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WEALTH INEQUALITY, INCOME REDISTRIBUTION AND GROWTH IN 15 OECD COUNTRIES

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

by

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Very Preliminary.
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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 higher redistribution affects growth conditioning on the degree of tax progressivity and the taxation level. We find that in those countries characterised 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.

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- 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, Goverments in charge pay more attention to the growth effect of redistributive policy[2].

The literature in this area can be divided in two categories. First, the conventional textbook view which suggests that redistribution 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 redistribution 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 emphasises that equality 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 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 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

[2]If one, instead, is interested in analysing the relationship between the economic growth and inequality, she might refer to the literature which focuses on the effect of capital accumulation and technological change on the distribution of income and wealth (this stream of the literature goes back at least to Smith and Ricardo).

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.

Perotti [1996] finds empirical support for the second and third two types of explanations whereas weak evidence corroborates the last one. Thus, the data appear to sustain less the endogenous fiscal policy mechanism.

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 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 an income effect according to which the growth effect of a redistributive policy financed by an increase in tax progressivity is ambiguous.

As suggested by Perotti (1996), empirical evidence lags behind the theoretical literature on income distribution and economic growth. One of the main reasons is the limitations of existing cross-section data on income distribution. We, then, also conduct an empirical analysis of

[3]Notice that we focus on the economic mechanism of the fiscal policy approach (i.e. distortionary taxation disincetives 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)

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 characterised by a low (high) degree of tax progressivity and a low (high) taxation level.

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

2 The Model

Consider a closed economy characterised 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 Bolton (1997), AB henceforth, at the beginning of the first period individuals choose whether to invest 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 $i = se\left(employer\right), s\left(skilled-employed\right), u\left(unskilled-employed\right)$; c_i and b_i denote consumption and bequests respectively, the term $h\left(e_i\right)$ represents the effort cost function. Finally δ is a parameter that mea-

[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 simplicitly.

sures the marginal utility of consumption. Equation (1) descrives 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 (ω^i):

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

where:

$$\omega^i = \begin{cases} y_{i,r} - T(y_i,z) & if \quad successful \quad employer \\ w_{i,m} - T(w_i,z) & if \quad skilled \quad employed \end{cases} \tag{3}$$

where r and m stand for rich and middle class individual.

The expression $T(.,z)$ defines a progressive taxation system which takes into account of any non-linearities within the system. Notice that the reasons 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].

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

Then, the individual initial wealth can be used to invest either in an entrepenurial activity or in education or in an economy-wide mutual fund whose equilibrium unit (gross) return corresponds to the parameter A. Finally, each individual supplies inelastically a unit of labour.

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, ($n > 0$). 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 entreprenurial activity and in the projects of other agents via the capital

[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.

market[7]. This entrepenurial activity requires a set up cost (φA) and the agent's unit of labour. The return of this activity in post-tax terms is uncertain and given by:

$$y_i - T(y_i, z) = \begin{cases} A(e_{i,m}N)^{\alpha} - T(y_i,z) & with \quad probability \quad e_{i,r} \\ 0 \quad with \quad probability \quad (1-e_i) \end{cases} \tag{5}$$

Notice that the probability of success depends on the amount of effort supplied by both the employer ($e_{i,r}$) and the employee ($e_{i,m}$).

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

$$\omega_{it} - T(\omega_{it}, z) = b_{it} - T(b_{it}, z) \tag{6}$$

The return of this project corresponds to:

$$y_m - T(y_m, z) = \begin{cases} w_m - T(y_i,z) - r(\psi A - (b_{it} - T(b_{it},z))) & with \quad probability \quad e_{i,m} \\ 0 \quad with \quad probability \quad (1-e_{i,m}) \end{cases} \tag{7}$$

where w denotes the wage.

2.1 Capital Market Static Equilibrium

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

$$R(\omega_i, T(\omega_i, z)) = \begin{cases} r(\psi A - (\omega_{it} - T(\omega_{it},z))) & if \quad the \quad project \quad succeeds \\ 0 \quad if \quad the \quad project \quad fails \end{cases} \tag{8}$$

The optimisation problem of the middle-class borrower agent is to choose the effort which maximises her expected revenue net of both repayment and effort costs

[7] They could also invest in education in order to become a skilled employeed 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.

$$\max_{e} \{e_m(w_m - T(w_m(e_m), z)) - e_m r(\psi A - (b_{i,m} - T(b_{i,m}, z))) - h(e_m)\} \tag{9}$$

where according to equation (6) the initial endowment is equal to $b_{i,m}$ and finally the effort cost function is quadratic in effort $\left(h(e) = A\frac{e_m^2}{2}\right)$.

The effort supply function is therefore the following:

$$e_m(w_m, \omega_m) = \frac{w_m \nu_{wm}}{A} - \frac{r}{1 - t_{wm}}\psi + r\frac{b_{i,m}\nu_{w,m}(1 - \tau_{bm})}{(1 - \tau_{wm})} \tag{10}$$

where the subscript wm and bm refer to the wage 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 coefficient of income progression $\left(\nu_{w,m} = \frac{1-\tau}{1-t}\right)$ and for a given average tax rate $t_{w,m}$, the lower the initial wealth b_m, the higher the loan repayment, the lower the marginal return from the education investment, the less the effort. Furthemore, the effort supply function is increasing in the wage and in the coefficient of income progression for a given interest rate and initial wealth. That is, a higher tax progressivity in the skilled workers' income brackets disincentives human capital accumulation. However, holding fixed the degree of tax progressivity, a redistributive policy which finances the reduction in the marginal tax rate in the initial endowment with an increase in the marginal tax rates of skilled workers favours the individual's supply of effort for a sufficient small interest rate. The net of payment return in education is indeed increased.

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

$$\max_{e} \{e_r(y_i - T(y_i(e), z)) - h(e)\} \tag{11}$$

and its solution corresponds to:

$$e_r(e_m, N) = (1 - \tau_i)(e_w N)^{\alpha} \tag{12}$$

where τ_r denotes the 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 individual depends on her future output 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:

$$r(\omega)\, e_m(\omega) = A \tag{13}$$

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

$$r(\omega)\left(\frac{w_{mt+1}\nu_{mt+1}}{A} - \frac{r}{1-t_{mt+1}}\psi + r\frac{\omega_{mt}\nu_{_{mt+1}}(1-\tau_{mt})}{(1-\tau_{mt+1})})\right) = A \tag{14}$$

As in AB the above equation (14) shows that even when the interest rate is endogenous, the effort supply function is in 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. agriculturial sector) or as unemployment.

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

$$Y_j = A\,(e_i N_i)^{\alpha} \tag{15}$$

Since only middle class agents, that have invested in education, access to this sector the labor input is homogeneous and the unit of labour is supplied inelastically. Therefore, the optimisation problem of the firm is to maximise 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 $\left(\frac{w_i}{e_i}\right)$.

$$\min\left\{\psi A + \frac{w_i}{e_i} e_i N_i\right\} \tag{16}$$

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

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

Further, we are assuming that the invidual's effort supplied to achieve an educational degree corresponds to the effort supplied as employed.

Then, according to the Solow condition:

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

Pre tax wages of successfull 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. The employment implicit form solution is therefore:

$$N_i\left(w_i, e_i\right) = \left[\frac{w_i\left(e\right)}{\alpha A}\right]^{\frac{1}{\alpha-1}} \frac{1}{\frac{w_{mt+1(e_m)}\nu_{mt+1}}{A} - \frac{r}{1-t_{mt+1}}\psi + r\frac{\omega_{mt}\nu_{mt+1}(1-\tau_{mt})}{(1-\tau_{mt+1})}} \tag{19}$$

As usual, employment level of successfull skilled workers defined by equation (19) is a decreasing function of both wages and individual's effort.

2.3 The Economy growth rate

By definition, the growth rate of the economy, expressed in logs is the following:

$$g = \ln \frac{\int_0^i \left(e_m N\right)_t di}{\int_0^i \left(e_m N\right)_{t-1} di} = \ln \Delta \int_0^i \left(e_m N\right)_t di \tag{20}$$

Then, the output growth rate depends on the variations of both the effort of the successfull middle class skilled workers and their employment level.

2.4 Qualitative Analysis

This qualitative analysis aims at describing the growth effects of a redistributive policy measured as an increase in tax progressivity. According to equation (20), we can easily obtain:

Proposition 1 *The growth effect of a rise in tax progressivity in the successfull skilled worker income bracket determined by a rise (reduction) in the marginal (average) personal income tax rate keeping constant all the other tax parameter depends on a "greater opportunities effect" and on a "effort supply income effect."*

Proof.

$$\frac{dg}{d\tau_m} = \frac{\partial g}{\partial e_m}\frac{\partial e_m}{\partial \tau_m} + \frac{\partial g}{\partial N}\frac{\partial N}{\partial w_m}\frac{\partial w_m}{\partial e_m}\frac{\partial e_m}{\partial \tau_m} \tag{21}$$

where $\frac{\partial g}{\partial e_m} > 0, \frac{\partial e_m}{\partial \tau_m} < 0, \frac{\partial g}{\partial N} > 0, \frac{\partial N}{\partial w_m} < 0, \frac{\partial w_m}{\partial e_m} > 0$

$$\frac{dg}{dt_m} = \frac{\partial g}{\partial e_m}\frac{\partial e_m}{\partial t_m} + \frac{\partial g}{\partial N}\frac{\partial N}{\partial w_m}\frac{\partial w_m}{\partial e_m}\frac{\partial e_m}{\partial t_m} \lesseqgtr 0$$

where $\frac{\partial e_m}{\partial t_m} \lesseqgtr 0$ ■

Equation (21) shows that effort supply introduces an income effect $\left(\frac{\partial g}{\partial e_m}\frac{\partial e_m}{\partial v_m} > 0; \frac{\partial g}{\partial N}\frac{\partial N}{\partial w_m}\frac{\partial w_m}{\partial \nu_m} > 0\right)$ that contrasts the *"greater opportunities effect"* $\left(\frac{\partial w}{\partial M}\frac{\partial M}{\partial \nu}\frac{\partial \nu}{\partial \tau} < 0\right)$ on the growth rate of the economy. A rise in the marginal tax rates in the successfull skilled worker income bracket disincentives individual's effort and requires a higher wage in order to garantee the same investment in education. However, following the effort supply reduction employment increases. Then, the sign of the above total differential is ambiguous and depends on the larger of the two effects. This result holds even when a higher tax progressivity (a higher redistribution in the income tax bracket of successfull skilled workers) is achieved by reducing the average personal income tax rate. Notice, however, that under this latter hypothesis the effort effect of the taxation policy is ambiguous. If on the one hand higher tax progressivity

disincentives the investment in education, on the other the reduction in the average personal income tax rate lowers the repayment to the loan $\left(\frac{r\psi}{1-t_m}\right)$ [9].

Clearly, according to equation (21) growth effects of redistributive policy depends on the effort effect since the employment level vary with the effort. If we allow for a reduction in the initial endowment marginal tax rate financed by an increase in marginal tax rate in the successful skilled worker income bracket, the effect on the growth rate of the economy is still ambiguous. A lower marginal tax rate in the initial endowment reduces the amount to borrow to invest in education and through this channel incentives the amount of effort supplied. Nevertheless, the increase in the marginal tax rate burdened on the skilled worker wage has the opposite impact on the economy's growth. These are goods reasons to believe that the sign of the growth effect of a redistributive policy depends on the taxation level and the degree of tax progressivity.

3 The Empirical Model

As long as we consider the static equilibrium, equation (20) solves the growth rate of the economy as

$$g^* = g(\Delta e\left(\Delta T(\cdot),\right)\Delta N\left(\Delta T(\cdot),\right)) \tag{22}$$

Notice that the growth rate depends on the effort provided and the entire tax structure, described by the tax parameters τ_{bm}, τ_{wm}, t_{wm} and ν_{wm}. 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 log-linear approximation of (22) yield the following empirical model

[9] See equation (10).

$$\ln g_{it} = f_i + \beta_{1i}\Delta\tau_{it} + \beta_{2i}\Delta t_{it} + \beta_{3i}\ln g_{i(t-k)} + \epsilon_{it} \tag{23a}$$

$$\ln g_{it} = f_i + y_{t-1} + \beta_{1i}\Delta\tau_{it} + \beta_{2i}\Delta t_{it} + \beta_{3i}\ln g_{i(t-k)} + \epsilon_{it} \tag{23b}$$

where g is per capita output growth, $\Delta\tau_{it}$ denotes the change in the marginal income tax rate, Δt_{it} is the average income tax rate of change and f_i is an individual fixed effect and ϵ_{it} is the random error term ($\epsilon_{it} \sim i.i.d$). The term $\ln g_{i(t-k)}$ is introduced to correct for any kind of dynamic misspecification and the term y_{t-1} in the ($23b$) specification to capture the speed of convergence towards the steady state. Notice that ($23a$) can refer to an endogenous growth model where there is not transitional dynamics. In contrast, ($23b$) 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. 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 specification differs from them by introducing the rate of change of tax rates rather than the tax level. 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 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.[10] On the other, in presence of imperfection in the capital market, progressive taxation allows more individuals to be able to invest in human capital leading to a higher growth rate. Then, it is also reasonable to expect the negative (positive) effect to dominate in those countries characterised by high marginal (average) tax rate and a high (low) degree of tax progressivity. Expectations on countries characterised 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 restriction that the sign of the effect depends on the taxation level and the degree of tax progressivity according to the following scheme:

Figure 1

ν \ τ	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
15	SPA														
14		AUS													
13					JAP										
12									FRA						
11				+		ITA					?				
10											CAN				
9				NOR											
8			GER												
7										US					
6													UK		
5								SWE							
4				?							-				BEL
3												FIN			
2							DEN								
1														NET	

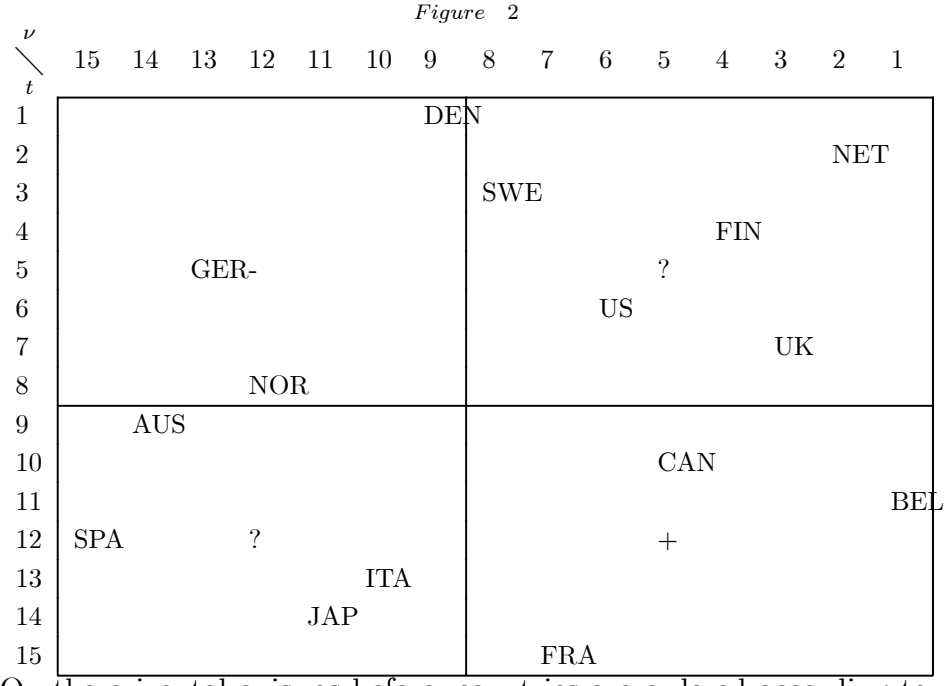
On the orizontal axis countries are ordered according to their average

[10] According to the fiscal policy approach, see among the others Alesina and Rodrick [1994], Perotti [1993] and Persson and Tabellini [1994], equality is not harmful for growth since more equal society claims for less redistribution and therefore distortionary taxation decreases as equality increases. This implies a positive relationship between equality and growth in a reduced form regression.

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 penalised by) of more redistribution measured as a rise in the marginal tax rate since the positive effect of increasing the number of people who can invest in human capital should be higher (lower) than the negative disincentive effect on human capital accumulation of increasing the marginal tax rates. 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[11].

Figure 2



On the orizontal axis, as before, countries are ordered according to their degree of tax progressivity, averaged over the sample period, from

[11] 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.

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 (fourth) quadrangle. That is, countries with high (low) average tax rates and low (high) tax progressivity might benefit (be penalised 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 in developing countries 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.

4 The Data

We investigate the relationship between redistribution and growth using an orginal 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 pubblication "*The tax-benefit position of production workers.*"

For each year and for each country in the sample, we compute pre-tax wages by using the information on income tax rates, tax brackets, 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 manifacturing sector, who has a dependent spouse and two children). Given pre-tax and net 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 distribu-

tion 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 A1 provides a summary description of the data by group classified on the basis of their level of the marginal tax rate[12]. 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[13]; the second ($GR2$) (low marginal tax rate countries whose redistributive effects might be positive) all those belonging to the first one[14] and the third group incorporates all those countries whose redistributive effects are not signed on a priori grounds[15]. 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[16] have increased (see panel 2), especially 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%. 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

[12] On the basis of our theoretical model which suggests different redistributive effects associated to tax levels and the degree of tax progressivity, we esclude the possibility of considering the evolution of the pooled (among the 15 countries) growth rate. As a consequence, we could cluster the countries on the basis of two criterion combining alternatively the degree of tax progressivity to the marginal or the average tax rates.

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

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

[15] Namely: Canada, Denmark and France.

[16] Countries' groups classification is based on Figure 1.

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 A2 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 first quadrangle of Figure 2[17]; the second ($GR2$) (high average tax rate countries whose redistributive effects might be positive) all those belonging to the fourth one[18] and the third group incorporates all those countries whose redistributive effects are not signed on a priori grounds[19].We notice that the evolution of the growth rate for the second and third group is quite similar over the entire sample period. A different pattern in the evolution of the rate of growth of the first 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 second group. Panel 3 shows that the average income tax of the first 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.

5 Results

We start our empirical analysis by estimating $(23(a,b))$ on the longitudinal data for the years 1974-1997. Since individual fixed effects are eliminated by taking first differences; the term f_i 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:

$$\beta_{ji} = \beta_j + \eta_{ji}$$

that is, individual coefficient are distributed around a common mean

[17] Namely: Denmark, Germany and Norway.

[18] Namely: Belgium, Canada and France.

[19] Namely: Australia, Finland, Italy, Japan, The Netherlands, Spain, Sweden, UK and US.

and the disturbance component η_{ji} has a zero mean and a costant 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 the growth effect of redistribution might differ across countries according to their taxation level and the degree of tax progessivity. Second, Pesaran and Smith (1995) show that in a dynamic setting the pooled estimator is inconsistent even for $T \to \infty$ when coefficient heterogeneity is ignored.

Poolability is tested by the method proposed by Lee, Pesaran and Pierse (LPP) (1990), that is following partially the author notation[20]:

$$q_2 = t^{-1} \hat{\vartheta}_j' \hat{\Phi}_t^{-1} \hat{\vartheta}_j \sim \chi_s^2$$

where t stands for number of temporal observations and s denotes the number of regressors.

for $(s \leq j)$ under the null hypothesis of parameter homogeneity:

$$H_0 : \vartheta_j = 0$$

where

$$\vartheta_j = \hat{b_j} - \frac{1}{n} \sum_{i=1}^{n} \hat{\beta_j}$$

We perform the above test since the familiar method proposed by Zellner (1962) is too restrictive[21]. Since according to Lee et al., the null could hold even when the homogeneity assumption is rejected.

Our main results are reported in Table 1 which shows both the estimated coefficients and the implied long-run elasticities associated to the change in the tax variables under the homogeneity assumption.

[20] 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" (e.g. parameter homogeneity)

[21] Zellner (1962) tests the homogeneity hypothesis as follows:

$$H_{0z} : \beta_{j1} = \beta_{j2} = .. = \beta_{ji} = ... = \beta_{jn}$$

The dependent variable is the change in the (log) GDP per capita g, obtained by dividing the annual GDP by total population. 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 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 equal. Further, notice that there is not much difference between the two model specifications.

Therefore, redistribution appear to affect the OECD countries' growth negatively**.** On the other hand, their mean lag elasticities appear to be quite small (0.10)[22].

The LPP criterion clearly rejects the hypothesis of homogeneity. We then estimate a version of $(23\,(a,b))$ where we allow for parameter heterogeneity under the assumption of a random coefficient model. We capture the time fixed effect in levels with specific constants and estimate two alternative empirical specifications. In the former specification we follow Pesaran and Smith (1997) by considering coefficient heterogeneity across all sectional units. Therefore, estimates are based on what Pesaran and Smith define as "weighted group mean 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 latter specification, we impose and test restictions 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 2 shows our estimates, with the former specification in the first column and the latter specification in the second column. The first col-

[22]Mean Lag Elasticities as usual are calculated under the assumption of $g_t = g_{t-1} = g_{t-2}$. So far we can not consider these elasticities as properly long run ones since the term which describes the long-run relationship is not explicitly included. This should not be regarded as a severe misspecification problem if as Aghion and Bolton [1997] show one shot changes in taxes have only temporary effects.

Table 1: SUR estimates of (23a) and (23b) based on panel data (1974-97). Dependent variable: rate of change in log annual GDP per capita $\ln g$

	Coefficient	Coefficient
$\Delta\tau$	-0.079	-0.096
	(.024)	(.023)
Δt	0.084	0.082
	(.015)	(.015)
y_{t-1}	-	0.027
		(.006)
η_1	.102	.119
η_2	.108	.101
$Nobs$	315	315
R^2	.18	.59
LPP	.00	.01

Note: Each regression includes a specific constant, (that is we are allowing for time fixed effects in levels) and two lags of the dependent variable. Robust standard errors within parentheses. R^2 adjusted for the degree of freedom η_1 : marginal (rate of change) income tax mean lag elasticity of the per capita growth; η_2 : average (rate of change) income tax mean lag elasticity of the per capita growth. LPP : P- value of the Lee, Pesaran and Pierse test for the homogeneity of parameters ($\chi^2(4) = 16.87; \chi^2(5) = 16.69$).

umn shows that a higher redistribution obtained as negative (positive) rate of change in the marginal (average) income tax reduces the economy growth. These findings confirm the results in Table 1 although now the coefficient of the marginal income tax rate is insignificant. Moreover, compared to that table, we find that the impact of redistribution on growth differs quantitatively. The effect is smaller and stronger to that found in Table 1 for a change in the marginal and average personal income tax rate respectively. The long-run elasticities confirm this pattern. Notice that mean lag elasticities calculated from the average of country specific short-run coefficients are lower than those derived from the mean of the mean lag country-specific coefficients. Both the two former findings are not surprising in lights of the Pesaran and Smith (1995) results. Overall, this evidence suggests that the assumption of homogeneity can produce misleading results and that the estimates of the average mean lag effects do differ: the weighting affects mostly the average of the short run coefficients which has a larger dispersion.

Next we ask whether the impact of redistribution on growth vary by tax level and the degree of tax progressivity, as suggested by our theoretical framework and identification scheme reported in Figures (1) and (2). This is done by selecting the empirical specification in the second column 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 $(GR1)$ [23], positive $(GR2)$ [24] or unsigned effect $(GR3)$ [25] 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

[23] 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.

[24] Countries included in this group, which is defined with respect to the marginal tax rate, are: Australia, Germany, Italy, and Japan.

[25] 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.

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. This seems to be the case for the marginal tax rate. Then, we started from what suggested by Figures (1) and (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.

Column 2 in Table (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[26]. The three groups of country present the sign expected. Notice that the country group classification is quite close to what suggested by Figure (1) and (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 effect can be obtain if one allows a change in the marginal (negative) rather than an average (positive)[27] tax rate. As expected, the size of the country groups coefficients are larger than those estimated by the "weighted mean group estimator" for all countries strongly penalised 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 $H_{0z} : \beta_{j1} = \beta_{j2} = .. = \beta_{ji} = ... = \beta_{jn}$). Once, the test is accepted, since as discussed above is too restrictive, we apply the Pesaran and Smith "weighted mean group estimator" within the three country groups.

Mean lag elasticities are almost all significant and larger than those calculated from the mean group estimates. For example, under $(23a)$ the specification a one percent increase in redistribution measured by the rate of change in the marginal tax rate for the first and third group

[26] Only the change in the marginal tax rate of the second group is almost significant in the $(23a)$ specification.

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

Table 2: Mean Group Estimator on $(23a)$ and $(23b)$. Dependent variable: change in log annual GDP per capita $\ln g$

	(1)	(1a)	(2)	(2a)
$\Delta\tau$	-0.022	-0.161	–	–
	(.002)	(.019)		
Δt	0.116	0.197	–	–
	(.002)	(.011)		
y_{t-1}	–	-0.036	–	-0.033
		(.029)		(0.138)
$GR1\Delta\tau$	-	-	-0.271	-0.265
			(.174)	(.098)
$GR2\Delta\tau$	-	-	0.186	0.120
			(.141)	(.092)
$GR3\Delta\tau$	-	-	-0.125	-0.195
			(.054)	(.038)
$GR1\Delta t$	-	-	0.246	0.305
			(.025)	(.019)
$GR3\Delta t$	-	-	-0.098	-0.075
			(.024)	(.0173)
η_1	.072**	.232**	-	-
η_2	.275**	.366**	-	-
η_3	.030	.190**	-	-
η_4	.154**	.231**	-	-
$Nobs$	315	315	315	315
R^2	.188	.654	.186	.649
ZEL	-	-	.459	.128

Note: Additional regressors: specific constant and two lags of the dependent variable. Robust standard errors within parentheses. η_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; η_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; η_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; η_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 $(\chi^2(3) = 2.59; \chi^2(3) = 5.69)$. ** and * if the estimated elasticity is significantly different from zero respectively at the 5 and 10 percent level of confidence.

Table 3. Mean Lag elasticities based on the three groups of countries specification.

	(2)	(2a)
$GR1\eta_1$	.386**	.368**
$GR1\eta_2$	.521**	.596**
$GR1\eta_3$	.362**	.315**
$GR1\eta_4$	.328**	.362**
$GR2\eta_1$	.234**	.131*
$GR2\eta_3$	.249*	.144
$GR3\eta_1$	.269**	.311**
$GR3\eta_2$	.069**	.023
$GR3\eta_3$	.166**	.233**
$GR3\eta_4$	.131**	.090**

Note: η_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; η_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; η_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; η_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;

(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 higher redistribution. Notice that our measure of redistrinution which derives by costruction from the earnings distribution and which refers to a sort of representative employee tax-payer, 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 costant, a current and first lag of a 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 a SUR estimates of $(23\,(a,b))$, the Hausman test implies comparing the GLS variance-covariance matrix to the three stage least square one. Table (4) illustrates the results. Notice that we are testing the endogeneity issue under the assumption of parameter heterogeneity across 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 second column are reported SUR estimates which differ from those reported in Table (2) by cross-country classification. Since the 3 stage estimates of column (1) Table (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 Mean Group estimates.[30]

[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 $(23b)$, 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.

Table 4. Three Stage estimates of $(23\,(a,b))$. Dependent variable: log annual rate of growth $\ln g$.

	(3ST)	(3STa)	MGE	MGEa
$GR1\Delta\tau$	-0.220	-0.339	-0.186	-0.290
	(.020)	(.056)	(.045)	(.050)
$GR2\Delta\tau$	0.252	0.071	0.195	0.140
	(.031)	(.218)	(.043)	(.114)
$GR3\Delta\tau$	-0.050	-0.284	-0.105	-0.177
	(.050)	(.027)	(.049)	(.041)
$GR1\Delta t$	0.506	0.386	0.354	0.382
	(.030)	(.031)	(.057)	(.031)
$GR3\Delta t$	-0.135	-0.115	-0.053	-0.063
	(.010)	(.016)	(.012)	(.014)
y_{t-1}	–	-0.028	–	-0.033
		(.158)		(.134)
$Nobs$	315	315	315	315
R^2	.165	.626	.188	.653
ZEL	.576	.01	.259	.078
$HAUS$	.998	.981	–	–

Note: Additional regressors 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 $(\chi^2\,(3) = 1.99; \chi^2\,(3) = 10.6; \chi^2\,(3) = 4.02; \chi^2\,(3) = 6.28)$. $HAUS$: P-value of the Hausman test for the endogeneity of the explanatory variables $(\chi^2\,(57) = 29.7; \chi^2(81) = 56.7)$.

The Hausman test suggests that change in tax rates are not endogenous. Clearly, estimates illustrated in the first column ($3ST$) do not diverge too much from those reported in the second column (SUR). Then, we are quite confident in the Mean Group estimates, although if we try to test the endogeneity hypothesis through the Hansen test, we are not able to reject the endogeneity of the explanatory variables[31].

Notice further that results are quite close to the previous country group classification.

By considering column (2) since the coefficient of the speed of convergence parameter does not appear to be 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 third group (0.116) than in the first and second group (0.324 and 0.241 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 higher across the first group (0.656) than across the third group (0.038) 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. However, all these elasticities are significantly different from zero. 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 disincentive 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 adjust as much as in the case of the other two groups where the negative (positive) effects should be stronger.

[31] Hansen's key testing result is that:

$$u'ZWZ'u \sim \chi^2$$

where u denotes the disturbance vector and the Z's are the instruments.

The main difference with the Hausman test is that in Hansen's context the weighting matrix (W) does not take into account of the correlations in the cross-countries disturbances' terms.

Table 5. Mean Lag elasticities based on the three groups of countries specification.

	(2)	(2a)
$GR1\eta_1$	.324**	.481**
$GR1\eta_2$	.656**	.959**
$GR1\eta_3$	.243**	.311**
$GR1\eta_4$	.462**	.410**
$GR2\eta_1$	.241**	.130
$GR2\eta_3$	.254**	.186**
$GR3\eta_1$	.116**	.195**
$GR3\eta_2$	.038*	.094**
$GR3\eta_3$	.137**	.237**
$GR3\eta_4$	.070**	.084**

Note: η_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; η_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; η_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; η_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;

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 governments of the first (second) group of countries decide to reduce (increase) the marginal income tax rate by 5% and 10%. This corresponds to a "pure" reduction (increase) on tax progressivity for the first (second) group. According to our estimates in Table (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. Using these estimates, this policy experiments would increase the growth of the first and second group by 1.6% and 2.41% which are quite close to the actual values.

6 Conclusions

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' 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 presents ambiguous results. A message of this paper is that the political agenda'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.

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Appendix

Figure 1

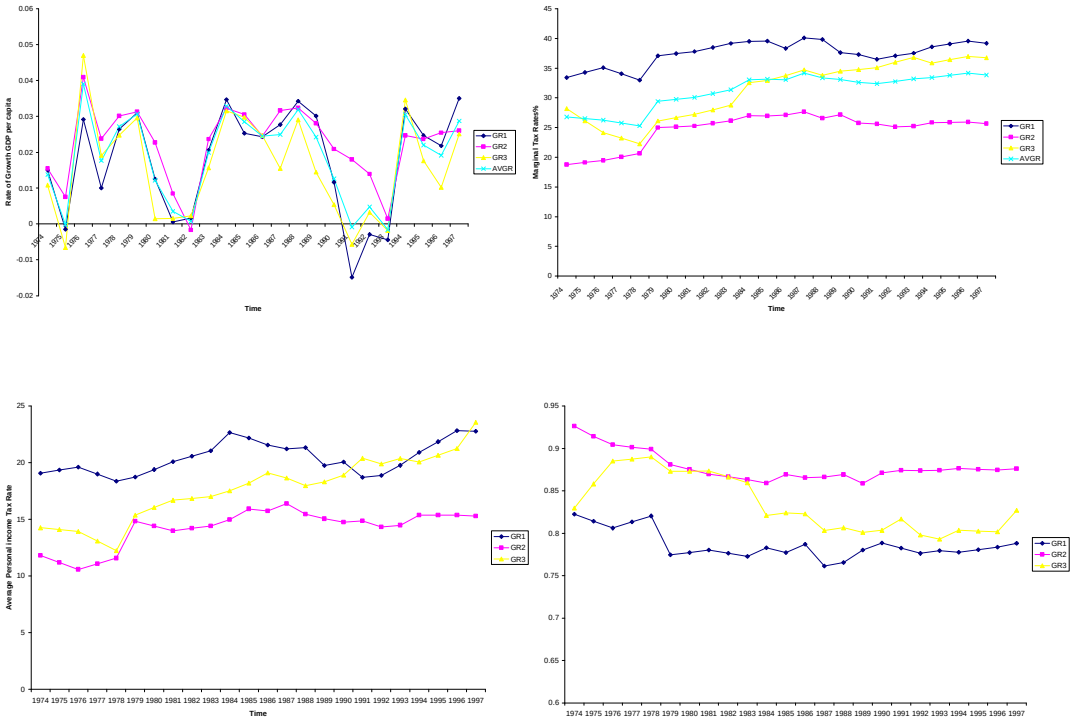
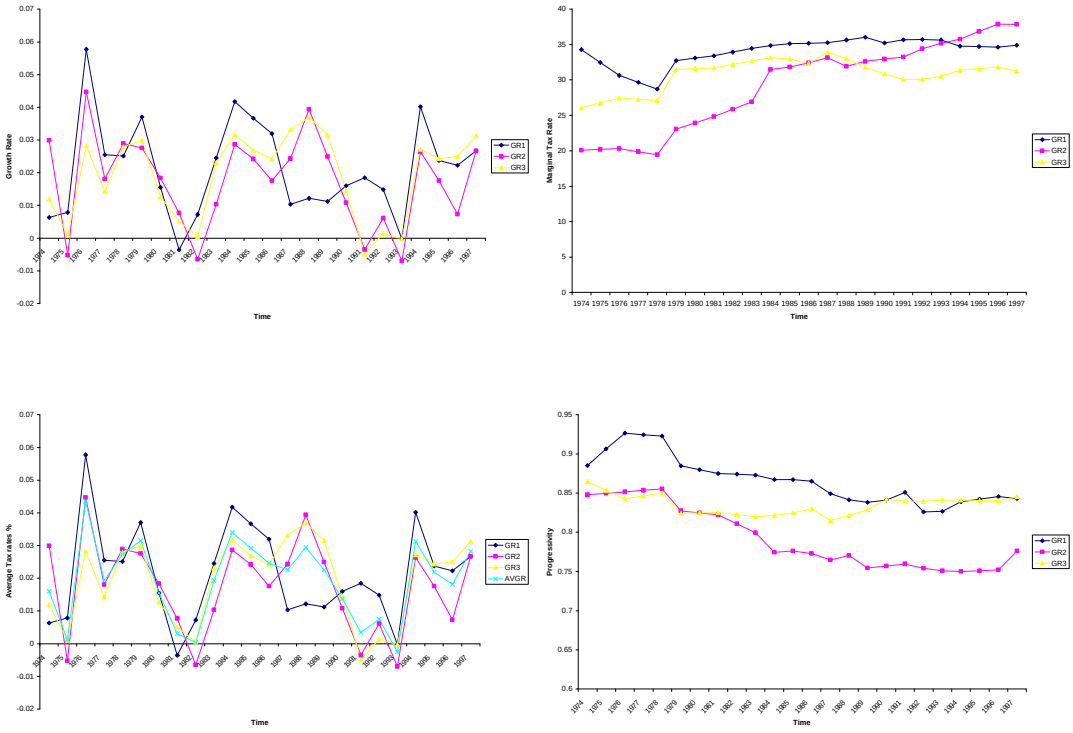


Figure 2


Growth Rate
Time
GR1
GR2
GR3
Marginal Tax Rate
Time
GR1
GR2
GR3
Average Tax rates %
Time
GR1
GR2
GR3
AVGR
Progressivity
Time
GR1
GR2
GR3

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. Since the taxation system is not linear, when aggregating across different industries, where earnings are reasonably different, the average marginal rate and the average average rate are not, in general, equal to the marginal and average tax rates evaluated at the average earnings:

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

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. Altough 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.[32].

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.

[32]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 Federals 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[33].

The effective average tax rate corresponds to the following expression:

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

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

[33]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 stardard 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 determing 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[34]. For this reason, the denmark effective average tax rate series is extrapolated by the personal income tax 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 serie 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.

[34] 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.