tax revenues are rising. Secondly, identifying aggregate *private* output as the sum of consumption and savings, the above results seem to imply that a lower tax progressivity ($\tau \downarrow$) determines higher employment and output. Though the effect on employment is somehow controversial to the majority of the papers within the literature, the effect on output is not surprising to the most. Many argue that higher tax progressivity ($\tau \uparrow$) disincentives human capital accumulation. What is novel here is that it appears to disincentive the capital accumulation as well.

Figure 1-4: Changes in the Marginal Personal Income Tax Rates Cont.

![Graphs showing changes in marginal personal income tax rates](image)

**Average Personal Income Tax Rate Effects.**

The following graphs show that, consistently with Remark 1, a decrease in the average personal income tax rate triggers a wage reduction (cfr Figure 1.5) and a rise in the employment rate (cfr Figure 1.6).
More specifically, a 1% decrease in $\lambda$ yields to an increase in the employment rate equal to 0.4%; 0.59 and 0.6% for Italy, $\text{ITA}_{\text{autax}}$ and the US. Three things deserve to be noted. First, reducing both personal income tax rates has a positive effect on employment, though it is stronger when determined by a reduction in the average tax rate. Note that a decrease in $\lambda(\tau)$ implies a higher (smaller) degree in tax progressivity. Secondly, this policy experiment provides further evidence that what mostly matters for the size of the effect is the initial taxation level. Thirdly, we can shed more light on the general equilibrium implications of a change in the average personal income tax rate by focusing on the role played by the real interest rate.

![Figure 1-5: Average Personal Income Tax Rates and Wages](image)

In particular, the US case is quite interesting where, independently of decreasing or

![Figure 1-6: Average Personal Income Tax Rates and Employment](image)
increasing the tax rate, the effect on consumption (cfr Figure 1.7 graph on the left in the first row), savings (cfr Figure 1.7 graph on the right in the first row) and private output is negative.

Table 1.7 can shed some light on this.

Figure 1-7: Changes in the Average Personal Income Tax Rates

For both countries, the relation between the real interest rate and $\lambda$ is negative triggering a higher employment rate for a reduction in the average personal income tax rate.
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Table 1.7: Effects of Changes Of Average Personal Income Tax Rates
However, in the US we observe a fall down in consumption and savings despite of the employment rate is increasing. Since the economy's savings function is a weighted average of the employed's and unemployed's savings, the observed reduction in overall savings implies that the employment effects when negative ($\lambda \uparrow$) are stronger than the positive effects on the wage, the hours worked and the real interest rate. Notice that, given our parameter value for the inter-temporal elasticity of substitution between consumption, we expect a partial negative relationship between the real interest rate and savings. Indeed, the negative effect on consumption, savings and private output diminishes as the reduction in $\lambda$ is bigger due to the increase in the employment rate. This implies that under this policy experiment, the more progressive the taxation system becomes the less the negative impact on output.\(^{36}\)

In contrast, in Italy and ITA\textsubscript{ustax} for a reduction in the average personal income tax rate, the combined effect of a higher interest rate and employment rate leads to a slight increase in consumption and savings. Thereby, the new steady state is associated to a somewhat higher output level.

**Marginal Payroll Tax Rate Effects**

Changes in the marginal payroll tax rate, are positively correlated to changes in wages (cfr Figure 1.8) for both countries.

Provided that $\delta$ does not influence worked hours, variations in the general equilibrium wage depends entirely on changes in union markup and the real interest rate.\(^{37}\) Yet this union wage moderation substitution effect is very small and slightly stronger in Italy where the initial level of taxation is higher.

Furthermore, in Italy variations of the employment rate seem primarily to reflect changes in wages whereas in the US they do not. We can be more precise by looking

\(^{36}\)Note that in the previous policy experiment an increase in tax progressivity (e.g. a rise in the marginal personal income tax rate) leads always to a lower output level. In contrast, a higher degree of tax progressivity achieved by decreasing the average tax rate does (may) not have this negative effect in Italy (in the US).

\(^{37}\)Table 1.8 shows that changes in hours of work are very close to zero.
Figure 1-8: Marginal Payroll Tax Rate and Wages

Figure 1-9: Marginal Payroll Tax Rate and Employment
at Table 1.8 according to which there is a strong link between savings (cfr Figure 1.10 graph on the right in the first row), consumption (cfr Figure 1.10 graph on the left in the first row) and payroll taxes.\(^\text{38}\)

While in Italy and in ITA\text{tax} consumption and savings' changes are quite small, in the US they are large enough to determine a relatively large negative effect on private output. This negative effect is stronger when associated to an increase in the tax rate (e.g. when the payroll progressivity increases). Nevertheless, changes in \(\delta\) affect positively the employment rate for a reduction of the tax rate higher than 1%. This is due to the fact that the increase in the real interest rate and the reduction in wages lead firms to substitute capital for labour. Note however that for both countries, the gains in terms of employment are so small to suggest that pure changes in marginal payroll taxes can not represent a policy solution to unemployment.

Figure 1-10: Changes in the Marginal Payroll Tax Rates

\(^{38}\) This strong link in particular emerges if one compares the effect on consumption and savings to the effects on all the other macroeconomic variables.
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Average Payroll Tax Rate Effects

Figures 1.11, 1.12 and 1.13 describe the role played by changes in the average payroll taxes.

Figure 1-11: Average Payroll Tax Rates and Wages

For both countries the changes in the wage (cfr Figure 1.11) are much lower than the employment rate effects (cfr Figure 1.12).
In Italy when we allow for a reduction in $d$, the increase in union markup (cfr Figure 1.13 graph on the left in the third row) is almost identical to wage changes. Average payroll taxes enter into the labour demand as a labour cost and for this reason they can be conceived as a sort of hiring cost. Then, it seems quite obvious that employment increases as long as $d$ decreases (payroll tax progressivity increases).

Though at a first look the effect appears to be quite strong (0.83 employment elasticity for Italy whereas it is smaller (0.56 and 0.57) for ITA_unlax and the US), employment increases less than the reduction in labour costs. That is, firms are not translating completely lower labour costs into more employment. This policy experiment supports further the highly robust result that stronger employment effects are associated to a higher initial taxation level. Moreover, as illustrated by Table 1.9, in Italy the reduction in $d$ is combined with an increase in private output. In contrast, in the US the effect on private output is negative.

\[\text{In a model where it is allowed for firms' heterogeneity, we can interpret the positive effect of increasing payroll tax progressivity in another way. It favours small firms by reducing their hiring costs more than those sustained by big ones. Small firms are those which might require a higher product demand for hiring new labour. Thereby, increasing payroll tax progressivity lowers the level of product demand necessary to small firm to hire more work and on average it implies higher employment. This argument is sustained by Kolm [1999] who argues that imposing different payroll taxes on different sectors implies higher employment.}\]
Figure 1.14 summarises for both countries all the previous results by comparing the different effects on wages (cfr Figure 1.14 graph on the left in the first (second) row for Italy (the US)) and employment (cfr Figure 1.14 graph on the right in the first (second)
Table 1.9: Effects of Changes Of Average Payroll Tax Rates

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row for Italy (the US)) of changes in the four tax parameters (In Figure 1.14, the blue line identifies the marginal personal income tax rate; the pink line identifies the average personal income tax rate; the yellow line identifies the marginal payroll tax rate; the ski blue line identifies the average payroll tax rate).

Figure 1-14: Changes in the Four Labour Tax Parameters

First, changes in the employment rate are much larger than those related to wages. Secondly, the higher the initial taxation level, the stronger the employment effect.

Finally, we consider as a benchmark for the last policy experiment the actual tax variations reported in Table 1.5. We obtain that according to our model in Italy the

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40 This kind of policy experiment allow us to assess the robustness of our result in presence of simultaneous changes in the four tax parameters.

41 Note further that we find positive employment effects (0.41% and 0.58% for Italy and the US) even when we allow for a 1% reduction in the average payroll tax rate holding constant the total tax revenues. The required increase in the average personal income tax rate results to be equal to 0.90% and 0.10% for Italy and the US respectively. As expected, given the non-linear structure of the two taxation systems, these values differ from 1%.

65
employment (unemployment) rate should be reduced (increased) by 7.9% whereas in US it should decrease (increase) by 2.32%. By looking at the same Table 1.5, these rates of changes are quite close to the real ones in particular for Italy suggesting that the taxation structure is important for determining the general equilibrium employment effects but the labour market structure may be relevant as well.

1.6 Conclusions

This chapter has presented a general equilibrium model on the relation among tax progressivity, wage setting and employment which distinguishes between the implications of changes in the degree of personal income and payroll tax progressivity. Furthermore, this current chapter has pointed to the importance of the effects of each of the four types of labour taxes which define the two indices of tax progression. From a theoretical point of view three main conclusions can be derived. First, a general equilibrium framework points to the importance of the role played by the "interest rate effect". Then, it would be interesting to analyze whether this result would hold in a small open economy where the real interest rate has to be taken as given. Future research will investigate further on this issue. Secondly, the role played by the labour supply is crucial in determining the size and the sign of the effect of changes in personal income taxation over unions' wage setting and cancels out the hypothesis that given individuals' rational behaviour, personal income taxes and payroll taxes affect wage determination in the same manner. Thirdly, employment effects depend on the initial taxation level: the higher the tax level, the stronger the effect.

Some of these points address the question of whether unions are able to shift the tax burden onto firms. According to our policy experiments, that were run through a calibration approach, the answer is no. Union markup variations can not help to account for employment changes. On the basis of this, the labour economists' common view seems to be right. Another extension of the model might consider if this result is robust to a
industry level wage determination where the monopolistic union can not internalize all the macroeconomic effects but where the Nash equilibrium is not longer the equilibrium solution.

However, our policy experiments find also some evidence in favour of the Daveri and Tabellini's [2000] hypothesis according to which an economy's poor employment performance can be related to labour taxation. In particular, a 1% decrease in the average personal income and payroll tax rates has a relevant impact on employment (namely, 0.43% and 0.83%, respectively, for Italy; 0.59% and 0.56% respectively for the counterfactual country ITA$_{ustax}$; 0.60% and 0.57%, respectively, for the US). These effects are strongly related to the general equilibrium interest rate mechanism and to the initial taxation level. Furthermore, in contrast to a linear taxation system, a nonlinear taxation system allows for the possibility that the effects of counterbalancing tax changes do not cancel out and may influence employment equilibrium.

Taking as a benchmark for our policy experiment the actual fiscal reform during the period 1978-97, we find that for the Italian case variations in the employment rate implied by our model are quite close to those empirically observed. This raises the issue of the importance of the labour market structure. This chapter has focused on the general equilibrium employment effects of changes in tax progressivity for a given labour market structure. Future research will consider both the taxation and the labour market structures by comparing the US, modelled as a competitive labour market, to the unionised Italian economy.
Robustness check

The parameter \( \theta \) is set equal to 1.25 for both countries. However, since \( \theta \) is a crucial parameter we present some robustness checks of our analysis for Italy obtained by identifying an upper and lower bound (± 30%) of this \( \theta \) value. Notice that changing the value for \( \theta \) implies a new value for the worked hours elasticity with respect to a wage rate which is equal to:

\[
\varepsilon_h = \frac{1 - \theta}{\theta + \gamma - 1}
\]

We start by assuming \( \theta = 0.88 \) (−30%) and \( \theta = 1.63 \) (+30%) which means, for a given value of \( \gamma \), \( \varepsilon_h \) equal to 0.05 and (−0.21) respectively.

The following Tables illustrate all the robustness checks. All these checks can be conceived as satisfactory. Although the band which define the upper and lower bounds is pretty large (then our checks are quite powerful) results are robust. They differ only when \( \theta \) is allowed to be lower than 1 but this is perfectly consistent with the theoretical model. Further, our results are more sensible when \( \theta > 1 \) and there are good reasons to believe that \( \theta \) is indeed higher than 1 (individuals prefer to consume more today rather than tomorrow).
### Table 1.11: Robustness Check: Changing Marginal Personal Income Tax Rates

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<th>(% R )</th>
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### Table 1.12: Robustness Check: Changing Average Personal Income Tax Rates

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Table 1.11: Robustness Check: Changing Marginal Personal Income Tax Rates

Table 1.12: Robustness Check: Changing Average Personal Income Tax Rates

69
Table 1.13: Robustness Check: Changing Marginal Payroll Tax Rates

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Table 1.14: Robustness Check: Changing Average Payroll Tax Rates

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Chapter 2

Progressive Taxation and Wage Setting when Unions Strategically Interact

2.1 Introduction

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

As discussed in the previous chapter, the literature in this area has clearly pointed out that a decline in average labour taxes reduces unemployment if it generates lower pre-tax wages. Pre-tax wages fall if real after tax income from unemployment and leisure is not affected or only partially affected by the change in average taxes. When unemployment benefits are not taxed, for instance, lower average labour taxes reduce the replacement ratio, and unions are willing to accept lower pre-tax wages because the net income loss from employment increases (see Pissarides [1998], Lockwood and Manning [1993], Daveri
Changes in labour taxation do not necessarily require that average labour taxes vary. In principle, a switch from payroll to income taxes, given average rates, could affect wage pressure and unemployment. Koskela and Schöb [1999] show that the equivalence between personal income tax rates and payroll taxes ceases when the two tax bases differ because of the presence of tax allowances. In particular, under the assumption of a “right to manage” wage bargaining process, a revenue neutral tax reform which raises the marginal personal income tax rate and reduces the payroll tax rate decreases the gross wage and leads to higher employment. The empirical evidence to date, however, does not support this possibility (see Nickell and Layard [1999] for a recent review).

When labour taxation is nonlinear, another opportunity is to vary the degree of labour tax progressivity. Economic theory suggests that higher progressivity could reduce unemployment. The economic intuition is illustrated by Calmfors [1995]. Suppose that wages are bargained over by unions. When a union contemplates the possibility of a wage hike, it has to consider that say for a 1% increase in the after tax rate the pre-tax wage increases by \( \frac{1}{\nu} \), where \( \nu \) denotes the coefficient of residual income progression. This implies that the expected employment loss associated to the higher after tax wage is \( \frac{\xi}{\nu} \), where \( \xi \) is the elasticity of labour demand. Since \( \nu < 1 \) with progressive taxation, this loss is higher with progressive than with proportional taxation (\( \nu = 1 \)). It follows that, when labour markets are not perfectly competitive, a certain degree of tax progressivity can be desirable because it makes wage increases less attractive to unions, with positive consequences on the unemployment rate. We refer to this latter effect as "the wage moderation effect". As above discussed this occurs because, when the marginal tax rate

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1. The presence of tax allowances implies that the employee's tax base is narrower than the employer's tax base.
2. The coefficient of residual income progression, \( \nu \), suggested by Musgrave and Musgrave [1976] is defined as

\[
\nu = \frac{1 - \tau}{1 - t}
\]

where \( \tau \) (\( t \)) stands for the marginal (average) personal income tax rate. Further, this coefficient corresponds to the elasticity of the after tax wage with respect to the pre tax wage.
3. Notice that this "wage moderation effect" corresponds to the union (wage moderation) substitution effect.
increases, the price in terms of foregone employment of a higher take-home pay goes up. This allows the union to buy more employment through wage moderation, because a given fall in the pre-tax wage leads to a smaller change in the after-tax wage (see Sørensen [1997], p.228).

Most studies of the effects of tax progressivity on wages (and employment) consider unionized labour markets and decompose the impact of tax progressivity on pre-tax wages into the above wage moderation effect and a labour supply effect. The labour supply effect can generate higher wage pressure when an increase in tax progressivity reduces the supply of working hours, because the income effect is dominated by the substitution effect. If the wage moderation effect prevails over the labour supply effect, higher labour tax progressivity reduces pre-tax wages and increases employment. This could be the case of unskilled workers if they are heavily unionized and if their hours supply function is flatter than that of skilled workers.

In spite of its popularity, the empirical support of the view that unemployment can be reduced by cutting average labour taxes has not been overwhelming. In a well-known empirical investigation of the causes of European unemployment carried out in the mid-1980s, Bean, Layard and Nickell [1986] did not find much correlation between average labour taxes and unemployment rates. As recently argued by Daveri and Tabellini [2000], this pessimistic result could be explained by the fact that Bean and co-authors used cross-section data and ignored the correlation of these variables over time. More recent studies by Scarpetta [1996], Nickell and Layard [1999], Daveri and Tabellini [2000] and Brunello, Lupi, Ordine and Parisi [2001], that use time varying data, have documented a significant positive relationship between unemployment rates and average labour taxes.

Another result in this literature is that changes in tax progressivity, holding average labour taxes constant, can affect wage pressure. Given price setting, changes in wage pressure affect employment and unemployment. Lockwood and Manning [1993] find that

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*effect described in Chapter 1.*

4*Notice that this "labour supply effect" corresponds to the labour supply income effect described in Chapter 1.*
an increase of tax progressivity reduces wage pressure in the UK. In empirical studies of Italy and Sweden, Malcomson and Sartor [1984] and Holmlund and Kolm [1995] also find evidence of a negative relationship between tax progressivity and wage pressure. Sørensen [1997] provides further evidence on the positive employment effects of reduced tax progressivity.

On the other hand, Newell and Symons [1993] find that the change in unemployment between the 1970s and the 1980s is a significantly increasing function of the change in marginal tax rates over the same period. Hansen, Pedersen and Sløk [1999] present empirical evidence based on Danish data and distinguish between blue and white collar workers. They find that a reduction of tax progressivity increases the pre-tax wages of blue collars but have no significant effects on the pre-tax wages of white collar employees. Somewhat different results are obtained by Lockwood, Sløk, and Traae [2000], who also study the Danish case and show that the relationship between tax progressivity and pre-tax wages is negative for low levels of income (and unskilled) and positive for high levels of income (and skill).

In the previous chapter, we have developed an overlapping generations model of a unionized economy where hours of work are allowed to vary endogenously. The model is calibrated for Italy, a country where unskilled workers are highly unionized and can use overtime to vary their supply of hours. Our quantitative results show that an increase in income tax progressivity raises union wages, and that the labour supply effect prevails over the wage moderation substitution effect. In the current chapter, we add to the wage moderation and labour supply effects another mechanism which builds on the strategic interactions among unions.

Indeed, so far this literature has focused either on decentralized (see Lockwood and Manning [1993]) or on centralized (see Alesina and Perotti [1997]) wage bargaining and has ignored the interdependence between union wage claims. Typical examples of inter-

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5 See Nickell and Layard [1999], p.3061.
6 See also Hansen et al [1999].
dependence are imitative union behaviour and union rivalry over "fair" wage differentials across firms or industries (see Oswald [1979] and Gylfason and Lindbeck [1984]). In this chapter we show that the explicit consideration of the interdependence of unions adds to the wage moderation and the labour supply effects a third effect of a change in tax progressivity on pre-tax wages, which we call a "strategic interaction" effect. When unions are large enough to take into account the consequences of a change in their own wage on the average wage, the average wage affects the utility of a union member who quits or is laid off and individuals care about their relative wage, this strategic interaction effect goes in the same direction as the labour supply effect and reduces the likelihood that an increase in tax progressivity can benefit employment and reduce unemployment.

To provide some economic intuition, consider the simplest described above case where only the wage moderation effect exists. In this case, when a union contemplates the possibility of a net wage hike, it has to consider that say for a 1% increase in the utility of each employed union member the pre-tax wage increases by \( \frac{1}{\nu} \). This implies that the expected employment loss associated to the higher after tax wage is \( \frac{e}{\nu} \), where \( e \) is the elasticity of labour demand (see Calmfors [1995]). When progressivity increases (\( \nu \) declines), the employment cost of a higher take home wage increases, and this higher cost induces the union to moderate its wage claims.

In the presence of interdependence between union wage claims, we show that the increase in the employment cost of a higher take home pay when progressivity increases is lower the more important is the relative wage effect, the higher the weight of the average wage in the expected outside opportunities available to union members and the stronger the interaction between the union wage in a given industry and the average wage.

A closely related strand of literature shows that the institutions regulating wage bargaining have important effects both on equilibrium unemployment and on the relationship between labour taxation and unemployment. On the one hand, Calmfors and Drifill [1988] have shown that the relationship between the degree of centralization of the
wage bargain and equilibrium unemployment is hump-shaped and highest in countries with an intermediate degree of centralization. On the other hand, Daveri and Tabellini [2000] have shown that the negative impact of higher (average) labour taxes on unemployment is strongest in Continental Europe, where unions are powerful, wage bargaining takes place mainly at the industrial level and centralization is lower than in the Nordic or the Anglo-saxon countries. Since union interaction effects are stronger when unions are relatively large and bargain at the industry level, our chapter adds to this literature by showing that the impact of higher tax progressivity on employment (and unemployment) is smaller, if positive, and can even be negative when the degree of centralization of the wage bargain is intermediate.

Notice further that the idea that unions are concerned not only with the absolute wage of union members but also with its relative purchasing power goes back at least to Keynes (see Gylfason and Lindbeck [1984]). A relative wage concern can also be justified either by “fairness” (Fehr and Schmidt [1999], Agell and Lundborg [1995], Akerlof and Yellen [1990] and Oswald [1980]) or by “envy” considerations (Clark and Oswald [1996]).

We therefore model a multisector economy with unionized labour markets and monopolistic competitive product markets where workers care about their consumption and their relative position in the distribution of income. This simple framework suggests that, in unionized labour markets where labour supply is endogenous, and unions care about the wage differential and there is a certain interdependence of unions, changes in tax progressivity have ambiguous effects on wage. There are three important mechanisms at work: a) a union wage moderation effect; b) a labour supply effect c) a strategic interaction effect. While the former effect reduces wage pressure in the presence of an increase in tax progressivity, the other two effects increase it.

Moreover, our reading of the empirical literature is that there is no broad consensus on the key empirical issues. While most contributions find some effects of average and marginal tax rates on wages (and employment), there is no agreement either on the size or on the direction of these effects. While this chapter is mainly concerned with the presen-
tation of a theoretical model, we also include an empirical case study of the relationship between tax progressivity and pre-tax wages in Italy. In this country, unions are fairly powerful, imitative union behaviour is widespread, bargaining takes place mainly (albeit not exclusively) at the industrial level and the degree of coordination among unions is generally classified as intermediate (see Nickell and Nunziata [2000] and Soskice [1990]).

We use two datasets. The first set is a panel of individuals observed before and after the personal income tax reform of 1998, which reduced tax bands and changed tax allowances. The second set is a pseudo panel of cells, with each cell identified by the industrial sector, gender, age and education, which covers a much longer time span and includes several tax reforms. With regard to evidence using the panel of individuals, we find that higher marginal taxes, given the retention rate, significantly increase the pre-tax wage. In the full sample a 1 percent increase in the marginal tax rate leads to a close to 2 percent increase in annual earnings. This elasticity is lower for blue collar workers than for white collars. An increase in average taxes, given marginal taxes, also increases annual earnings, but the elasticity is significantly lower. In the full sample, a 1 percent increase in the average tax rate leads to a 0.417 percent increase in earnings. This elasticity is higher among blue collar workers.

Using instead the pseudo panel dataset, we present some evidence with regard to the earnings equation and to the wage equation.

For the earnings equation specification we find that a higher average income tax retention rate and a lower rate of tax progressivity significantly reduce pre-tax annual wages, thereby confirming the results drawn from panel data. However, the impact of changes in average income taxes and in marginal taxes is significantly lower. In particular, we estimate that a 1 percent increase in the marginal and in the average tax rates increase real annual earnings by 0.454 and by -0.016 percent respectively. It is difficult to explain these large elasticities with respect to the marginal tax rate exclusively with the argument that the labour supply effect prevails over the wage moderation effect. Therefore, our findings clearly call for another economic mechanism as suggested by our theoretical
model.

Even for the wage equation specification, our empirical evidence clearly shows that the relationship between the coefficient of residual income progression and pre-tax wages is negative and statistically significant, which suggests that an increase in progressivity increases wages and unemployment.

This chapter is organized as follows. Section 2 illustrates the model and Section 3 presents a qualitative analysis on its implications. Section 4 introduces the empirical analysis and describes the data. The empirical results are discussed in Section 5. Conclusions follow.

2.2 The Model

Consider a closed economy characterized by $S$ sectors and $fS$ firms, with $f \geq 1$, and composed of three economic agents: households, unions and firms. This economy is populated by a fixed number of monopolistic competitive firms, indexed by $i$, which operate in different sectors, indexed by $j$. In each sector, the inverse of the firm product demand corresponds to the following expression:

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

(2.1)

where $p$ and $y$ stand for price and output respectively; $K_j$ denotes the real expenditure in sector $j$ and $\sigma_j > 1$ measures the output elasticity with respect to the price.

Since each firm is quite small with respect to the economy, $K_j$ is taken as given by the firms. We decompose the labour force into employment $N$ and hours of work $h$ by assuming that they are perfect substitutes in production. The technology is described by the following production function:

$$y_{ij} = \alpha_j L_{ij}^\lambda$$

(2.2)
where $L_{ij} = N_{ij}h_{ij}$ and $\alpha_j$ is a productivity parameter which by assumption differs across sectors$^7$ and $\lambda > 0$ but lower than 1.

Firms set prices and employment by taking wages and hours as given. They solve the following problem:

$$\max \pi_{ij} = y_{ij}p_{ij} - w_j(1 + s)L_{ij}$$

(2.3)

where the parameter $s$ defines the average payroll tax rate and $w$ stands for wage.

Therefore the optimal price is equal to:

$$p_{ij} = w_{ij}(1 + s)\frac{\sigma_j}{\alpha_j\lambda (\sigma_j - 1)}L_{ij}^{1-\lambda}$$

(2.4)

The above price setting can also be expressed in terms of the labour demand$^8$ by substituting equations 2.1 and 2.2 into 2.4:

$$N_{ij} = h_{ij}^{-1}C_{Lj}w_{ij}^{-\xi_j}(1 + s)^{-\epsilon_j}$$

(2.5)

where:

$$\epsilon_j = \frac{1}{1 - \xi_j}$$

$$\xi_j = \frac{\lambda (\sigma_j - 1)}{\sigma_j}$$

$$C_{Lj} = \left[\frac{\alpha_j}{\xi_j}\left(\frac{K_j}{\alpha_j}\right)^{\frac{1}{\sigma_j}}\right]^{\frac{1}{1 - \xi_j}}$$

For sake of simplicity we assume symmetry within sectors. Therefore, within sectors,

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$^7$That is we are assuming different disembodied technological change across sectors. Reasons for this may be the adoption of different techniques or organizational processes.

$^8$The labour market here is represented in the space wage-employment instead of real wage-employment. Therefore the price enters implicitly into the labour market.
in symmetric equilibrium, the firm specific price, labour demand and wage are equal to the aggregate ones and henceforth, the subscript “i” is then omitted.

Risk neutral ex-ante identical individuals care about their consumption and their relative position in the distribution of income. They earn only wage income and have homothetic preferences described by a utility function, separable over consumption, hours of work and the wage differential between their own income and the average income. Notice that a relative wage concern in individuals' preferences can also be justified either by “fairness” (Fehr and Schmidt [1999], Agell and Lundborg [1995], Akerlof and Yellen [1990] and Oswald [1980]) or by “envy” considerations (Clark and Oswald [1996]).

The utility function is linear in all arguments but the disutility from work and takes the following form:

\[ U_j = \omega_j + a \left[ \omega_j - \chi_j(\omega_j) \right] - \frac{d}{\beta} \]

where the term \( \left[ \omega_j - \chi_j(\omega_j) \right] \) is the income differential expressed in post tax terms; \( d > 0 \) measure the households' evaluation of leisure; \( \frac{1}{\beta-1} (\beta > 1) \) is the elasticity of marginal disutility of hours worked. Finally \( a \) is a parameter that measures the marginal utility of the income differential\(^9\). Parameters which describe households' preferences are equal across individuals.

Post tax earnings are defined as \( \omega_j = w_j h_j - T(w_j h_j, Z) \) and \( \chi_j = z h_z - T(z h_z, Z) \) with \( w_j h_j - T(w_j h_j, Z) \) and \( z h_z - T(z h_z, Z) \) as, respectively, the sector specific individual's wage income \( (w_j) \) and the average wage \( (z) \) both net of taxes and where \( h_z \) defines the hours worked at the average wage income level.

As in Lockwood and Manning [1993], \( T(w_j, Z) \) is for personal labour income taxes and \( Z \) is a vector of parameters (marginal tax rates, tax brackets...) which takes into account any non-linearities in the tax system. We do not introduce the indices for the labour tax parameters since for sake of simplicity we assume that the sectorial wage \( (w_j) \)

\(^9\)We believe that the introduction of the income differential in the utility function cannot be considered as arbitrary since fairness or envy motives truly affect behaviour. See Fehr and Schimdt [1999], who refer to a more general context than the labor market.
belongs to the same tax bracket of the average wage.

Through a standard utility maximization procedure, it is possible to derive the general solutions for the employed hours worked:

\begin{equation}
    h_j = \left( \frac{(1 + a)(1 - \tau)}{d} \right)^{\frac{1}{\beta - 1}} \tag{2.7}
\end{equation}

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

Each sector is fully unionized and we assume that the sectorial wage derives from a unions-firms bargaining process. Unions' aim is to maximize the expected utility of members subject to the sectorial labour demand and the hours supply function. Following Lockwood and Manning [1993], we define the following union utility function:

\begin{equation}
    V_j = N_j^\gamma \left[ U_j - \bar{U} \right]^{1-\gamma} \tag{2.8}
\end{equation}

where \( U_j \) corresponds to equation [2.6] and \( \bar{U} \) is the expected utility available to an employed union member who is laid off or quit, equal to \((1 - x)(zh_z - T(zh_z, Z)) + xb\) where \( b \) corresponds to an unemployment subsidy which is constant and not taxable by assumption and the parameter \( x \) is a measure of the labour market conditions. That is, it corresponds to the probability of becoming unemployed once the individual is laid off or quit. In other words, for sake of simplicity\(^{10}\) this probability is here exogenous but it could be easily endogenised by conceiving it as the unemployment rate.

Equation [2.8] can be conceived as a fairly general unions' objective function. Indeed, for \( \gamma = 1/2 \) equation [2.8] describes the preferences of an utilitarian union whereas for \( \gamma = 0 \) the unions' preferences fully reflect those of the insiders.

With a small number of industries, each union is large enough to take into account the responses of other unions and of the average wage to changes in its own wage. We model this interdependence by assuming that \( \frac{\partial x}{\partial w} = \frac{\partial x h_z (1 - t_z)}{\partial w h (1 - t)} \approx \frac{\partial x h_z}{\partial w h} = \phi_j \), where \( \phi_j > 0 \)

\(^{10}\)In particular, treating the parameter \( x \) as constant simplifies the log linearisation of the wage setting equation.
is the conjectural variation of union \( j \). Clearly, the use of conjectural variations is a convenient shortcut, but we show later in the Appendix that the postulated positive interaction among wages is fully consistent with the behaviour of wages in equilibrium. Moreover, we can interpret the static model with conjectural variations as the steady state of a dynamic model where unions bargain sequentially rather than simultaneously (see De Fraja [1993]). In a similar setting, Dowrick [1989] interprets the parameter \( \phi_j \) as a measure of the degree of union coordination in the wage setting process. When it takes the value of 0 the wage bargaining process is fully decentralised. When instead it takes the value of 1 the unions perfectly collude.

The bargaining process takes the following form:

\[
\text{Max}_{w_j} \left[ V_j - \bar{V}_j \right]^{\rho_j} \left[ \Pi_j - \bar{\Pi}_j \right]^{1-\rho_j}
\]  

(2.9)

where \( \rho_j \) measures the sector specific unions’ bargaining power and as in Layard and Nickell [1990], \( \bar{V} \) and \( \bar{\Pi} \) are set equal to zero.

Optimal earnings in sector \( j \) turn out to be equal to

\[
\omega_j = \frac{q b + (1-q) \chi}{1 - \nu \left[ \frac{1}{\bar{\beta}} + \frac{1}{m_j} - \frac{\beta \cdot 1}{\bar{\beta} -1 m_j} \right]} \]  

(2.10)

where \( q = \frac{1}{1+\alpha} \) and \( m_j = \frac{\rho_j \gamma \left( \varepsilon_j + \frac{1}{\bar{\beta} -1} \right) - (1-\rho_j) (1-\varepsilon_j)}{\rho_j (1-\gamma)} \).

In the above expression \( \nu \) is the coefficient of residual income progression \( (\nu = \frac{1-t}{1-t}) \) where the average tax rate \( t \) is equal to \( \frac{T(w_j h_j)}{w_j h_j} \).

Hence, the sectorial wage is a markup over a weighted average between the unemployment benefit and the average wage. The denominator of equation [2.10] must be positive and a sufficient condition for this is \( \nu \left( \frac{1}{\bar{\beta}} + \frac{1}{m_j} \right) < 1 \).

Further, it can be shown that

Remark 5 Given the average tax rate and a common tax bracket for the industrial and the average wage, an increase in \( \nu \) reduces industrial earnings \( \omega_j \) if and only if \( \frac{\rho_j \cdot 1}{\bar{\beta} -1 m_j} (1- \frac{\gamma}{\bar{\beta} -1} (1-\varepsilon_j) - (1-\rho_j) (1-\varepsilon_j) \)}{\rho_j (1-\gamma)} \).
\( q \phi_j > \frac{1}{\beta} + \frac{1}{m_j} \)

**Proof.**

\[
\frac{\partial \ln \omega_j}{\partial \ln \bar{u}} = \frac{v \left[ \frac{1}{\beta} + \frac{1}{m_j} - \frac{\beta}{\beta-1} \frac{1}{m_j} (1-q) \phi_j \right]}{1 - v \left[ \frac{1}{\beta} + \frac{1}{m_j} - \frac{\beta}{\beta-1} \frac{1}{m_j} (1-q) \phi_j \right]} < 0
\]  

(2.11)

if and only if:

\[
\frac{\beta}{\beta-1} \frac{1}{m_j} (1-q) \phi_j > \frac{1}{\beta} + \frac{1}{m_j} \]

The condition above is more likely to hold when \( \phi \), the expected change in the average wage following a change in the own wage, is large, when the weight of the average wage in the expected utility \( \bar{U} \) is high (\( x \) is low), the relative wage concern is important (\( a \) is high), \( \beta \) is relatively large and \( m_j \) is relatively small. The latter parameter is smaller the larger is \( \rho_j (1 - \gamma) \). Therefore, \( m_j \) decreases when union preferences tend to coincide with the preferences of insiders (\( \gamma \to 0 \)) and when the union bargaining power increases. Finally, for given values of \( \rho_j \) and \( \gamma \), \( m_j \) decreases with the absolute value of the labour demand elasticity \( \epsilon_j \).

While the term \( v \left[ \frac{1}{\beta} + \frac{1}{m_j} \right] \) in the numerator of [2.11] is the wage moderation effect, we call the term \( v \left( \frac{\beta}{\beta-1} \frac{1}{m_j} (1-q) \phi_j \right) \) the wage interaction effect, because it relies on the positive interdependence between the industrial wage and the average wage.

Notice that the elasticity of the net union's utility with respect to the pre tax wage is equal to:

\[
\frac{\partial U_j - \bar{U}}{\partial w} \frac{w}{U_j - \bar{U}} = h [(1 + a) (1 - \tau) - (a + (1 - x)) \phi (1 - \tau)] \frac{w}{U_j - \bar{U}}
\]

The presence of interdependence between union wage claims (\( \phi \neq 0 \)), lowers this elasticity and thus the employment cost associated to a higher pre-tax wage. That is, according to the above expression, when progressivity increases the rise in the employment cost of a higher take home pay is lower the more important is the relative wage concern in individuals' preferences (\( a \)), the higher the weight of the average wage in the expected outside opportunities available to union members (\( x \)) and the stronger the interaction
between the union wage in a given industry and the average wage ($\phi$). If these effects are strong enough, the employment cost can even decrease when progressivity increases.

Recalling that $\omega_j = w_j h_j (1 - t)$ and $h_j = \left[ \frac{(1+a)(1-\tau)w_j}{d} \right]^{\frac{1}{\beta-1}}$ we also have

**Remark 6** Given the average tax rate and a common tax bracket for the industrial wage and the average wage, the labour supply income effect reinforces the interaction. It follows that an increase in $v$ reduces the hourly wage $w_j$ if equation [2.11] holds.

**Proof.**

\[
\frac{\partial \ln w}{\partial \ln v} = \frac{\beta}{\beta - 1} \frac{v \left[ \frac{1}{\beta} + \frac{1}{m_j} - \frac{\beta}{\beta - 1} \frac{1}{m_j} (1 - q) \phi_j \right] - 1}{\beta - 1 - v \left[ \frac{1}{\beta} + \frac{1}{m_j} - \frac{\beta}{\beta - 1} \frac{1}{m_j} (1 - q) \phi_j \right]} \quad (2.12)
\]

The term $\left( \frac{1}{\beta} \right)$ identifies the negative labour supply effect. Therefore equation [2.12] proves that if equation [2.11] holds, the labour supply effect is reinforced by the union interaction effect. Then, an increase in tax progressivity unambiguously determines a higher pre-tax wage. Since union interaction effects are stronger when unions are relatively large and bargain at the industry level, the impact of higher tax progressivity on employment (and unemployment) is smaller, if positive, and can even be negative when the degree of centralization of the wage bargain is intermediate.

The second order conditions associated to the optimization problem [2.9], both when $\omega_j > \chi$ and when $\omega_j < \chi$, are satisfied if $(1 + a) - (1 - x) \phi_j \frac{\beta}{\beta - 1} > 0$ and $\frac{\beta}{\beta - 1} < \frac{1}{1 - (1 - x) \frac{\beta}{\beta - 1} \frac{\phi_j}{\phi_j - \chi}}$. The former condition is consistent with the condition established by Remark 1, which only requires that $(1 - q) \phi_j > 1 - \frac{(\beta + m_j - m_j \beta)}{\beta^2 \beta}$. The latter condition is satisfied if $|\omega_j - \chi|$ is relatively small.

Since the reaction function defined by [2.10] is upward sloping, both post-tax and pre-tax earnings are strategic complements\(^{11}\). Therefore, by having positive conjectural variations, the unions in this model correctly anticipate the direction of change of the average

\(^{11}\)If we substitute [2.7] into [2.10], we obtain that the industrial hourly wage $w_j$ as an increasing function of the average hourly wage $\bar{z}$. 

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wage when the own wage is varied. This is the economic meaning of the formal proof presented in the Appendix. Finally, an equilibrium of this simultaneous game requires that each union attains positive utility. This condition is guaranteed if \[
\left( \frac{M_i}{1-q} \right) > (1-q) \, M_j \]
where \( M_i \) and \( M_j \) are the union markups associated to the average and the industrial wage respectively\(^{12}\).

### 2.3 Analysis

In this section we study how changes in the labour tax parameters affect equilibrium earnings (wages). In order to do so, it is convenient to conceive [2.10] as a reaction function and to re-write it in implicit form as follows:

\[
\psi_\omega = \psi(\omega_j, \chi, \nu, X_j) = 0 \tag{2.13}
\]

\[
\psi_\chi = \psi(\omega_j, \chi, \nu, X_j) = 0 \tag{2.14}
\]

where \( X_j \in (a, b, q, \beta, m_j, \phi_j) \) and \( \psi_\omega \) and \( \psi_\chi \) define the first order condition of the objective function [2.9] at the sectorial wage and at the average wage level respectively. Notice that the “average wage reaction function” varies as long as the other sectors wages respond to a wage change in sector \( j \).\(^{13}\)

Total differentiation of [2.13] and [2.14] and the application of Cramer’s rule allows us to establish the following

\(^{12}\)Recall from [2.10] that the industry specific union markup is

\[
M_{\omega j} = \left[ 1 - \nu \left( \frac{1}{\beta} + \frac{1}{m_j} - \frac{\beta - 1}{m_j (1-q) \phi_j} \right) \right]^{-1}
\]

\(^{13}\)For obvious reasons, the average wage would change following a sole variation in the sector \( j \) wage rate. But considering only this variation would contradict the hypothesis of a certain degree of unions’ coordination in the wage determination process.
Remark 7  Given the average tax rate and a common tax bracket for the industrial and the average wage, the strategic interaction among unions amplifies the effect of an increase in \(\nu\) on earnings \(\omega_j\) if 

\[ \text{sg}(\psi_{\omega\nu}) \equiv \text{sg}(\frac{\partial \omega_j}{\partial \nu}) = \text{sg}(\psi_{\chi\nu}) \equiv \text{sg}(\frac{\partial \chi_j}{\partial \nu}). \]

Proof.

\[
\frac{d\omega_j}{d\nu} = -\left[\psi_{\omega\nu}\psi_{\chi\nu} \psi_{\omega\chi}\right] / |J| \tag{2.15}
\]

where \(\text{sg}(\psi_{\omega\nu}) \equiv \text{sg}(\frac{\partial \omega_j}{\partial \nu}); \psi_{\chi\nu} < 0; \text{sg}(\psi_{\chi\nu}) \equiv \text{sg}(\frac{\partial \chi_j}{\partial \nu}); \psi_{\omega\chi} > 0 \]

We show in the Appendix that \(\text{sg}(\psi_{\omega\nu}) = \text{sg}(\psi_{\chi\nu})\) is a plausible assumption. Notice that the assumption of \(\text{sg}(\psi_{\omega\nu}) = \text{sg}(\psi_{\chi\nu})\) is a proof of the consistency of our conjectural variation hypothesis. Indeed, it implies that the parameter \(\phi\) is positive.

The sign of (2.15) depends on the sign of the numerator, because the sign of the determinant of the Jacobian matrix \(J\) must be positive to guarantee stability. Following Padilla, Bentolila and Dolado [1996], we distinguish between a direct effect, which consists in a shift of the union reaction function and is captured by the first terms within brackets, and a strategic effect, which corresponds to movements along the union reaction function and are captured by the latter term within brackets in the numerator.

The combined effect of a relative wage concern, the fallback utility \(\bar{U}\) and the interdependence of union wages is captured by the ambiguity of the partial derivative \(\frac{\partial \psi}{\partial \nu}\). The strategic complementarity between wages adds a further effect which goes in the same direction of the partial derivative \(\psi_{\omega\nu}\). When \(\psi_{\omega\nu} < 0\) the post-tax wage in industry \(j\) increases in general equilibrium both because of the direct effect and because the net average wage increases (\(\psi_{\chi\nu} < 0\)). The union in sector \(j\) reacts to the expected increase in \(\chi\) by rising further its own wage in order to maintain its relative wage and the gain in utility with respect to \(\bar{U}\). In the absence of the combined effect, we simply have:

In the absence of this combined effect, we simply have:

\[
\frac{d\omega_j}{d\nu} = -\frac{\psi_{\omega\nu}\psi_{\chi\nu}}{|J|} \tag{2.16}
\]

where \(\psi_{\omega\nu} > 0\) which suggests that an increase in \(\nu\) (a reduction in tax progressivity)
reduces industrial earnings, the well known wage moderation effect.

Since

\[
\frac{\partial w}{\partial v} = \frac{1}{h} \frac{\partial \omega}{\partial v} - \frac{w}{h} \frac{\partial h}{\partial v}
\]

(2.17)

the labour supply effect, identified by the second term in [2.17] is unambiguously negative. Therefore, if equation [2.17] holds, this effect further amplifies the positive effect on wage determination of an increase in tax progressivity.

If we cancel out the hypothesis of a relative wage concern in individuals' preferences \((a = 0)\) but we still allow for some intersectoral mobility and a certain degree of coordination, the union in the \(j\) sector, may still increase its wage pressure if she perceives that higher tax progressivity will reduce its own wage relatively to the outside income. Therefore, the overall effect on the wage determination is still ambiguous and depends on the parameters of the model.

If we relax the hypothesis of equal marginal and average tax rates, and we assume a tax progressivity change which affects only the sector \(j\) wage, our results still hold and might be strengthened.

To summarize, we have shown that the explicit consideration of the interdependence among wages in unionized labour markets increases the likelihood that the effect of higher tax progressivity on the pre-tax wage be positive, with negative consequences for unemployment. There are three mechanisms at work: a) a union wage moderation effect; b) a labour supply effect c) a wage interaction effect. The latter mechanism requires an intermediate level of centralization of the wage bargain. With fully decentralized bargaining, unions are too small to take into account the impact of their actions on the average wage and \(\phi = 0\). With full centralization, the net wage bargained by the encompassing union is equal to the average net wage. Since in this case the fallback utility \(\bar{U}\) is simply equal to \(b\) (see Layard, Nickell and Jackman [1991]) and the relative wage is equal to one, there is no interaction effect.

Therefore, we can extend the results by Calmfors and Drifill [1988] and Daveri and
Tabellini [2000] to the relationship between tax progressivity and unemployment and establish that, ceteris paribus, the possibility that higher tax progressivity could reduce unemployment is lower for intermediate degrees of centralization of the wage bargain than for either decentralized or fully centralized bargaining.

2.4 Empirical Evidence from Italy

A simplifying assumption of the model discussed in the previous section is that payroll taxes are proportional. While this is not true in general, it does apply in the case of Italy. The theoretical section of the paper shows that the equilibrium relationship between hourly wages and the coefficient of residual income progression critically depend on how each reaction function shifts in response to a change in \( v \). Our empirical strategy is to estimate these reaction functions using both individual and sectorial data.

In the Appendix we show that the reaction function \( (\psi_w) \) can be log-linearized as follows

\[
\ln wh = \text{constant} + \vartheta_1 \ln zh + \vartheta_2 v + \vartheta_3 \ln u + \vartheta_4 \ln(1 - t) \tag{2.18}
\]

where \( \vartheta_2 = \left[ \frac{1}{\beta} + \frac{1}{m_j} - \frac{\beta}{\beta - 1}(1 - q)\frac{\phi_j}{m_j} \right] \). Notice that the parameter \( \vartheta_2 \) is positive in the absence of strategic interaction between unions \( (\phi_j = 0) \), and could be negative in the presence of such interaction.

Since our interest is to identify the causal effect of changes in progressive taxation on sectorial wages, conditional on average wages, we need to find suitable comparison groups. Our strategy is to compare pre-tax wages (gross of hours worked) before and after tax reforms. The identification of union effects in the relationship between progressive taxation and wages would require a comparison between union and non union workers. In the Italian institutional setup this is particularly difficult, however, because union
contracts have almost complete coverage and extend negotiated settlements *erga omnes*.

We use two datasets. The first set is a panel of individuals observed before and after the personal income tax reform of 1998, which reduced tax bands and changed tax allowances. The second set is a pseudo panel of cells, with each cell identified by the industrial sector, gender, age and education, which covers a much longer time span and includes several tax reforms.

### 2.4.1 The Data

The panel of individuals is drawn from the 1995, 1998 and 2000 waves of the Survey on Income and Wealth of Italian Households, carried out by the Bank of Italy (SHIW), and the pseudo panel is obtained from the same source by grouping individual data covering a longer period, from 1977 to 2000. Genuine longitudinal information is available from SHIW only from 1989, and we choose the 1995 - 2000 window to focus on the 1998 tax reform and to minimize attrition in the data.

Our union model suggest that unions bargain over wages by taking the tax system as given. In order to evaluate the impact of the 1998 tax reform on earnings in 2000 we need to make sure that collective bargains did take place after 1998. In 1999, a substantial number of industry - level agreements were renewed, including important settlements in manufacturing - such as metalworking - services - such as commerce and banking - and the public sector - such as school teachers and employees of the national health service. Other important renewals took place during the year 2000 - such as building, textiles and local bus transport. To these one needs to add local agreements, which are negotiated at the firm rather than at the industry level.

The SHIW survey covers most years from 1977 to 1989 and the years 1991, 1993, 1995, 1998 and 2000. Individual earnings in this dataset are net of taxes and social security contributions. For each year and for each individual in the sample, we compute pre-tax wages (gross of income taxes but net of payroll taxes) by using the information on income tax rates, tax bands and tax allowances from the relevant tax legislation and
information on the composition of the household (whether the individual has a dependent spouse and/or children, is a single parent and whether she is employed or self-employed) from SHIW. Given pre-tax and net wages, we compute for each individual the relevant average and marginal income tax rate. These rates are based on labour income only, and do not take into account additional income from capital and self-employment.

Grouped data are obtained by collapsing individual data into cells, and each cell in the data contains the average value of the relevant variables by gender, educational attainment, age group and industrial sector. We classify educational attainment into two categories, at least upper secondary education (the skilled) and less than upper secondary education (the unskilled). We also group individuals into two age groups, the young (15-29) and the adults (30-64) and in three broad industrial sectors (industry and building, private services and the public sector).

Figure 2.1 gives a summary description of the data. The panels in the figure show the dynamics of average income taxes and of the coefficient of residual income progression. Income tax rates in Italy were almost proportional before the sweeping fiscal reform of 1974, which introduced steeply rising marginal tax rates\textsuperscript{14}. This reform was followed by a significant cut in the payroll tax wedge in 1976\textsuperscript{15}. In the early 1980s, two-digits inflation increased significantly the average tax rate and tax progressivity. As remarked by Giavazzi and Spaventa [1988]

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

Since fiscal drag was responsible of a sharp increase in the tax burden of employees, unions started to negotiate with the government both the restitution of the drag and measures that could reduce the progressivity of income taxation. These measures were

\textsuperscript{14} Notice that progressivity increases when the coefficient of residual income progression declines.

\textsuperscript{15} See Brunello et al [2001] for a detailed discussion.
eventually implemented with the drastic reduction in the number of tax bands in 1983, so that progressivity was generally lower in the late 1980s than in the 1982 peak. Tax bands were cut twice again, in 1989 and in 1998, and progressivity declined after the cut. Overall, the 1990s saw a return of progressivity to a new peak in 1993 and a decline thereafter.

2.5 The Estimates

We start our empirical analysis by estimating [2.18] on the 1995 to 2000 panel. We remove the time invariant individual effect by taking differences over time. Therefore, we end up with two observations for each individual, one relative to the 1995 to 1998
variations and the other relative to the 1998 to 2000 variation. We measure the average
gross wage $\chi$ as the average nominal pre-tax wage in the economy. Since we control for
aggregate effects by including time dummies in the regression, the coefficients associated
to the average wage and to the unemployment rate cannot be estimated.

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

The endogeneity of the current changes in tax progressivity and in the retention rate
requires that we use instrumental variables. A natural instrument to use in this context
is the change in the number of tax bands, that is defined exogenously by the tax law (see
Lockwood and Manning [1993]). This variable is correlated with average and marginal
taxes without being correlated in any obvious way to annual earnings, conditional on
taxes. During the sample period, the number of tax bands changed from 7 in 1995 to 5

Additional instruments are variables which capture changes in tax allowances. In
Italy household allowances depend on the number of dependent children, on whether the
spouse is dependent and on whether the household has a single parent. We capture the
exogenous variation in the structure of households with birth dummies, one for birth
in the more developed North and the other for birth in the less developed South. The
underlying idea is that individuals born in the South are likely to have, because of
cultural reasons, more dependent children and a dependent spouse. The actual number
of dependent children ($CHIDEP$) and the dummies indicating whether the spouse is
dependent ($SPODEP$) or whether the household has a single parent ($SINGLEP$) are
correlated with annual household earnings and cannot be considered as valid instruments.
When we fit these variables on a constant and on annual earnings, it turns out that
earnings explain a very small part of the total variance. We interpret the residuals as exogenous variation and use their changes as additional instruments. Finally, we add to the list of instruments additional lagged information on whether the individual or other members of the households participate to a private pension scheme or hold a life or health insurance contract. According to the Italian tax code, investments in these schemes can generate tax rebates.

Instrument validity is tested with the Sargan criterion, a misspecification test of whether additional instruments can be omitted from the vector of explanatory variables. The quality of instruments is tested with the Bound test, an F test of the additional instruments in the regression of each endogenous variable on the full list of instruments.

Table 2.1 reports the main results. The first two columns in the table show the OLS and IV estimates for the full sample and the remaining two columns present the IV estimates in the sub-samples of blue collars and white collars in low to medium hierarchical levels. Both for the full sample and in the two sub-samples, the Bound test always rejects the null hypothesis that the additional instruments are not jointly significant. The Sargan criterion also clearly rejects the hypothesis of misspecification in all cases.

We find that higher marginal taxes, given the retention rate, significantly increase the pre-tax wage. In the full sample a 1 percent increase in the marginal tax rate leads to a close to 2 percent increase in annual earnings. This elasticity is lower for blue collar workers than for white collars. An increase in average taxes, given marginal taxes, also increases annual earnings, but the elasticity is significantly lower. In the full sample, a 1 percent increase in the average tax rate leads to a 0.417 percent increase earnings. This elasticity is higher among blue collar workers.

Annual earnings can change because of changes either in hourly earnings or in hours worked or in both.

\[16\] This test is equal to 28.75 (p-value: .000) for the average income tax rate and to 35.38 (p-value: .000) for the coefficient of residual income progression.
Dependent variable: change in the log annual pre-tax wage

<table>
<thead>
<tr>
<th></th>
<th>OLS</th>
<th>IV</th>
<th>IV</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta \ln(1 - t)$</td>
<td>-6.463</td>
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<td>-5.972</td>
<td>-6.615</td>
</tr>
<tr>
<td></td>
<td>(.209)</td>
<td>(.995)</td>
<td>(1.166)</td>
<td>(1.242)</td>
</tr>
<tr>
<td>$\Delta v$</td>
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<td>-5.084</td>
<td>-4.526</td>
<td>-6.272</td>
</tr>
<tr>
<td></td>
<td>(.146)</td>
<td>(1.629)</td>
<td>(1.650)</td>
<td>(1.744)</td>
</tr>
<tr>
<td>$\eta_1$</td>
<td>1.508</td>
<td>0.417</td>
<td>0.504</td>
<td>0.306</td>
</tr>
<tr>
<td>$\eta_2$</td>
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<td>1.957</td>
<td>1.742</td>
<td>2.414</td>
</tr>
<tr>
<td>Nobs</td>
<td>1266</td>
<td>1266</td>
<td>472</td>
<td>514</td>
</tr>
<tr>
<td>$R^2$</td>
<td>.835</td>
<td>.611</td>
<td>.673</td>
<td>.454</td>
</tr>
<tr>
<td>$SC(7)$</td>
<td>-</td>
<td>.411</td>
<td>.961</td>
<td>.786</td>
</tr>
</tbody>
</table>

Note: Each regression includes a constant and year dummies. Additional instruments are the changes in the number of tax bands, two area of birth dummies, the change in the residuals of CHIDEP, SPODEP and SINGLEP, and the lagged indicators of whether the individual or the household hold a private pension, a life insurance or a private health insurance. Robust standard errors within parentheses. $\eta_1$: average income tax elasticity of gross earnings; $\eta_2$: marginal income tax elasticity of gross earnings. $SC(7)$: P-value of the Sargan test for the validity of instruments, with 7 degrees of freedom.

Table 2.1: OLS and IV Estimates of [2.18] based on panel data (1995/2000)
Using the hours supply function in [2.7], we have that

\[
\frac{\partial \ln wh}{\partial \ln \tau} = \frac{\partial \ln w}{\partial \ln \tau} - \frac{1}{\beta - 1} \frac{\tau}{1 - \tau} \tag{2.19}
\]

\[
\frac{\partial \ln wh}{\partial \ln t} = \frac{\beta}{\beta - 1} \frac{\partial \ln w}{\partial \ln t} + \frac{1}{\beta - 1} \frac{t}{1 - t} \tag{2.20}
\]

On the one hand, a positive elasticity of annual earnings to changes in the marginal tax rate implies an even higher elasticity of hourly earnings, because worked hours decline with labour tax progressivity. On the other hand, a positive elasticity to changes in the average tax rate does not rule out the possibility that higher average income taxes reduce pre-tax hourly earnings. A distinction between these two elasticities require that we have an estimate of \( \frac{1}{\beta - 1} \), the (uncompensated) elasticity of hours with respect to hourly wages. According to Blundell and McCurdy [1999], this elasticity in a linear hours supply model ranges between 0.08 and 0.16 for males and is close to 0.77 for females. A ballpark estimate of \( \beta \) consistent with these numbers is \( \beta = 3.5 \) and the implied elasticities of hourly earnings with respect to marginal and average income taxes\(^\text{17}\) turn out to be 2.138 and 0.241 respectively.

The negative and large coefficient attracted by tax progressivity suggests that strategic interactions among unions are important. It also implies that the wage pressure effect and the hours supply effect prevail on the wage moderation effect. According to these results, there is little hope that increases in tax progressivity could reduce the unemployment rate. In anything, the opposite is likely to occur.

The evidence in Table 2.1 is based on data which cover a short period of time (three years) and include the personal income tax reform of 1998. We next consider a longer span of time, which includes several tax reforms, by using grouped data over the period 1977-2000\(^\text{18}\). We group the original micro data into three sectors, because the corner-

\(^{17}\)The lower average tax rate elasticity reflects one model implication according to which this elasticity results from two counterbalancing effects when equation [2.11] holds as it turns out to be the case of our estimates.

\(^{18}\)Not all the years in this span are available. We miss 1985, 1988, 1990, 1992, 1994, 1996, 1997 and
stone of union bargaining in Italy is the industry, two age, education and gender groups. Given the fairly long time span and the fact that some of the years are missing, we include among the explanatory variables the first lag of the dependent variable. Since each cell includes a sub-group of individuals who differ by industrial sector, age group, educational attainment and gender, we treat the average wage $zh_2$ and the unemployment rate as exogenous. Both the dependent variable and the average wage are deflated by the consumer price index.

By construction, income tax rates are endogenous. A disadvantage of the longer span of time is that some of the variables used as instruments in Table 2.1 are not available. We retain the number of tax bands, both alone and interacted with the gender and age dummies, and the residuals of the regressions of CHIDEP, SPODEP and SING LEP and add the real tax allowance for the first dependent child, which is independent of income earned.

Table 2.2 shows our estimates for the full sample, with the OLS in the first column and the IV in the second column. As in the case of the three year panel, we find that the Bound test does not reject the null that the selected instrument are jointly significant in the regressions of $\ln(1 - t)$ and $v$ on the full set of exogenous variables. Following Nickell [1981], we also notice that the lagged dependent variable in grouped data should be instrumented, and we use the second lag as an instrument. The Sargan criterion rejects the hypothesis of misspecification.

Both columns in the table show that a higher average income tax retention rate and a lower rate of tax progressivity significantly reduce pre-tax annual wages, thereby confirming the results drawn from panel data. Compared to that table, however, we find that the impact of changes in average income taxes and in marginal taxes is significantly lower. In particular, we estimate that a 1 percent increase in the marginal and in the average tax rates increase real annual earnings by 0.454 and by -0.016 percent respectively. Assuming again that $\beta = 3.5$, we get that a 1 percent increase in marginal and average tax rates would increase real annual earnings by 0.454 and decrease them by 0.016 percent, respectively.
### Table 2.2: IV Estimates of [2.18] based on grouped data

<table>
<thead>
<tr>
<th></th>
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<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\ln(1 - t)$</td>
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<td>-1.262</td>
</tr>
<tr>
<td></td>
<td>(.263)</td>
<td>(.312)</td>
</tr>
<tr>
<td>$v$</td>
<td>-0.525</td>
<td>-1.554</td>
</tr>
<tr>
<td></td>
<td>(.278)</td>
<td>(.336)</td>
</tr>
<tr>
<td>$\ln (wh)_{-1}$</td>
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<td>0.805</td>
</tr>
<tr>
<td></td>
<td>(.037)</td>
<td>(.043)</td>
</tr>
<tr>
<td>$u$</td>
<td>-0.347</td>
<td>-0.235</td>
</tr>
<tr>
<td></td>
<td>(.032)</td>
<td>(.042)</td>
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<tr>
<td>$\ln z h_2$</td>
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<td>0.605</td>
</tr>
<tr>
<td></td>
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<td>(.102)</td>
</tr>
<tr>
<td>$\eta_1$</td>
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</tr>
<tr>
<td>$SC(5)$</td>
<td></td>
<td>.102</td>
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</tbody>
</table>

Note: instruments are the number of tax bands, the interactions of tax bands with age and gender dummies, the real tax allowance for the first dependent child, the residuals of CHIDEP, SPODEP and SINGLEP. Robust standard errors. $\eta_1$: average income tax elasticity of the gross wage; $\eta_2$: marginal income tax elasticity of the gross wage; $SC(5)$: $p$-value of the Sargan test for the validity of instruments (5 degrees of freedom).
income taxes leads respectively to a 0.587 and -0.115 change in hourly pre-tax earnings.

Following Hamermesh [1993], a reasonable confidence interval for the wage elasticity of labour demand is [0.15, 0.75]. Using this range, our results from grouped data suggest that a 1 percent increase in the marginal tax rate, given the average tax rate, would reduce employment by a percentage ranging from —.088 and —.440. The impact on employment rises significantly when we use the estimates from panel data. In this case, we obtain a range from —0.321 to —1.600. On the other hand, a 1 percent increase in the average tax rate, given the marginal tax rate, would increase employment by a percentage ranging from 0.017 and 0.086. The impact on employment is negative, however, when we use the results from panel data, and ranges from —0.036 to —0.181.

2.5.1 Further estimates based on the hourly pre-tax wage equation

Using the pseudo panel dataset, we remove from (2.18) the time invariant cell - specific effect by using the fixed effects estimator and measure the average real hourly wage $z$ either as the annual average of cell data or as the average by year and education. We treat both $z$ and the (log) aggregate unemployment rate $u$ as endogenous variables.

We instrument $z$ and $u$ with their first lags and a lagged indicator of fiscal stance, the ratio of public deficit to GDP. As before, a natural instrument for residual income progression and the retention rate is the change in the number of tax bands, that is defined exogenously by the tax law (see Lockwood and Manning [1993]). This variable is correlated with average and marginal taxes without being correlated in any obvious way to annual hourly earnings. As shown in Figure 2.1, the number of tax bands changed three times during the sample period.

We interact both the number of tax bands and the lagged deficit to GDP ratio with the gender and education dummies and test instrument validity with the Sargan criterion, a misspecification test of whether additional instruments can be omitted from the vector of explanatory variables. The quality of instruments is also tested with the Bound test,
an F test of the additional instruments in the regression of each endogenous variable on the full list of instruments.

Table 2.3 reports the main results. In the first column we define the z as the annual average of cell data and in the second column we define it as the average by year and education. Not reported in the table, the Bound test always rejects the null hypothesis that the additional instruments are not jointly significant\textsuperscript{19}. Moreover, the Sargan criterion clearly rejects the hypothesis of misspecification in both columns.

We find that higher marginal taxes, given the retention rate, significantly increase the pre-tax real hourly wage. In particular, a 1 percent increase in the marginal tax rate, given average taxes, leads to an increase in annual hourly earnings which ranges between 0.523 and 0.591 percent, depending on the definition of the average wage. On the other hand, a 1 percent increase of average income taxes, given marginal taxes, increases annual hourly earnings between 0.127 and 0.177 percent, but these elasticities are not significantly different from zero, which suggests the absence of significant real resistance of net wages to changes in average income taxes.

The positive and significant elasticity of pre-tax wages to changes in tax progressivity suggests that the combination of the labour supply and interaction effects discussed in the paper is strong enough to offset the wage moderation effect. With a negative relationship between pre-tax wages and employment, our results give little hope that increases in tax progressivity could reduce the unemployment rate. In anything, the opposite is likely to occur.

\textsuperscript{19}This test is equal to 8.98 (p-value: .000) for the average income tax rate and to 37.09 (p-value: .000) for the coefficient of residual income progression for the estimates presented in the first column and to 9.17 (p-value: .000) and 39.24 (p-value: .000) respectively for the estimates reported in the second column.
<table>
<thead>
<tr>
<th>Dependent variable: log of the real hourly pre-tax wage</th>
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<tbody>
<tr>
<td>(1)</td>
</tr>
<tr>
<td>ln(1 - t)</td>
</tr>
<tr>
<td>-2.461</td>
</tr>
<tr>
<td>(.563)</td>
</tr>
<tr>
<td>v</td>
</tr>
<tr>
<td>-1.969</td>
</tr>
<tr>
<td>(.722)</td>
</tr>
<tr>
<td>ln z</td>
</tr>
<tr>
<td>0.891</td>
</tr>
<tr>
<td>(.176)</td>
</tr>
<tr>
<td>ln u</td>
</tr>
<tr>
<td>-0.347</td>
</tr>
<tr>
<td>(.063)</td>
</tr>
<tr>
<td>η₁</td>
</tr>
<tr>
<td>0.127</td>
</tr>
<tr>
<td>(.159)</td>
</tr>
<tr>
<td>η₂</td>
</tr>
<tr>
<td>0.591</td>
</tr>
<tr>
<td>(.216)</td>
</tr>
<tr>
<td>Nobs</td>
</tr>
<tr>
<td>360</td>
</tr>
<tr>
<td>P²</td>
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<tr>
<td>.666</td>
</tr>
<tr>
<td>SC(2)</td>
</tr>
<tr>
<td>.860</td>
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<table>
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<th>(2)</th>
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<tbody>
<tr>
<td>-2.567</td>
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<td>(.133)</td>
</tr>
<tr>
<td>0.523</td>
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<tr>
<td>(.191)</td>
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<tr>
<td>360</td>
</tr>
<tr>
<td>.671</td>
</tr>
<tr>
<td>.701</td>
</tr>
</tbody>
</table>

Note: Robust standard errors within parentheses. Additional instruments are the lagged average wage and unemployment rate, the interactions between the number of tax bands and the gender and education dummies, and the interactions of the lagged public deficit GDP with gender and education. η₁ : average income tax elasticity of gross hourly earnings; η₂ : marginal income tax elasticity of gross hourly earnings. SC(2) : P- value of the Sargan test for the validity of instruments, with 2 degrees of freedom.

Table 2.3: Fixed Effects IV Estimates on the Pseudo Panel 1977-2000
2.6 Conclusions

In this chapter, we have shown that the explicit consideration of the interdependence among wages in unionized labour markets increases the likelihood that the effect of higher tax progressivity on the pre-tax wage be positive, with negative consequences for unemployment. There are three mechanisms at work: a) a union wage moderation effect; b) a labour supply effect c) a wage interaction effect. The latter mechanism requires an intermediate level of centralization of the wage bargain.

We have extended the results by Calmfors and Driffill [1988] and Daveri and Tabellini [2000] on the relationship between wage bargaining, average taxes and unemployment, to the relationship between tax progressivity and unemployment and have established that, ceteris paribus, the possibility that higher tax progressivity could reduce unemployment is lower for intermediate degrees of centralization of the wage bargain than for either decentralized or fully centralized bargaining.

In our empirical study of Italy, a country with an intermediate degree of centralization of the wage bargain, we have shown that higher tax progressivity increases pre-tax wages, with negative consequences for employment and unemployment. The positive effect of higher marginal income tax rates, given average rates, on the pre-tax wage is not in line with the previous empirical literature, which typically finds a negative effect. We interpret this finding as evidence that when unions strategically interact both the labour supply and the wage interaction effect dominate the wage moderation effect. A message of this paper is that the opportunity to reduce unemployment by varying the degree of labour tax progressivity can vary with the institutional context regulating wage bargaining.
2.7 Appendix

2.7.1 Some comments on the assumption of $sg(\psi_{\omega}) = sg(\psi_{\chi})$.

The assumption of $sg(\psi_{\omega}) = sg(\psi_{\chi})$ is a proof of the consistency of our conjectural variation hypothesis. It implies that the parameter $\phi$ is positive. Clearly, the use of conjectural variations is a convenient shortcut, but this Appendix shows that the postulated positive interaction among wages is fully consistent with the behaviour of wages in equilibrium.

Let's consider the case of $\chi > \omega_j$ (i.e. the average wage is higher than the sector $j$ wage).

Under this assumption we have that the union's markup in the sector $j$ is lower than the what would be observed as the union's markup at the average wage level. That is:

$$\left\{ 1 - v \left( \frac{1}{\beta} + \frac{1}{m_j} - \frac{\beta}{\beta - 1} \frac{1}{m_j} (1 - q) \phi_j \right) \right\}^{-1} < \left\{ 1 - v \left( \frac{1}{\beta} + \frac{1}{m_x} - \frac{\beta}{\beta - 1} \frac{1}{m_x} (1 - q) \phi_x \right) \right\}^{-1}$$

then:

$$\left\{ 1 - v \left( \frac{1}{\beta} + \frac{1}{m_j} - \frac{\beta}{\beta - 1} \frac{1}{m_j} (1 - q) \phi_j \right) \right\} = \left\{ 1 - v \left( \frac{1}{\beta} + \frac{1}{m_x} - \frac{\beta}{\beta - 1} \frac{1}{m_x} (1 - q) \phi_x \right) \right\}$$

$$\left\{ \left( \frac{1}{\beta} + \frac{1}{m_j} - \frac{\beta}{\beta - 1} \frac{1}{m_j} (1 - q) \phi_j \right) \right\} < \left\{ \left( \frac{1}{\beta} + \frac{1}{m_x} - \frac{\beta}{\beta - 1} \frac{1}{m_x} (1 - q) \phi_x \right) \right\}$$  \hspace{1cm} (A.2.3)

$$\left\{ \frac{1}{m_j} \left( 1 - \frac{\beta}{\beta - 1} (1 - q) \phi_j \right) \right\} < \left\{ \frac{1}{m_x} \left( 1 - \frac{\beta}{\beta - 1} (1 - q) \phi_x \right) \right\}$$  \hspace{1cm} (A.2.4)
Under the assumption of $\chi > \omega_j$, rational unions which aim at keeping constant the relative wage would satisfy the following conditions:

\[ \phi_{\omega j} < \phi_{\chi} \quad \text{(A.2.5)} \]

which implies that:

\[ m_{\omega j} > m_{\chi} \quad \text{(A.2.6)} \]

If equation [2.11] holds we have $sg(\psi_{\omega \nu}) < 0$ given that

\[ \left( \frac{\beta}{\beta - 1} \frac{1}{m_j (1 - x) \phi_j} \right)_{\omega} > \left( \frac{1}{\beta} + \frac{1}{m_j} \right)_{\omega} \]

We know from equation A.2.4, A.2.5 and A.2.6 that:

\[ \left( \frac{\beta}{\beta - 1} \frac{1}{m_j (1 - x) \phi_j} \right)_{\omega} < \left( \frac{\beta}{\beta - 1} \frac{1}{m_{\chi x} (1 - x) \phi_{\chi}} \right)_{x} \quad \text{(A.2.7)} \]

Therefore in order to have $sg(\psi_{\omega \nu}) \neq sg(\psi_{\chi \nu})$ we should observe:

\[ \left( \frac{1}{\beta} + \frac{1}{m_{\chi x}} \right)_{x} > \left( \frac{\beta}{\beta - 1} \frac{1}{m_{\chi x} (1 - q) \phi_{\chi}} \right)_{x} > \left( \frac{\beta}{\beta - 1} \frac{1}{m_j (1 - x) \phi_j} \right)_{\omega} > \left( \frac{1}{\beta} + \frac{1}{m_j} \right)_{\omega} \quad \text{(A.2.8)} \]

A required condition for equation A.2.8 to hold is for a given $\beta$ a quite small value of $m_{\chi x}$.

Notice, however that a quite small value of $m_{\chi}$ combined with a relatively high value of $\beta$ (which is always greater than 1) is the condition required to guarantee:

\[ \left( \frac{\beta}{\beta - 1} \frac{1}{m_{\chi x} (1 - x) \phi_{\chi}} \right)_{x} > \left( \frac{1}{\beta} + \frac{1}{m_{\chi x}} \right)_{x} \]

or in other words: $sg(\psi_{\omega \nu}) = sg(\psi_{\chi \nu})$. 

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2.7.2 Log-linearization of the reaction function

The reaction function [2.10] can be re-written as

\[ m_j = \frac{\nu \left[ 1 - \frac{\beta}{\beta-1} (1-q) \phi_j \right]}{1 - \frac{\beta}{\beta-1} - (1-q) \frac{\omega}{\chi} - q \frac{b}{\omega}} \]  
\[ \text{(A.2.9)} \]

A loglinear approximation of [A.2.9] is

\[ \ln \omega = \ln(1-q) + \ln \chi + \frac{q}{1-q} \frac{b}{\chi} + v \left[ \frac{1}{\beta} + \frac{1}{m_j} - \frac{\beta}{\beta-1} \frac{1-q}{m_j} \phi_j \right] \]  
\[ \text{(A.2.10)} \]

Next, we use the approximation

\[ \frac{b}{\chi} \approx \frac{(\ln \chi - \ln b)}{\chi - b} \]  
\[ \text{(A.2.11)} \]

and the assumptions that \( \frac{b}{\chi - b} \) is approximately a constant and that \( q \) depends on the unemployment rate to obtain

\[ \ln \omega = \text{const} + \vartheta_1 \ln \chi + \vartheta_2 v - \vartheta_3 \ln u \]

The final assumption is that \((1 - t) \approx (1 - t_z)\), which allows us to write the expression in the text.

2.7.3 Data and variables

The Bank of Italy [2000] supplies information on net income for each individual in the interviewed household. Income can be from employment, self-employment and welfare (pensions and other benefits). For each household, there is also information both on the number of individuals earning income and on the number of dependents (spouse or children). This information is available by gender, educational attainment, occupation, sector of activity, region of residence and age.
<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>St.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual wage</td>
<td>31764.48</td>
<td>17588.2</td>
</tr>
<tr>
<td>Hourly wage</td>
<td>18.86</td>
<td>10.4</td>
</tr>
<tr>
<td>Payroll tax rate</td>
<td>0.48</td>
<td>0.07</td>
</tr>
<tr>
<td>Average tax retention rate</td>
<td>0.83</td>
<td>0.06</td>
</tr>
<tr>
<td>Tax progressivity</td>
<td>0.85</td>
<td>0.04</td>
</tr>
<tr>
<td>Gender</td>
<td>0.38</td>
<td>0.48</td>
</tr>
<tr>
<td>Age</td>
<td>40.62</td>
<td>9.52</td>
</tr>
<tr>
<td>Part time</td>
<td>0.04</td>
<td>0.20</td>
</tr>
<tr>
<td>Marital status</td>
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<tr>
<td>Educational attainment</td>
<td>0.56</td>
<td>0.49</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>0.15</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Table 2.4: Summary Statistics

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

\(^{20}\)These data are available at the following electronic address: www.aiel.it.
Chapter 3

Wealth Inequality, Income Redistribution and Growth in 15 OECD Countries

3.1 Introduction

The political agenda of the developed countries' governments can be regarded as a recognition of one main economic concern: boosting the economy's growth rate without determining a socially unacceptable level of income-wealth inequality. With the so called "skilled-biased technological change" and the consequent increase in wage (income) inequality, governments in charge pay more attention to the growth effect of redistributive policy.

There is no broad consensus neither on the analysis of the relationship between inequality and growth nor on the relationship between redistribution and growth. Though, this chapter will focus on this latter issue, it is useful to have a look at the former.

Most of recent papers posit a negative relationship between growth and inequality (See for instance Persson and Tabellini [1994] and Aghion and Bolton [1997]). However, many of them suggest different implications in terms of the growth effects of redistributive
policies. For instance Persson and Tabellini [1994] claims for a positive relationship between growth and equality but suggests a negative effect of redistribution on growth given that the latter implies distortionary policy instruments. In contrast, the approach followed by Aghion and Bolton [1997] seems to suggest that redistribution might be beneficial for growth.

Then, ambiguous growth effect of a redistributive policy can be easily generated by introducing in a framework similar to Aghion and Bolton [1997] and Galor and Zeira [1993] one feature of the Persson and Tabellini [1994] approach such as a distortionary taxation system.

The same result can be found in Benabou [1996] where greater redistribution leads to two conflicting effects: on the one hand, it discourages the individuals’ investment rate. On the other, it relaxes the credit constraints faced by the poor and given the assumption of decreasing returns to investments allows the less wealthy to earn a higher return. That is, the economy faces a trade off between costs and benefits of the redistributive policy.

The costs of redistributive policies derive from the distortions in agents’ labour supply and/or savings decisions. The benefits of these policies are expressed in terms of lower credit constraints which do not allow certain investment. According to the author, the growth maximizing tax rate of redistribution is positive and depends on the degree of pre-tax inequality.

If liquidity constraints are impeding investment by the poor or lower middle class any form of progressive transfer contributes to relax them. Further, ambiguous growth effects can be easily obtained by introducing some growth enhancing mechanisms to the model presented in the first chapter of this thesis.

The main objective of the current chapter is to present some empirical evidence on the growth effects of higher redistribution, proxied by changes in labour tax progressivity.

We use an original data set on marginal and average tax rates in 15 OECD\textsuperscript{1} countries

\textsuperscript{1}For this reason, the fiscal policy approach to which we refer, takes into account of the political mechanism only indirectly. If one is interested in evaluating the political mechanism should consider a broader set of countries. It is reasonable to expect that the political mechanism is stronger in democracies
for the period 1974-1997. We expect that the relationship between taxation and growth is hump shaped [Barro, 1990]. Our further a priori prediction is that the relationship between redistribution and growth is hill shaped [Benabou, 1996]. We, then, impose and test the identifying assumption that the sign of the growth effect depends on the taxation level and the degree of tax progressivity of the economy. To preview our results, we find statistical support to these imposed restrictions. Redistribution has a positive (negative) effect on growth in those countries characterized by a low (high) degree of tax progressivity and a low (high) taxation level.

The chapter is organized as follows. Section 2 presents a review of the literature on the relationship between taxation and growth. Section 3 adds some growth enhancing mechanisms to the model presented in the first chapter and discuss the implication of a changes in labour tax progressivity on growth. Section 4 introduces the empirical analysis and presents the data. The empirical results are discussed in Section 5. Conclusions follow.

3.2 Brief Review of the Literature on the relationship between growth and taxation

3.2.1 Growth Effects of Taxation

The development of the endogenous growth theory has increased the value of analysing the growth effects of taxation. For instance, Lucas [1990] evaluates the impact of a zero tax rate on capital in a endogenous growth model. The main economic message is that a tax on capital income distorts the investment decision. Then, taxes on labour income are less harmful. He finds no significant growth effect but a strong level effect. However as suggested by Pecorino [1993] in Lucas' model taxes on wages can be conceived as

and therefore the relation between income distribution and economic growth could be upward biased in our sample of 15 OECD countries.
a consumption tax since individual's decision on investment in human capital is only indirectly affected by changes in taxes. Indeed, the cost of further education corresponds only to the forgone earnings. Then, when one considers both human and physical capital as inputs, taxes on wages are harmful to the economy growth rate. Further, these growth effects appear to be larger than those found by Lucas. Therefore, different growth effects can be related to the specific engine of growth adopted in the theoretical model. Another possible and testable explanation is that different growth effects of changes in taxation are related to the presence of non linear effects.

3.2.2 Non-linear growth effects of taxation.

Drawing on the main contribution by Barro [1990], several empirical findings are based on a hump shaped relationship between taxation and growth (see for instance Fölster and Henrekson [2001]). In Barro [1990], for low tax rates, the provision of productive government expenditure such as the infrastructure brings about higher growth. Indeed, the return of an additional infrastructure is higher than the costs associated to the increasing distortionary tax rate required to finance the above fiscal policy. When the tax rate exceed the growth maximising rate, further infrastructure has a detrimental effect on growth. Similar conclusions apply if the government provides investments in education rather than investment in physical capital. This is what suggested by Galor and Zeira [1993] and Perotti [1993]. Within their framework also characterised by the presence of some imperfection in the capital markets, government expenditures are non productive and take the form of transfer payments which allow poor people to invest in education. Higher education implies a higher human capital accumulation and therefore growth. This line of the literature points to the importance of the relationship between inequality and growth. This issue is matter of concern of one of the following subsections. Notice, however, that the main linkage between these two lines of literature is the redistributive pressure that arises in presence of an unequal society. That is, high inequality calls for fiscal policies. These fiscal policies may affect the economy's growth rate.
Empirical Evidence on the relationship between taxation and growth

As argued by Myles [2000], one of the reason of weak growth effect of changes in taxation is related to definition of the proper measure of the tax rate. In particular, since almost all taxation systems are progressive, what matters is the marginal tax rate: the individual’s choice of earning an additional pound depends on the amount of that pound that can be effectively perceived. One could argue that even defining the relevant marginal tax rate is not an easy task. The main question is: within a progressive taxation system there are several marginal rates, which of them is the appropriate measure for evaluating the growth effects? For instance Easterly [1993] instead of looking at the tax rates directly tries to focus on the distortions generated by those taxes. The variance of the prices for 151 commodities in 57 countries relative to the US is conceived as a proxy of these distortions. This variable appears to be a significant determinant of the countries’ growth rate.

Plosser [1993] provides the strongest evidence for a negative relationship between the GDP per capita growth rate and the ratio of income taxes to GDP. This result is consistent with the view of non linear growth effects if one interpret this hump shaped relationship in the following way. Developed countries are those characterised by large public sectors and therefore by tax rates higher than the growth maximising rate. Therefore one should expect a positive relationship for developing countries and a negative relationship for developed countries. This view is also suggested and supported by Fölster and Hemrekson [2001]. They present some empirical evidence on a sample of rich countries covering the period 1970-1995. They find a robust negative relationship between government expenditures and growth. When the sample is extended to rich but non-OECD countries also taxation is growth impeding.

Indeed, the Plosser’s analysis refer to a sample of OECD countries. Nevertheless, Easterly and Rebelo [1993] cast some doubt on this strong negative relationship. Once they control for the initial GDP per capita level, its significance vanishes. They conclude: "The evidence that tax rates matter for economic growth is disturbingly fragile."
Similar view is supported by Agell, Lindh and Ohlsson [1997]. Further, Mendoza, Milesi-Ferretti and Asea [1997] test the Harberger's superneutrality hypothesis according to which changes in taxes affect the investment rate but have insignificant long-run effect on growth. This view is supported by their findings, relative to panel regressions of quinquennial averages for 18 OECD countries from 1965 to 1991. Some numerical simulations built on the class of endogenous growth models driven by human capital accumulation confirm the negligible long run growth effects of changes in the tax structure. Therefore, this analysis concludes by pointing to the importance of tax reforms as a welfare gains device (in terms of efficiency gains on the levels of consumption, investment and output) rather than as a growth enhancing policy instrument. However, it is interesting to note that using a panel of annual data, the authors do find some evidence on the growth effects of changing taxes. This latter result is interpreted as some short-run variability of growth determinants which would be consistent with stochastic endogenous growth models or as the existence of short run effects. Then, it might be case that changes in taxes may affect growth in the short but not in the long run unless the fiscal policy is permanently implemented.

In contrast Leibfritz, Thornton and Bibbee [1997] find that direct taxes reduces marginally more the economy's growth rate than the indirect taxation. This evidence regards the average growth rates of OECD countries over the period 1980-1995 regressed on three measures of tax rates: average and marginal tax rate and average direct tax rate. Further, Bleaney, Gemmell and Kneller [2002] find a strong robust evidence in favour of endogenous growth models such as Barro [1990] which suggest long run fiscal effects. This empirical support is based on panels of annual and period-averaged data for OECD countries during the period 1970-1995. They find robust long run adverse growth effects of distortionary taxation but positive effects associated to changes in productive expenditures. According to the authors, many previous works do not fully capture these long run fiscal effects since their evidence refers to period averaging and static panel methods. These techniques are not able to separate the short run effects from those
related to the long run. Therefore they cannot discriminate between neoclassical and endogenous growth models.

### 3.2.3 Inequality and Growth

The literature on the relationship between inequality and growth can be divided in two categories. First, the conventional textbook view suggests that equality has a negative impact on growth. According to this literature, a more unequal distribution of income is good for incentives and therefore growth-enhancing. Furthermore, under the assumption of a rising in income marginal propensity to save, savings, and possibly growth, are positively related to wealth inequality (see for example, Bourguignon [1981]).

Second, a new challenging literature supports the view that equality may affect growth positively. As illustrated by Perotti [1996], it is possible to identify four mechanisms according to which this latter result may occur. The first, defined as the “Fiscal Policy” approach emphasizes that more equal societies require less redistribution. Since redistributive government expenditures as well as distortionary taxation reduce the economy’s rate of growth, more equal economies grow faster (see for further details Alesina and Rodrik [1994], Perotti [1993] and Persson and Tabellini [1994]). Notice that under this view, equality is positively related to growth but a higher redistribution leads to a lower growth rate. The work by Bertola [1993] belongs to this stream of the literature but allows for considerations of a wider range of tax policies. In particular, savings and growth increase as long as investments are subsidized by higher labour income taxes whereas savings and growth fall down when investments are financed by higher capital income taxes. However, since it is the median voter who will establish the optimal tax rate, his position within the functional distribution of income matters. Investments subsidies financed by labour taxation will not receive political support if the median voter is poorly

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2 If one is interested in analyzing the relationship between the economic growth and inequality, she basically might refer to the literature which focuses on the effect of capital accumulation and technological change on the distribution of income and wealth.
endowed of capital income.

The second, known as the "socio-political Instability" approach, posits a positive relationships between equality and growth given that economic growth increases if the socio-political instability is reduced and more equal societies are more politically stable (see Alesina and Perotti [1996], Benhabib and Rustichini [1996], Fay [1993], Gupta [1990] and Svensson [1994]).

The third, called by Perotti [1996] the "Endogenous Fertility" approach implies that fertility decreases as the income dispersion is reduced. That is, more equal societies are less fertile. Lower fertility implies that there are more resources to be allocated within each family. For instance, a lower fertility rate allows more children to be able to attend school. This leads to a higher human capital accumulation and therefore to a higher growth rate. Then, the economy grow faster as fertility decreases (see Barro and Becker [1989], Becker, Murphy and Tamura [1990]).

The forth, the "Borrowing constraints-investment in education and physical capital" approach is related to the trickle-down effects of growth. Galor and Zeira [1993] show that when individuals cannot borrow freely, redistribution from the more to the less wealthy allows more individuals to invest in human capital leading to a higher growth rate. Aghion and Bolton [1997] develops a growth model where, in presence of capital market imperfections, redistribution fosters the trickle-down process and therefore growth by bringing about greater equality opportunities.

Inter-generational earnings mobility, inequality and growth is instead matter of concern of Owen and Weil [1998]. According to their model, even if the economies present identical taste and technology, different initial wealth distributions can lead to different steady states with, respectively, high and low output levels. Equilibria characterized by higher income levels also have higher inter-generational mobility and lower wealth and earnings inequality. As long as the economic growth raises, the wage gap between educated and uneducated workers reduces, the probability that more children of un-educated workers may have access to the education system increases leading to more
inter-generational mobility. This higher inter-generational mobility is growth enhancing since resources are allocated more efficiently. Therefore, the causal relationship between inter-generational mobility and growth in per capita income runs both ways. Notice finally that their model does not belong to the endogenous growth model category. This implies that their framework does not allow for different steady state income growth rates unless one endogenises the technological progress.

Benabou [2002] presents a dynamic heterogenous agent model with endogenous effort and missing credit and insurance markets. He evaluates the costs and benefits of redistributive policies defined as progressive income taxes or progressive education finance. The costs of these policies derive from the distortions in agents' labour supply and/or savings decisions. Consumptions taxes and investment subsidies are introduced to correct for the distortions in the savings decisions and therefore savings are restored to their optimal level. The benefits of these policies are expressed in terms of higher insurance against the risk of negative shocks and lower credit constraints which do not allow certain investment. He shows that in order to achieve a higher growth rate, an education finance redistributive policy always dominates income tax progressivity and transfers. This is due to the fact that the former policy implies smaller distortions to agents' effort. The opposite holds from an insurance point of view. Further, he develops a new measure of economic efficiency which builds on the sum of consumption-certainty equivalents instead of either aggregating individuals incomes and consumptions (eliminating thus the idiosyncratic uncertainty) or summing up individuals utilities (introducing then a bias towards the egalitarian allocations). This new efficiency measure instead can be conceived as a risk-adjusted GDP measure and it is shown to be maximized at some strictly positive rate of redistribution. This positive rate depends on the elasticity of labour supply, the variance of the idiosyncratic shocks and on the credit constraints on investments. Finally, the author also provides some simulations based on a calibration exercise using empirical parameters estimates. Similar findings are obtained when considering a redistributive income tax policy or a redistributive school finance policy: the richest 30%
families subsidize the education of the remaining 70%.

Much research has further pointed to the importance of the link among inequality, redistribution and skill-biased technical change or education. For instance, Rehme [2002] presents a model where human capital drives economic growth and simultaneously determines income inequality. He shows that the relationship between growth and pre-tax and post-tax income inequality is inverted U shaped. Then, a more efficient education technology determines a higher growth rate and less income distribution (a higher post-tax income inequality).

In the current chapter, we add to the “borrowing constraints-investment” approach a feature of the Fiscal Policy approach, a distortionary taxation system and show how it affects the relationship between redistribution and growth. Briefly put, we measure redistribution as a rise in the progressivity of the taxation system.

**Empirical support on the relation among inequality, redistribution and growth.**

Another empirical strategy is to evaluate the effects of redistribution on growth. However, the empirical evidence is mixed. For instance, Perotti [1993], Alesina e Rodrick [1994] and Persson and Tabellini [1994] find that redistribution affects growth negatively whereas empirical analyses presented by Easterly and Rebelo [1993] and Perotti [1994] support the opposite view. In particular, Perotti [1996] finds empirical support for the “socio-political Instability” and “Endogenous Fertility” types of explanations whereas weak evidence corroborates the “Borrowing constraints-investment in education and physical capital”. Finally, the data appear to sustain less the endogenous fiscal policy mechanism.

By comparing pre-tax and post-tax income inequality as measured by the Gini coefficient, Rehme [2002] evaluates the impact of redistribution on growth. Using income data

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3 Notice that we focus on the economic mechanism of the fiscal policy approach (i.e. distortionary taxation discourages human capital accumulation) and we do not take directly into account the political mechanism (i.e. an endogenous fiscal policy reflects the preferences of the majority)
from the *Luxembourg Income Study*\(^4\) for a sample of rich countries\(^5\), the author finds a negative relationship between pre-tax and post-tax income inequality. As a consequence long-run growth might be enhanced by more redistribution. Furthermore, according to Rehme [2002], from an empirical point of view the link between education (measured as secondary and tertiary education or overall education spending) and growth appears to be positive but weak. Higher government spending on all levels of education determines more redistribution, lower pre-tax and post-tax income inequality. After controlling for the dropout rate (as a proxy of a less efficient use of resources for education), higher education expenditure is negatively related to redistribution, pre-tax and post-tax income inequality but affects the growth rate positively. These findings appear to support the view that in a developed economy higher growth combined with a lower degree of inequality can result from an increase in education spending.

### 3.3 The Model

We start our analysis by looking at the capital accumulation equation presented in Chapter 1. Given the assumptions of constant return to scale and diminishing marginal productivity of both inputs, this model belongs to the exogenous growth model category. Clearly by definition, changes in labour tax progressivity do not affect the exogenous growth rate but the steady state output per head level. More specifically, we can look at the capital accumulation equation of the model presented in the first Chapter of this thesis:

\[
1 + g_t = \frac{k_{t+1}}{k_t} = \frac{\mu(r)}{1 + \mu(r)} \left[ \frac{1 - \alpha}{\alpha} r (1 - \lambda) + \frac{(1 - \eta)}{K^*} b \right]
\]

where \(g\) denotes the economy's growth rate, \(\lambda\) the average personal income tax rate.

\(^4\)Results are robust to a broader set of countries with less consistent inequality data from the World Income Inequality Database.

\(^5\)More specifically, the 13 countries are the following: Australia, Canada, Denmark, Finland, France, Germany, Ireland, Netherlands, Norway, Sweden, Switzerland, UK and US.
and $k$ defines the capital/labour ratio.

As it is shown in the first Chapter a progressive taxation system affects the incentive to invest in physical capital. However, in the long run changes in the tax progressivity do not have growth effects but they only modify the equilibrium factor ratios. Of course, this does not exclude the possibility of transitional growth effects. Therefore, if we wish to observe permanent effects on growth of changes in tax progressivity we need to introduce some endogenous mechanism which acts as the engine of this long run growth rate.

Following Daveri and Tabellini [2000] the production function is now defined as:

$$ Y = AK^{1-\alpha}L^{1-\alpha} $$

where $LF$ stands for labour force and $k$ now defines the capital per capita ratio ($k = \frac{K}{LF}$) and is conceived to be a measure of an externality in production. The larger the aggregate knowledge proxied by the stock of per capita capital, the stronger the externality, the more productive the firm.

The labour demand (the employment rate) is now equal to:

$$ n = \frac{1}{h} \left[ \frac{(1-\alpha)Ak^{1-\alpha}}{w} \right] $$(3.3)

Thus the employment rate depends on the wage rate ($w$), the hours of work ($h$) and on per capita stock of capital ($k$). If for sake of simplicity we assume that labour force is constant, changes in the per capita capital stock depends entirely on the stock of capital.

Under this latter assumption, the economy's rate of growth corresponds to the following expression:

$$ 1 + g_t = \frac{k_{t+1}}{k_t} = \frac{\mu(r)}{1 + \mu(r)} \left[ (1-\alpha) A L^{2-\alpha} (1-\lambda) + \frac{\mu}{k} \right] $$

(3.4)

As in the model presented in Chapter 1 since all individuals are allowed to participate, the labour force is an approximation of the entire population.
3.3.1 Analysis

The effect on growth of an increase in tax progressivity obtained as a rise in the marginal personal income tax rate keeping constant the average rate, is ambiguous. It depends on how this change affects the employment rate, the hours of work (i.e. notice that \( l = nh; n = \frac{N}{LF}; LF \sim \text{population} \)), the unemployment rate (\( u \)) and the per capita stock of capital. As in the model presented in the first Chapter only the effect on the hours of work of a change in tax progressivity is clear cut (an increase in tax progressivity reduces the hours of work). Therefore, on this ambiguity is based the empirical evidence presented in the following sections.

3.4 The Empirical Model

Equation [3.4] solves, among the other factors, the growth rate of the economy as

\[
g = G(\ln (\Delta T(\cdot, Z)),) \tag{3.5}
\]

Notice that the growth rate depends on the entire tax structure. Considering a progressive taxation system, our model suggests that the growth effect of a redistributive tax-subsidy scheme may be ambiguous. Since an increase (reduction) in the marginal (average) tax rates implies higher progressivity, we identify the marginal and average tax changes as a measure of redistribution.

With these additional assumptions, a simplified log-linear approximation of equation [3.5] yields the following empirical models:

\[
gjt = f_j + \beta_{1j} \Delta T_{jt} + \beta_{2j} \Delta \lambda_{jt} + \beta_{3j} g_{j(t-k)} + \epsilon_{jt} \tag{3.6a}
\]

\[
gjt = f_j + \beta_{1j} \Delta T_{jt} + \beta_{2j} \Delta \lambda_{jt} + \beta_{3j} g_{j(t-k)} + \beta_{4j} \ln y_{j,t-1} + u_{jt} \tag{3.6b}
\]

where the index \( j \) is country specific; \( g_{jt} \) is per capita output growth (expressed as
\( \ln \Delta y_{jt}, \Delta \tau_{jt} \) denotes the change in the marginal income tax rate, \( \Delta \lambda_{jt} \) is the average income tax rate of change and \( f_j \) is a country specific fixed effect and \( \epsilon_{jt} \) is the random error term (\( \epsilon_{jt}, u_{jt} \sim i.i.d. \)). The term \( g_j(t-k) \) is introduced to correct for any kind of dynamic misspecification and the term \( \ln y_{jt, t-1} \) in the [3.6b] specification to capture the speed of convergence towards the steady state\(^7\). Within an annual panel data the role played by the lags of the dependent variable is similar but not identical to the role played by the initial level value of the dependent variable in either cross section regressions or averaging periods panel data. Both denote a kind of persistency. However, in annual data this persistency is expressed in terms of short run fluctuations whereas in cross countries regression has the meaning of evaluating path dependency of the initial conditions. That is, the use of annual data allows us to clearly separate short run dynamics from the long run. Therefore the difference between the first two model specifications relies on the statistical significance of the first lag level of the dependent variable. If the coefficient is significant, this implies that the process is "mean reverting". The mean towards the process goes back is indeed the steady state. In fact, notice that equation [3.6a] can refer to an endogenous growth model where there is not transitional dynamics (i.e. the process is not mean reverting). In contrast, equation [3.6b] allows for a transitional dynamics although so far we do not introduce explicitly the long run equilibrium term. The introduction of some lags into equation [3.6b] has the same interpretation and motivation of the introduction of some lags into the well known Dickey Fuller test leading to the so called Augmented Dickey Fuller test. Higher order autoregressive terms are included to control for serial correlation (short run fluctuations). The coefficient of the first lag of the dependent variable instead verify whether or not the process goes back to the steady state. Finally, we consider a third model specification according to which the long run equilibrium relates output to the two tax levels of interest and a measure of the stock of

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\(^7\)As it is well known, the estimated coefficient on \( \ln y_{t-1} \) suffer from a downward bias of \( 1/T \) as proved by Nickell [1981]. However, in our case, this bias is not so severe as in a dynamic panel where \( N \) is large and \( T \) relatively small.
human capital such as the average years of education \((hc)^8\). That is:

\[
g_{jt} = f_j + \beta_1 \Delta \tau_{jt} + \beta_2 \Delta \lambda_{jt} + \beta_3 g_{jt(t-k)} - \phi_j (\ln y_j - \theta_1 \tau_j - \theta_2 \lambda_j - \theta_3 h c_j)_{t-1} + \varepsilon_{jt} \tag{3.6c}
\]

Equation can be conceived as a simplified ECM model specification of [3.5]. Notice further that the hypothesis of homogenous long-run parameters is specifically tested. As long as it is accepted we will adopt a Pooled Mean Group procedure as suggested by Pesaran, Shin and Smith [1999].

The model is estimated on a sample of 15 OECD countries observed from 1974 to 1997.

As suggested in the brief survey of the literature a possible link between wealth inequality and growth is the pressure for redistribution that arises. Social security and welfare, health and housing and public expenditure on education represent types of government expenditures which are redistributive in nature. However, as suggested by our theoretical model, what matters for growth is the distortionary effect of taxation. For this reason, following explicitly our model we introduce the rate of change of marginal and average personal income tax rates.

Previous empirical work, most notably by Perotti [1996], have added marginal tax rates as income distribution variables to the set of independent variables of standard growth regressions. This specification differs from it by introducing the rate of change of tax rates rather than the tax level. Eastearly and Rebelo [1993] introduce in their growth regression the rate of change of the tax rates. However, their evidence suggests that the relationship between taxation and growth is very fragile.

Following Perotti [1996], the identifying assumption of the structural form are the exclusion of an “equality measure” from the above model specification (the economic mechanism) and the exclusion at least in the short run in what Perotti [1996] calls

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8This variable is taken from page 28 of the OECD working paper n.282/2001 by Andrea Bassanini and Stefano Scarpetta.
the political mechanism of both a human capital measure and the unemployment rate.

In the current setup, on the one side, progressive taxation and high tax rates discourage investment in human capital and the supply of hours of work. Then growth might increase as distortionary taxation decreases. On the other, progressive taxation could have a beneficial effect on the employment rate, leading thus to a higher growth rate. Then, it is reasonable to expect the negative (positive) effect to dominate in those
countries characterized by high marginal (average) tax rate and a high (low) degree of tax progressivity. Expectations on countries characterized by a mixed combination of high marginal (average) tax levels and low (high) degree of tax progressivity are not signed. For this reason, in the empirical specification we will also test the restrictions that the sign of the effect depends on the taxation level and the degree of tax progressivity according to the scheme described by Figure [3.1].

On the horizontal axis countries are ordered according to their average over the sample period degree of tax progressivity from the lowest (i.e. the highest value for the coefficient of income progression) to the highest whereas on the vertical axis they are ranked on the basis of their average level of marginal personal income tax rates from the lowest to the highest.

If the relation of interest is hump-shaped, we expect a positive (negative) effect of redistribution on growth for those countries in the first (fourth) quadrangle. That is, countries with low (high) marginal tax rates and low (high) tax progressivity might benefit (be penalized by) of more redistribution measured as a rise in the marginal tax rate.

Countries in the second and third ones are not signed on a priori grounds.

A similar identification scheme relates the degree of tax progressivity and the level of the average personal income tax rate\(^9\).

On the horizontal axis, as before, countries are ordered according to their degree of tax progressivity, averaged over the sample period, from the lowest to the highest whereas now on the vertical axis they are ranked on the basis of their average personal income tax rates averaged over the sample period from the highest to the lowest.

We expect a positive (negative) effect of redistribution on growth for those countries in the first (fourth) quadrangle. That is, countries with high (low) average tax rates and low (high) tax progressivity might benefit (be penalized by) of more redistribution

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\(^9\)Although, a pure increase in tax progressivity is determined by a rise in the marginal tax rate holding constant the average tax rate, if the policy maker lowers, ceteris paribus, the average tax rate we observe a higher progressivity in the taxation system.
measured as a reduction in the average tax rate.

As in the previous figure, countries in the second and third ones are not signed on a priori grounds.

When these restrictions hold, we say that the sign of the effect of redistribution on growth depends on the degree of tax progressivity and the tax rates levels.

In the next sections we will then test whether these restriction hold.

Figure 3-2: Degree of Tax Progressivity and Average Tax Rates
3.4.1 The Data

We investigate the relationship between redistribution and growth using an original data set on marginal and personal income taxes: a panel for 15 OECD countries (Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Spain, Sweden, UK, US) covering the period 1974-1997. The main source which has allowed the creation of this data set is an OECD publication “The tax-benefit position of production workers.”

Figure 3-3: Country Groups classified on the basis of their Marginal Tax Rate.

For each year and for each country in the sample, we compute pre-tax wages by using the information on income tax rates, tax allowances and credits from the relevant tax
legislation and using information on the composition of our “representative” household (a worker, earning the average wage in the manufacturing sector, who has a dependent spouse and two children). Given pre-tax wages and social security contributions paid by the employee, we compute the relevant average and marginal tax rate. These rates are based on labour income only, and do not take into account additional income from capital and self-employment. The Appendix at the end of the chapter provides additional technical details.

Data refer to the income distribution rather than the wealth distribution. However, one can argue that this first approximation can be accepted given the large correlation between indicators of equality derived from the two distributions.

Figure 3.3 provides a summary description of the data by group classified on the basis of their level of the marginal tax rate\(^\text{10}\).

The first group \((GR1)\) (high marginal tax rate countries whose redistributive effect might be negative) includes all countries in the fourth quadrangle of Figure 3.1\(^\text{11}\); the second \((GR2)\) (low marginal tax rate countries whose redistributive effects might be positive) all those belonging to the first one\(^\text{12}\) and the third group incorporates all those countries whose redistributive effects are not signed on a priori grounds\(^\text{13}\).

The first panel of the figure shows that the GDP per capita growth has fluctuated during the sample period, among all the three groups of countries. Per capita growth rate \((AVGR)\) averaged over the 15 countries is also included. The three groups seem to present a similar evolution of the GDP per capita growth rate at the beginning of the sample period whereas they seem to respond differently to shocks.

In particular, the second group appears to be less responsive. Marginal tax rates by countries’ groups\(^\text{14}\) have increased (see panel 2), especially among the third group. As

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\(^{10}\) We cluster the countries on the basis of two criterion combining alternatively the degree of tax progressivity either to the marginal or to the average tax rates.

\(^{11}\) Namely: Belgium, Finland, The Netherlands, Sweden, UK and US.

\(^{12}\) Namely: Australia, Germany, Italy, Japan, Norway and Spain.

\(^{13}\) Namely: Canada, Denmark and France.

\(^{14}\) Countries’ groups classification is based on Figure 3.1.
a consequence, the relative marginal tax rate between the third and the first group has lowered from less than 7% in 1974 to about 5% in 1997. The absolute gap between the first and the second group is almost stable around 6%.

Panel 3 shows that first and second group average income tax has increased up to mid eighties, bounced back to increase again at the beginning of the nineties. Finally, the evolution of tax progressivity is illustrated in the last panel of the figure. For the first and second group, progressivity increased sharply up to 1983, partially bounced back in the mid 1980 to decrease in the rest of the period. For the third group, it has decreased sharply up to 1982 and increased thereafter.

Figure 3.4 presents similar evidence by average personal income tax rate group.
The first group (GR1) (low average tax rate countries whose redistributive effect might be negative) now includes all countries in the fourth quadrangle of Figure 3.2\textsuperscript{15}; the second (GR2) (high average tax rate countries whose redistributive effects might be positive) all those belonging to the first\textsuperscript{16} one and the third group incorporates all those countries whose redistributive effects are not signed on a priori grounds\textsuperscript{17}. We notice that the evolution of the growth rate for the first and third group is quite similar over the entire sample period. A different pattern in the evolution of the rate of growth of the second group has been accompanied by a higher marginal tax rate with the exception of the last four years when it has been overtaken by that of the first group. Panel 3 shows that the average income tax of the second group has decreased mildly whereas average income tax rate of the third group has increased. Clearly, their gap has lowered sharply in the 1990s. Income tax progressivity has increased across the first two groups, while the third group degree of tax progressivity have declined since the mid 1980s.

3.5 Results

We start our empirical analysis by estimating equations [3.6a], [3.6b], [3.6c] on the longitudinal data for the years 1974-1997. Since individual fixed effects are eliminated by taking first differences; the term $f_j$ captures time fixed effects in levels. First, we test the hypothesis of homogenous coefficients, second, if we reject the above hypothesis, we assume a random coefficient model:

$$\beta_{jz} = \beta_z + \xi_{jz}$$

that is, individual coefficient are distributed around a common mean and the disturbance component $\xi_{jz}$ has a zero mean and a constant variance.

\textsuperscript{15}Namely: Belgium, Canada and France.
\textsuperscript{16}Namely: Denmark, Germany and Norway.
\textsuperscript{17}Namely: Australia, Finland, Italy, Japan, The Netherlands, Spain, Sweden, UK and US.
Providing a statistical support to the heterogeneity of the parameters is important for at least two main reasons. First, our theoretical framework suggests that coefficients which measures the growth effect of redistribution might differ across countries according to their taxation level and the degree of tax progressivity. Second, Pesaran and Smith [1995] show that when the coefficients' heterogeneity is ignored in a dynamic setting, the pooled estimator is inconsistent even if the time dimension goes to infinity.

Poolability is tested by the method proposed by Lee, Pesaran and Pierse (reported as LPP) [1990], that is following partially the author notation\textsuperscript{18}:

\[ q_2 = t^{-1} \theta_x \Phi_t^{-1} \theta_x \sim \chi_k^2 \]

where \( t \) stands for number of temporal observations and \( k \) denotes the number of regressors. For \((k \leq x)\) under the null hypothesis of parameter homogeneity, we have:

\[ H_0 : \theta_x = 0 \]

where

\[ \theta_x = b_x - \frac{1}{\zeta} \sum_{j=1}^{\zeta} \beta_x \]

where \( \zeta \) denotes the number of the cross sectional units \( j \).

We perform the above test since the familiar method proposed by Zellner [1962] is too restrictive\textsuperscript{19}. Since according to Lee et al. [1990], the null could hold even when the homogeneity assumption is rejected.

\textsuperscript{18}Where \( \Phi = t^{-1} \sum_{ij} \sigma_{ij} P_i P_j \); \( P_i = (X_a X_a)^{-1} X_a - \frac{1}{n} (X_i' X_i)^{-1} X_i' \) and the subscript \( a \) stands for "aggregate" (i.e. parameter homogeneity).

\textsuperscript{19}Zellner [1962] tests the homogeneity hypothesis as follows:

\[ H_0 : \beta_{j1} = \beta_{j2} = \ldots = \beta_{xj} = \ldots = \beta_{xc} \]
According to our model specification \([3.6c]\), we will test further the homogeneity restriction on the long-run parameters through an Hausman test which as usual evaluates whether the estimated coefficients using a mean group procedure and a pooled mean group one do differ.

Our main results are reported in Table 3.1 which shows both the estimated coefficients and the implied mean lag elasticities associated to the change in the tax variables under the homogeneity assumption.

The dependent variable is the change in the (log) GDP per capita, where the latter is obtained by dividing the annual GDP at constant price by the total population. Under all model specifications, we find that higher redistribution induced by a positive (negative) change in the marginal (average) taxes significantly reduces the per capita growth rate of the economy. It is interesting to note, that according to Table 3.1, column \([3.6a]\), a change in the marginal tax rate is equivalent, in terms of the redistribution effect on growth, to a change in the average tax rate since the size of the two coefficients is quite similar. Further, notice that the estimates appear to be robust to the three model specifications.

Therefore, redistribution appears to affect the OECD countries' growth negatively. On the other hand, their mean lag elasticities appear to be small (0.10)\(^{20}\).

The LPP criterion (reported as POOL) clearly rejects the hypothesis of homogeneity. We then estimate a version of equations \([3.6a]\), \([3.6b]\), \([3.6c]\) where we allow for parameter heterogeneity under the assumption of a random coefficient model. Notice that when considering equation \([3.6c]\), according to the Hausman test (reported as POLR) the homogeneity hypothesis on the long run parameters is accepted and therefore we proceed further under this assumption. (i.e. when we estimate equation \([3.6c]\) we use the Pooled Mean Group Estimator). We capture the time fixed effect in levels with specific constants and estimate two alternative empirical specifications.

\(^{20}\)Mean Lag Elasticities as usual are calculated under the assumption of \(g_t = g_{t-1} = g_{t-2}\). We can not consider these elasticities as properly long run ones. Notice, further, that they could represent an econometric approximation of the long run when equations \([3.6a]\) and \([3.6b]\) are considered. In fact, these two empirical specifications do not explicitly include the economic long-run relationship.
Dependent variable: rate of change in log annual GDP per capita

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<th>3.6a</th>
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Note: Each regression includes a specific constant and two lags of the dependent variable.

Robust standard errors within parentheses. 𝑅² adjusted for the degree of freedom 𝜂₁: marginal (rate of change) income tax mean lag elasticity of the per capita growth; 𝜂₂: average (rate of change) income tax mean lag elasticity of the per capita growth. POOL: P-value of the test for the homogeneity of parameters (χ²(4) = 16.87; χ²(5) = 16.69; χ²(5) = 34.33); POLR: P-value of the test for the homogeneity of the long run coefficients (χ²(4) = 3.99).

Table 3.1: SUR Estimates of 3.6(a,b,c) based on panel data (1974-1997)
In a former specification we follow Pesaran and Smith [1997] by allowing for short run coefficients heterogeneity across all sectional units. Therefore, estimates are based on what Pesaran and Smith define as a "Mean Group Estimator". Mean-lag elasticities are then calculated from the mean of the mean lag country-specific coefficients and from the average of country specific short-run coefficients.

In the second specification, we impose and test restrictions on parameter heterogeneity within three groups of countries according to our identification scheme. The second specification allows us to verify whether the effect of distribution on growth depends on the tax level and the degree of tax progressivity.

Table 3.2 shows our estimates, with the former specification in the first three columns (without country groups classification) and the latter specification (with country groups classification) in the last three columns. The first three columns show that a higher redistribution obtained as positive (negative) rate of change in the marginal (average) income tax reduces the economy growth. These findings confirm the results in Table 3.1. Moreover, compared to that table, we find that the impact of redistribution on growth differs quantitatively. The effect is stronger to that found in Table 3.1 for both a change in the marginal and a change in the average personal income tax rate\(^\text{21}\). The mean lag elasticities confirm this pattern. Overall, this evidence suggests that the assumption of homogeneity can produce misleading results in terms of the size of the effects and that the estimates of the average mean lag effects do differ.

Next we ask whether the impact of redistribution on growth vary by the tax level and the degree of tax progressivity, as suggested by our identification scheme reported in Figures 3.1 and 3.2. This is done by selecting the empirical specification in the last three columns of Table 3.2 and by classifying the countries in three groups according to which, given their tax levels and degree of tax progressivity, a higher redistribution obtained as an increase (a reduction) in the marginal (average) tax rate might have a

\(^{21}\)Although now, when considering equation [3.6a] the coefficient of the marginal income tax rate is smaller and insignificant.
negative \((GR1)\)\(^{22}\), positive \((GR2)\)\(^{23}\) or unsigned effect \((GR3)\)\(^{24}\) on growth. Notice that, by averaging, the mean group estimator provides a consistent estimator of the effect with respect to all the country set. Nevertheless, if the sign of the effect depends on the tax levels and the degree of tax progressivity, a simple average could change the sign of the effect for some countries and could weaken the effect. That is, the Mean Group Estimator is a consistent linear estimator and therefore it can not fully capture the non linear relationship between redistribution and growth.

We started from what suggested by Figures 3.1 and 3.2 and the final country classification to which we arrived differ slightly from that only on the basis of the statistical tests. In particular we were unable to identify what we define as a second group for a change in the average tax rate.

The last three columns in Table 3.2 broadly confirm that the sign of the redistribution effect on growth may depend on the tax level and the degree of tax progressivity. All the tax change coefficients appear to be significant\(^ {25}\). The three groups of country present the sign expected. Notice that the country group classification is quite close to what suggested by Figure 3.1 and 3.2. Furthermore, it is worth pointing out that the third group (i.e. the unsigned from a theoretical point of view) suggest that different redistribution effects can be obtain if one allows a change in the marginal (negative) rather than an average (positive)\(^ {26}\) tax rate\(^ {27}\). That is, with respect to changes in the marginal tax rate the third group behaves as the first group whereas with respect to the average tax rate it

\(^{22}\)Countries included in this group are: Denmark, Finland, Netherlands, Sweden and the UK with regard to the marginal tax rate; Belgium, Canada, Finland, France, Italy, Japan, Netherlands, Spain, Sweden and the UK with regard to the average tax rate.

\(^{23}\)Countries included in this group, which is defined with respect to the marginal tax rate only, are: Australia, Germany, Italy, and Japan.

\(^{24}\)Countries included in this group are: Belgium, Canada, France, Norway, Spain and the US with regard to the marginal tax rate; Australia, Denmark, Germany, Norway and the US with regard to the average tax rate.

\(^{25}\)Only the change in the marginal tax rate of the second group is almost significant in the \([3.6a]\) specification (i.e. column \((2a)\)).

\(^{26}\)A decrease (increase) in the average (marginal) tax rate determines higher redistribution captured by a higher tax progressivity.

\(^{27}\)This result does not hold when we introduce the long run term.
<table>
<thead>
<tr>
<th></th>
<th>(1a)</th>
<th>(1b)</th>
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Note: Additional regressors are a specific constant and two lags of the dependent variable. Robust standard errors within parentheses. 
$\eta_1$: marginal (rate of change) mean lag income tax elasticity of the GDP per capita growth rate calculated from the mean of the mean lag country-specific coefficients; $\eta_2$: average (rate of change) mean lag income tax elasticity of the GDP per capita growth rate calculated from the mean of the mean lag country-specific coefficients; $\eta_3$: marginal (rate of change) mean lag income tax elasticity of the GDP per capita growth rate calculated from the average of country specific short-run coefficients; $\eta_4$: average (rate of change) mean lag income tax elasticity of the GDP per capita growth rate calculated from the average of country specific short-run coefficients; $ZEL$: P-value of the test for the identification of the three groups of countries $(\chi^2(3) = 2.59; \chi^2(3) = 5.69; \chi^2(3) = 14.8)$.

Table 3.2: Mean Group Estimates on equations 3.6(a,b) and Pooled Mean Group Estimates on equation 3.6c
<table>
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<th>(PMG,2c)</th>
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<td>( GR1\eta_2 )</td>
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<td>( GR1\eta_3 )</td>
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<tr>
<td>( GR1\eta_4 )</td>
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<td>.362</td>
<td>.306</td>
</tr>
<tr>
<td>( GR2\eta_1 )</td>
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<td>.131</td>
<td>.134</td>
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<td>( GR2\eta_3 )</td>
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<td>( GR3\eta_2 )</td>
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<td>.246</td>
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<td>( GR3\eta_3 )</td>
<td>.166</td>
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<tr>
<td>( GR3\eta_4 )</td>
<td>.131</td>
<td>.090</td>
<td>.029</td>
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</tbody>
</table>

Note: \( \eta_1 \): marginal (rate of change) mean lag income tax elasticity of the GDP per capita growth rate calculated from the mean of the mean lag country-specific coefficients; \( \eta_2 \): average (rate of change) mean lag income tax elasticity of the GDP per capita growth rate calculated from the mean of the mean lag country-specific coefficients; \( \eta_3 \): marginal (rate of change) mean lag income tax elasticity of the GDP per capita growth rate calculated from the average of country specific short-run coefficients; \( \eta_4 \): average (rate of change) mean lag income tax elasticity of the GDP per capita growth rate calculated from the average of country specific short-run coefficients.

Table 3.3: Mean Lag elasticities based on the three groups of countries classification

behaves as the second group. As expected, the size of the country groups coefficients are larger than those estimated by the "mean group estimator" for all countries, since the latter is strongly penalized by the ambiguity of the sign of the effect. Notice however that we test the country classification by imposing the "homogeneity" restrictions across the three groups (i.e. a Zellner test of the kind \( H_0 : \beta_{j1} = \beta_{j2} = \ldots = \beta_{jx} = \ldots = \beta_{jz} \)).

Once, the test is accepted, since as discussed above is too restrictive, we apply the "mean group estimator" within the three country groups. Notice that asymptotically the two estimators are equivalent if the parameters are homogenous.

Mean lag elasticities are larger than those calculated from the mean group estimates. For example, under [3.6a], column 2a in Table 3.3, a one percent increase in redistribution measured by the rate of change in the marginal tax rate for the first and third group (second group) determines a 0.39 and 0.27 (0.23) decrease (increase) in the economy growth.
From an economic perspective, redistribution could be endogenous. That is, a higher rate of growth could lead to higher redistribution. Notice that our measure of redistribution derives by construction from the earnings distribution and refers to a sort of representative employee tax-payer. Therefore, it could also end up to be exogenous. Then, the endogeneity of the current changes in the two tax rates requires to be tested. Our selected instruments for lack of other appropriate variables include a constant, a current and a squared time trend, and the first and second lags of the changes in both tax variables\(^{28,29}\).

Instrument validity is tested with the Hausman Criterion, a misspecification test of whether explanatory variables are exogenous. Notice that since we start from estimates of our three model specifications (i.e. equations [3.6a], [3.6b], [3.6c]), the Hausman test implies comparing the GLS variance-covariance matrix to the three stage least square one. Table 3.4 illustrates the results. We are testing the endogeneity issue under the assumption of parameter heterogeneity across the three country-groups. Therefore, the Wald test reported as ZEL verifies further this country-groups restrictions in the Three Stage Least Square estimates. In the last three columns are reported the mean group estimates which differ from those reported in Table 3.2 by cross-country classification. Since the 3 stage estimates of Table 3.4 do not accept the previous country classification, we need to shift some countries from the first to the third group for providing a consistent comparison between the 3 Stage and the Mean Group estimates.\(^{30}\) Indeed, when we introduce the long run equilibrium term, the first and the third group present the same

\(^{28}\)We checked whether the use of lagged tax variables introduces some autocorrelation. The null hypothesis of the absence of serial correlation is always accepted.

\(^{29}\)When estimating 3.6(\(b, c\)), we introduce second and third lags of the tax variables in order to avoid inconsistency problems.

\(^{30}\)Countries included in the first group are now: Finland, Netherlands, Norway, Spain, Sweden and the UK with regard to the marginal tax rate; Finland, Italy, Spain, Sweden and the UK with regard to the average tax rate.

The second group, classified only with respect to the marginal tax rate is made of: Australia, Germany, Italy and Japan.

Finally the third group: Belgium, Canada, Denmark, France and the US with regard to the marginal tax rate; Australia, Belgium, Canada, Denmark, France, Germany, Japan, The Netherlands, Norway and the US.
Dependent variable: log annual rate of growth.

<table>
<thead>
<tr>
<th></th>
<th>(3STa)</th>
<th>(3STb)</th>
<th>(3STPMGc)</th>
<th>MGEa</th>
<th>MGEb</th>
<th>PMGc</th>
</tr>
</thead>
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<tr>
<td>$GR1\Delta\tau$</td>
<td>-0.220</td>
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<td>(.020)</td>
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<td>(.045)</td>
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<td>(.034)</td>
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<td>0.382</td>
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<td>(.019)</td>
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<td>.981</td>
<td>.787</td>
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Note: Additional regressors are a specific constant and two lags of the dependent variable. Robust standard errors within parentheses. $ZEL$: P-value of the test for the identification of the three groups of countries $(\chi^2(3) = 1.99; \chi^2(3) = 10.6; \chi^2(3) = 3.18; \chi^2(3) = 4.02; \chi^2(3) = 6.28; \chi^2(3) = 7.23)$. $HAUS$: P-value of the Hausman test for the endogeneity of the explanatory variables $(\chi^2(57) = 29.7; \chi^2(81) = 56.7; \chi^2(72) = 62.2)$.

Table 3.4: Three Stage Estimates of Equations 3.6(a,b,c)

The Hausman test suggests that change in tax rates are not endogenous. For each model specification, estimates illustrated in the first three columns $3ST (a, b, PMGc)$ do not diverge too much from those reported in the last three columns $MGE (a, b, PMGc)$. Then, we are quite confident in the Mean Group estimates.

Notice further that results are not quite different from the previous country group classification.

For example, by considering column $(PMGc)$ in Table 3.5 since the long run equi-
Table 3.5: Mean Lag Elasticities based on Estimates reported on Table 3.4

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<tr>
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<th>(MGEb)</th>
<th>(PMGc)</th>
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<td>0.682</td>
</tr>
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<td>0.291</td>
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<td>0.145</td>
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<td>GR3η3</td>
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<td>0.309</td>
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<td>0.070</td>
<td>0.084</td>
<td>0.103</td>
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Note: η1: marginal (rate of change) mean lag income tax elasticity of the GDP per capita growth rate calculated from the mean of the mean lag country-specific coefficients; η2: average (rate of change) mean lag income tax elasticity of the GDP per capita growth rate calculated from the mean of the mean lag country-specific coefficients; η3: marginal (rate of change) mean lag income tax elasticity of the GDP per capita growth rate calculated from the average of country specific short-run coefficients; η4: average (rate of change) mean lag income tax elasticity of the GDP per capita growth rate calculated from the average of country specific short-run coefficients.

The equilibrium term is highly significant, we find that the elasticity, calculated from the mean of the mean lag country-specific coefficients, of the rate of growth to changes in the marginal tax rates is significantly lower in the second group (0.128) than in the first and third group (1.29 and 0.291 respectively). Similarly, the elasticity, calculated from the mean of the mean lag country-specific coefficients, of the rate of growth to changes in the average tax rate is much higher across the first group (2.05) than across the third group (0.145) where it is particularly small. As already observed there is a certain difference between elasticities calculated from the mean of the mean lag coefficients and those derived from the average of the short-run coefficients. The low elasticities in the third group could be explained with the fact that the positive effects of higher redistribution of this group have been relatively close to the negative discouraging effects in an economic environment characterized either by high tax rates or an high degree of tax progressivity. As a consequence of these two counterbalancing effect, the impact on growth could not

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adjust as much as in the case of the other two groups where the negative (positive) effects should be stronger.

We can further illustrate our results in this section by considering the following policy experiment. Marginal income taxes have changed from 1975 to 1997 by close to 5% and 10% (-4.62% and 8.51) respectively for the first and second group of countries and both growth rates during the same period are close to 2% (1.7% and 1.97%). Suppose that the government of the first (second) group of countries decide to reduce (increase) the marginal income tax rate by 5% (10%). This corresponds to a "pure" reduction (increase) on tax progressivity for the first (second) group. According to our estimates in column \( MGEa \) of Table 3.5, the mean lag elasticity of growth to change in marginal tax rate is 0.324 and 0.241 for the first and second group respectively\(^{31}\). Using these estimates, this policy experiment would increase the growth of the first and second group by 1.6% and 2.41% which do not differ much from the actual values.

### 3.6 Conclusions

We have found that higher redistribution affects growth conditioning on the degree of tax progressivity and the taxation level. In those countries characterized by a high taxation level and a high degree of tax progressivity, further redistribution has a negative impact on growth since the discouraging effects on individuals' choices prevail the positive effect of allowing more people to have access to the labour market.

This result is consistent with our theoretical framework where a feature extrapolated from the so called "Fiscal Policy" approach, as a distortionary taxation system, has been introduced in a growth model closed to the model presented in the first Chapter of this thesis.

Our findings could also explain why empirical evidence on this issue presents ambigu-

\(^{31}\) When we control for the long run term, the elasticities are much higher (lower) for the first and the second group of countries respectively. In this respect, the policy experiment seems to more consistent with our [3.6a] model specification.
ous results. A message of this paper is that the political agenda's dilemma could be less costly than it seems to be. In societies characterized by a high level of income-wealth inequality, boosting the economy's growth and reducing the income disparities can both be obtained by the same redistributive policy.
The data set

Some few assumptions regarding the identification of a common socio-economic group are needed in order to have a dataset which is able to provide comparable data among countries.

Following Lockwood and Manning [1993], a married with two children male production worker that earns the average gross wage from employment in the manufacturing sector is believed to be a good approximation of this representative agent (APW henceforth). Since the taxation system is not linear, when aggregating across different industries, where earnings are reasonably different, the average marginal rate and the average rate are not, in general, equal to the marginal and average tax rates evaluated at the average earnings:

\[
\left( \frac{1}{n} \sum_{i=1}^{n} T(W^i) \right) \neq T \left( \frac{1}{n} \sum_{i=1}^{n} W^i \right)
\]  

(3.A.1)

where now \( n \) stands for the number of individuals (i).\(^{32}\)

However, given that the basic rate tax bracket is so large for almost all countries and for most of the sample period this aggregation bias is not likely to be severe.

The spouse of this representative tax-payer does not work. Although this assumption may lack of reality, it is difficult to see any other alternative given that the OECD data until 1995 are collected assuming this household’s characteristic.\(^{33}\)

Only wage income is considered. That is, the actual tax rates may be higher than those presented in this database. However, in the United States only, such representative

\(^{32}\)We slightly change the chapter's notation for convenience.

\(^{33}\)For further details about the guidelines on the methodology and limitations of the data, see OECD "The Tax Benefit position of production workers", Part I.
tax payer receives an unearned income equal, on average, to the 5 % of its income. In almost all the other countries, different sources of income than wage are not significant. For example, in Australia and Finland, they account for 0.5 per cent of the APW’s wage.

Then, marginal tax rates are calculated as follows:

\[ \tau = \frac{ITL}{TI} + \frac{SSC}{Y} \]  

(3.A.2)

where ITL stands for Income Tax Liability, TI for Taxable Income, SSC for Social Security Contributions and Y for Wage or Taxable Income according to the country legislation.

Income Tax Liability consists of the liability due to the central government. Yet, it takes into account state and local liabilities in those Federal countries where income taxes are levied by intermediate levels of government. In particular, Canada and the United States levy state taxes, Belgium, Denmark, Finland, Japan, Norway, Sweden and the United States local taxes. For sake of simplicity and without a big loss of precision they are all considered as proportional to taxable income. The latter is defined as:

\[ TI = GWE - STA + TC \]  

(3.A.3)

The Gross Wage Earnings (GWE) corresponds to the Wage paid to the Average Production Worker (APW) in the manufacturing sector; the Standard Tax Allowances (STA) and Tax Credits (TC) are those applicable to the average production worker who is married, with two children, and satisfies all the requirement specified in the legislation.

Social Security Contributions are those compulsory contributions paid by the employees at the APW income level to government or social security funds controlled by the government. They are levied on gross earnings for almost all countries with the exception of Denmark, Finland, France, the Netherlands and Norway where they are based on the taxable income.\(^{34}\)

\(^{34}\)This is true for almost the entire sample period.
The effective average tax rate corresponds to the following expression:

\[
\lambda = \frac{TPG - CT}{W}
\]  \hspace{1cm} (A.3.4)

where \( TPG \) stands for Total Payment to the Government, \( CP \) for Cash Transfer and \( W \) for Gross Wage Earnings.

Total payments to general government includes all central, state and local income taxes finally paid and the employees' social security contributions. Cash Transfers mainly regards the "standard tax allowances" paid in respect of a wife and dependent children between five and twelve years old.

A more accurate measure of the effective average labour income tax rate should include also the non standard reliefs. By "non standard tax reliefs" is meant all those reliefs associated to the actual expenses incurred. Yet, for various reasons explained by the OECD, it is possible to have this data for very few years only. Therefore, the main concerns are related to those countries where they have a relevant weight in determining the effective average tax rate. This is in particular the case of Denmark where ignoring these reliefs is quite misleading. Indeed, the effective average tax rate for our representative agent is reduced of the 30% if the non standard tax reliefs are considered\(^{35} \). For this reason, the Denmark effective average tax rate series is extrapolated by the personal income tax revenue.

The last remarks regard cross-countries and time series limitations of the dataset.

First, from the cross-country point of view, it should be bore in mind that even though the APW corresponds to workers who are doing the same kind of jobs, its wage is not in the same position in the distribution of earnings in each country.

Second, from the time series point of view the main problem relates to the fact that it is likely that the earnings data do not refer to the same taxpayer throughout the period.

\[^{35}\text{Spain and Sweden suffer of the same problem. However, on the basis of the few years where the OECD provides both measures the effective average tax rate (e.g. including or excluding the non standard tax relief ), it seems that the bias is not so relevant as in the Denmark case.}\]
However, as pointed out by the OECD, results can be misleading only if many of the limitations are taken cumulatively within a specific country.
Conclusions

This thesis has presented two chapters on the relationship between tax progressivity and the labour market.

In particular, Chapter 1 has described a general equilibrium model on the relation among tax progressivity, wage setting and employment which distinguishes between the implications of changes in the degree of personal income and payroll tax progressivity. From a theoretical point of view three main conclusions can be derived.

First, we consider another effect, the “general equilibrium interest rate effect”. Then, it would be interesting to analyse whether this result would hold in a small open economy where the real interest rate has to be taken as given.

Secondly, the role played by the labour supply is crucial in determining the size and the sign of the effect of changes in personal income taxation over wage setting and cancels out the hypothesis that given individuals’ rational behaviour, personal income taxes and payroll taxes affect wage determination in the same manner.

Thirdly, employment effects depend on the initial taxation level: the higher the tax level, the stronger the effect.

Some of these points address the question of whether unions are able to shift the tax burden onto firms. According to our policy experiments, that were run through a calibration approach, the answer is no. However, our policy experiments find also some evidence in favour of the Daveri and Tabellini’s [2000] hypothesis according to which an economy’s poor employment performance can be related to labour taxation. In particular, a 1% decrease in the average personal income and payroll tax rates has a
relevant impact on employment (namely, 0.43% and 0.83%, respectively, for Italy; 0.60% and 0.57%, respectively, for the US). These effects are strongly related to the interest rate mechanism and to the initial taxation level.

Chapter 2 has presented a multisector model with unionized labour markets and monopolistically competitive product markets where workers care about their consumption and their relative position in the distribution of income. This simple model suggests that the explicit consideration of the interdependence among wages in unionized labour markets increases the likelihood that the effect of higher tax progressivity on the pre-tax wage be positive, with negative consequences for unemployment. There are three mechanisms at work: a) a union wage moderation effect; b) a labour supply effect c) a wage interaction effect. The latter mechanism requires an intermediate level of centralization of the wage bargain.

We have extended the results by Calmfors and Driffill [1988] and Daveri and Tabellini [2000] on the relationship between wage bargaining, average taxes and unemployment, to the relationship between tax progressivity and unemployment and have established that, ceteris paribus, the possibility that higher tax progressivity could reduce unemployment is lower for intermediate degrees of centralization of the wage bargain than for either decentralized or fully centralized bargaining.

In our empirical study of Italy, a country with an intermediate degree of centralization of the wage bargain, we have shown that higher tax progressivity increases pre-tax wages, with negative consequences for employment and unemployment. The positive effect of higher marginal income tax rates, given average rates, on the pre-tax wage is not in line with the previous empirical literature, which typically finds a negative effect. We interpret this finding as evidence that when unions strategically interact both the labour supply and the wage interaction effect dominate the wage moderation effect. A message of this paper is that the opportunity to reduce unemployment by varying the degree of labour tax progressivity can vary with the institutional context regulating wage bargaining.

Finally, Chapter 3 has focused on the relationship between tax progressivity as a
measure of income redistribution and growth. We have found that higher redistribution affects growth conditioning on the degree of tax progressivity and the taxation level. In those countries characterised by a high taxation level and a high degree of tax progressivity, further redistribution has a negative impact on growth since the disincentive effects on individuals' choices prevail the positive effect of allowing more people to have access to the labour market.

Our findings could also explain why empirical evidence on this issue presents ambiguous results. A message of this paper is that the political agenda's dilemma could be less costly than it seems to be. In societies characterised by a high level of income-wealth inequality, boosting the economy's growth and reducing the income disparities can both be obtained by the same redistributive policy.

By looking at the overall thesis, one may read a message according to which is not only that labour taxation can be an effective policy instrument, but also that it should be used in the same direction as the other tax instruments (average income taxes).

Nevertheless, before concluding, a note of caution has to be introduced. In promoting a fiscal policy solution the Government should carefully take into account of the public debt implications. The simulations presented in the first chapter are encouraging as long as a higher tax progressivity obtained through a reduction in the average tax rate leads to a overcompensating rise in the employment. Further, we find positive employment effects even when we allow for a revenue neutral labour tax change. However, as shown by the third chapter, a more progressive taxation system may or may not lead to higher growth. Then, some other policy measures could be required to foster the stability of the public debt-GDP ratio. This issue will be considered by future research.
Bibliography


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