# Wealth Inequality, Income Redistribution and Growth in 15 OECD Countries[1]

by

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This version: January 2003

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**Abstract**

We model the individuals' investment in physical capital and education decisions in presence of borrowing constraints and a progressive taxation system. Our empirical evidence for 15 OECD countries supports the theoretical model predictions according to which the effects on growth of higher redistribution are ambiguous. We find that in those countries characterized by a high (low) taxation level and a high (low) degree of tax progressivity, further redistribution has a negative (positive) impact on growth since the disincentive effects on individuals' effort prevail (is dominated by) the positive effect of allowing more people to have access to the capital market.

- JEL Code:O5,E25,H24

- Keywords: Growth, Income Distribution, Progressive Taxation

# 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 paper will focus on this latter issue, it is useful to have a look at the former.

The literature in this area 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 instance, Alesina and Rodrick [1994] and Persson and Tabellini [1994]). Notice that under this view, equality is positively related to growth but in general a higher redistribution leads to a lower growth rate.

The second, known as the "Sociopolitical Instability" approach, posits a positive relationships between equality and growth given that economic growth increases if the sociopolitical instability is reduced and more equal societies are more politically stable. (See among the others

Benhabib and Rustichini [1996]).

The third, called by Perotti [1996] the "Endogenous Fertility" approach implies that fertility decreases as the income dispersion is reduced and 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.

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' labor 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.

In the current paper, 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[3]. Briefly put, we measure redistribution as a rise in the

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[3]Notice that we focus on the economic mechanism of the fiscal policy approach (i.e. distortionary taxation disincentives human capital accumulation) and we do not

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progressivity of the taxation system.

Starting from the Aghion and Bolton [1997] framework we model, as Galor and Zeira [1993], both the investment in physical capital and education decisions which depends on the wealth distribution and the opportunities to access to the capital market. In contrast to these authors, the presence of a distortionary taxation system introduces a conflicting effect according to which the growth effect of a redistributive policy financed by an increase in tax progressivity is ambiguous. The same result can be found in Benabou [1996] where greater redistribution leads to two conflicting effects: on the one hand, it disincentives 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. According to the Author, the growth maximizing tax rate depends on the degree of pretax inequality. In contrast to Benabou [1996], we do not impose the assumption of decreasing returns. This allows our framework to generate ambiguous effects on growth of higher redistribution, proxied by changes in labor tax progressivity, even in absence of fixed cost in investments. A higher labor tax progressivity implied by a rise in the marginal tax rates in the skilled worker (middle class) income bracket disincentives individual's effort and requires a higher wage in order to guarantee the same investment in education. Then if wages increases effort increases as well. In presence of increasing returns to scale, this leads to an increase of the level of the employment per unit of effort and then to higher growth. The nonconvexity generated by the assumption of fixed costs in investments amplifies this ambiguity.

As suggested by Perotti [1996], empirical evidence lags behind the theoretical literature on income distribution and economic growth. Indeed, empirical support on the effects of redistribution on growth is mixed. For instance, 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

take directly into account the political mechanism (i.e. an endogenous fiscal policy reflects the preferences of the majority)

[1994] support the opposite view. In particular, Perotti [1996] finds empirical support for the "Sociopolitical Instability" and "Endogenous Fertility"types of explanations whereas weak evidence corroborates the "Borrowing constraints-investment in education and physical capital". Moreover, the data appear to sustain less the endogenous fiscal policy mechanism.

However, perhaps, one of the main reason for this lack of empirical support is the limitations of existing panel data on the income (re)distribution.

We, then, also conduct an empirical analysis of the relationships between redistribution and growth by using an original data set on marginal and average tax rates in 15 OECD[4] countries for the period 1974-1997. We impose 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 paper is organized as follows. Section 2 presents the model and its implications. Section 3 introduces the empirical analysis and presents the data. The empirical results are discussed in Section 4. Conclusions follow.

## 2   The Model

Consider a closed economy characterized by two periods overlapping generations and composed of three main economic groups: the very rich (employers), the middle class (skilled-employed), the very poor (unskilled-employed in the backyard activity)[5]. Following Aghion and

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[4]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 and therefore the relation between income distribution and economic growth could be upward biased in our sample of 15 OECD countries.

[5]Basic results are not affected by this strict classification which is made for sake of simplicity.

Bolton (1997), AB henceforth, at the beginning of the first period individuals choose whether to invest in physical or human capital and work. In the second period they simply allocate their net wealth between consumption and bequest. The utility function depends on consumption, bequest and effort cost and takes the following form:

$$U = \min\left\{(1-\delta)\, c_i; \delta b_i\right\} - h\left(e_i\right) \tag{1}$$

where $i = e\left(employer\right), se\left(skilled-employed\right), ue\left(unskilled-employed\right)$; $c_i$ and $b_i$ denote consumption and bequests respectively, the term $h\left(e_i\right)$ represents the effort cost function. Finally $\delta$ is a parameter that measures the marginal utility of consumption. Equation 1 describes Leontieff preferences and we further assume, as AB, that preferences are warm glow over bequests. This implies that optimal bequests are a linear function of the end of period net wealth $\left(\omega_{t+1}^i\right)$:

$$b_{it+1} = (1-\delta)\, \omega_{t+1}^i \tag{2}$$

where:

$$\omega_{t+1}^i = \begin{cases} Y_{i,u} - T(y_{i,u}, Z) & if \quad successful \quad employer \\ w_{i,m} - T(w_{i,m}, Z) & if \quad skilled \quad employed \end{cases} \tag{3}$$

$$\omega^i = \begin{cases} p & if \quad unskilled \quad employed \\ 0 & otherwise \end{cases} \tag{4}$$

where $u$ and $m$ stand for upper and middle class.

The expression $T(\cdot, Z)$ defines a progressive taxation system which takes into account of any non-linearities within the system. Notice that the reason for considering a progressive taxation system is twofold. First, it can easily be conceived as a measure of redistribution. Second, since the taxation system is non-linear, this assumption introduces some distortions in the individuals' investment decisions even though preferences are warm glow over bequest[6].

Then, the individual initial wealth can be used to invest either in an entrepreneurial activity or in education or in an economy-wide mutual

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[6]Indeed, the warm glow assumption does not alter the basic result of AB even in presence of a proportional taxation system. See note 21 in AB paper for further details.

fund whose equilibrium unit (gross) return corresponds to the parameter $A$.

According to our simple classification, the poor have such a small initial endowment that they choose to work in a backyard activity which requires no education investment. The return of this activity is deterministic and quite small, $(p > 0)$. We can interpret this return either in terms of a competitive wage in a low-productivity sector or in terms of unemployment benefits. Further, following AB, they lend their initial endowment to an economy-wide mutual fund.

The rich are those people who have funds enough to invest in a entrepreneurial activity and in the projects of other agents via the capital market[7]. This entrepreneurial activity requires a set up cost $(\varphi A)$ and the agent's unit of labor. The return of this activity in post-tax terms is uncertain and given by:

$$\omega^{i,u} - T\left(\omega^{i,u}, Z\right) = \begin{cases} Y^{i,u} - T\left(y^{i,u}, Z\right) & with & probability & e_{i,u} \\ 0 & with & probability & (1 - e_{i,u}) \end{cases} \tag{5}$$

That is, in case of a successful entrepreneurial project, the return, or in other words the profits of the firm, are positive and corresponds to the total revenues. This implies that under such circumstances total costs (initial set up costs plus all variable costs) equalize the return on the initial endowment. In contrast, the unsuccessful outcome is equal to zero since total costs are now just covered by the return on the initial endowment and total revenues. The probability of success depends on the amount of effort supplied by both the employer $(e_{i,u})$ and the employee $(e_{i,m})$ since as, it will be shown later, total revenues are functions of the employee's effort.

Finally, the middle class may invest in education by complementing their initial endowment with a loan $[\psi A - \omega_{i0} - T\left(\omega_{i0}, Z\right)]$ to cover the fixed initial cost $(\psi A)$[8]. In post-tax terms, the initial endowment is equal to the post tax bequest:

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[7]They could also invest in education in order to become a skilled employed or they simply could choose the backyard activity.

[8]For sake of realism we assume $\varphi > \psi$ in such a way to exclude the possibility that some middle-class individuals invest in a enterprenurial activity rather than in education. However, basic results are not alter if we relax this assumption.

$$\omega_{i0} - T(\omega_{i0}, Z) = b_{i0} - T(b_{i0}, Z) \tag{6}$$

where $b_{i0} = A\varepsilon_i$ and $\varepsilon_i$ is a random variable, $\varepsilon_i \sim (0, \sigma_\epsilon)$.

The return of this project corresponds to:

$$\omega^{i,m} - T\left(\omega^{i,m}, Z\right) = \begin{cases} w_i - T(w_i, e_{i,m}, Z) - r(\psi A - (b_{i0} - T(b_{i0}, Z))) & with \quad probability \quad e_{i,m} \\ 0 \quad with \quad probability \quad (1 - e_{i,m}) \end{cases} \tag{7}$$

where $w$ denotes the wage. The unsuccessful outcome is equal to zero since the returns in the backward activity just equalizes the repayment of the loan.

## 2.1 Capital Market Equilibrium

As in AB, the equilibrium condition in the capital market requires that the aggregate demand for funds emanating from the middle class equalizes the aggregate supply from the very rich and the very poor. Then, the optimal lending contract is such that the repayment schedule is the following:

$$R\left(\omega_i, T\left(\omega_i, Z\right)\right) = r\left(\psi A - \left(b_{it} - T\left(b_{it}, Z\right)\right)\right) \tag{8}$$

The optimization problem of the middle-class borrower agent is to choose the effort which maximizes her expected post-tax revenue net of both repayment and effort costs taking as given the real interest rate $r$, the unit (gross) return of the economy-wide mutual fund $A$, the initial endowment $b_{i0}$ and the wage $w_i$.

$$\max_e \left[e_m w_i - T\left(w_i, e_{i,m}, Z\right) - e_{i,m} r\left(\psi A - \left(b_{i,0} - T\left(b_{i,0}, z\right)\right)\right) - h\left(e_{i,m}\right)\right] \tag{9}$$

where the effort cost function for all agents is quadratic in effort $\left(h\left(e\right) = A\frac{e_{i,m}^2}{2}\right)$.

Notice that the taxation function $T\left(w_i, e_{i,m}, Z\right)$ depends on the individual's effort. In fact, the individual's effort determines to which tax bracket the agent's income belongs.

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The effort supply function is therefore the following:

$$e_{i,m}(w_i, b_{i0}) = \frac{w_i(1-\tau_w)}{A} - r\psi + r\frac{b_{i0}(1-\lambda_b)}{A} = \frac{w_i(1-\tau)}{A} - r\psi + r\varepsilon_i(1-\lambda_{\varepsilon_i})$$
(10)

where $\frac{\partial T(e_{i,m}w_i, Z)}{\partial w_i} = \tau_w$; $\frac{T(b_{i0}, Z)}{b_{i0}} = \lambda_b$ or $\frac{T(A\varepsilon_i, Z)}{A\varepsilon_i} = \lambda_{\varepsilon_i}$ and the subscripts $w$ and $b$ refer to the successful middle class agent wage's and bequest's income brackets respectively.

As in AB, when the interest is fixed and independent from the individual's wealth, for a given tax structure, for a given degree of tax progressivity, captured by the level of the marginal tax rate faced by the middle class $(1 - \tau_w)$ for a given average tax rate $\lambda_w = \frac{T(e_{i,m}w_i, Z)}{w_i}$[9], the lower the initial wealth $b_{i0}$, the higher the loan repayment, the lower the marginal return from the education investment, the less the effort. Furthermore, the effort supply function is increasing in the wage and decreasing in the marginal tax rate, $\tau_w$, for a given interest rate and initial wealth. That is, a higher marginal tax rate tax in the skilled workers' income brackets disincentives human capital accumulation. However, holding fixed the degree of tax progressivity at the middle class income's bracket and for a given interest rate, a redistributive policy which finances the reduction in the average tax rate in the initial endowment $((1 - \lambda_b)\uparrow)$ with an increase in the average tax rate of the upper class individuals favours the individual's supply of effort. Under this assumptions, the net of payment return in education is indeed increased.

The very wealthy do not need to borrow and their optimization's problem takes the following form:

$$\max_e \left[e_u(Y_{i,u} - T(e_u y_{i,u}, Z)) - h(e_u)\right]$$
(11)

and its solution corresponds to:

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[9]By considering the coefficient of residual income progression as a measure of tax progressivity:

$$\nu_w = \frac{1-\tau_w}{1-\lambda_w}$$

we can attribute the change in tax progressivity to the marginal tax rate if the average tax rate is constant.

$$e_r(e_m, N) = (1 - \tau_u) \left( e_m^{(1-\beta)} N^\beta \right)_i^\alpha \tag{12}$$

given that according to the technology the output is equal to $Y_i = A \left( e_{i,m}^{(1-\beta)} N^\beta \right)^\alpha$ and where $\frac{\partial T(e_{i,u}y_i, Z)}{\partial e_{i,u}y_i} = \tau_u$ denotes the upper class individual's marginal tax rate.

Notice that in contrast with AB, because of the presence of a distortionary non-linear taxation system the rich do not supply the first-best level of effort. Furthermore, the effort supplied by the rich individuals depend on the output produced in their firms and therefore on the employment level $(N)$ and the employees' effort.

The equilibrium condition implies that all loans yield the same expected return, that is:

$$r\left(\omega_i\right) e_m(\omega_i) = A \tag{13}$$

By considering that only middle class agents borrow, combining equations (10) and (13) we obtain:

$$r\left(\omega_i\right) \left( \frac{w_i\left(1 - \tau_w\right)}{A} - r\psi + r\frac{b_{i0}(1 - \lambda_b)}{A} \right) = A \tag{14}$$

As in AB the above equation (14) shows that even when the interest rate is endogenous, the effort supply function is increasing in wealth.

## 2.2 Labour Market Static Equilibrium

We concentrate on the labour market of the skilled workers. Indeed, for sake of simplicity, we can interpret the backyard activity as a self-employed activity (e.g. agricultural sector) or as unemployment.

The very healthy with a successful entrepreneurial activity constitute the fixed number of identical competitive firms, indexed by $j$. Their technology is described by the following production function:

$$Y_j = A \left( e_{i,j,m}^{(1-\beta)} N_j^\beta \right)^\alpha \tag{15}$$

We do not impose any restriction on the parameter $\alpha$. Therefore, the model is general enough to allow for diminishing, constant or even increasing returns to scale.

Since only middle class agents that have invested in education access to this sector, we then omit the index $m$.

The optimization problem of the firm is to maximize her profit function with respect to wages and employment for a given effort supplied by the workers. This problem is solved in two stages: first, the firm chooses wages to minimize the cost per unit of effort $\left(\frac{wj}{e_{i,j}}\right)$.

$$\min\left\{\psi A + \frac{w_j}{e_{i,j}}N_j\right\} \tag{16}$$

From this cost minimization we obtain the well-known Solow condition according to which:

$$\frac{\partial e_m}{\partial w_i}\frac{w_i}{e_m} = 1 \tag{17}$$

The individual's effort supplied to achieve an educational degree corresponds to the effort supplied as employed.

Then, according to the Solow condition:

$$w_i = \frac{e_m A}{\nu_w} \tag{18}$$

Pre tax wages of successful skilled workers defined by equation (18) is an increasing function of the technological parameter $A$ and of the individual's effort supplied. A rise in the marginal tax rates disincentives human capital accumulation, therefore an increase in wages is required to compensate for higher levels of marginal tax rates (higher tax progressivity) .

Second, given wages and effort, the firm chooses the employment level to maximize profit. Suppose further that once educated, the effort provided by the successful skilled worker is homogeneous. The employment implicit solution form is therefore:

$$N_j\left(w_j,e_j\right) = \left[\frac{w_j\left(e\right)}{\alpha A\beta}\right]^{-\frac{1}{1-\alpha\beta}} e_j^{\frac{\alpha(1-\beta)}{1-\alpha\beta}} \tag{19}$$

If $\alpha\beta < 1$ (i.e. if there are decreasing or constant return to scale) the employment level of the successful skilled workers, defined by equation

(19), is a decreasing function of wages and increasing in individual's effort. Substituting equation (18) into (19) we finally have:

$$N_j\left(w_j, e_j\right) = \left[\alpha\left(1 - \tau_w\right)\beta\right]^{\frac{1}{1-\alpha\beta}} e_j^{\frac{\alpha(1-\beta)-1}{1-\alpha\beta}} \tag{20}$$

Therefore, according to equation $(20)$, the employment level is a decreasing function of the effort supplied by the middle class agents as long as either $\alpha\beta < 1$ and $\alpha\left(1 - \beta\right) - 1 < 0$ or $\alpha\beta > 1$ and $\alpha\left(1 - \beta\right) - 1 > 0$.

Finally substituting equation (20) into (15) we obtain:

$$Y_j = A\left[\alpha\left(1 - \tau_w\right)\beta\right]^{\frac{\alpha\beta}{1-\alpha\beta}} e_j^{\frac{\alpha(1-2\beta)}{1-\alpha\beta}} \tag{21}$$

Since firms are identical, if the effort supplied by the successful skilled workers is homogeneous, we have a symmetric equilibrium, according to which the firm specific wage, labour demand and output are equal to the aggregate ones. Under this hypothesis we can omit the subscript "$j$". Notice that this symmetric equilibrium can be easily conceived as equal to the within generation equilibrium. In contrast if we allow for heterogeneity in individuals' effort which depends on the initial wealth (i.e. individual's effort supplied to achieve an educational degree corresponds to the effort supplied as employed) aggregating wages, employment and output we have:

$$w = \frac{A}{\left(1 - \tau_w\right)} \int_{j=0}^{\xi} \int_{i=0}^{1} e_{i,j,m}\, dj\, di \tag{22}$$

$$N = \left[\alpha\left(1 - \tau_w\right)\beta\right]^{\frac{1}{1-\alpha\beta}} \int_{j=0}^{\xi} \int_{i=0}^{1} e_{i,j,m}^{\frac{\alpha(1-\beta)-1}{1-\alpha\beta}}\, dj\, di \tag{23}$$

$$Y = A\left[\alpha\left(1 - \tau_w\right)\beta\right]^{\frac{\alpha\beta}{1-\alpha\beta}} \int_{j=0}^{\xi} \int_{i=0}^{1} e_{i,j,m}^{\frac{\alpha(1-2\beta)}{1-\alpha\beta}}\, dj\, di$$

Equations (22) can be instead thought as a steady state intergenerational equilibrium where the initial functional distribution of wealth

matters. How this latter matters depends on the technological parameters. A similar result can be found in Benabou [1996] where the negative relationship between pretax inequality and output builds on the assumption of decreasing return to scale.

## 2.3   Analysis

We now proceed with some comparative statics. We start, for sake of simplicity, with the assumption of homogeneous effort supplied. Indeed, as it is clear from equations (22) the technological parameters play a crucial role under both the assumption of homogeneous and heterogeneous individuals' effort in determining the effects on employment, output and growth of an increase in the marginal tax rate of the successful skilled worker income bracket. Notice further that we can interpret this symmetric equilibrium also in terms of a steady state intergenerational equilibrium in absence of fixed costs in investment of education.

**Remark 1** *An increase in tax progressivity obtained through a higher marginal tax rate in the middle class tax bracket holding constant all the other tax parameters has a positive effect on employment and output either if $1 - \alpha\beta > 0$ and $\beta > 1$ or $1 - \alpha\beta < 0$ and $\beta < 1$.*

**Proof.**

$$\frac{\partial N}{\partial (1 - \tau_w)} = [\alpha (1 - \tau_w) \beta]^{\frac{1}{1-\alpha\beta}} \frac{1}{(1 - \tau_w)} e^{\frac{\alpha(1-\beta)-1}{1-\alpha\beta}} \frac{\alpha(1 - \beta)}{1 - \alpha\beta} \qquad (24)$$

$$\frac{\partial Y}{\partial (1 - \tau_w)} = [\alpha (1 - \tau_w) \beta]^{\frac{\alpha\beta}{1-\alpha\beta}} \frac{1}{(1 - \tau_w)} e^{\frac{\alpha(1-2\beta)}{1-\alpha\beta}} \frac{\alpha(1 - \beta)}{1 - \alpha\beta} \qquad (25)$$

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Given, our model specification $1 > \beta > 0$, an increase in tax progressivity, measured as an increase of the marginal tax rate holding all the other tax parameters constant, leads to higher employment only if the labour demand is upward sloping ($\alpha\beta > 1$). An increase in tax progressivity requires a higher wage in order to compensate the disincentive effect of providing less effort. Therefore, the rise in the wage leads to higher effort and then to higher output. If return to scale are increasing,

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this increase of the production has a positive effect on the employment. In contrast if the labour demand is downward sloping (i.e. return to scale are decreasing), the increase in the wage implies lower employment and therefore a output reduction.

Depending on the parameters' value are also the effects on employment and output of a reduction in the average tax rate of the bequest which is compensated by an increase of the average tax rate in the income bracket faced by the upper class agents[10]. Indeed, considering a simultaneous increase in $\lambda_u = \frac{T(e_{i,u}y_{i,u},Z)}{y_{i,u}}$ and a reduction in $\lambda_b$ :

$$\frac{\partial N}{\partial (1 - \lambda_b)} = \frac{\alpha(1 - \beta) - 1}{1 - \alpha\beta} \left[\alpha (1 - \tau_w) \beta\right]^{\frac{1}{1-\alpha\beta}} e^{\frac{\alpha-2}{1-\alpha\beta}} rb \qquad (26)$$

According to equation (25) we observe a *greater opportunities effect* when either $\alpha\beta - 1 < 0$ and $\alpha(1 - \beta) - 1 < 0$ or $\alpha\beta - 1 > 0$ and $\alpha(1 - \beta) - 1 > 0$. For *greater opportunities effect* we mean that higher redistribution allows more individuals to access the credit market (since the net of taxes loan repayment is smaller) and thus enhances production and employment. Notice that the above conditions correspond to those required for an employment level as a decreasing function of the effort supplied by the middle class agents. Consider for example the case of decreasing returns to scale $(\alpha\beta - 1 < 0 \ ; \alpha(1 - \beta) - 1 < 0)$. This is exactly the result obtained by Benabou [1996]. Allowing more individuals to invest in education brings them to earn a higher return.

## 2.4 The Economy growth rate

Let's still consider the assumption of homogeneous effort supplied.

The within generation growth rate or the growth rate of the economy in absence of fixed costs in investment is the following:

$$g_y = \alpha\beta An^{\alpha\beta} \left(\frac{s_h}{n} - m\right) + \frac{d (A_{t+1} - A_t)}{A_t} \qquad (27)$$

where $n = \frac{N}{e}$ defines the employment per unit of effort; $s_h$ is the fraction of output devoted to investment in education; $m$ is the fraction

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[10]Of course, this comparative statics exercise is relevant only in presence of fixed costs in investment in education.

of output devoted to the accumulation of effort and $g_A = \frac{d(A_{t+1}-A_t)}{A_t}$ finally stands for the rate of growth of the technological change.

Then, the output growth rate depends on the variations of the employment per unit of effort of the successful middle class skilled workers.

According to equation (27), we can describe the growth effects of a redistributive policy measured as an increase in tax progressivity.

**Remark 2** *The growth effect of a rise in the marginal tax rate in the successful skilled worker income bracket depends on how the change in tax progressivity affects the level of the employment per unit of effort.*

**Proof.**

$$\frac{dg}{d\left(1-\tau_w\right)} = (\alpha\beta)^2 An^{\alpha\beta-1}\frac{\partial n}{\partial\left(1-\tau_w\right)}\left[\frac{s_h}{n}-m\right]+\alpha\beta An^{\alpha\beta}\left(-\frac{\partial n}{\partial\left(1-\tau_w\right)}\frac{s_h}{n^2}\right)$$
(28)

where $\left[\frac{s_h}{n}-m\right] < 0$ if $n > 1$ given that $0 < m < 1$ and $0 < s_h < 1$

$$\frac{\partial n}{\partial\left(1-\tau_w\right)} = [\alpha\left(1-\tau_w\right)\beta]^{\frac{1}{1-\alpha\beta}}\frac{1}{(1-\tau_w)}\frac{\alpha-1}{1-\alpha\beta}e^{\frac{\alpha-2}{1-\alpha\beta}}$$
(29)

where $\frac{\partial n}{\partial(1-\tau_w)} > 0$ if $\{{\alpha>1;1-\alpha\beta>0;\atop\alpha<1;1-\alpha\beta<0;}$

where $\frac{\partial n}{\partial(1-\tau_w)} < 0$ if $\{{\alpha>1;1-\alpha\beta<0;\atop\alpha<1;1-\alpha\beta>0;}$

$\frac{\partial g}{\partial(1-\tau_w)} < 0$ if $\left[\frac{s_h}{n}-m\right] < 0$ and $\frac{\partial n}{\partial(1-\tau_w)} > 0$

$\frac{\partial g}{\partial(1-\tau_w)} > 0$ if $\left[\frac{s_h}{n}-m\right] < 0$ and $\frac{\partial n}{\partial(1-\tau_w)} < 0$

$$\frac{\partial g}{\partial(1-\lambda_b)} = (\alpha\beta)^2 An^{\alpha\beta-1}\frac{\partial n}{\partial(1-\lambda_b)}\left[\frac{s_h}{n}-m\right]+\alpha\beta An^{\alpha\beta}\left(-\frac{\partial n}{\partial(1-\lambda_b)}\frac{s_h}{n^2}\right)$$
(30)

$$\frac{\partial n}{\partial(1-\lambda_b)} = [\alpha\left(1-\tau_w\right)\beta]^{\frac{1}{1-\alpha\beta}}\frac{1}{(1-\tau_w)}\frac{\alpha-2}{1-\alpha\beta}e^{\frac{\alpha(1+\beta)-3}{1-\alpha\beta}}rb$$
(31)

where $\frac{\partial n}{\partial(1-\lambda_b)} > 0$ if $\{{\alpha>2;1-\alpha\beta>0;\atop\alpha<2;1-\alpha\beta<0;}$

where $\frac{\partial n}{\partial(1-\lambda_b)} < 0$ if $\{{\alpha>2;1-\alpha\beta<0;\atop\alpha<2;1-\alpha\beta>0;}$

$\frac{\partial g}{\partial(1-\lambda_b)} < 0$ if $\left[\frac{s_h}{n}-m\right] < 0$ and $\frac{\partial n}{\partial(1-\lambda_b)} > 0$

$\frac{\partial g}{\partial(1-\lambda_b)} > 0$ if $\left[\frac{s_h}{n}-m\right] < 0$ and $\frac{\partial n}{\partial(1-\lambda_b)} < 0$ ∎

Let's consider the case where the labour demand is upward sloping $1 - \alpha\beta < 0$. A rise in the marginal tax rates in the successful skilled worker income bracket disincentives individual's effort and requires a higher wage in order to guarantee the same investment in education. Then if wages increases effort increases as well. If $1 - \alpha\beta < 0$, the increase in effort determines higher output and employment as shown in Remark 1. Under these assumptions, if the parameter $\alpha$ is bigger than 1 (i.e. if we have increasing returns to scale), then a rise in tax progressivity increases the level of employment per unit of effort and therefore leads to higher growth.

According to equation (30), for a given $\tau_w$, if we allow for a reduction in the initial endowment average tax rate financed by an increase in average tax rate in the upper class income bracket, the effect on the growth rate of the economy is still ambiguous.

So far, we have treated $s_h$ and $m$ as constant. Results are even more ambiguous if we assume that $s_h$ and $m$ are a function of the taxation level and the degree of tax progressivity[11]. Under these latter assumptions we could conceive the sign of the growth effect of a redistributive policy as an increasing in tax progressivity depending not only on the technology parameters but also on the taxation level and the degree of tax progressivity.

Finally, when we relax the assumption of homogenous individuals' effort supplied the effects on growth of changing the marginal tax parameters are still ambiguous. See the Appendix for further details.

## 3   The Empirical Model

Equation (26) solves the growth rate of the economy as

$$g = G(\ln \Delta e, \ln (\Delta T(\cdot, Z), )) \tag{32}$$

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[11]The effect of a tax progressivity change on the economic growth would now be equal to: $\frac{dg}{d(1-\tau_w)} = (\alpha\beta)^2 An^{\alpha\beta-1}\frac{\partial n}{\partial(1-\tau_w)}\left[\frac{s_h}{n} - m\right] + \alpha\beta An^{\alpha\beta}\left(-\frac{\partial n}{\partial(1-\tau_w)}\frac{s_h}{n^2} + \frac{\partial s_h}{\partial(1-\tau_w)}\frac{1}{n} - \frac{\partial m}{\partial(1-\tau_w)}\right)$ where it is reasonable to expect $\left(\frac{\partial s_h}{\partial(1-\tau_w)} > 0; \frac{\partial m}{\partial(1-\tau_w)} > 0\right)$, that is the fraction of output dedicated to investment in education (the accumulation of effort) decreases as long as the marginal tax rate in the skilled workers income bracket increases.

Notice that the growth rate depends on the growth rate of the effort provided and the entire tax structure. Aghion and Bolton (1997) show that following a redistributive tax-subsidy scheme effort is either increasing or constant leading to an unambiguous positive effect on output and growth. Considering a progressive taxation system, our model suggests that this effect 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 the growth equation yields the following empirical models:

$$g_{jt} = f_j + \beta_{1j}\Delta\tau_{jt} + \beta_{2j}\Delta\lambda_{jt} + \beta_{3j}g_{j(t-k)} + \epsilon_{jt} \qquad (32a)$$

$$g_{jt} = f_j + \beta_{1j}\Delta\tau_{jt} + \beta_{2j}\Delta\lambda_{jt} + \beta_{3j}g_{j(t-k)} + \beta_{4j}\ln y_{j,t-1} + u_{jt} \qquad (32b)$$

where henceforth the index $j$ is country specific instead of firm 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 $\epsilon_{jt}$ and $u_{jt}$ are the random error terms ($\epsilon_{jt}$ and $u_{jt} \sim i.i.d$). The term $g_{j(t-k)}$ is introduced to correct for any kind of dynamic misspecification and the term $\ln y_{j,t-1}$ in the 32$b$ specification to capture the speed of convergence towards the steady state[12]. Notice that 32$a$ can refer to an endogenous growth model where there is not transitional dynamics. In contrast, 32$b$ allows for a transitional dynamics although so far we do not introduce explicitly the long run equilibrium term. This made is for a comparison with many other empirical studies on the growth equation. 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 human capital such as the average years of education $(hc)$[13]. That is:

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[12] As it is well known, the estimated coefficient on $\ln y_{t-1}$ suffers 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.

[13] This variable is taken from page 28 of the OECD working paper n.282/2001 by Andrea Bassanini and Stefano Scarpetta.

$$g_{jt} = f_j + \beta_{1j}\Delta\tau_{jt} + \beta_{2j}\Delta\lambda_{jt} + \beta_{3j}g_{j(t-k)} - \phi_j \left(\ln y_j - \theta_{1j}\tau_j - \theta_{2j}\lambda_j - \theta_{3j}hc_j\right)_{t-1} + \varepsilon_{jt}$$

$$(32c)$$

Equation can be conceived as a simplified ECM model specification. 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. According to our model the link among wealth inequality, borrowing constraints 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 Eastearly and Rebelo [1993] and by Perotti [1996], have added marginal tax rates as income distribution variables to the set of independent variables of standard growth regressions.

This empirical analysis differs from them by using an original data set and by exploiting both the time and the cross-sectional variation. 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 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 disincentive investment in human capital and effort. Then growth might increase as distortionary taxation decreases. On the other, progressive taxation could incentive effort through a rise in the wage, 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

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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 following scheme:

Figure 1: Degree of Tax Progressivity and Marginal Tax Rates
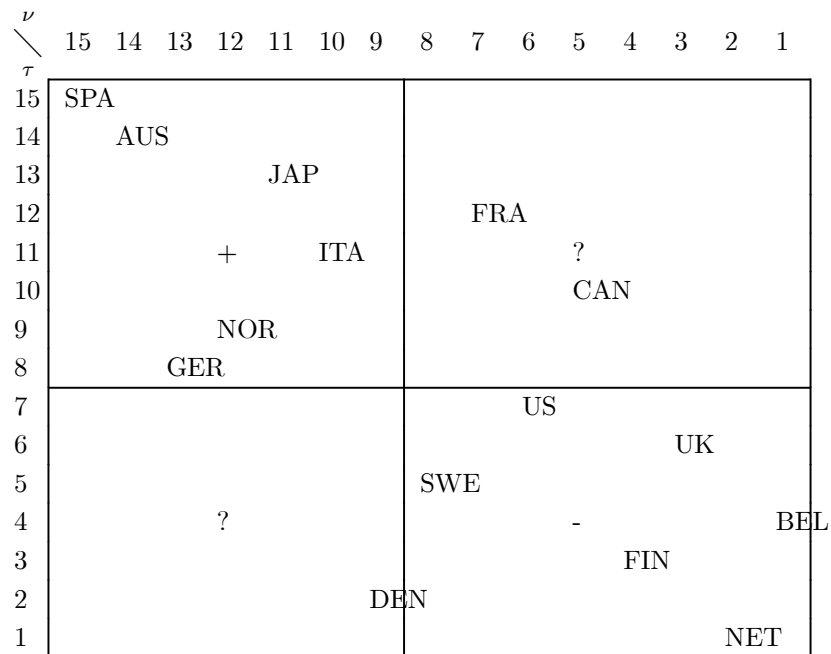


On the horizontal axis countries are ordered according to their average over the sample period degree of tax progressivity from the lowest (i.e. the highest value for the coefficient of income progression ) to the highest whereas on the vertical axis they are ranked on the basis of their average level 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) 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[14].

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 negative (positive) effect of redistribution on growth for those countries in the first[15] (fourth[16]) quadrangle. That is, countries with high (low) average tax rates and low (high) tax progressivity might benefit (be penalized by) of more redistribution 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.

## 3.1  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.*"

For each year and for each country in the sample, we compute pretax

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[14]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.

[15]Namely: Germany, Norway and Denmark

[16]Namely: Belgium, Canada and France

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 pretax wages and social security contributions paid by the employee, we compute the relevant average and marginal tax rate. These rates are based on labor income only, and do not take into account additional income from capital and self - employment. The Appendix at the end of the paper provides additional technical details.

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

Figure 2 provides a summary description of the data by group classified on the basis of their level of the marginal tax rate[17].

The first group ($GR1$) (high marginal tax rate countries whose redistributive effect might be negative) includes all countries in the fourth quadrangle of Figure 1[18]; the second ($GR2$) (low marginal tax rate countries whose redistributive effects might be positive) all those belonging to the first one[19] and the third group incorporates all those countries whose redistributive effects are not signed on a priori grounds[20].

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 have increased (see panel 2), especially

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[17]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.

[18]Namely: Belgium, Finland, The Netherlands, Sweden, UK and US.

[19]Namely: Australia, Germany, Italy, Japan, Norway and Spain.

[20]Namely: Canada, Denmark and France.

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among the third group. As 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%.

*Figure* 2
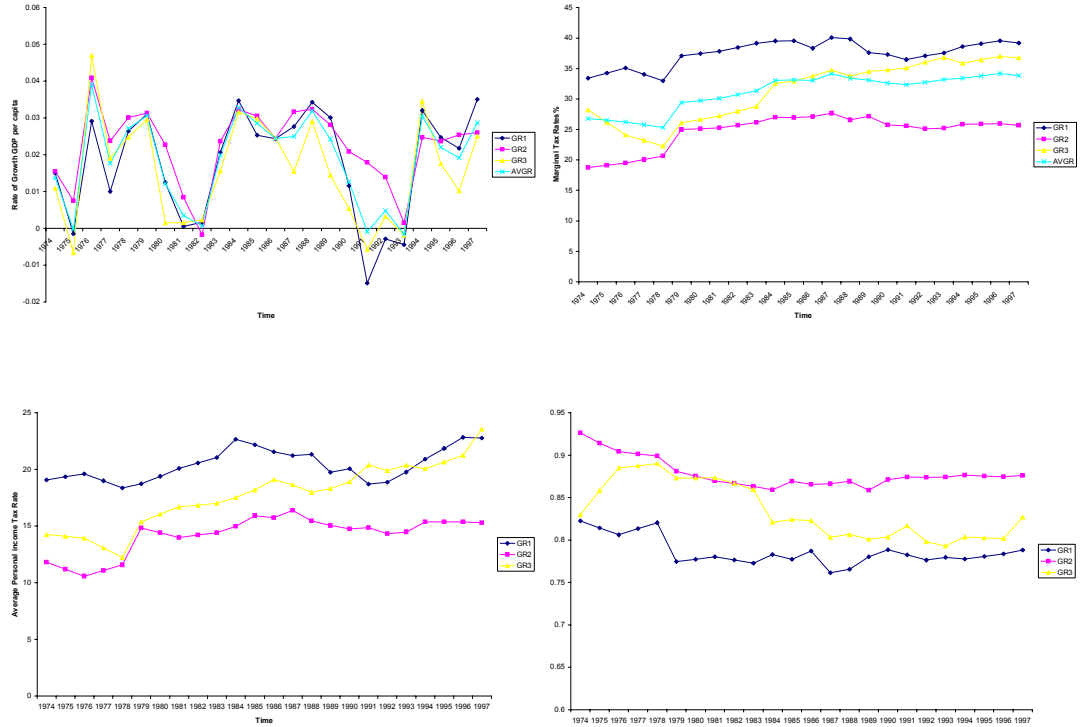


Panel 3 shows that first and second group average income tax has increased up to mid eighties, bounced back to increase again at the beginning of the nineties. Finally, the evolution of tax progressivity, measured by the coefficient of residual income progression, is illustrated in the last panel of the figure. For the first and second group, progressivity increased sharply up to 1983[21], 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.

For space constraint, we do not report a similar figure presenting evidence by clustering countries according to the combined level of tax progressivity and the average personal income tax rate.

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[21]Remind that progressivity increases when the coefficient of residual income progression decreases.

# 4 Results

We start our empirical analysis by estimating $32a, b, c$ 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:

$$\beta_{jx} = \beta_x + \xi_{jx}$$

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

Providing a statical 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 in a dynamic setting the pooled estimator is inconsistent when the coefficients' heterogeneity is ignored even if the time dimension goes to infinity.

Poolability is tested by the method proposed by Lee, Pesaran and Pierse ($LPP$) [1990], that is following partially the author notation[22]:

$$q_2 = t^{-1} \, \hat{\vartheta}'_x \, \hat{\Phi}_t^{-1} \hat{\vartheta}_x \sim \chi_k^2$$

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:

$$H_0 : \vartheta_x = 0$$

where $\vartheta_x = \hat{b}_x - \frac{1}{\varsigma} \sum_{j=1}^{\varsigma} \hat{\beta}_x$ and $\varsigma$ denotes the number of the cross sectional units j.

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[22] Where $\hat{\Phi} = t^{-1} \sum \hat{\sigma}_{ij} \, P_i P'_j$ ; $P_i = \left(X'_a X_a\right)^{-1} X'_a - \frac{1}{n}\left(X'_i X_i\right)^{-1} X'_i$ and the subscript $a$ stands for "aggregate" (i.e. parameter homogeneity)

| Dependent variable: $\ln \Delta y_{jt}$ | | | |
|---|---|---|---|
| | $(32a)$ | $(32b)$ | $(32c)$ |
| $\Delta\tau$ | -0.079 | -0.096 | $-0.081$ |
| | (.024) | (.023) | (.020) |
| $\Delta\lambda$ | 0.084 | 0.082 | 0.066 |
| | (.015) | (.015) | (.014) |
| $\ln y_{t-1}$ | - | 0.027 | $-0.249$ |
| | | (.006) | (.015) |
| $\eta_\tau$ | - | - | 1.48 |
| $\eta_\lambda$ | - | - | -.817 |
| $\eta_{hc}$ | - | - | .786 |
| $Nobs$ | 315 | 315 | 315 |
| $R^2$ | .18 | .59 | .66 |
| $POOL$ | .00 | .01 | .00 |
| $POLR$ | - | - | .41 |

Note: Each regression includes a specific constant and two lags of the dependent variable. Robust standard errors within parentheses. $R^2$ adjusted for the degree of freedom $\eta_\tau$ : marginal income tax long run elasticity of the per capita output; $\eta_\lambda$ : average income tax long run elasticity of the per capita output; $\eta_{hc}$ : human capital long run elasticity of the per capita output. $POOL$ : P- value of the test for the homogeneity of parameters $\left(\chi^2\left(4\right)=16.87; \chi^2\left(5\right)=16.69; \chi^2\left(5\right)=34.33\right)$; $POLR$ : P- value of the test for the homogeneity of the long run coefficients $\left(\chi^2\left(4\right)=3.99\right)$.

Table 1: Estimates of 32a,b,c based on panel data (1974-1997)

We perform the above test since the familiar method proposed by Zellner [1962] is too restrictive[23]. Since according to Lee et al. [1990], the null could hold even when the homogeneity assumption is rejected. According to our model specification 32c, 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 1 which shows the estimated coefficients associated to the change in the tax variables under the ho-

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[23]Zellner [1962] tests the homogeneity hypothesis as follows:

$$H_0 : \beta_{j1} = \beta_{j2} = .. = \beta_{xj} = ... = \beta_{x\varsigma}$$

mogeneity 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 1, column 32a, 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. However, the LPP criterion clearly rejects the hypothesis of homogeneity. We then estimate a version of $(32\,(a,b,c))$ where we allow for parameter heterogeneity under the assumption of a random coefficient model. We estimate two alternative empirical specifications.

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".

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.

Notice that when considering equation 32c, 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.

Table 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 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 1 for both a change in the marginal and a change in the average personal income tax rate[24].

Next we ask whether the impact of redistribution on growth vary by tax level and the degree of tax progressivity, as suggested by our identification scheme. This is done by selecting the empirical specification in the last three columns of Table 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 negative $(GR1)$ [25], positive $(GR2)$ [26] or unsigned effect $(GR3)$ [27] 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. Then, we started from what suggested by our diagrams such as Figure 1 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 depends on the tax level and the degree of tax progressivity. All the tax change coefficients appear to be significant[28]. The three groups of country present the sign expected.

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[24]Although now, when considering equation $32a$ the coefficient of the marginal income tax rate is smaller and insignificant.

[25]Countries included in the first group are: 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.

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

[27]The third group consists of 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 with respect to the average tax rate.

[28]Only the change in the marginal tax rate of the second group is not significant

| Dependent variable: change in log annual GDP per capita | | | | | |
|---|---|---|---|---|---|
| | (1-32a) | $(1-32b)$ | $(PMG,1)$ | (2-32a) | (2-32b) | $(PMG,2)$ |
| $\Delta\tau$ | $-0.022$ (.002) | $-0.161$ (.019) | $-0.169$ (.013) | $-$ | $-$ | $-$ |
| $\Delta\lambda$ | 0.116 (.002) | 0.197 (.011) | 0.172 (.012) | $-$ | $-$ | $-$ |
| $\ln y_{t-1}$ | $-$ | $-0.036$ (.029) | $-.273$ (.084) | $-$ | $-0.033$ (.134) | $-0.267$ (.018) |
| $GR1\Delta\tau$ | - | - | $-$ | $-0.186$ (.045) | $-0.290$ (.050) | $-0.277$ (.027) |
| $GR2\Delta\tau$ | - | - | $-$ | 0.195 (.043) | 0.140 (.114) | 0.094 (.034) |
| $GR3\Delta\tau$ | - | - | $-$ | $-0.105$ (.049) | $-0.177$ (.041) | $-0.164$ (.034) |
| $GR1\Delta\lambda$ | - | - | $-$ | 0.354 (.057) | 0.382 (.031) | 0.362 (.019) |
| $GR3\Delta\lambda$ | - | - | $-$ | $-0.053$ (.012) | $-0.063$ (.014) | 0.054 (.017) |
| $\eta_\tau$ | - | - | 1.35 | - | - | 1.38 |
| $\eta_\lambda$ | - | - | -.744 | - | - | -.763 |
| $\eta_{hc}$ | - | - | .715 | - | - | .734 |
| $Nobs$ | 315 | 315 | 315 | 315 | 315 | 315 |
| $R^2$ | .188 | .654 | .714 | .188 | .653 | .708 |
| $ZEL$ | - | - | - | .259 | .078 | .065 |

Note: Additional regressors: specific constant and two lags of the dependent variable. Robust standard errors within parentheses. $\eta_\tau$ : marginal income tax long run elasticity of the per capita output; $\eta_\lambda$ : average income tax long run elasticity of the per capita output; $\eta_{hc}$ : human capital long run elasticity of the per capita output. $ZEL$ : P- value of the test for the identification of the three groups of countries $\chi^2(3) = 4.02; \chi^2(3) = 6.28; \chi^2(3) = 7.23.$

Table 2: Mean Group Estimates on equations 32a,b and Pooled Mean Group Estimates on equation 32c

Furthermore, it is worth pointing out that the third group (i.e. the unsigned from a theoretical point of view) suggest that different redistribution effect can be obtain if one allows a change in the marginal (negative) rather than an average (positive)[29] tax rate[30]. Notice that, as before, we test the country classification by imposing the "homogeneity" restrictions within the three groups by carrying out a Zellner [1962].

Finally, from an economic perspective, redistribution could be endogenous. That is, a higher rate of growth could lead higher redistribution. Notice, however, 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. The Hausman test clearly suggests that changes in tax rates are not endogenous[31,32].

## 5  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 disincentive effects on individuals' effort prevail the positive effect of allowing more people to have access to the capital 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 borrowing -constraint investment in education and capital market approach.

Our findings could also explain why empirical evidence on this issue

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in the 32b specification (i.e. column $(2 - 32b)$).

[29] A decrease (increase) in the average (marginal) tax rate determines higher redistribution captured by a higher tax progressivity.

[30] This result does not hold when we introduce the long run term.

[31] The values of the Hausman test are the following: 0.99; 0.98 and 0.79 respectively when we consider model specification 32a, b and c.

[32] We do not report the full table of results which is available from the author upon request.

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 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.

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## Appendix

## 5.1 Heterogenous individuals' effort supplied

Consider now the case of heterogenous agents' effort which depends on the initial wealth distribution. Our production function now becomes:

$$y_t = F(n) = A \int\limits_{j=0}^{\xi} \int\limits_{i=0}^{1} n_{i,j,t}^{\alpha\beta} \, dj \, di \tag{A.1}$$

recalling that:

$$n_{i,j,t} = [\alpha(1-\tau_w)\beta]^{\frac{1}{1-\alpha\beta}} \int\limits_{j=0}^{\xi} \int\limits_{i=0}^{1} e_{i,j,t}^{\frac{\alpha-2}{1-\alpha\beta}} \, dj \, di \tag{A.2}$$

transforming $(A.1)$ into logs we have:

$$\ln y_t = cons + \ln A + \frac{\alpha\beta}{1-\alpha\beta} \ln(1-\tau_w) + \ln \int\limits_{j=0}^{\xi} \int\limits_{i=0}^{1} e_{i,j,t}^{\frac{\alpha\beta(\alpha-2)}{1-\alpha\beta}} \, dj \, di \tag{A.3}$$

It is clear from equation $(A.3)$ that the effects on output of an increase in the marginal tax rate depends on the initial wealth distribution. How the initial wealth distribution affects the output depends on the technological parameters. When returns to scale are decreasing, we obtain an ambiguous effect of an increase in the marginal tax rate $\tau_w$. When returns to scale are increasing but $1 < \alpha < 2$ we still have that a higher $\tau_w$ ambiguously increases output.

Finally, the growth equation is:

$$\ln \frac{y_{t+1}}{y_t} = cons + \ln \frac{A_{t+1}}{A_t} + \ln \frac{(1-\tau_w)_{t+1}}{(1-\tau_w)_t} + \ln \frac{\int\limits_{j=0}^{\xi} \int\limits_{i=0}^{1} e_{i,j,t+1}^{\frac{\alpha\beta(\alpha-2)}{1-\alpha\beta}} \, dj \, di}{\int\limits_{j=0}^{\xi} \int\limits_{i=0}^{1} e_{i,j,t}^{\frac{\alpha\beta(\alpha-2)}{1-\alpha\beta}} \, dj \, di} \tag{A.4}$$

# 6 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). 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:

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

where now $n$ stands for the number of individuals (i).[33]

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.[34].

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 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.

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[33] We slightly change here notation for convenience.

[34] 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.

Then, marginal tax rates are calculated as follows:

$$\tau = \frac{ITL}{TI} + \frac{SSC}{Y}$$

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 simplicity' sake and without a big loss of precision they are all considered as proportional to taxable income. The latter is defined as:

$$TI \;=\; GWE \;-\; STA \;+\; TC$$

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[35].

The effective average tax rate corresponds to the following expression:

$$\lambda = \frac{TPG - CT}{W}$$

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

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[35]This is true for almost the entire sample period.

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[36]. 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 points 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.

However, as pointed out by the OECD, results can be misleading only if many of the limitations are taken cumulatively within a specific country.

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[36]Spain and Sweden suffer of the same problem. However, given 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 in not so relevant as in the Denmark case.