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**Income Skewness, Redistribution and Growth:  
A Reconciliation**

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# Income Skewness, Redistribution and Growth: A Reconciliation\*

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## Abstract

The so-called "fiscal policy approach" predicts that increases in income skewness should be associated with an intensification of redistributive efforts, at least in democracies. If redistribution is detrimental to growth, then this implies that a poor middle class is bad for long-run productivity; a prediction which has found empirical support. However, cross-country studies tend to find a *negative* association between income skewness and the amount of redistribution taking place, and, a *positive* relationship between redistributive taxation and growth. This paper offers a reconciliation of the existing theory and these puzzling findings. Specifically, the model predicts that the traditionally stipulated chains of causality holds within countries, whereas the puzzling correlations mentioned above may arise across countries. We provide a test of our explanation and find support for our approach using data on income taxes, taxes on property and expenditures on education.

Keywords: Income distribution, Political economy, Endogenous growth  
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# 1 Introduction

In recent years the question of how income inequality affects economic activity in the long run has received significant attention from macro-economic researchers. At present several theoretical models compete and complement each other in trying to explain how the size distribution of income affects economic growth.<sup>1</sup> The present paper is preoccupied with one such theory: The so-called fiscal policy approach.<sup>2</sup>

Oversimplifying, one may summarize the main theoretical predictions of the approach as: (i) increasing skewness of the income distribution tends to increase redistributive government intervention, and (ii) redistribution is detrimental to growth. Accordingly, the reduced form prediction of the theoretical literature is that a more *skewed* distribution of income is bad for long term growth.<sup>3</sup>

Notwithstanding the fact that the evidence seems to broadly support the reduced form prediction of the fiscal policy approach (e.g. Clarke, 1995; Perotti, 1996a; Easterly 2001, 2002), the empirical success in terms of the specific mechanisms advocated has been limited. In fact, a number of cross-country studies find that if anything: (i) Countries with a more skewed distribution seems to redistribute *less* (Perotti, 1996a; Lindert, 1996; Bassett et al, 1999) and (ii) taxation/redistribution seem to be *beneficial* to growth (e.g. Perotti 1994, 1996a; Easterly and Rebello, 1993; Sala-i-Martin, 1996). Hence, the conclusion seems to be that:

Although it [the fiscal policy approach] accounts for the negative correlation between inequality and growth found by reduced-form equations, the political economy approach is not fully supported by data ... redistribution is found to have positive rather than negative influence on growth. Moreover, when measures of redistribution such as tax rates or the extend of social spending are regressed on

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<sup>1</sup>The seminal contribution is Galor and Zeira (1993). A review of the literature can be found in Aghion et al (1999).

<sup>2</sup>A non-exhaustive list of theoretical contributions include: Alesina and Rodrik (1994); Bertola (1993); Perotti (1993), and Persson and Tabellini (1994); Saint-Paul and Verdier (1993).

<sup>3</sup>The paper by Saint-Paul and Verdier (1993) contains a slightly different prediction. In their model a poor median voter will prefer more redistribution in the shape of expenditures on education. Since such expenditure is shown to spur growth, an initially skewed distribution is predicted to enhance growth.

measures of inequality, the coefficients are either insignificant or have the sign opposite to what the theory would predict.

– Aghion et al, 1999, p. 1621.

The first contribution of the present paper lies in developing a model capable of reconciling the original theory with the above conflicting evidence. Specifically, we show that under plausible assumptions, a negative income skewness/tax relationship, and a positive tax/growth relationship may emerge in a cross-section of countries, while *within* any one economy, a poorer middle class will lead to more taxation, and more taxation to less growth. The second contribution lies in providing a test of our proposed explanation, as detailed below.

The model developed below builds on the Alesina and Rodrik (1994) framework. Hence, the formal structure allows for productive government investments (financed by wealth taxes) that affect growth, and redistributes consumption.

The key difference to the Alesina and Rodrik analysis lies in the assumption that fundamental (and slow-moving) structural characteristics – notably institutional quality or key determinants thereof – matters *both* for the distribution of income, and to the level of productivity. Specifically, we posit that countries equipped with a stronger institutional framework tend to be more productive and feature a richer middle class. This is consistent with the empirical work of Acemoglu *et al* (2001) and Easterly (2002). Acemoglu *et al* find that settler mortality rates in 19th century colonies are strongly related to institutional "scores" as of the late 1990s. Instrumenting proxies of institutional quality by settler mortality rates, they find that the institutional framework has a strong causal impact on productivity across ex-colonies. Easterly find that settler mortality rates also predicts income equality in the late 20th century: Low mortality tends to go hand in hand with a richer middle class.

Formally the link between institutions, productivity and the income distribution is introduced in a very simple way. First, stronger institutions is simply assumed to increase the level of Harrod-neutral productivity.<sup>4</sup> Second, since we are applying a standard

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<sup>4</sup>Hall and Jones (1999) show that institutions have a strong causal effect on not only GDP per worker

neoclassical production function, changes in the level of productivity will affect the distribution of factor income. In line with Alesina and Rodrik the main source of income inequality in the model is heterogeneity with respect to factor endowments. Specifically, wealth is unequally distributed, labor income is not. Given this assumption it follows that the extent to which inequality of the distribution of wealth is translated into inequality of *income* depends, in general, on the income shares of capital and labor, respectively. In particular, we assume that countries with a stronger institutional environment are characterized by a higher labor share, and therefore, have a more equal distribution of income, *ceteris paribus*. The former link is consistent with Rodrik (1999). Using manufacturing data for 93 countries he find that labor's share of value added is higher in countries with democratic institutions. Moreover, Rodrik document that democratic institutions tend to be accompanied by superior performance in terms of bureaucratic efficiency and rule of law; standard measures of institutional quality.<sup>5</sup>

On this basis we present the following explanation for what one might term "the fiscal policy puzzle". *Within* any given economy, increasing wealth inequality, and therefore, holding fundamental structural characteristics fixed, increasing income inequality, will lead to more redistributive taxation. However, this relationship may break down as soon as one consider economies that differ with respect to the strength of institutions. The reason is that a strong institutional framework implies that the marginal cost of public investment (measured in terms of foregone future consumption) tend to be low, and marginal benefit high, since the level of productivity is "high". As a result, a majority of the electorate may prefer a relatively higher level of government activity than what holds for economies with a weaker institutional infrastructure. Since countries with strong

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but also capital-output ratios, human capital stocks and, in particular, total factor productivity.

<sup>5</sup>Gollin (2002) recently compiled data on *aggregate* labor shares for a number of countries and corrected them for the income of the self-employed. While he finds no systematic relationship between the corrected shares and income per capita, there is a positive correlation between the adjusted labor share (Column labeled "Adjustment 2" in table 2) and the institutional variable used by Hall and Jones (1999) ("GADP") . A linear regression (covering 26 countries where data is available for both variables) yields a coefficient of .13 with a p-value of 0.06 (using robust standard errors). Hence Gollin's work is not necessarily at variance with our assumption of a positive relationship between "institutions" and labor shares. Needless to say, however, a more careful investigation involving more countries is called for in order to provide a more definite test of our assumption (and Rodriks' findings), at the aggregate level.

institutions tend to be equal ones, the relationship between taxation and the middle class' share may well be a positive one, but is generally ambiguous.

At the same time, the model can account for a positive correlation between growth and taxes across countries. As in Barro (1990) the relationship between taxes and growth exhibits the well-known hump-shaped form. However, the growth maximizing tax level is shown to vary across countries. In particular, being higher in countries with stronger institutions. Consequently, in a cross section of countries, it may appear as if taxation is good for growth. But, as the analysis shows, this is solely a cross-sectional phenomenon. Within any given economy, more taxation will lead to slower growth as the intensity of government involvement moves further beyond the level at which growth is maximized. This is a clear cut prediction since the tax chosen by the median voter always exceeds the growth maximizing level, as in the Alesina and Rodrik model.

The empirical contribution of the paper lies in providing a test of this explanation. Invoking panel data techniques, we attempt to disentangle the time-series variation in income skewness, taxes and growth, from the pure cross-section variation. Using data on income taxes and taxes on property we find evidence in favor of the "traditional" fiscal-policy approach when the time-series information is studied, whereas the puzzling relationships mentioned above only emerges when we focus on the cross-country dimension of the data.

The paper falls in two main sections. After a brief review of related literature, Section 2 develops the model and discusses its implications for a cross-section of countries. Section 3 reports the empirical evidence. A final Section 4 offers brief concluding remarks.

## **1.1 Related literature**

A number of possible explanations for the above mentioned puzzling evidence has been suggested in recent years. Bénabou (1996), Saint-Paul and Verdier (1996) and Lee and Roemer (1998) all demonstrate how more inequality may lead to less redistribution when there is a wealth bias in the political system. In the plausible case where income is lognormal or Pareto distributed, and where the pivotal voter is richer than the person

with median income, an increasing variance of the distribution may imply an increasing income share for the pivotal (median) voter, ultimately yielding a negative, or U-shaped, association between inequality and redistribution.

In the empirical work discussed above, however, the independent distribution variable is typically not measures of dispersion (like the Gini-coefficient), but rather measures of income skewness.<sup>6</sup> Since the before mentioned contributions all have a measure of dispersion as their inequality variable, they are unable to explain why *the middle class share* appears to exhibit a positive (/insignificant) correlation with measures of taxes/redistribution. In contrast, the model developed below is able to account for this fact, but, at the same time, warns that the cross-sectional result may not reflect a causal relationship.

In an extension of previous work, Benabou (2000) develop a model featuring multiple steady states. Importantly, when comparing steady states the relationship between pre-tax inequality and redistribution is a negative one; where inequality is measured by the variance of a lognormal distribution. The stylized prediction of the model, then, is that within countries the relationship between redistribution and inequality is ambiguous (unless the individual regimes can be identified), whereas the findings of e.g. Perotti (1996a) arises across countries. Aside from the measurement issue of inequality, mentioned above, the key difference to our framework is that the model below predicts the "standard" relationship between income skewness and redistribution within countries: More skewness raises redistributive efforts.

Perotti (1996b) points to another reason why inequality and redistribution may be related in the manner suggested by the cross-section evidence. In the standard model redistribution is assumed to be directed towards the poor in a monotonic fashion. This might not be the case empirically. Based on this observation Perotti suggests (informally) that variations of benefit shares across individuals might hold some explanatory power. If redistribution predominantly benefits the rich, then a poorer median voter might want less redistribution. However, evidence from the Luxemburg Income Study (LIS), presented in Milanovic (2000), suggests that (at least in the countries covered) redistribution does

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<sup>6</sup>For example, Perotti (1996a) uses the third quintile as a measure of the median voters income.

in fact benefit the poor. Indeed, net transfers appear to be more or less monotonically decreasing as one moves across income deciles, starting with the poorest.

Yet another argument is put forward in Lee and Roemer (1999). In their analysis credit markets are absent, and the population is (endogenously) segmented into a group who invests and one who does not (the poorer individuals). Taxes are levied on post-investment income. They proceed to demonstrate that if inequality increases, tax revenues tend to decline because the share of the population who does not invest rises. This "tax-base effect" may ultimately be strong enough to produce a negative relationship between income inequality (measured by the variance of a lognormal distribution) and taxes, as the outcome of majority voting. In general their analysis suggest an *inverted* U-shaped relation between taxes and inequality.

Somewhat relatedly Rodriguez (1999) questions the assumption of "tax compliance". In standard models it is assumed that everyone pay their taxes, which may not always be the case. Rodriguez demonstrates that if the median voter recognizes the incentive, on the part of the wealthy, to lobby for tax favors she might choose to lower taxes in the face of increased inequality.

In terms of testable predictions the key difference between these theories, and the one developed below, is the nature of the relationship between inequality and redistribution when moving from cross-section to across-time data. All the existing explanations (except Benabou, 2000) imply that the relationship between redistribution and inequality should be the same across time and space whereas our model implies that the correlations may change sign.

The relationship between taxes and growth may also be reversed, as pointed out by e.g. Benabou (1996, 2000) and Aghion et al (1999), if credit markets are imperfect. In this case redistribution may be good for growth as it grants borrowing constrained (poor) individuals the ability to invest. Again, in contrast to our hypothesis, the work of Benabou (1996, 2000) and Aghion et al (1999) suggests a uniformly positive relationship between taxes/redistribution and growth when moving from the cross-country to across-time dimension of the data.



On the empirical side Milanovic (2000) recently found some corroborating evidence in favor of the original political economy mechanism, using survey data from the LIS, and, adopting a fixed effects approach: The income share of the "middle class" is significant in explaining the amount of redistribution accruing to this group. In terms of the taxes/growth nexus a recent study by Kocherlakota and Yi (1997) reports a negative impact of taxation on growth, using data spanning more than a century for the United States and United Kingdom. Likewise, looking at a panel of OECD countries Kneller et al (1999) find a negative impact from taxes on growth.

Our empirical findings should be viewed as complementary to these results, as we use different data on "redistribution" and inequality. Moreover, our model provides a theoretical explanation as to why results differ so markedly between pure cross-section regressions and panel data (/time series) regressions.

Finally, the contribution by Sylwester (2000) deserves special mentioning. Sylwester examines both the relationship between inequality (measured by the Gini-coefficient) and redistribution (measured by expenditures on education as a fraction of GDP) and the relationship between such expenditures and growth. Within a pure cross-section regression analysis he find: (i) more inequality in 1970 is associated with a higher level of educational expenditures, and (ii) expenditures in the 1970s are *negatively* related to growth from 1970-85, whereas expenditures in the 1960s are *positively* associated with growth from 1970-85. Sylwester argues that the productivity enhancing effects of educational expenditures only manifests itself after a (long) lag, which is why expenditures in the 60s raise growth in the 70s and 80s. The detrimental effects of the expenditures in the "current" period on growth might be explained by the likely adverse effects of higher taxation required to finance government investments. In the empirical part of this paper we revisit Sylwester's findings. We suggest an alternative interpretation of his finding and argue they are consistent with the explanation forwarded in the present paper.

## 2 The Model

Consider a closed economy with a constant population of measure one. The factor markets are assumed to be competitive and the credit markets are perfect. Individuals are identical with respect to preferences and productivity. We allow for heterogeneity with respect to wealth. Taxes are levied on wealth; labor income is exempt from taxes. Each consumer has a unit endowment of labor which is supplied inelastically. Furthermore, we assume a balanced government budget at all times.

### 2.1 The Consumers

The basic problem facing individual  $i$  is to maximize the discounted utility from consumption,  $c_i(t)$

$$\max_{\{c_i(t)\}_{t=0}^{\infty}} \int_0^{\infty} \ln c_i(t) e^{-\rho t} dt, \quad \rho > 0, \quad (1)$$

subject to the identity that accumulation of wealth  $\dot{k}_i(t)$  depends on labor income,  $w(t)$ , after-tax income from wealth  $[r(t) - \tau] k_i(t)$ , and consumption

$$\dot{k}_i(t) = w(t) + [r(t) - \tau] k_i(t) - c_i(t). \quad (2)$$

The consumer's problem of deciding on optimal consumption and saving is completed with the No-Ponzi-Game condition,  $\lim_{t \rightarrow \infty} k_i(t) e^{-rt} \geq 0$ . Standard computations lead to the well known Keynes-Ramsey rule,

$$\frac{\dot{c}_i(t)}{c_i(t)} = r(t) - \tau - \rho \equiv \gamma_{c_i}, \quad (3)$$

which states that the individual will prefer rising consumption if the after-tax real rate of interest exceeds the rate of time preference. As all individuals face the same interest and tax rate and are equally patient, equation (3) implies that  $\gamma_{c_i}$  equals the per capita growth rate of consumption,  $\gamma_c$ . As is shown formally below, the real rate of interest is constant at all points in time ( $r(t) = r$ ). Hence, wealth, and thus capital, must also be accumulated at the rate,  $\gamma_c$ .<sup>7</sup>

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<sup>7</sup>If this were not the case, the savings rate would be either increasing or decreasing through time. This would violate either the no-ponzi game condition or the transversality condition connected to the

## 2.2 The Firms

Production in firm  $j$ ,  $Y_j(t)$ , is characterized by

$$Y_j(t) = g\left(\frac{G(t)}{K(t)}\right) F(K_j(t), E(t) L_j). \quad (4)$$

$G(t)$  is productive government expenditure,  $K(t)$  is the aggregate capital stock,  $K_j(t)$  and  $L_j$  is the input of physical capital and labor, respectively, while,  $E(t)$  is an index of each workers productivity at time  $t$ . Both  $E(t)$  and  $G(t)/K(t)$  are treated as exogenous by the producers. Note that  $\int_i L_j dj = 1$  as total labor supply is of measure one. The properties of  $g(\cdot)$  and  $F(\cdot)$  are discussed below.

The level of government intervention is divided by the aggregate capital stock so as to capture congestion effects. Hence, in order to increase over-all productivity,  $G(t)$  has to rise in proportion to  $K(t)$  (see Barro and Sala-i-Martin, 1992). The function  $g(\cdot)$  determines the extent to which such an increase is transformed into an increase in (Hicks-neutral) productivity. We assume  $g' > 0$ ,  $g'' < 0$  and the Inada condition  $\lim_{\tau \rightarrow 0} g' = \infty$ , thereby allowing for diminishing returns to government productive investments. As we have assumed a balanced government budget, whereby  $G(t) = \tau K(t)$ , it follows that

$$g\left(\frac{G(t)}{K(t)}\right) = g(\tau).$$

$E(t)$  expands as productive knowledge is accumulated in the process of capital accumulation:

$$E(t) = AK(t), \quad (5)$$

Equation (5) signify, that two countries (at a given point in time) with identical capital stocks, labor endowments, and government intervention, may differ with respect to the *level* of income per capita. The parameter  $A$  in equation (5) parameterizes such cross-country differences. In the sequel we will refer to  $A$  as productivity enhancing "institutions".

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problem, i.e.,  $\lim_{t \rightarrow \infty} \frac{k_i(t)}{c_i(t)} e^{-\rho t} = 0$ . Hence, the only (non-trivial) possibility for a balanced growth path is  $\frac{\dot{c}_i(t)}{c_i(t)} = \frac{\dot{k}_i(t)}{k_i(t)} = \gamma_c \forall i, t$ .

Turning to the functional form of the production function,  $F(\cdot)$  summarizes how combinations of physical capital and labor input are transformed into output. We assume that  $F(\cdot)$  exhibits constant returns in  $K_j(t)$  and  $L_j$ .

Given the production function, equation (4), the producers will acquire capital and hire labor until the marginal product equals the real interest rate,  $r(t)$ , and the real wage,  $w(t)$ , respectively:

$$\frac{\partial Y_j}{\partial K_j} = r(t), \quad (6)$$

$$\frac{\partial Y_j}{\partial L_j} = w(t). \quad (7)$$

In symmetrical equilibrium, all producers choose the same factor intensity  $K_j/L_j$ . Using this we may write the general equilibrium factor demand equations as

$$g(\tau)(f(A) - Af'(A)) = r, \quad (8)$$

$$g(\tau)Af'(A)k(t) = w(t), \quad (9)$$

where  $f(A) \equiv F(1, A)$ ,  $f' > 0$ ,  $f'' < 0$ .

## 2.3 Measuring Inequality

To incorporate a measure of inequality in the analysis we follow Alesina and Rodrik (1994) and define

$$\sigma_i \equiv \frac{k(t)}{k_i(t)}, \quad (10)$$

where  $k$  is the per capita stock of capital. Thus,  $\sigma_i$  denotes the (inverse) relative factor endowment of individual  $i$ . Observe that  $\sigma_i$  is constant as  $\frac{\dot{k}(t)}{k(t)} = \frac{\dot{k}_i(t)}{k_i(t)}$  for all  $i$ . Hence, the distribution of wealth (capital) is time-invariant and predetermined.<sup>8</sup>

In the present framework, the distribution of wealth is paramount to the political equilibrium. Typically, however, empirical investigations of the fiscal policy approach use

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<sup>8</sup>Moreover, this might be a fairly reasonable property of the model from an empirical point of view. In a study of the post world war II period, Li, Squire and Zou (1998) find substantial variation in inequality across countries, but little evidence of substantial long term trends in the size distribution of income within countries. This does not mean, however, that changes in the distribution never occur (see e.g., Atkinson, 1997).

measures of income, and not wealth, inequality. Hence, in order to make the theoretical analysis comparable with these empirical studies we need to consider the mapping from the wealth distribution to the (pre-tax) distribution of income, within the present framework. Using the definition of before-tax household income, the definition of  $\sigma_i$ , and the equilibrium values of factor prices leads to the following expression for individual  $i$ 's relative income share:

$$\frac{y_i(t)}{y(t)} = \sigma_i^{-1} + \frac{Af'(A)}{f(A)} (1 - \sigma_i^{-1}),$$

where  $\frac{Af'(A)}{f(A)}$  is labors share in total income while  $y(t)$  signifies per capita (or mean) income. As an over-all summary measure of income equality, we use the *median* income share,

$$\frac{y_m(t)}{y(t)} = \sigma_m^{-1} + \frac{Af'(A)}{f(A)} (1 - \sigma_m^{-1}), \quad (11)$$

where  $\sigma_m^{-1}$  (the wealth share of the person with median wealth) is reasonably assumed to be less than one. In the remaining we make the following important assumption:

**A1** Labors' share in national income,  $w/y = \frac{Af'(A)}{f(A)}$ , is increasing in  $A$ .

Under A1 it follows that countries with stronger institutions, which works to increase  $A$ , will tend to have a more equal distribution of income, *ceteris paribus*.<sup>9</sup>

## 2.4 The Economic Equilibrium

The model can be reduced to a simple AK-model:

$$y(t) = g(\tau) f(A) k(t). \quad (12)$$

A well-known property of this type of model is the lack of transitional dynamics. This means that *all* endogenous variables grow at a common, constant rate. Consequently,

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<sup>9</sup>Technically, A1 amounts to assuming an elasticity of substitution between capital and labor above 1. Duffy and Papageorgiou (2000) estimate aggregate production functions for a large number of countries and find an elasticity of substitution, between physical and human capital, above unity. Still a straight forward reparameterization of the model could allow us to obtain the same result ( $w/y$  increases in  $A$ ), while assuming an elasticity of substitution between capital and labor below 1.

the Keynes-Ramsey rule, equation (3), pins down the over-all growth rate of (per capita) income in the economy:

$$\gamma = g(\tau)(f(A) - Af'(A)) - \tau - \rho. \quad (13)$$

If  $g(\tau)(f(A) - Af'(A)) - \tau > \rho$ , the economy will grow at a constant positive rate. Taxes have a dual impact on the growth rate, which leads to the familiar hump-shaped relationship between taxes and per capita income growth: At low levels of taxation the productive effect dominates, which is why higher taxes tend to raise growth. But at a sufficiently high level of capital taxation,  $\tau^*$ , savings are reduced to an extent which exactly off-sets the productive effect. If a higher tax rate is implemented, growth will be reduced. Hence,  $\tau^*$ , represents the ‘growth-maximizing’ level of wealth taxation.  $\tau^*$  is given by

$$\frac{\partial \gamma}{\partial \tau} = 0 : g'(\tau^*) = \frac{1}{f(A) - Af'(A)}. \quad (14)$$

Notice that if  $A$  varies from country to country then  $\tau^*$  varies too. In particular we have the following result

**Proposition 1** *The growth-maximizing tax rate,  $\tau^*$ , is increasing in  $A$ .*

**Proof.** Differentiation of equation (14) yields  $\partial \tau^* / \partial A = (Af''(A)) / g''(\tau^*) > 0$ . ■

Thus, countries with stronger institutions reaches maximum growth at a higher level of taxation. We now turn to the determination of the tax rate.

## 2.5 The Political Equilibrium

We assume that taxes are chosen through majority voting. Hence we follow the conventional approach to determination of the political equilibrium within this line of literature, the median voter theorem. To apply the median voter theorem, preferences must be single peaked and the preferred tax rate must be monotonic across individuals, i.e., across relative factor endowments. As a consequence of the balanced growth property of the model,  $\sigma_i$  is constant, so we can abstract from issues of time inconsistency and strategic voting when it comes to the political equilibrium.

To solve for the preferred tax rate we need an expression for the path of consumption. This can easily be found by using  $\gamma_{c_i} = \gamma_{k_i}$  to equate (3) and (2). After rearranging one obtains:

$$c_i(t) = \left[ \frac{w(t)}{k_i(t)} + \rho \right] k_i(t) = [g(\tau) A f'(A) \sigma_i + \rho] k_i(t), \quad (15)$$

where the last part of equation (15) follows from the equilibrium real wage, equation (9), and the definition of  $\sigma_i$ , equation (10). Furthermore, since  $\frac{\dot{k}_i(t)}{k_i(t)} = \gamma \forall i$  the entire time path of consumption can be written as

$$c_i(t) = [g(\tau) A f'(A) \sigma_i + \rho] k_i(0) e^{\gamma t}. \quad (16)$$

Note that the level of consumption is increasing in  $\tau$  through the real wage. At the same time, however, the tax rate will have a negative effect on (future) consumption via reductions in the growth of consumption  $\gamma$  (insofar as  $\tau > \tau^*$ , of course). In other words, the consumer ultimately faces the problem of trading-off these two effects against each other, i.e., a static gain versus a dynamic loss. The solution will depend on the individual's relative factor endowment,  $\sigma_i$ , as will be clear momentarily.

The problem of individual  $i$  is to choose the tax rate which maximizes discounted intertemporal utility. Insertion of the consumption path in equation (1), and integration of the resulting expression leads to the following, obviously static, maximization problem:

$$\max_{\tau} \frac{1}{\rho} \left( \ln c_i(0) + \frac{\gamma}{\rho} \right), \quad (17)$$

subject to equation (13). The first order condition is

$$\frac{\partial c_i(0)}{\partial \tau} \frac{1}{c_i(0)} = \frac{\sigma_i g'(\tau) A f'(A)}{\rho + \sigma_i g(\tau) A f'(A)} = -\frac{1}{\rho} \frac{\partial \gamma}{\partial \tau} = \frac{1 - g'(\tau) (f(A) - A f'(A))}{\rho}. \quad (18)$$

The semi-elasticity,  $\frac{\partial c_i(0)}{\partial \tau} \frac{1}{c_i(0)}$ , represents the marginal benefit (*MB*) from an increase in taxes, and  $-\frac{1}{\rho} \frac{\partial \gamma}{\partial \tau}$  is the marginal cost. It is apparent that all individuals face the same marginal costs (*MC*) while *MB* varies. The first order condition is illustrated in the upper panel of Figure 1; the lower panel shows the relation between growth and taxes.

Marginal cost is zero if  $\frac{\partial \gamma}{\partial \tau} = 0$ , i.e., when the tax rate equals the growth maximizing rate,  $\tau^*$ . The *MC*-curve is upward sloping in  $\tau > \tau^*$  as the dynamic loss mentioned above increases with the deviation from the growth-maximizing tax level.

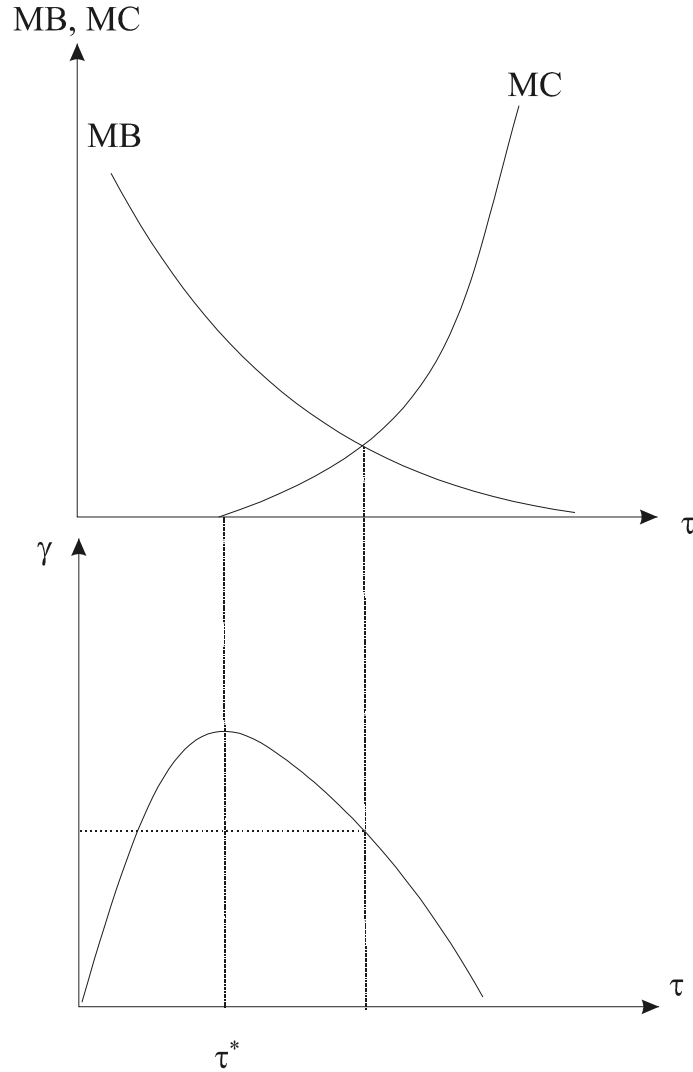


Figure 1: Determining the growth rate of the economy.

Next, consider the MB term. As  $g'' < 0$  it follows from equation (18) that the MB-curve will be downward sloping. Individual  $i$ 's preferred tax rate is uniquely determined at the intersection of the two curves. As can be seen from equation (18), the MB-curve shifts up if  $\sigma_i$  increases.

As for the actually implemented tax rate, it follows from the median voter theorem that the chosen tax rate through majority voting should be the one preferred by the median voter. Hence, the implemented tax rate reflects the median wealth share,  $\sigma_m$ , assuming full participation at elections. In sum we have:



**Proposition 2** *Redistribution, income skewness and growth within an economy.* Assume a fixed institutional framework, i.e.  $A$  constant. Then: (i) The chosen tax rate is decreasing in the wealth (and income) share of the median voter; (ii) the chosen tax rate is above the growth maximizing level; (iii) growth is decreasing in the degree of wealth, or income, skewness.

**Proof.** (i) Assuming majority voting the selected tax rate fulfills  $\frac{\sigma_m g'(\tau) A f'(A)}{\rho + \sigma_m g(\tau) A f'(A)} = -\frac{1}{\rho} \frac{\partial \gamma}{\partial \tau}$ . Differentiation shows that the left hand side is increasing in  $\sigma^m$  - the inverse wealth share. Given  $A$  is constant, equation (11) implies that a higher income share is associated with a lower level of taxation. (ii) Note that if  $\sigma_i = 0$ , the first order condition reads  $\frac{\sigma_i g'(\tau) A f'(A)}{\rho + \sigma_i g(\tau) A f'(A)} = 0 = -\frac{1}{\rho} \frac{\partial \gamma}{\partial \tau}$ . The last equality is fulfilled by  $\tau^*$ . Observe that  $\frac{\sigma_i g'(\tau) A f'(A)}{\rho + \sigma_i g(\tau) A f'(A)}$  is monotonically increasing in  $\sigma_i$ . Hence for  $\forall \sigma_i > 0$ , the individually preferred tax rate  $\tau_i > \tau^*$ . (iii) follows directly from (i) and (ii). ■

Thus, increases in wealth inequality, and therefore income inequality (cf. equation (11)), will lead to more taxation and less growth, as the selected tax rate moves further beyond the growth maximizing level.

## 2.6 Cross-sectional Implications of the Model

In this section we examine the nature of the relationship between income inequality, taxes and growth when different countries are compared, each of which being equipped with different levels of institutional quality, i.e. different  $A$ 's. We start by noting that:

**Lemma** *For  $\sigma_i$  given, stronger institutions (higher  $A$ ), implies higher marginal benefits (MB) from taxation/redistribution, and lower marginal costs (MC).*

**Proof.**  $MB = \frac{\sigma_i g'(\tau) A f'(A)}{\rho + \sigma_i g(\tau) A f'(A)} = \frac{\sigma_i g'(\tau) \alpha_L(A) f(A)}{\rho + \sigma_i g(\tau) \alpha_L(A) f(A)}$ , where  $\alpha_L(A) \equiv f'(A) A / f(A)$  is labor's share. Under A1, and since  $f'(A) > 0$  it follows immediately that  $\partial MB / \partial A > 0$ .  $MC = -\frac{1}{\rho} \frac{\partial \gamma}{\partial \tau} = -\frac{1}{\rho} [g'(\tau) (f(A) - A f'(A)) - 1]$ . Clearly  $\partial MC / \partial A < 0$  since  $f''(A) < 0$ . ■

Consequently we have the following result:

**Proposition 3** *Redistribution and income skewness in a cross-section of countries.* All else equal, countries with stronger institutions (higher  $A$ ) will (i) choose a higher level of taxation/redistribution and (ii) be more equal measured by income skewness.

**Proof.** The first part follow directly from the Lemma. The second part of the proposition follows from A1 and equation (11) directly. ■

Hence, Proposition 3 show that if a (sufficiently) large fraction of the cross-country variation, in personal income inequality, is driven by variations in the institutional framework of individual economies, then societies featuring a less skewed income distribution may well be characterized by higher levels of taxation and redistribution. However, as Proposition 2 demonstrates, this can occur even though "the world works" in accordance with standard political economy growth models, associated with the fiscal policy approach to income distribution and growth.

Figure 2 illustrates these results geometrically. Two economies are gathered in one MC/MB diagram; they differ solely with respect to  $A$ . For the purpose of illustration the figure is drawn such that equilibrium MC(/ MB) are identical across the two countries. This need not be the case in general however, as it depends on the relative size of the shifts in the MB and MC-curves, brought forth by changes in  $A$ .

The lower panel illustrates how the variation in taxes get translated into variation in growth rates. Proposition 1 says that in the society with strong institutions the growth maximizing tax will be higher, as illustrated in Figure 2. As is clear from the figure; when comparing the two economies growth- and tax rates, they may show up in  $(\gamma, \tau)$  – space as points A and B. Hence, the relative more equal society, featuring higher taxes, will end up growing faster (point B). Again, this is solely a cross-section phenomenon. Increasing the tax rate will unambiguously hamper growth within both economies.

It should be recognized that this analysis only illustrates *the potential* for these patterns to arise in a cross-section of countries. Ultimately, other configurations are theoretically feasible. For example, suppose the country with "bad" institutions also has a more unequal distribution of *wealth*. Then the associated MB–curve (i.e.  $MB_{\text{LOW } A, \text{UNEQUAL}}$ )

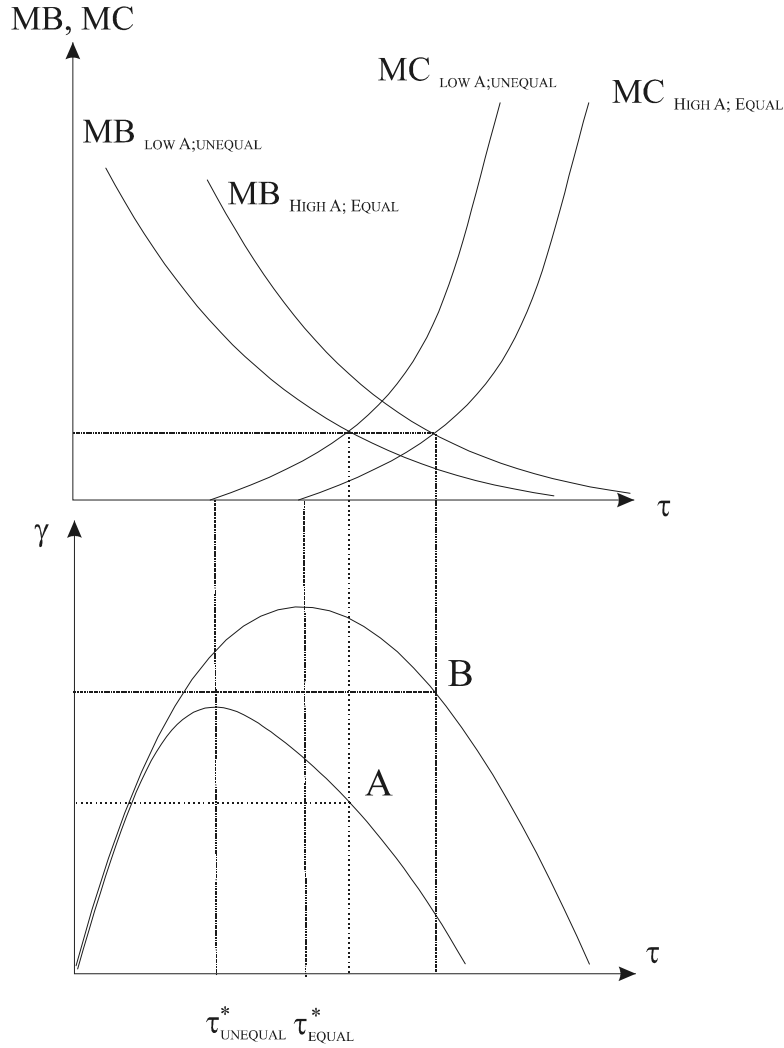


Figure 2: A possible configuration of income skewness, redistributive taxes and growth in a cross-section.

will be placed further to the right than illustrated in Figure 2. This is due to the effect discussed in section 2.5; a poorer median voter will prefer more redistribution since MB increases when the wealth share declines (cf. proposition 2, i). As a result, depending on the size of the difference in wealth inequality between the two economies, the unequal country may end up implementing a relatively higher tax level.

Likewise, the implied relationship between growth and taxes may be a negative one. Indeed, in general we have

**Proposition 4** *Growth and taxes in a cross section of countries. Suppose in-*

dividual countries differ solely with respect to institutional quality, i.e.  $A$ . Then the cross-country relationship between equilibrium taxes and growth is ambiguous.

**Proof.** Changes in  $A$  will affect  $\gamma$  both directly, and indirectly through the selected tax rates. Total differentiate equation (13) :

$$d\gamma = (g'(\tau)(f(A) - Af'(A)) - 1)d\tau - g(\tau)Af''(A)dA.$$

Hence, the impact on  $\gamma$  from an incremental increase in  $A$  is

$$\frac{\partial\gamma}{\partial A} = (g'(\tau)(f(A) - Af'(A)) - 1)\frac{\partial\tau}{\partial A} - g(\tau)Af''(A).$$

The latter term is positive, but the first term is negative. This follows from the first order conditions associated with optimal choice of the tax rate which says that  $MB = \frac{\sigma_i g'(\tau) Af'(A)}{\rho + \sigma_i g(\tau) Af'(A)} = MC = -\frac{1}{\rho} \frac{\partial\gamma}{\partial\tau} = -\frac{1}{\rho} [g'(\tau)(f(A) - Af'(A)) - 1] > 0$ , implying that  $1 - g'(\tau)(f(A) - Af'(A)) > 0$  at an interior solution for taxes. Since proposition 3 establishes that  $\partial\tau/\partial A$  is positive, the net effect on growth will, in general, depend on the absolute size of  $\frac{\partial\tau}{\partial A}$ . If the indirect effect is small – either because  $\frac{\partial\tau}{\partial A}$  is "small" or because the economy is close to its  $\tau^*$  (implying  $g'(\tau)(f(A) - Af'(A)) \approx 1$ ) – then  $\frac{\partial\gamma}{\partial A} > 0$ . As a result, one should expect a positive relationship between the selected tax rate, and  $\gamma$ , when looking across countries that differ with respect to  $A$ . However, if  $|\frac{\partial\tau}{\partial A}|$  is sufficiently large, the implied covariation between  $\gamma$  and  $\tau$  could be negative. ■

Nevertheless, the key insight gained from this analysis is that, *a priori*, the puzzling cross-sectional relationships between income skewness, redistribution/taxes and growth are fully reconcilable with an essentially standard political economy growth model featuring majority voting over taxes.

Importantly, this proposed theoretical explanation can be confronted with data. According to the model, within any single country one should expect the "standard" interrelationships between income skewness, taxes and growth (Proposition 2). In a cross-section of countries, on the other hand, one may observe a reversal of correlations (Propositions 3 and 4). These predictions clearly differs from the results in the literature discussed in Section 1.1. In these contributions the cross-sectional findings are given a causal interpretation. Accordingly, the positive correlation between taxes and equality, and between

taxes and growth, should arise within as well as across countries. This provides a case for testing the model to which we now turn.

### 3 Regression Analysis

The empirical testing of the model falls in two main parts. First we use data on tax revenues in OECD countries organized as a panel. Second we use data on expenditures on education in a cross-section covering both high- and low- income countries.

#### 3.1 Income Skewness, Taxes and Growth in OECD

The empirical analysis of inequality, taxes and growth is based on a panel of 19 OECD countries over the period 1971-1995. Following standard practise in panel growth regressions we aggregate the observations in the time dimension by averaging over five years. Hence the panel is given as 19 countries and five time epochs (1971-75 to 1991-95).

The two individual causal relationships stressed by the literature are examined in turn. First, the link between income skewness and redistribution ("the political mechanism"), and then the link between taxes/redistribution and growth ("the economic mechanism").

In line with the theoretical model, the inequality variable is a measure of income skewness. We use the average of the second and third cumulative quintiles as a measure of the median income share. The quintiles are from the high quality panel compiled by Deininger and Squire (1996).

With respect to the data for redistribution, Perotti (1996a:169) discuss the choice of relevant fiscal variables to include in the model. In particular he selects a set of (average) tax rates along with four expenditure measures from the functional classification of public expenditure. However, a broad country coverage of public expenditure limits the data source to "Government Finance Statistics" (GFS) from the IMF. Unfortunately, GFS concentrate on central government statistics, while the local government expenditure are more difficult to assess intertemporally. Since many expenditures are administered by local governments in federal countries, cross country comparisons of central government expenditure are problematic if the composition of local and central government expen-

ditures changes over time.<sup>10</sup> Consequently, we have chosen to limit ourselves to the use of tax revenue statistics from OECD, which include both local and central government revenue. Specifically, we have compiled a dataset encompassing two average taxes; taxes on income, profits, and capital gains (in brief: taxes on income) and taxes on property. Both are measured as percentages of GDP.

Inspired by the specification in Perotti (1996a) the political mechanism is analyzed by regressing the two tax measures on the median income share and three additional control variables. We include (log) GDP per capita to capture the notion of redistribution as a luxury good (“Wagner’s law”), the dependency ratio to capture increased need for (tax financed) redistributive expenditures dictated by demographic changes (in ways of child care, health care, social security and so forth), and finally the size of population (in logs).<sup>11</sup> The size of population is included so as to control for possible scale-effects in the provision of public goods.<sup>12</sup> Hence, we expect the log of total population to have a negative impact on the average tax rate.

As our measure of the median income share is a proxy, we apply the multiple indicator solution, so that in the regressions below we instrument for the median income share using the Gini coefficient.<sup>13</sup> Although the median income share and the Gini are functionally related the relation is highly non-linear. Therefore we expect a very low correlation between the measurement errors in the two proxies. The full list of instruments for the median share of income is given in Table 1. The estimation procedure is single equation two-step GMM.

The results for the political mechanism are given in Table 1. Regressions (1) and (2) report the results of ‘typical’ political mechanism regressions: Redistributive measures,

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<sup>10</sup>The much cited study by Easterly and Rebelo (1993) notes explicitly that their expenditure data (which derives from GFS) suffers from this problem.

<sup>11</sup>GDP per capita is from Penn World Tables, 5.6 with updates from the Global Development Network Growth Database. The dependency ratio and size of population are both from the World Development Indicators. Note that Perotti use the share of population over 65, rather than the dependency rate. We found the dependency ratio to be the statistically preferred choice in our OECD sample.

<sup>12</sup>Sylwester (2000) uses population density, for the same reason, in his analysis of expenditures on education. We return to this study below. He notes in passing, however, that the results are robust to using the size of population in stead.

<sup>13</sup>See e.e., Wooldridge (2002).

here taxes on income and property, are regressed on the controls and on the median income share. As seen we obtain the by now standard result that an increase in the median income share has a positive impact on taxes (as a percentage of GDP). This means that less income skewness seems to be accompanied by higher taxes.

Table 1 about here

Now, in order to test the theoretical hypothesis developed above, there are at least three different strategies one could consider adopting.

The first approach is "simply" to control for all the institutional factors (i.e. the determinants of "A" in the theoretical model) that generate the cross-country correlations stated in Proposition 3. While this is the most natural approach, it is also the least useful. Imagine the above detected positive correlation between middle-class share and taxation persists after rigorously controlling for institutional factors, using available proxy variables. Should this result then be taken to imply that the theory of Section 2 is refuted, or, that important determinants of "A" are still omitted from the regression?

The second and more promising approach is to "remove" the cross-country correlation by some form of differencing, i.e., perform fixed effects regressions. Here, the problem is that fixed effects regressions remove between 60 and 95 per cent of the variation in the data.<sup>14</sup> In addition, these fixed effects estimators require either strong exogeneity assumptions or instrumental variables for (nearly) all regressors to avoid bias.<sup>15</sup>

As a result, we have chosen a third estimation strategy. According to the theory developed above the observed relationship between income skewness and taxes should be decomposable into two elements; one within country (across time) and another across countries. While the time-series effect can be given a causal interpretation (Proposition 2), the cross-country correlation reflects the association between slow moving determinants of income skewness (e.g. institutions) and the level of taxation (Proposition 3). Such

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<sup>14</sup>Around sixty per cent of the variation in the growth rates is due to pure cross-country variation, while more that 95 (90) per cent of the variation in taxes on income (property) is cross-country variation. See the Appendix for further details.

<sup>15</sup>In light of these difficulties it is not surprising that none of the regressors are individually, statistically significant in fixed effects type versions of regressions (1) and (2).

a decomposition can be achieved in the regression in the following way. The regression model leading to regressions (1) and (2) in Table 1 takes the following form

$$y_{it} = w_{it}\alpha + \beta x_{it} + \varepsilon_{it}, \quad i = 1, \dots, N, \quad t = 1, \dots, T, \quad (19)$$

where  $y_{it}$  is the tax variable,  $w_{it}$  is the vector of control variables,  $x_{it}$  is the median share of income and subscript  $it$  indexes countries and time. A standard within-between decomposition of the median share of income results in the following regression equation

$$y_{it} = w_{it}\alpha + \beta^b \bar{x}_i + \beta^w (x_{it} - \bar{x}_i) + \varepsilon_{it}, \quad \bar{x}_i = \frac{1}{T} \sum_{t=1}^T x_{it} \quad (20)$$

Under Proposition 2 and 3 we expect to find a negative  $\beta^w$  in the extended regression, while  $\beta^b$  is positive.<sup>16</sup> The decomposition in equation (20) is chosen because it is an orthogonal transformation of the middle income share, i.e., the two regressors are uncorrelated by construction which makes a sharper interpretation of the results possible. However, if the same transformation is used for the instrument – the Gini coefficient – strict exogeneity of the Gini would be required. To avoid the (clearly unreasonable) strict exogeneity assumption, we apply a slightly different decomposition to the Gini coefficient:

$$G_{it} = G_{i1} + (G_{it} - G_{i1}) \quad (21)$$

Using the first observation of the Gini for each country,  $G_{i1}$ , and the difference between the Gini at time  $t$  and at time 1,  $(G_{it} - G_{i1})$ , as instruments all that is required is predeterminedness of the Gini coefficient.

Regressions (3) and (4) in Table 1 show the political mechanism when we separate the cross-country and the time series impact of the median share of income as explained above. Consistent with the theoretical model the correlations in time and space are of opposite sign: The correlation between the middle-class share and taxation is positive in the cross-country dimension, while the time series (within country) effect is significantly negative. This result obtains for both taxes on property and income.<sup>17</sup> These "reversals

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<sup>16</sup>If  $\beta^w$  turns out to be negative, then  $\beta^b$  must be positive; otherwise we would not get the over-all positive correlation in regressions (1) and (2).

<sup>17</sup>We also experimented with adding measures of openness to trade as independent variable, inspired by the work of Rodrik (1998), but found its influence to be insignificant in the present sample.



of correlations" are hard to reconcile with preexisting rationalizations of the fiscal policy puzzle (cf. Section 1.1).

Turning next to the economic mechanism, the two tax variables are included in growth regressions as endogenous regressors. The instruments for taxes are given from the political mechanism. In addition, however, we also use the Gini coefficient as an instrument for taxes. The control variables in the growth regression are initial GDP per capita, the dependency ratio and the average years of secondary schooling in the population above 25 (from Barro and Lee, 1996).<sup>18</sup>

Table 2 about here

Regressions (1) and (2) in Table 2 report results for the economic mechanism using the two taxes without any transformation. As seen we find that taxes on income have no significant impact on growth while higher taxes on property seems to be associated with higher growth rates according to regression (2).

Using the within-between transformation from equation (20) (of course, now " $y_{it}$ " represents growth rates, and " $x_{it}$ " average tax rates) we find in regressions (3) and (4) that the cross-country impact is positive but insignificant (or borderline significant for taxes on income) while the impact within countries is significantly negative. Accordingly, the results indicate that changes in taxation have in fact lead to a de-acceleration of economic growth in the OECD area during the 1970-95 period. At the same time a positive cross-country correlation between taxes and growth is obtained. Under the theoretical model this latter correlation can be interpreted as reflecting the relationship between fundamental determinants of "A", and long-run growth (cf. Proposition 4). Again, most explanations of a positive "effect" of taxation on growth would predict a uniform correlation in the two dimensions of the data, whereas the model developed above suggests that conflicting correlations could easily arise

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<sup>18</sup>We have experimented with a number of other controls, in particular measures of institutions and trade openness. However, none of the institutional variables nor openness were significant. Note also that controlling for the investment share in physical capital would not be sensible in the present context as this is precisely the mechanism through which taxes are supposed to matter for growth.

Overall, data seem to support the version of the fiscal policy approach presented in Section 2, at least when we look at taxes on income and taxes on property.

Until now we have completely neglected the expenditure side of the government budget. As mentioned above, the lack of comparable data on expenditures, encompassing both local and central government outlays, precludes a full panel-data analysis. However, the recent cross-sectional analysis of Sylwester (2000) uses data on expenditures on education which does not suffer from this shortcoming. The next section revisits Sylwester's analysis and argues that it too is consistent with our theoretical explanation for the fiscal policy puzzle.

### **3.2 Inequality, Expenditures on Education and Growth**

As mentioned in the introduction, Sylwester (2000) analyze the relationship between inequality, expenditures on education, and growth. The novelty of his work is that he shows a positive impact from past expenditures on education on future growth alongside a negative contemporaneous impact. The result is obtained using three-stage least squares regressions for the political and the economic mechanisms.

More specifically, the dependent variable in the political mechanism is average expenditures on education for the period 1970-85 in 54 countries, where the expenditure data is from UNESCO. The controls are, apart from income inequality measured by Gini coefficients from Deininger and Squire (1996), the initial level of income, initial human capital, a measure of democracy, initial population density, and average expenditures on education in 1960-64 (see Sylwester (2000) for precise data definitions).

In the economic mechanism the dependent variable is the average growth rate in real GDP per capita 1970-85, and the identifying restrictions are that population density, democracy, and income inequality have no direct effect on growth.

Table 3 about here

Regressions (1a) and (1b) in Table 3 report results which are identical to Table 2 in Sylwester (2000).<sup>19</sup> The impact of inequality on education expenditures is positive in

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<sup>19</sup>We have rescaled expenditure on education and the average annual growth rate to be per cent.

accordance with the fiscal policy approach. In the growth regression one finds a negative impact from current expenditures while the lagged (1960-64) expenditures have a positive impact. One perspective on these results is that they support the theoretical argument forwarded by Saint-Paul and Verdier (1993). Saint-Paul and Verdier argue that a majority of the electorate in unequal countries should opt for high levels of expenditures on education, which redistribute income (from generation to generation), and spur growth. But another interpretation also appears to be feasible.

We begin by observing that Sylwester's growth regression can be expressed as

$$y_i = w_i\alpha + \beta_1x_i + \beta_0x_i^0 + \varepsilon_i, \quad i = 1, \dots, N, \quad (22)$$

where  $w_i$  are the controls,  $x_i$  is average expenditure on education in 1970-85 and  $x_i^0$  is average expenditure on education in 1960-64. Next, note that the equation can be reformulated as

$$y_i = w_i\alpha + \beta_1(x_i - x_i^0) + (\beta_1 + \beta_0)x_i^0 + \varepsilon_i, \quad i = 1, \dots, N. \quad (23)$$

This reparameterization shows that  $\beta_1$  could be interpreted as capturing the pure time series relation between educational expenditure and growth, whereas the sum  $(\beta_1 + \beta_0)$  measures the cross-country effect. Likewise, in terms of the political mechanism (inequality vs. expenditures on education), the key result to note from regression (1a) is that the coefficient on education 1960-64 is close to one. In fact, one cannot reject the hypothesis, that regression (1a) indicate a positive relation between inequality and *changes* in educational expenditures.

These ideas are explored further in regressions (2a) and (2b) in Table 3 where the above restrictions have been imposed explicitly. As seen, there is a significant positive impact of inequality on the change in expenditures and a negative impact on growth from changes in these expenditures. This pattern is consistent with the theory developed in Section 2.<sup>20</sup>

Unfortunately, we cannot test directly if our interpretation of the regression results is “better” than the interpretation given in Sylwester. But it is possible to give an indication.

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<sup>20</sup>We have also estimated the model using single equation methods (2SLS and GMM). The results are not sensitive to such changes in estimation strategy.

If the cross-country/time-series interpretation is to hold one should expect a change of sign in the growth regression when the lagged expenditure on education is omitted from the equation because the positive cross-country correlation is then only represented by current expenditure. This change of sign is not expected in the past/present interpretation since the negative impact of present expenditure should not be affected by omission of the positive "investment" effect.<sup>21</sup> Regressions (3a) and (3b) in Table 3 report the results for the model when lagged expenditures are omitted from the growth equation. The effect on the coefficient upon the contemporaneous expenditures is remarkable as it changes into an insignificant positive effect. Even though this is not a proper test it is consistent with the cross-country/time-series interpretation of the results.

## 4 Conclusion

In this paper we have suggested a theoretical explanation for the fiscal policy puzzle. The theoretical model demonstrates how slow-moving structural characteristics (like institutions) – which matter for both long-run productivity and the distribution of income – could be responsible for the following puzzling cross-country regularities:

- (i) A positive relationship between the income share of the middle-class and the amount of redistribution/taxation;
- (ii) A positive correlation between average tax rates and average growth rates.

At the same time, however, the model also predict that the relationships (i) and (ii) may change radically when moving from pure cross-country to across-time observation of economic systems. Specifically, within countries a reduction in the income share accruing to the middle-class should be associated with increasing taxes; and this in turn with slower growth in income per capita.

We have taken a first pass at testing this possible reconciliation of the fiscal policy approach with the conflicting findings mentioned above. Essentially our estimation

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<sup>21</sup>Needless to say, omitted variable bias invalidates a strict interpretation of the results.

strategy consists of an attempt to discriminate between times series and cross country variations in the data. While the former, under the theoretical model, can be given a causal interpretation, the latter should not. The results are encouraging. Using data on income and property taxes, and expenditures on education we do in fact detect the type of "reversals of correlation" suggested by the model. In addition, our "within-country" estimates are broadly consistent with the independent findings of Milanovic (2000), as for the inequality/redistribution link, and Kocherlakota and Yi (1997) and Kneller *et al* (1999), in terms of the tax/growth mechanism. Whether these results stand up in more heterogeneous samples, encompassing *non*-OECD countries, is a question for future work to resolve. Nevertheless, it seems fair to conclude that the fiscal policy approach might still prove to be a viable theoretical account of why a skewed distribution of income should hamper growth.

## A Summary statistics

Countries in the OECD sample	
Australia	Italy
Belgium	Japan
Canada	Korea
Denmark	Mexico
Spain	Netherlands
Finland	Norway
France	Portugal
United Kingdom	Sweden
Greece	United States
Ireland	

### Summary statistics for the OECD sample

Variable	Mean	Std.Dev.	Min	Max	R-sq
hline Growth	2.207	1.788	-1.79	9.18	0.60
Tax on income	12.783	5.642	3.80	29.16	0.95
Tax on property	1.860	1.102	0.16	4.71	0.89
Median income share	27.399	3.632	15.95	33.84	0.81
Gini-coefficient	34.166	5.681	23.30	54.98	0.84
Initial GDP per capita (log)	9.169	0.44	7.43	9.80	0.81
Dependency ratio	55.296	9.262	43.65	95.80	0.70
Population (log)	16.892	1.216	14.95	19.32	0.998
Secondary schooling	2.119	1.045	0.42	5.09	0.83

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Table 1: The impact of the median income share on taxes

Dependent variable	Tax on			
	income (1)	property (2)	income (3)	property (4)
Initial GDP per capita (log)	7.81** (5.66)	0.54** (2.70)	9.22** (6.40)	1.04** (3.50)
Dependency ratio	0.04 (0.58)	-0.001 (0.09)	0.21** (2.70)	0.06* (1.86)
Population (log)	-1.88** (4.73)	0.58** (7.31)	-1.41** (4.46)	0.62** (5.50)
Median income share	0.35** (2.52)	0.16** (3.77)		
Median income share, cross-country			0.86** (3.29)	0.26** (3.34)
Median income share, time series			-1.16** (2.28)	-0.26** (2.09)
Partial $R^2$ in first stage regressions <sup>a</sup>				
Median income share	0.73	0.73		
Median income share, cross-country			0.53	0.53
Median income share, time series			0.27	0.27
Overidentification test (p-value)	0.11	0.18	0.65	0.40
RMSE	3.51	0.96	4.35	1.13
Observations	71	71	71	71

Note: Two-step GMM-regressions of 19 countries over 5 periods. Instruments in (1) and (2): The Gini coefficient, initial GDP per capita squared and time dummies. In (3) and (4) the Gini coefficient is replaced by first period Gini and deviations from first period Gini. \* significant at 10%; \*\* significant at 5%. <sup>a</sup>The partial  $R^2$  from the first stage regressions takes the presence of several endogenous variables into account. See Shea (1997) and Goodfrey (1999).

Table 2: The impact of taxes on growth

Dependent variable	Growth rate in real GDP per capita			
	income	property	income	property
Tax regressor	(1)	(2)	(3)	(4)
Initial GDP per capita (log)	-3.97** (5.50)	-3.74** (15.1)	-3.66** (5.21)	-2.70** (5.25)
Dependency ratio	-0.08** (4.06)	-0.06** (3.39)	-0.08** (4.04)	-0.10** (4.92)
Secondary schooling	0.32** (2.24)	0.13 (0.57)	0.27* (1.78)	0.46** (1.99)
Tax regressor	0.07 (0.89)	0.92** (2.15)		
Tax regressor, cross-country			0.11 (1.63)	0.004 (0.02)
Tax regressor, time series			-0.47** (2.31)	-4.41** (2.36)
Partial R <sup>2</sup> in for first stage regressions <sup>a</sup>				
Tax variable	0.26	0.13		
Tax variable, between countries			0.34	0.21
Tax variable, within countries			0.27	0.12
Overidentification test (p-value)	0.13	0.09	0.08	0.55
RMSE	1.43	1.54	1.45	2.21
Observations	78	78	78	78

Note: Two-step GMM-regressions of 19 countries over 5 periods. Instruments in (1) and (2): Initial middle income share, the Gini coefficient, initial GDP per capita squared, population (log), and time dummies. In (3) and (4) the Gini coefficient is replaced by first period Gini and deviations from first period Gini. \* significant at 10%; \*\* significant at 5%. <sup>a</sup>See comments in Table 1.

Table 3: Three-stage least squares results for expenditure on education and the growth rate in GDP per capita 1970-85.

Dependent variable	Education Average		Change in Average		Education Average	
	exp.	growth	edu. exp.	growth	exp.	growth
Regression	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)
Income	0.52 (2.27)	0.12 (0.17)	0.49 (2.16)	0.60 (0.09)	0.54 (2.32)	-1.09 (1.90)
Human capital	-0.41 (1.44)	0.07 (0.08)	-0.44 (1.57)	0.11 (0.01)	-0.47 (1.63)	1.51 (2.37)
Democracy	-0.12 (2.06)		-0.11 (1.93)		-0.09 (1.24)	
Population density	-0.27 (3.32)		-0.27 (3.35)		-0.24 (2.75)	
Income inequality	0.02 (2.08)		0.03 (2.08)		0.02 (1.23)	
Education exp. 1960-64	0.89 (6.92)	2.26 (3.60)		0.64 (2.50)	0.94 (7.24)	
Education exp. 1970-85		-1.79 (2.91)				0.13 (0.45)
Change in education exp.				-1.78 (2.89)		
hline RMSE	0.93	2.34	0.94	2.34	0.94	2.16
Observations	54	54	54	54	54	54

Note: *t*-statistics in parentheses.