

**Fiscal Policy, Income Distribution,  
and Growth**

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# **Fiscal policy, income distribution, and growth.**

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# 1 Introduction.

This paper deals with two questions: (i) is there an empirically robust relation between income distribution and growth? (ii) if yes, does this relation work through the effects of income distribution on fiscal policy, as posited by several recent models?

Schematically, it is possible to distinguish three main approaches in the recent literature on income distribution and growth.<sup>1</sup> In the first approach income distribution (or, more precisely, wealth distribution) affects growth due to the presence of imperfect capital markets: when agents cannot borrow against future investment income, it is intuitive that the existing distribution of wealth will determine how many agents can start a project and therefore what the resulting growth rate will be: notable examples of this strand of literature are Galor-Zeira [1988], Bannerje-Newman [1991] and Aghion-Bolton [1992]. In the second approach, the degree of income inequality influences growth by affecting the incentives to engage in rent-seeking activities (Benhabib-Rustichini [1991]) or by affecting the outcome of the bargaining process over the size and use of tax revenues (Chang [1992]). Finally, the third approach focuses on the pattern of government expenditure as determined by the political equilibrium resulting from a given income distribution. In turn, government expenditure affects growth through several channels, mainly distortions created by the taxation needed to finance expenditure and positive effects of government expenditure on the productivity of private investment. Thus, the role of income distribution in this class of models can be usefully understood as that of endogenizing government expenditure in a typical model of government and growth like Barro [1990]. Contributions include Alesina-Rodrik [1991] (henceforth A-R), Bertola [1991] (B), Perotti [1992b] (P), Persson-Tabellini [1991] (P-T) and Saint-Paul-Verdier [1991] (SP-V).

This paper concentrates on the third approach. The main contribution is to shed

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<sup>1</sup>The large literature on the topic that flourished in the 60's and 70's is surveyed in Adelman-Robinson [1988].

light on the economic and especially the political mechanisms behind the reduced form relations that have been estimated so far. This is accomplished by estimating the underlying structural relations between income distribution, growth and political variables. In doing so, the empirical part of this paper goes beyond the standard tests of growth models, that are almost invariably based on a reduced form approach.<sup>2</sup>

Aside from the literature on income distribution and growth that provides the initial motivation for this paper, most of the empirical evidence presented here is relevant also for a number of positive models of fiscal policy that rely on some form of the median voter theorem: among others, political economy models of the government sector (Meltzer-Richard [1981], [1983], Tabellini-Alesina [1990]), the social security system (Tabellini [1991], Browning [1975]), and developing country external debt (Alesina-Tabellini [1990]).<sup>3</sup>

The paper is organized as follows. After a brief survey of the literature in section 2, sections 3 and 4 develop the specifications to be estimated for the structural systems and the reduced form respectively. I then discuss some econometric issues in section 5, and then proceed to estimate the reduced form and the structural system in sections 6 and 7 respectively. In this last section, particular attention is devoted to limited information estimation of the link between income distribution and fiscal policy. Finally, section 8 concludes with some comments and some discussion of possible avenues of future research.

## 2 A brief survey of the literature.

To understand the common logical structure of this class of models, it is very convenient to identify an *economic mechanism* and a *political mechanism* in each of them.<sup>4</sup> The former maps values of the government expenditure and/or revenue variables into rates of growth of GDP. The latter maps income distribution into government expenditure or

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<sup>2</sup>A recent exception is Benhabib-Spiegel [1992].

<sup>3</sup>There is also a long tradition of testing the median voter result at the local level: see for example Inman [1978], Pommerhane [1978], Gramlich-Rubinfeld [1982] and Mueller [1989] for a brief survey.

<sup>4</sup>This section develops the approach taken in Perotti [1992a].

revenue variables. The two mechanisms together deliver a reduced form relation between income distribution and growth, which is the implication of these models that has been tested so far. The main contribution of this paper consists in explicitly estimating the political mechanism along with the economic mechanism.

## 2.1 The economic mechanism.

This subsection identifies the channel through which fiscal policy influences growth in each model. To organize the discussion, it is useful to distinguish models with infinitely lived agents (A-R, B) from overlapping generations models (P, P-T, SP-V).

Agents in the first class of models are characterized by different ratios of their endowments of capital and labor. Under the assumption of homothetic preferences, it is easy to show the standard result that the desired rate of growth of consumption, capital and output for every agent and therefore for the whole economy is equal to the difference between the after-tax marginal product of capital perceived by private agents (PMPK) and the rate of time preference  $\rho$ , all multiplied by the coefficient of intertemporal substitution  $\sigma$ :

$$\frac{C}{C} = \frac{K}{K} = \frac{Y}{Y} = \sigma [(1 - \tau)PMPK - \rho] \quad (1)$$

where  $\tau$  is the proportional tax rate on capital. Since  $\rho$  and  $\sigma$  are preference parameters, in these models fiscal policy affects growth by influencing PMPK and  $\tau$ .

Technology in A-R is essentially the same as in Barro [1990]: the production function is Cobb-Douglas of the form  $Y = L^\alpha K^{1-\alpha} G^\alpha$ , where labor  $L$  is inelastically supplied and normalized to 1 in what follows, private capital  $K$  is accumulated by the private sector and services from productive government expenditure  $G$  are provided by the government using the revenues of proportional taxation on private capital. Under the assumption of a balanced budget,  $G = \tau K$ ; replacing this expression for  $G$  in the production function one obtains  $Y = \tau^\alpha K$ . Thus, the after-tax PMPK is  $(1 - \tau)\tau^\alpha$  and the social marginal product of capital is  $\tau^\alpha$ . Since the private and social marginal product of capital are

constant, given  $\tau$ , this model clearly belongs to the class of endogenous growth models, with a constant rate of growth and no transitional dynamics.

An increase in  $\tau$  and therefore  $G$  has two opposite effects on the after-tax PMPK and the rate of growth of the economy. On one hand, a higher  $G$  raises the pre-tax PMPK and therefore encourages investment. This positive effect is captured by the term  $\tau^\alpha$  in the expression for the after-tax PMPK. On the other hand, the higher tax rate that accompanies an increase in  $G$  decreases the return from investment that an individual can appropriate. This negative effect is captured by the term  $(1 - \tau)$ . As Barro [1990] shows, the first effect prevails for low levels of the tax rate, while the second prevails at high levels of the tax rate. This is intuitive since the physical marginal productivity of public capital is very high when the public capital stock is low. Thus, the relation between the tax rate  $\tau$  (and therefore government expenditure  $G$ ) and growth has the shape of an inverted U.

The setup is the same in B, except that the production function displays constant returns to scale to private capital directly:  $Y = f(L)K$ . As a consequence, now perfect competition everywhere is obviously impossible to assume. The analysis is therefore conditional on a particular share  $\gamma$  of the inelastically supplied factor,  $L$ , in output. For a given  $\gamma$ , the marginal product of capital perceived by an atomistic agent is again constant: therefore, this economy too displays a constant rate of growth without transitional dynamics. The role of government in this model is twofold: redistribute income from labor to capital, thus reducing the after-tax share of labor  $\gamma$ , or tax consumption in order to subsidize investment, thus reducing the relative price of investment below one. Both actions tend to increase the rate of growth of the economy, the former because it increases the after-tax return from investment, the latter because it increases the cost of consumption now relative to consumption later.

The second class of models is characterized by the presence of a sequence of generations. In P-T, past accumulation of "knowledge useful for technical progress" enhances the productivity of the current stock of capital, which can be physical or human. The

role of government consists in taxing the income of the old. Revenues from proportional taxation of income of the old are used for purely redistributive purposes: all agents in the economy receive the same per capita share of tax revenues. Therefore, a higher tax rate unambiguously reduces the after-tax return to investment and therefore the rate of growth of the economy.

SP-V develop a non-overlapping-generations model where agents live for one period. In a first version of the model, public education and inherited human capital are the two sources of growth of productivity. Taxes are used for public education only. With inelastic labor supply, more taxation and government expenditure increase growth by enhancing the accumulation of human capital through public education. In a second version of the model, there is a third source of increases in productivity: accumulation of expertise by participating in the production of a market good. However, agents also have the opportunity to allocate part of their endowment of time to the production of a home good, where no technological progress is possible. The government obtains revenues by taxing income deriving from the production of the market good. Taxation and the resulting government expenditure on public education have therefore two opposite effects on growth. On one hand, they spur growth by directly promoting the accumulation of human capital. On the other hand, they distort the allocation of resources towards the production of the home goods, where productivity cannot increase. Again, it is quite intuitive that the first, positive effect of taxation and expenditure on growth prevails at low levels of taxation while the second, negative effect prevails at high levels, so that the relation between the tax rate and growth will be hump-shaped.

A different type of non-linearity is present in the economic mechanism of my model. Growth here results exclusively from private investment in education and there is a positive externality from investment by one class to the productivity of all other classes.<sup>5</sup> There are three classes of pre-tax income in the economy. Taxation is proportional and

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<sup>5</sup>In another version of the model (Perotti [1990]) *ceteris paribus* investment by one class is good for the other classes because it increases the resources available for redistribution in the future.

its proceedings are redistributed lump-sum. In the absence of capital markets, only those agents whose post-tax income is sufficient to cover the costs of education can accumulate human capital and therefore enjoy a higher income in the following period. Since the cost of education is independent of per capita GDP, taxation has different effects on investment in human capital depending on the average income of the economy. In poor economies, only the rich can potentially invest in education. Higher taxation can therefore hurt growth by preventing the only potential investors from accumulating human capital. The opposite occurs in rich economies: here, high growth occurs when the poor (together with the other two classes) invest in education. Since their post-tax income increases in the tax rate, now higher taxation increases the rate of growth of the economy.

## 2.2 The political mechanism.

To obtain testable predictions from these model, one only needs to specify the political mechanism. Not surprisingly, in all these models the equilibrium outcome of fiscal policy corresponds to the one preferred by the median voter. The reason is that an agent's indirect utility over the fiscal policy variable is a function of his position in the relevant distribution of endowments<sup>6</sup> relative to the average. To understand this result, note that the agent with average endowments will behave exactly as the representative agent in a model with a degenerate distribution.<sup>7</sup> Except for my model, the representative agent, i.e. the agent with average endowment would vote for the growth-maximizing tax rate. However, the poorer an agent is relative to the agent with average endowment the higher the tax rate he will vote for. The intuition is that, with proportional taxation and lump-sum benefits, at any given tax rate a poorer agent faces a lower tax price of the benefits. Thus, one obtains the standard Meltzer-Richard-type result that there is a monotonically decreasing relation between the distance of the decisive voter from the average and the

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<sup>6</sup>The relevant distribution of endowments is the distribution the of capital/labor endowment ratio in models with infinitely lived agents and the distribution of human capital in overlapping generations models.

<sup>7</sup>The fact that taxes are proportional is crucial for this result.

equilibrium level of expenditure. To make this model of determination of government expenditure operative, it is only necessary to identify an empirical counterpart of the distance between the decisive voter and the average voter. Since in all these models the decisive voter is the median voter, the share of the third quintile in the relevant distribution is a good proxy for the distance between the median and the average of the distribution.

Although the same basic relation is present in my model, it is modified by the fact that agents are now genuinely forward-looking. Thus, in a poor economy the median voter might implement a lower redistribution than he would in the static problem because he realizes that, by letting the rich invest, he too will have a higher productivity in the future because of the positive production function externality. This case will occur when the median voter (i.e., the middle class) is sufficiently close to the upper class, so that the deviation from his preferred static tax rate, in order to allow investment by the rich, need not be too large. Symmetrically, in a rich economy the median voter might implement a *higher* tax rate than he prefers in a static problem because he recognizes that, by so doing, the poor will invest and therefore again he will be more productive in the future. It is intuitive that this will occur when the distance between the middle class and the poor is not too large: otherwise, the present cost of allowing the poor to invest will exceed the future gains.

### 3 Specification of the structural systems.

In this section I will set up the estimable structural models that best reflect the features of the various models examined so far. All models share the same logical structure. There are three endogenous variables. The first two are the usual ones of a typical model of endogenous growth: the rate of growth of GDP and the rate of accumulation of capital (physical or human) which directly affects growth. The third variable, a government expenditure measure, affects the incentives to accumulate private capital and, in some

cases, it also has a direct impact on growth. The government expenditure variable is endogenized through the main novelty of the models surveyed here, the political mechanism.

It turns out that the models by A-R, P-T and SP-V give rise to very similar structural systems. In A-R, growth is a positive function of the rate of private investment, given public investment, and of the rate of public investment, given private investment:<sup>8</sup>

$$\Delta GDP = \alpha_0 + \alpha_1 PRIVINV + \alpha_2 PUBINV + \alpha_3 X_{\Delta GDP} + \epsilon_1 \quad (2)$$

where  $\alpha_1 > 0$ ,  $\alpha_2 > 0$  under the null and  $X_{\Delta GDP}$  represents a vector of control variables typical of growth models. However, as discussed in Section 2 private investment depends on public investment:

$$PRIVINV = \gamma_0 + \gamma_1 PUBINV + \gamma_2 X_{PRIVINV} + \epsilon_2 \quad (3)$$

The sign of  $\gamma_1$  is in principle ambiguous, since the relation between the tax rate (and therefore public investment) and private investment is hump shaped. In the next section it will be shown that the model implies  $\gamma_1 < 0$  in the empirically relevant range. Finally, public investment depends negatively on the share of the third quintile in income, which is a proxy for the income of the median voter relative to the mean:

$$PUBINV = \theta_0 + \theta_1 \Delta GDP + \theta_2 GDP + \theta_3 MID + \theta_4 X_{PUBINV} + \epsilon_3 \quad (4)$$

and  $\theta_3 < 0$ . Note that  $\Delta GDP$  and  $GDP$  appear in the regression in order to control for possible Wagner's Law effects, which states that the share of government expenditure in GDP increases as GDP increases because the demand for government services is income elastic. Also, it is clear that a proper test of the model by A-R would require the use of the distribution of wealth as well as of labor income in the population. The problem

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<sup>8</sup>See Appendix 1 for a definition of the variables that appear in all the following expressions.

is that it is practically impossible to obtain a reliable cross-section on the distribution of wealth. However, it is well known that the distribution of wealth tends to be more inegalitarian than that of labor income. If this is the case, when the median labor income in country A is lower than the median labor income in country B, the same relation will hold between the median wealth/labor income ratios. Therefore, it seems reasonable to use the share of the different quintiles in labor income as proxies for the measures one should use in estimating the A-R model.

Specifying an estimable relation that captures the essence of B is slightly more difficult. A first problem is that the effects of fiscal policy on investment and growth depend on the policy instrument used. Recall that in B two policy instruments are available to the government: a direct transfer of resources from capital to labor, and a tax on consumption used to subsidize investment. If only redistribution of income from capital to labor (or viceversa) can be implemented, then redistribution of resources from the rich to the poor will decrease the rate of growth of GDP. The argument is essentially the same as the one used in discussing the specification of A-R: because the distribution of wealth is more inegalitarian than that of labor, more redistribution of income from the rich to the poor is in general also associated with more redistribution of resources from capital to labor, which is the relevant redistribution in B's model. In this case a lower capital/labor ratio of the median voter would translate into more redistribution and therefore lower growth. Thus, this version of the model could be tested using exactly the same specification as A-R, with the only difference that the government expenditure variable is now government transfers (*GTRAN*) rather than public investment.

When only investment subsidies can be used, and they are financed through consumption taxes, more government expenditure will cause the price of capital to fall and will therefore spur growth. However, now a median voter endowed with a low capital/labor ratio would have little interest in subsidizing capital, and would vote for low taxes and therefore low subsidies. This would lead to low growth. A plausible specification of this

version of the model would therefore be:

$$\Delta GDP = \alpha_0 + \alpha_1 PRIVINV + \alpha_2 X_{\Delta GDP} + \epsilon_1 \quad (5)$$

$$PRIVINV = \gamma_0 + \gamma_1 PPPI + \gamma_2 X_{PRIVINV} + \epsilon_2 \quad (6)$$

$$PPPI = \theta_0 + \theta_1 MID + \theta_2 X_{PPPI} + \epsilon_3 \quad (7)$$

where  $PPPI$  is the PPP value of the investment deflator in 1960 (U.S.=1) and  $\alpha_1 > 0$ ,  $\gamma_1 < 0$ ,  $\theta_1 < 0$ .<sup>9</sup>

To test the model by P-T, one would again specify a model similar to A-R, with the only difference that now the government expenditure variable is the share of transfers in GDP as in the first version of B.

The specification used to test P-T can also be used to test the model of SP-V, with some suitable modifications. First, strictly speaking the private investment variable is now a human capital accumulation variable. Second, the fiscal policy variable is represented by government expenditure on education ( $GOVED$ ). More importantly, the effects of government expenditure on the accumulation of human capital is non linear: positive at low levels of expenditure (and therefore inequality) and negative at high levels of expenditure, since in this case the distortionary effects associated with the financing of expenditure prevails. This suggests including a quadratic term in  $GOVED$  among the r.h.s. variables of the human capital accumulation equation.

In terms of testable predictions, my model is qualitatively different from the others in both components. In the economic mechanism the effect of government transfers on investment in human capital and therefore growth depends on per capita income: it is

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<sup>9</sup>I am assuming here a rather artificial scenario, where one instrument only is used in each cross-section. This is not only due to the theoretical problems with the existence of a non-cycling majority when agents vote over two issues. A more important problem is that, as the numerical solutions in B show, there is no clear-cut relation between income distribution and wealth when both fiscal policy instruments are used: what the numerical solutions show is that the pattern of income distribution makes very little difference when both redistributive measures and investment subsidies are available as fiscal instruments.

positive in rich countries but negative in poor countries. Therefore:

$$\Delta GDP = \alpha_0 + \alpha_1 \Delta H + \alpha_2 X_{\Delta GDP} + \epsilon_1 \quad (8)$$

with  $\alpha_1 > 0$ , and

$$\Delta H = \gamma_0 + \gamma_1 GTRAN + \gamma_2 GTRAN GDP + \gamma_3 TOP + \gamma_4 TOP GDP + \theta_5 X_{\Delta H} + \epsilon_2 \quad (9)$$

In the last expression  $\gamma_1 < 0$  and  $\gamma_2 > 0$ : given income distribution, transfers are bad for growth in a poor country and good in a rich country. Also, given transfers, a high share of the high income class favors growth in a poor country but hurts it in a rich country: thus,  $\gamma_3 > 0$  and  $\gamma_4 < 0$ . Specifying the political mechanism is much more difficult because of the presence of important discontinuities. The best approach probably consists in trying to capture the essence of the model. Due to the intertemporal considerations highlighted above, government expenditure still depends negatively on the income of the median voter, but also on the distance of the latter from the other groups of the economy, in particular those groups whose investment in human capital depends on the tax rate chosen by the median voter. Therefore:

$$GTRAN = \theta_0 + \theta_1 MID + \theta_2 TOP + \theta_3 X_{GTRAN} + \epsilon_3 \quad (10)$$

where  $\theta_1 < 0$ . To determine the sign of  $\theta_2$  under the null, remember that in a poor economy when the share of the high income class increases the median voter can increase government transfers without crowding out the only potential investors in the economy. Similarly, in a rich economy, when the share of the top quintile increases *given* the share of the third quintile, the share of the first quintile decreases, thus increasing the distance between the middle class and the low income class: the model suggests again that government transfers increase. Therefore,  $\theta_2 > 0$  according to the null.

## 4 Specification of the reduced form.

As shown above, in virtually all models the political mechanism implies a monotonic, negative relation between the share of the third quintile (where the median voter is) in the distribution of income or capital/labor endowments and the relevant tax rate.<sup>10</sup> The shape of the relation between the tax rate and per capita growth, described by the economic mechanism, determines then the reduced form relation between the share of the third quintile and growth.

Empirically, the median endowment is typically lower than the average one. It is intuitive that the tax rate preferred by the agent with average endowment in A-R is the growth-maximizing one. Since the median voter has lower endowment than the average voter, his preferred tax rate will be higher than the growth-maximizing one. Thus, the relevant portion of the inverted-U relation between the tax rate and the growth rate is the downward sloping one. This implies that the lower is the endowment of the median voter relative to the average endowment, the higher is the tax rate and the lower the rate of growth of the economy. This gives rise to the positive reduced form relation between the share of the third quintile (which captures the distance between the median and the average endowment) and the rate of growth of the economy. The same reduced form relation is implied by B when the policy instrument is the rate of subsidization of labor income.<sup>11</sup> The reduced form equation to estimate for these models would therefore be:

$$\Delta GDP = \beta_0 + \beta_1 MID + \beta_2 W_{\Delta GDP} + \eta_1 \quad (11)$$

where  $W_{\Delta GDP}$  is a set of reduced form controls and  $\beta_1 > 0$  is the crucial implication of these models that has been discussed and estimated in the literature so far (see A-R and P-T).

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<sup>10</sup>A qualification is needed only for my model.

<sup>11</sup>This conclusion of the model must be qualified when investment subsidies financed by consumption taxes are also available as policy instruments. See section 3 for a short discussion of this point.

Because of the richer menu of economic mechanisms, the overlapping generations models can give rise to more complex relations. As in A-R and B, in P-T growth decreases with the relative income of the median voter because of the disincentive effects of the resulting taxation. The reduced form of this model is therefore the same as that of A-R and B, equation (11).

In SP-V with non-distortionary taxation, the relation is exactly the opposite: the poorer the median voter, the higher the rate of growth of the economy because of the high level of expenditure on public education resulting in the political equilibrium. This version of the model would be tested using the same specification as in equation (11) above, only now  $\beta_1 < 0$  under the null. When taxation is distortionary, the nonlinear relation between expenditure on education and growth induces a nonlinear relation between the position of the median voter and the rate of growth of the economy: at high levels of inequality, i.e. when the median voter is poor relatively to the average, expenditure on public education is high and relatively unproductive. Accordingly, as the income of the median voter increases, taxation of the market economy decreases and growth increases. As the income of the median voter increases further, expenditure on public education decreases. Past a certain level, however, it is public education that is relatively more productive: growth is therefore now decreasing in the relative income of the median voter. The specification for this version would then be:

$$\Delta GDP = \beta_0 + \beta_1 MID + \beta_2 MID^2 + \beta_3 W_{\Delta GDP} + \eta_2 \quad (12)$$

with  $\beta_1 > 0$  and  $\beta_2 < 0$ . Finally, in my model not only the reduced form relation between the income of the median voter and the rate of growth is non linear in the average income of the economy, but it also depends on the whole shape of the income distribution. In a poor economy, growth is enhanced by a high share of the third and fifth quintiles. The first condition ensures that the tax rate will be low, while the second condition implies that the upper class is less vulnerable to redistribution. The opposite is true in a rich

economy: here, a low share of the third and fifth quintiles ensure both that there will be enough redistribution for the poor to be able to invest in education and that their income is sufficiently high to start with. Combining equations (8), (9) and (10) one would obtain:

$$\begin{aligned} \Delta GDP = & \beta_0 + \hat{\gamma}_1 \theta_1 MID + \hat{\gamma}_1 \theta_2 TOP + \hat{\gamma}_2 \theta_1 MIDGDP \\ & + \hat{\gamma}_2 \theta_2 TOPGDP + \gamma_3 TOP + \gamma_4 TOPGDP + \beta_5 W_{\Delta GDP} + \eta_3 \end{aligned} \quad (13)$$

where  $\hat{\gamma}_i = \alpha_1 \gamma_i$  has the same sign as  $\gamma_i$  in equation (9). As explained above, the model implies that  $\hat{\gamma}_2 \theta_2 + \gamma_4 < 0$  and  $\hat{\gamma}_1 \theta_2 + \gamma_3 > 0$ .

All the equations to be estimated have now been specified. Before commenting on the empirical results, however, it is necessary to consider briefly some important econometric issues that arise in estimating the models.

## 5 Econometric issues.

When dealing with income distribution variables, the issue of measurement error cannot be dismissed lightly. Indeed, the problems connected with collecting a reliable cross-section of comparable income distribution observations can be so severe<sup>12</sup> that one may justifiably be skeptical on the usefulness of any econometric exercise based on these data. Operationally, the econometric approach of this paper can be defended by checking in a honest way the sensitivity of the results to measurement errors and outliers. In particular, I deal with these issues in two main ways: by using a standard errors-in-variables approach and by applying the methods of bounded-influence regression.

The first approach is complicated slightly by the fact that in this paper I am mainly interested in the estimation of the structural components of the models, and therefore the natural framework is that of simultaneous-equation estimation. There are some delicate issues of identification and estimation in simultaneous equation models when one or

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<sup>12</sup>See for instance Lecaillon et al. [1984].

more variables are measured with error. A natural extension of the instrumental variable approach to the measurement error problem would clearly involve treating the exogenous variables measured with error as endogenous variables. No new identification and estimation issues would arise in this case only if (i) there are no restrictions on the covariance between measurement errors when more than one variable is measured with error; (ii) there are no restrictions on the correlation between measurement errors and the errors of the structural equations of the model. Under these assumptions, the usual rank and order conditions for identification holds when treating the variables measured with error as endogenous (see Hausman [1977]). Moreover, 3SLS on the original system is fully efficient since the implied structural equations for the variables measured with error are just identified. However, failure of one of these assumptions will result in a restricted variance-covariance matrix of the full system and therefore in several complications regarding the identification (see Geraci [1976] and Hsiao [1976]) and estimation (see Geraci [1977] and Hsiao [1976]) of the model.<sup>13</sup> For the same reason, it should be obvious that the two assumptions are not necessary to ensure that 2SLS is fully efficient in its class.

A second issue that should not be neglected, particularly in view of the variables used in this paper, is that of the sensitivity of LS methods to outliers. I deal with this problem by using robust regression diagnostics and robust estimation methods. More specifically, both the diagnostics and the estimation procedures used here are designed to respectively detect and limit the impact of outliers not only in the error space, but also in the regressor space. Because of lack of space, I refer entirely to the literature on the topic for a discussion of the techniques implemented here: see in particular Krasker-Welsch [1982] and Krasker-Kuh-Welsch [1983] for a theoretical discussion, and Kuh-Welsch [1980] and Peters-Samarov-Welsch [1981] for a more applied perspective.

In contrast to the errors-in-variables case, now there are no new conceptual issues when this approach is implemented in a instrumental variable framework. The only

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<sup>13</sup>Note however that, even when assumption (i) holds, the measurement error variance cannot be estimated: see Hsiao [1976].

difficulties are computational, since the program needed to obtain the bounded- influence estimators becomes considerably more involved.<sup>14</sup>

A problem strictly related to that of measurement error is that of heteroskedasticity. I apply a set of tests and use a number of heteroskedasticity-consistent estimators, both in the OLS regressions of the reduced form and in the instrumental variable regressions of the political mechanism.

Three completely different sets of issues should also be dealt with here: the dataset used in the regressions, the sample and the time period. Because the estimates in this paper relate to previous estimates by P-T and A-R, it is important to make sure that the results obtained here are not due to differences in one of the three elements above.

Regarding the first, the income distribution data used here is based on several sources in order to include the most reliable observation for each country. This dataset - based primarily on Jain [1975] but supplemented by other sources - is very similar to the ones used in Perotti [1991] and in A-R, but it is different from P-T who use the Paukert [1973] dataset.

The second problem, i.e. the sample used, arises because the theory obviously applies only to democracies, and the definition of "democracy" is clear a matter of judgment. In this paper as in Perotti [1991] a democracy is a country whose value for the political rights index in the Barro-Wolf dataset does not exceed 3. This leads to a sample of 30 democracies,<sup>15</sup> which is similar but not identical to the samples used by A-R and P-T, each of whom uses different criteria. Appendix 2 details the countries included in my dataset and the source of the income distribution data for each country.

Finally, the timing issues is important for two independent reasons. First, the sample period in most growth regressions is typically 1960-1985, and therefore ideally one would want income distribution variables as close as possible to the year 1960: indeed, 1960-1985

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<sup>14</sup>The programs used to compute the two types of robust estimators are available from the author upon request.

<sup>15</sup>Since observations on fiscal policy variables for Jamaica are not available, the number of countries that enter the simultaneous equation estimations is 29.

is the sample period used by A-R and P-T. However, it turns out that a more complete and presumably more reliable set of observations is available around the year 1970. Second, and more importantly perhaps, a consistent dataset on fiscal policy variables is available only from 1970. In the reduced form regressions of P-T and A-R this is not a problem, since fiscal policy variables are endogenous; however, for the structural estimations of this paper it might be more appropriate to use 1970 as the initial year, and therefore to use income distribution variables observed around the year 1970.

For all these reasons, the regressions of this paper are performed over two periods, 1960-85 and 1970-85, and using all three sets of data on income distribution variables for democratic countries: the ones by A-R and P-T, which refer to 1960 only, and mine, which refers to 1960 and 1970. The other variables are taken from the Barro-Wolf data set, except the political variables that are taken from Edwards-Tabellini [1991] and from the dataset used in Alesina-Ozler-Roubini-Swagel [1992]. Tables 1 and 2 present some sample statistics and the correlation matrix of these variables.

## 6 Reduced form estimations and tests.

Because the first tests of models of income distribution and growth have been performed on their reduced forms, it is instructive to start the empirical part of this paper from the same point. Therefore, in this section I essentially perform some sensitivity analysis on reduced forms where income distribution variables appear as explanatory variables in a standard growth regression. The main focus of interest is of course the coefficients of the income distribution variables that appear in the system.

I start in Table 3 by reestimating the reduced form estimated by A-R and P-T, using both my sample and dataset (column (1)) and those used by A-R (column (2)) and P-T (column (3)). Thus, column (2) exactly reproduces one of the regressions in Table 6 of A-R. The coefficient estimates in column (3) are very similar to those in Table 4, column (1) of P-T: the small differences are probably due to slightly different data for the variable

*PRIM*. The coefficient estimates are very similar across the three regressions, and as it was already emphasized by A-R and P-T they look very supportive of the null hypothesis by A-R, P-T and B, since the coefficient of *MID* is indeed positive and significant.

Three qualifications to this statement emerge from the other estimates in Table 5. First, once a Latin American dummy variable is added to any of these regressions, the size and significance of the income distribution coefficient decreases dramatically in all three regressions, and becomes negative in the A-R regression. With two samples (mine and A-R's) now one cannot reject the null hypothesis that the coefficients are zero (see columns (4), (5) and (6)). That the coefficient of *MID* should decrease is not entirely surprising, since the Latin America dummy covaries negatively both with the rate of growth of GDP and the share of the third quintile, and the latter correlation persists even after partialing out the effects of *PRIM* and *GDP*.

The second qualification to the success of the reduced form implications of the models is that the size and significance of the income distribution variable again drops drastically if one uses secondary enrollment instead of primary enrollment to control for the stock of human capital (column (7)). A possible explanation is that most of the countries in the sample are high-income countries with primary enrollment ratios very close (or in several cases even higher) than 100%. To the extent that one of the determinants of income distribution is the distribution of human capital, in high income countries it is the distribution of secondary school enrollment ratios in different income groups that makes the difference, since all income groups have a very high primary school enrollment ratios. In fact, in this sample of 29 countries the simple correlation between *MID* and secondary school enrollment is .681, much higher than the correlation between *MID* and primary school enrollment, .300.

Finally, as column (8) shows, the results for the 1970-85 period are slightly less supportive of the theory. Although the size of the coefficient of *MID* is actually higher than in the 1960-85 period for the same sample (column (1)), now it is statistically insignificant.

Since they use a very limited set of explanatory variables, the reduced forms presented

in Table 3 cannot easily be derived from structural models such as those developed in Section 3. In Tables 4 and 5 I present estimates of reduced forms that refer to the models by A-R, P-T and B (Table 4), and to SP-V and my model (Table 5). These estimates make use of all the exogenous variables of a typical specification of the whole system, as developed in the next section (see Table 8). In fact, to isolate clearly the role of income distribution, I have simply added income distribution variables to what can be regarded as a typical growth regression a' la Barro (see for instance Barro [1991]).

Consider first the models by A-R, P-T and B, as estimated in Table 4. Columns (1), (2), (6) and (7) use A-R's and P-T's income distribution data respectively to estimate the reduced form relation over the 1960-85 period. The results essentially confirm those of the simpler specification of Table 3: the reduced form performs well over the 1960-85 period, even though the introduction of a Latin America dummy variable causes the size and significance of the coefficient of *MID* to drop substantially when the A-R data is used. Column (3) also repeats the pattern of Table 3: in the 1970-85 sample, the coefficient of *MID* cannot be statistically distinguished from 0.

In column (4) I have simply added a second income distribution variable, the share of the top quintile. Strictly speaking, this last variable should not matter when taxes are proportional to income, as assumed in A-R and P-T. However, it might belong in the equation if taxes are progressive *and* the median voter is still the decisive voter. If this is indeed the case, then this might explain the negative coefficient for *MID* in column (3), since essentially that equation was omitting an important variable that covaries negatively with *MID* in the sample. Note, however, that even if one *assumes* that for small deviations from linear taxes the median voter is still the decisive voter, it is not clear theoretically what sign the coefficient of *TOP* should have. Note also that the estimates in this specification are robust to the introduction of a Latin American dummy (column (5)).

Column (1) in Table 5 shows that the reduced form of S-PV is rejected by the data: the implied relation between the share of the third quintile and growth is convex rather

than concave.

The results are clearly disappointing for my model too (columns (2) to (4)). In column (2) three of the four coefficients of the income distribution variables have the right sign, but none of them is significant at the 10% level.<sup>16</sup> One could argue that, for the reasons discussed above, secondary school enrollment is the variable one should use to control for human capital. Column (3) shows that in this case all the signs of the income distribution variables are correct and the t-statistics increase slightly, although still only the coefficient of *TOP* is marginally significant. A second possible defense of the model is that it is not very meaningful to estimate a nonlinearity with so few observation on poor democracies; therefore, it might then be more reasonable to use only rich countries to estimate my model. In this case, growth should depend positively on *MID* and negatively on *TOP*, while no interactive term should now be included. Accordingly, column (4) in Table 5 uses only those countries with a PPP-adjusted per capita GDP higher than U.S. \$ 1,500 (assuming a cut-off points of U.S. \$ 2,000 gives very similar results). Now the income distribution variables are significant, but *TOP* has the wrong sign.

Tables 6 and 7 show that the estimated coefficients are fairly robust. In Table 6, regression diagnostics for columns (1), (2) and (3) in Table 3 and column (3) in Table 4 are reported. Thus, the first three columns of Table 6 refer to the simple form of the reduced form of the models by A-R, P-T and B, using the three datasets. Column (4) of Table 6 refers to the more complete version of the reduced form obtained by specifying the whole structural model. Table 7 reports the Krasker-Welsch robust estimators of the same relations that appear in Table 6. As one can see from Table 6, there are some outliers in both the error space and the regressor space, but as Table 7 shows the Krasker-Welsch bounded-influence estimator that downweighs these outliers does not imply a substantial departure from the OLS estimates.

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<sup>16</sup>It should be noted, however, that the reduced form estimated here does not fall exactly from my model: due to the abundance of interactive terms, the exact reduced form would have left too few degrees of freedom. This applies, *a fortiori*, to SP-V, where the presence of a quadratic term in *MID* would have required using several quadratic and cross-product terms as regressors in the reduced form.

Note that there is always an element of arbitrariness in forming the bounded-influence estimator used here. One can be more or less demanding in defining an outlier, i.e. an observation that has to be downweighed in the robust estimator. In turn, the cut-off value that defines an outlier is a function of the bound on sensitivity that one requires the estimator to have, where the sensitivity is, roughly speaking, the maximum "influence" that a single observation is allowed to have in a large sample.<sup>17</sup> In the case of just one regressor, once the sensitivity is set the efficiency of the Krasker-Welsch estimator relative to the OLS estimator follows directly. With more than one regressor, the relative efficiency depends on the sample. I have chosen the sensitivity in such a way that the relative efficiency would be 95% in the case of one regressor. The actual relative efficiency for each estimator appears in Tables 7 and 15. Note that all the cutoff points for the regression diagnostics also depend on the value chosen for the sensitivity of the estimator.

In summary, the message of the reduced form estimations is mixed: the version implied by A-R, P-T and B is supported by the data only for the 1960-85 period, and even in this case it does not survive the introduction of a Latin American dummy. In the case of SP-V and my model, the verdict is less ambiguous: there is virtually no support for the reduced forms implied by these models.

## 7 Estimates of the structural models.

Whether one interprets the reduced form results as supporting or rejecting the recent models of income distribution and growth, it is still interesting to analyze if the political mechanism is consistent with these models or is responsible for their rejection. In addition, one may regard the political mechanism as of interest in itself, and therefore a test of the fairly general median voter-type result that it embeds can be valuable independently of the rest of the theory. In this section, I present the results of estimations

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<sup>17</sup>For a rigorous definition of the terms "sensitivity" and "influence" in this context, see for example Krasker-Kuh-Welsch [1983].

of the structural models, using both full information and limited information methods. Particular attention will be devoted to limited information estimation of the political mechanism, i.e. the equation describing the determination of the fiscal policy variable.

I will concentrate initially on full information estimation of the structural models implied by P-T and B on side and A-R on the other. The reason is that in SP-V and in my model the engine of growth is accumulation of human capital, and it is well known that reliable figures for this variable for all countries in the sample do not exist yet. However, when I turn to limited information estimation of the political mechanism, this problem does not arise and therefore the fiscal policy equation can be estimated for SP-V and my model as well.

In Table 8 I present 3SLS estimates of the models by P-T and B (top and bottom panels) and A-R (middle panel). The specification adopted is a simple but reasonable one that generates the reduced form of Table 4, column (3). The two models differ only in the dependent variable of the third equation, which is public investment in the case of A-R and government transfers for P-T, B. The specification of the first two relations, for GDP growth and private investment, is rather standard and does not require a detailed discussion. I have included the rate of growth of GDP as a regressor in the investment equation to capture possible accelerator effects (see Fischer [1991]). In the fiscal policy equation, the proportion of the population above 65 of age is included because a major component of government transfers is composed of social security programs and because, especially if Ricardian Equivalence does not hold, the age structure of the population should in principle have an impact on public investment.

Abstracting for a moment from the fact that virtually all coefficients are insignificant, from the first two panels one can see immediately that in both systems the two most important coefficients do not square with the theory: in the economic mechanism private investment depends positively on the government expenditure variable, while in the political mechanism government expenditure depends positively on the share of the third quintile.

It can be argued that, after all, for the 1970-85 subperiod the reduced form regressions were not very good to start with. I have estimated the structural models for the 1960-85 period, using my dataset and the datasets by A-R and P-T. In particular, in the third panel of Table 8 I report the results for the structural model of P-T, using their data on income distribution variables and their sample of democratic countries: this combination generated the reduced form perhaps most favorable to the theory (column (2) in Table 4). It is obvious that this interpretation was misleading: again both crucial coefficients in the economic and political mechanism have the wrong sign. Thus, *the correct sign of the income distribution variable in the reduced form appears to be the result of two wrong signs in the two components of the models.*<sup>18</sup>

The specification of the fiscal policy equation (i.e., the political mechanism) in Table 8 was admittedly tentative. In order to understand whether the disappointing results obtained so far are robust to other plausible specifications, in Tables 9 to 12 I concentrate on limited information (2SLS) estimation of the political mechanism. In Tables 9 and 10 the dependent variable is government transfers: these tables are therefore relevant for the political mechanism in P-T and B (first four columns) and in my model (last three columns). In Table 9 I experiment with different economic, demographic and geographic determinants of government transfers. One can see immediately that the size of the coefficient of *MID* is always positive except in one case, and always insignificantly different from 0. The sign of the coefficient of *TOP* is also always wrong, although it is always very imprecisely estimated and has little economic significance. In addition, this time the introduction of a Latin America (not shown) dummy does not affect the income distribution variables significantly. Among the other variables, *AGE* seems to be an important determinant of government transfers: its coefficient is large and always estimated rather precisely.

Table 10 focuses instead on the political determinants of government transfers. A

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<sup>18</sup>Estimating the structural model of A-R using their income distribution dataset delivers essentially the same message as in the bottom panel of Table 8.

group of variables representing the structure of the executive is strongly significant, both in statistical and economic terms. These variables are: *NPC*, the number of parties in the ruling coalition; *COAL*, a variable that takes a value of one if the government is made up of only one party and two if more than one party are in the government; *MAJ*, an indicator that takes the value of 0 if the party or coalition in office does not have an absolute majority, and one if it does. All variables are from Edwards-Tabellini [1991] and are averages over the 1970-1985 period approximately. These political variables perform quite well: the coefficient are always significant and with the expected signs, in the sense that "weaker" executives tend to be associated with larger government transfers. For instance, the addition of one party in a coalition is associated, on average, with an increase in the government transfers to GDP ratio of 2.61%. However, the coefficient of *MID* is still always positive and quite large in some cases.

I also run the same regressions using a different set of political and socio-economic variables that are *a priori* good candidates to affect government transfers. These variables are: *PROTEST*, the number of demonstrations against the government, *PSTRIKE*, the number of political strikes, *GCHANGE*, the number of government changes, all from Alesina et al. [1992], and *SPI*, an index of socio-political instability, from Alesina-Perotti [1992] and Venieris-Gupta [1986]. The results are much less clear than with the previous set of political variables from Edwards-Tabellini [1991]: the coefficient is almost never significant and there are in some cases large differences when the income distribution variable is assumed to be measured with error or when some adjustment for heteroskedasticity is applied.

Estimates of the political mechanisms of A-R and SP-V are displayed in Tables 11 and 12, which correspond to Tables 9 and 10 respectively. The dependent variable in the first 4 columns of Table 11 is the ratio of public investment to GDP: these regressions therefore estimate the political mechanism relevant for the model by A-R. Again, the coefficient of *MID* is positive in two cases, but its t-statistics are always extremely small. Much the same comments apply to the regression for the model by SP-V (column (5)): the

coefficient of the income distribution variable has the wrong sign and is estimated very imprecisely.

Adding political determinants of government expenditure (Table 12) does not modify the general picture regarding the income distribution variables. In addition, and contrary to the case of government transfers in Table 10, now the political variables are never significant in explaining either public investment or public expenditure on education.

I will now take up the issues of heteroskedasticity, measurement error and robustness of the estimates. Only for simplicity I will concentrate on the estimates relevant for P-T and B, but much of what follows applies to the other models as well. I will illustrate my procedure by commenting on the basic government transfers equation (column (1) in Table 9), but I also applied the same procedure to all the equations in Tables 9, 10, 11 and 12 with very similar results.

In Table 13 I deal with the issues of measurement error and heteroskedasticity. It is often argued that the error term is likely to be proportional to the inverse of GDP: accordingly, I run both a Breusch-Pagan test and a Hall-Pagan test (which is in principle robust to the presence of heteroskedasticity in other equations). In both cases, the null hypothesis of homoskedasticity cannot be rejected. One might still want to correct (asymptotically) the standard errors for the presence of heteroskedasticity: this is done in column (3) of Table 13 by correcting the standard errors of the 2SLS estimator using Withe's heteroskedasticity-consistent covariance matrix. However, the 2SLS estimator that uses the White heteroskedasticity-consistent covariance matrix is now less efficient than the two-stage instrumental variable estimator described in White [1982].<sup>19</sup> Accordingly, in column (4) I present the 2SIV estimate of the same relation. The only important difference is that now the size and significance of the income distribution coefficient drop substantially with respect to the two 2SLS estimators.

As to measurement errors, a rather indirect way to gather some idea of their role in

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<sup>19</sup>See Cragg [1983] for Monte Carlo evidence showing some small sample bias problems with the heteroskedasticity-consistent estimator of the variance-covariance matrix.

determining these results is to run a Hausman test using 3SLS and 2SLS (not shown) estimates of the model. The test statistic is a Chi-square with 7 degrees of freedom, and has a significance level of .788. This of course is only partially reassuring because the test might have low power, as it is well known, and its small sample properties are not clear. In the presence of heteroskedasticity, the relevant Hausman-type test would use the covariance matrices of the two estimators in columns (3) and (4) of Table 13, the heteroskedasticity-corrected 2SLS estimator and the 2SIV estimator. Again this specification test is well below the critical value, with a significance level of .208. Similarly, a Hansen test has a significance level of .350.

One might still want to reestimate the model under the assumption that the income distribution variable is observed with error. Column (2) in Table 13 shows that when *MID* is treated as an endogenous variable the picture is much the same as in the 2SLS estimator with *MID* exogenous. That measurement errors are not likely to be the main source of the results displayed so far is confirmed by a Hausman test for measurement error using the two 2SLS estimates in columns (1) and (2), i.e. the two 2SLS estimators obtained when *MID* is treated as exogenous and endogenous respectively.<sup>20</sup>

If *MID* is measured with error and in addition the disturbance of the government transfer equation is heteroskedastic, it is again possible to compute a 2SLS estimator using White's covariance matrix and a 2SIV estimator, with *MID* being treated as endogenous in both (columns (5) and (6) in Table 13). The same pattern displayed by the two estimators with exogenous *MID* is present here: the 2SIV estimator for the coefficient of *MID* is much smaller, although in both cases the coefficient remains insignificant.

Finally, I computed robust regression diagnostics and estimated the equation using the 2SLS version of the Krasker-Welsch estimator, as I did for the OLS growth regressions in

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<sup>20</sup>Only the  $TR^2$  version of the Hausman test could be computed (see Hausman [1983]). Neither Spencer-Berk version (see Spencer-Berk [1981]) could be computed because the relevant variance covariance matrix could not be inverted.

Tables 6 and 7. From Tables 14 and 15 one can see that the bounded-influence estimates are very close to those of the 2SLS estimator. In particular, the size and significance of the income distribution coefficient are almost identical in the two estimators.

## 8 Conclusions.

The evidence presented in this paper casts some doubt on the empirical relevance of a widely assumed model of the political process that endogenizes fiscal policy on the basis of income distribution, going back at least to Romer [1975], Roberts [1977] and Meltzer-Richard [1981]. Although nobody would want to take the median voter theorem literally as a paradygm of the actual political process, many would accept the view that fiscal policy in a democracy is related, in the long run, to a voter or class located more or less in the "middle" of the income distribution. Although of course there are myriads of other non-systematic political determinants of fiscal policy in the short-run, this paper has shown that this view of the determinants of fiscal policy might be difficult to defend even as a description of reality in the long-run.

The second important conclusion that this paper suggests is that government transfers seem to have a positive effect on growth rather than the negative effect posited by most recent theories. This finding, obtained by estimating a structural model, complements similar findings obtained in reduced form regressions by, among others, Devarajan-Vinaya-Zou [1992] and Sala-I-Martin [1992]. The relevance of this second empirical result might go beyond the models of income distribution and growth surveyed and tested in this paper.

Table 1: Summary statistics (sample 1970-85).

	NOBS	MEAN	STD. ERR.	MIN.	MAX.
$\Delta GDP$	29	2.24	1.57	-4.15	5.37
PUBIN	29	3.48	1.33	1.51	7.74
PRIVINV	29	21.06	5.36	12.67	32.67
GTRAN	29	14.34	7.76	2.17	30.65
GOVED	29	4.80	1.57	1.83	7.66
GDP	29	5.05	2.71	.58	9.46
PRIM	29	103.41	14.37	65.00	129.00
MID	29	15.40	2.29	10.90	18.80
TOP	29	46.70	6.99	37.20	60.60
REVCoup	29	.06	.11	.00	.36
PPPIDE	29	-.02	.22	-.34	.77
URB	29	57.21	21.31	9.00	86.00
AGE	29	8.54	3.75	3.00	14.20
CRISIS	24	.26	.17	.00	.54
NPC	26	1.55	.98	.00	.37
GOVCHANGE	29	.39	.17	.08	.85
POLSTRIKE	29	1.70	3.02	.00	10.46
PROTEST	29	12.20	28.49	.00	149.15
SPI	29	.29	.50	.00003	1.94

For definitions of variables, units of measurement and sources, see Appendix 1.

Table 2: Correlation matrix (sample 1970-85).

	$\Delta GDP$	PUBIN	PRIVINV	GTRAN	GDP	PRIM	MID	TOP	AGE
$\Delta GDP$	1.00	.50	.44	.10	-.31	-.06	-.06	.09	.09
PUBIN	.50	1.00	.67	.04	-.12	-.40	.02	.005	.12
PRIVINV	.44	.67	1.00	.28	.23	.03	.21	-.10	.24
GTRAN	.10	.04	.28	1.00	.58	.43	.72	-.69	.79
GDP	-.31	-.12	.23	.58	1.00	.29	.72	-.63	.70
PRIM	-.06	-.40	.03	.43	.29	1.00	.30	-.28	.35
MID	-.06	.02	.21	.72	.72	.30	1.00	-.97	.78
TOP	.09	.005	-.10	-.69	-.63	-.28	-.97	1.00	-.76
AGE	.09	.12	.24	.79	.70	.35	.78	-.76	1.00

See note to Table 1.

Table 3: Growth regressions, 1960-85 and 1970-85.

	60-85	60-85	60-85	60-85	60-85	60-85	60-85	70-85
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	P	A-R	P-T	P	A-R	P-T	P	P
constant	-.242 (-1.129)	-4.931 (-1.965)	-5.071 (-3.511)	2.341 (1.267)	2.137 (.605)	-4.937 (2.442)	2.294 (1.432)	.274 (.094)
<i>GDP</i>	-.431 (-2.825)	-.620 (-3.203)	-.613 (-3.839)	-.428 (-3.216)	-.382 (-1.963)	-.592 (-3.581)	-.498 (-3.298)	-.319 (-2.059)
<i>PRIM</i>	.016 (1.078)	.057 (3.044)	.052 (3.982)	.016 (1.203)	.030 (1.574)	.052 (3.910)		-.0003 (-.014)
<i>SEC</i>							.029 (1.783)	
<i>MID</i>	.200 (1.815)	.262 (2.059)	.300 (3.060)	.045 (.411)	-.053 (-.317)	.259 (2.187)	.069 (.529)	.234 (1.271)
<i>LAAMER</i>				-2.203 (-2.980)	-2.410 (-2.573)	-.402 (-.640)		
<i>NOBS</i>	29	24	29	29	24	29	29	29
$\bar{R}^2$	.172	.300	.495	.370	.453	.483	.231	.048
<i>SEE</i>	1.221	1.207	1.222	1.065	1.066	1.237	1.176	1.529

OLS. Dependent variable:  $\Delta GDP_{6085}$  (columns (1) to (7)) and  $\Delta GDP_{7085}$  (column (8)). In columns (2) and (5) the Alesina-Rodrik data and sample of democracies have been used. In columns (3) and (6) the Persson-Tabellini data and sample of democracies have been used. t-statistics in parentheses.

Table 4: Growth regressions, 1960-85 and 1970-85.

	60-85	60-85	70-85	70-85	70-85	60-85	60-85
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	A-R	P-T	P	P	P	A-R	P-T
<i>constant</i>	-3.626 (-1.582)	-5.720 (-4.036)	3.190 (1.603)	-21.221 (-2.452)	-18.376 (-1.527)	-1.114 (-.216)	-6.499 (-3.467)
<i>GDP</i>	-.679 (-2.749)	-.869 (-3.337)	-.165 (-1.256)	-.261 (-1.981)	-.281 (-1.725)	-.628 (-2.327)	-.908 (-3.350)
<i>PRIM</i>	.038 (2.115)	.048 (3.670)	.006 (.506)	.004 (.394)	.006 (.381)	.031 (1.453)	.046 (3.451)
<i>REVCoup</i>	-4.515 (-1.569)	-.239 (-.125)	-4.502 (-1.866)	-3.702 (-1.787)	-3.670 (-1.490)	-4.811 (-1.608)	-.037 (-.019)
<i>PPIDE</i>	-1.569 (-1.148)	-1.834 (-1.301)	-3.103 (-2.242)	-3.100 (-2.524)	-2.439 (-1.706)	-.798 (-.402)	-2.045 (-1.394)
<i>URB</i>	.016 (1.198)	.022 (1.518)	-.12 (-1.155)	-.012 (-1.370)	-.010 (-.689)	.014 (.988)	.021 (1.417)
<i>AGE</i>	.120 (.959)	.110 (.855)	.110 (1.296)	.137 (1.734)	.119 (1.903)	.102 (.770)	.151 (1.041)
<i>MID</i>	.212 (1.954)	.304 (3.400)	-.051 (-.371)	.778 (2.349)	.665 (1.524)	.107 (.482)	.350 (3.028)
<i>TOP</i>				.257 (3.072)	.236 (1.928)		
<i>LAAMER</i>					-.917 (-1.090)	-.901 (-.547)	.499 (.648)
<i>NOBS</i>	24	28	29	29	29	24	28
$\bar{R}^2$	.509	.601	.473	.547	.552	.456	.589
<i>SEE</i>	1.010	1.099	1.138	1.054	1.049	1.033	1.116

OLS. Dependent variable:  $\Delta GDP_{6085}$  (columns (1), (2), (6) and (7)) and  $\Delta GDP_{7085}$  (columns (3), (4) and (5)). In columns (1) and (6) the Alesina-Rodrik data and sample of democracies have been used. In columns (2) and (7) the Persson-Tabellini data and sample of democracies have been used. t-statistics in parentheses.

Table 5: Growth regressions, 1970-85.

	70-85	70-85	70-85	70-85
	(1)	(2)	(3)	(4)
	SP-V	P	P	P
constant	15.813 (1.654)	-16.410 (-.639)	-32.418 (-1.468)	-17.980 (-1.370)
<i>GDP</i>	-.167 (-1.103)	-.309 (-.006)	1.614 (.405)	-.248 (-1.560)
<i>PRIM</i>	.015 (.858)	.017 (.961)		-.008 (-.399)
<i>SEC</i>			.045 (2.920)	
<i>REVCoup</i>	-4.50 (-1.744)	-4.147 (-1.654)	-2.977 (-1.404)	-4.493 (-1.496)
<i>PPPIDE</i>	-3.224 (-2.339)	-2.618 (-1.938)	-1.788 (-1.512)	-3.551 (-2.630)
<i>URB</i>	-.010 (-.676)	.009 (-.580)	-.015 (-1.182)	-.016 (-1.029)
<i>AGE</i>	.108 (.958)	.161 (1.405)	.058 (.557)	.113 (.992)
<i>MID</i>	-1.913 (-1.39)	.386 (.394)	.898 (1.104)	.739 (1.620)
<i>TOP</i>		.243 (.948)	.442 (1.977)	.238 (1.715)
<i>MID</i> <sup>2</sup>	.062 (1.372)			
<i>MIDGDP</i>		.037 (.225)	-.015 (-.112)	
<i>TOPGDP</i>		-.011 (-.238)	-.039 (-6.940)	
<i>NOBS</i>	29	29	29	25
$\bar{R}^2$	.494	.545	.675	.600
<i>SEE</i>	1.115	1.057	.893	1.019

OLS. Dependent variable:  $\Delta GDP_{6085}$ . t-statistics in parentheses.

Table 6: Robust diagnostics for growth regressions.

Col. (1), Table 3

COUNTRY	$H_i$ (.414)	RSTUD (2.500)	DFFITS (1.114)	DFBETAS(MID) (.557)
BOTSWANA	.387	3.200	2.545	-.559
VENEZUELA	.236	-3.226	-1.791	1.455

Col. (2), Table 3

COUNTRY	$H_i$ (.500)	RSTUD (2.500)	DFFITS (1.225)	DFBETAS(MID) (.613)
COLOMBIA	.429	1.967	1.705	-1.375
VENEZUELA	1.08	-3.608	-1.254	.396

Col. (3), Table 3

COUNTRY	$H_i$ (.429)	RSTUD (2.500)	DFFITS (1.135)	DFBETAS(MID) (.567)
COLOMBIA	.164	1.679	.749	-.584
VENEZUELA	.106	-3.281	-1.133	.109

Col. (3), Table 4

COUNTRY	$H_i$ (.828)	RSTUD (2.500)	DFFITS (1.576)	DFBETAS(MID) (.557)
VENEZUELA	.645	-3.358	-4.524	.882

This table displays those countries that exceed the cutoff points for the diagnostics  $H_i$ , RSTUD, DFFITS, DFBETAS(GDP) (not reported) and DFBETAS for the income distribution variables. The cutoff points for each diagnostics are immediately after the name of the diagnostics, in parentheses.

Table 7: Krasker-Welsch estimators of growth equations, 1970-85.

	Col. (1), Tbl. 3	Col. (2), Tbl. 3	Col. (3), Tb3. 1	Col. (3), Tbl. 4
constant	-.914 (-.665)	-4.931 (-1.965)	-5.277 (-3.367)	5.239 (2.208)
<i>GDP</i>	-.352 (-3.231)	-.620 (-3.203)	-.602 (-3.472)	-.086 (-.574)
<i>PRIM</i>	.026 (2.327)	.057 (3.044)	.051 (3.591)	-.004 (-.301)
<i>REVCoup</i>				-3.119 (-1.322)
<i>PPPIDE</i>				-1.383 (-1.097)
<i>URB</i>				-.016 (-1.171)
<i>AGE</i>				.085 (.843)
<i>MID</i>	.158 (1.990)	.262 (2.059)	.320 (3.111)	-.102 (-.650)
<i>NOBS</i>	29	24	28	29
$\bar{R}^2$	.120	.300	.486	.314
Rel. eff.	.908	.895	.906	.920

For samples and dependent variables used, see Tables 3 and 4. Robust t-statistics in parentheses.

Table 8: 3SLS.

P-T, B, 1970-85 (29 obs.)

(1)	-4.54 (-1.43)	-.49 GDP (-3.41)	+.01 PRIM (.54)	+.32 PRIVINV (2.70)	+.09 GTRAN (1.22)	
(2)	28.21 (1.78)	-2.78 $\Delta GDP$ (-.58)	.16 GTRAN (.60)	-16.66 PPPIDE (-.88)	-.04 URB (-.32)	-23.35 REVCOU (-1.12)
(3)	-9.87 (-1.40)	.47 GDP (.76)	+1.17 $\Delta GDP$ (1.21)	+ 1.04 AGE (2.15)	+.67 MID (1.21)	

A-R, 1970-85 (29 obs.)

(1)	-7.70 (-1.83)	-.11 GDP (-.82)	+.02 PRIM (.57)	+.15 PRIVINV (.91)	+1.63 PUBINV (2.46)	
(2)	33.72 (2.25)	-.78 $\Delta GDP$ (-.22)	-2.45 PUBINV (-1.41)	-12.71 PPPIDE (-.85)	+.02 URB (.24)	-24.68 REVCOU (-1.40)
(3)	2.71 (2.04)	-.05 GDP (-.35)	+.37 $\Delta GDP$ (1.59)	.34 AGE (.35)	-.01 MID (-.01)	

P-T, B, 1960-85 (28 obs.)

(1)	.21 (-.18)	-.63 GDP (-3.37)	+.004 PRIM (.49)	+.10 PRIVINV (1.29)	+.16 GTRAN (2.43)	
(2)	10.63 (4.68)	2.46 $\Delta GDP$ (3.69)	.23 GTRAN (1.53)	1.60 PPPIDE (.56)	+.005 URB (.12)	-3.81 REVCOU (-.88)
(3)	-8.60 (-2.17)	2.89 GDP (2.92)	3.63 $\Delta GDP$ (3.05)	.14 AGE (.28)	.10 MID (.37)	

Dependent variables: Eq. (1):  $\Delta GDP$ ; Eq. (2):  $PRIVINV$ ; Eq. (3):  $GTRAN$  (P-T, B) and  $PUBINV$  (A-R). *t*-statistics in parentheses. In the first two panels my dataset and sample of democracies are used. In the bottom panel P-T's income distribution data and sample of democracies are used.

Table 9: Government transfers, 1970-85.

	P-T	P-T	P-T	P-T	P	P	P
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
constant	-12.838 (-1.453)	-14.858 (-1.583)	-22.212 (2.013)	-4.730 (.607)	11.099 (.171)	23.609 (.345)	11.083 (.172)
<i>GDP</i>	.365 (.524)	.125 (.163)	.392 (.56)	1.720 (1.432)	.473 (.545)	.312 (.342)	.566 (.655)
$\Delta GDP$	1.122 (1.050)	1.533 (1.286)	1.294 (1.213)	2.420 (1.779)	1.412 (.977)	1.632 (1.233)	1.379 (1.175)
<i>AGE</i>	.946 (1.850)	.950 (1.799)	.796 (1.534)	.640 (.928)	.916 (1.643)	.888 (1.539)	.736 (1.295)
<i>URB</i>		.066 (.911)				.069 (.912)	
<i>PRIM</i>			.010 (1.398)				.102 (1.393)
<i>MID</i>	.957 (1.307)	.858 (1.123)	.946 (1.302)	-.025 (-.036)	.153 (.066)	-.443 (-.179)	-.183 (-.079)
<i>TOP</i>					-.254 (-.366)	-.411 (-.556)	-.357 (-.514)
<i>NOBS</i>	29	29	29	26	29	29	29
<i>SEE</i>	5.062	5.266	5.020	6.353	5.156	5.331	5.122

2SLS. Dependent variable: Government transfers (*GTRAN*). t-statistics in parentheses. Instruments: *GDP*, *PRIM*, *URB*, *AGE*, *PPIDE*, *REVCUP*, *MID* and *TOP* (columns (5) to (7)). Therefore, the instruments are the same as the explanatory variables in the reduced form regressions of Table 4. Column (4) uses P-T's income distribution variables and sample of democracies.

Table 10: Government transfers, 1970-85.

	P-T	P-T	P-T	P-T
	(1)	(2)	(3)	(4)
constant	-15.439 (-.872)	-11.561 (-1.787)	-10.039 (-1.474)	-3.580 (-.524)
<i>GDP</i>	.026 (.038)	.020 (.042)	.073 (.147)	-.288 (-.522)
$\Delta GDP$	.372 (.122)	.553 (.815)	.602 (.845)	1.086 (1.399)
<i>AGE</i>	1.078 (1.925)	1.110 (3.078)	1.178 (3.101)	1.046 (2.619)
<i>MID</i>	1.146 (1.252)	.692 (1.271)	.385 (.677)	.741 (1.227)
<i>CRISIS</i>	5.960 (1.870)			
<i>NPC</i>		2.681 (3.624)		
<i>COAL</i>			4.929 (3.053)	
<i>MAJ</i>				-5.865 (-3.052)
<i>NOBS</i>	28	26	26	26
<i>SEE</i>	4.762	3.372	3.590	3.702

2SLS. Dependent variable: government transfers (*GTRAN*).  
t-statistics in parentheses. Instruments: same as in Table 9,  
except that *REVCoup* is replaced by the relevant political  
variable of each equation.

Table 11: Public inv. and public exp. on educ., 1970-85.

	A-R	A-R	A-R	A-R	SP-V
	(1)	(2)	(3)	(4)	(5)
constant	2.555 (1.182)	3.128 (1.399)	6.570 (2.706)	.314 (.192)	2.626 (.998)
<i>GDP</i>	-.033 (-.191)	.035 (.194)	-.044 (-.291)	-.048 (-.284)	.380 (1.830)
$\Delta GDP$	.381 (1.459)	.265 (.934)	.308 (1.310)	.285 (1.420)	.325 (1.020)
<i>AGE</i>	.052 (.415)	.051 (.043)	.116 (1.020)	.105 (1.012)	-.126 (-.825)
<i>URB</i>		-.019 (-.1084)			
<i>PRIM</i>			-.043 (-2.722)		
<i>MID</i>	-.013 (-.075)	.014 (.080)	-.009 (-.055)	.109 (.905)	.039 (.179)
<i>NOBS</i>	29	29	29	23	29
<i>SEE</i>	1.238	1.244	1.105	1.073	1.507

2SLS. Dependent variable: Public investment (*PUBINV*) (columns (1) to (4)) and public expenditure on education (*GOVED*) (column (5)). t-statistics in parentheses. Instruments: *GDP*, *PRIM*, *URB*, *AGE*, *PPIDE*, *REVCUP*, *MID* and *MID*<sup>2</sup> (column (5)). Therefore, the instruments are the same as the explanatory variables in the reduced form regressions of Table 4 (for A-R) and Table 5 (for SP-V). Column (4) uses A-R's income distribution variables and sample of democracies.

Table 12: Public inv. and public exp. on educ., 1970-85.

	(1)	(2)	(3)	(4)	(5)	(6)
	A-R	A-R	A-R	A-R	SP-V	SP-V
constant	-4.278 (-.727)	2.094 (.842)	2.286 (.936)	1.808 (.755)	4.637 (.771)	4.231 (1.457)
<i>GDP</i>	.073 (.318)	-.067 (-.370)	-.051 (-.288)	-.011 (-.057)	.306 (1.301)	.382 (1.811)
$\Delta GDP$	1.709 (1.688)	.351 (1.346)	.368 (1.439)	.422 (1.554)	-.090 (-.087)	.231 (.760)
<i>AGE</i>	-.062 (-.336)	.009 (.063)	.015 (.110)	-.0005 (-.004)	-.065 (-.345)	-.006 (-.039)
<i>MID</i>	.254 (.837)	.064 (.306)	.061 (.302)	.048 (.227)	-.031 (-.100)	-.011 (-.455)
<i>CRISIS</i>	-.498 (-.470)				-.210 (-.194)	
<i>NPC</i>		-.019 (-.068)				
<i>COAL</i>			-.277 (-.478)			-.202 (-.294)
<i>MAJ</i>				.211 (.314)		
<i>NOBS</i>	28	26	26	26	28	26
<i>SEE</i>	1.582	1.295	1.288	1.296	1.617	1.532

2SLS. Dependent variable: Public investment (*PUBINV*) (columns (1) to (4)) and public expenditure on education (*GOVED*) (columns (5) and (6)). t-statistics in parentheses. Instruments: same as in Table 11, except that *REVCoup* is replaced by the relevant political variable of each equation.

Table 13: Government transfers, 1970-85.

Col. (1), Table 9

	(1)	(2)	(3)	(4)	(5)	(6)
constant	-12.838 (-1.453)	-16.089 (.269)	-12.838 (-1.388)	-4.884 (-1.069)	-16.089 (-.788)	1.790 (.122)
<i>GDP</i>	.365 (.524)	.269 (.289)	.365 (.649)	.440 (.881)	.269 (.329)	.635 (1.005)
$\Delta GDP$	1.122 (1.050)	1.095 (1.010)	1.122 (1.304)	1.009 (1.405)	1.095 (1.179)	1.057 (1.486)
<i>AGE</i>	.946 (1.850)	.853 (1.086)	.946 (2.172)	1.285 (4.754)	.853 (1.144)	1.508 (2.643)
<i>MID</i>	.957 (1.307)	1.255 (.613)	.957 (1.259)	.218 (.561)	1.255 (.642)	-.420 (-.301)
<i>NOBS</i>	29	29	29	29	29	29
<i>SEE</i>	5.062	5.071	5.062	5.519	5.071	5.445

Dependent variable: Government transfers (*GTRAN*). t-statistics in parentheses. Column (1): 2SLS. Column(2): 2SLS with *MID* as endogenous variable. Column (3): 2SLS with White's heteroskedasticity consistent covariance matrix. Column (4): 2SIV. Column (5): 2SLS, with *MID* as endogenous variable and White's heteroskedasticity consistent covariance matrix. Column (6): 2SIV with *MID* as endogenous variable.

Table 14: Robust diagnostics for govt. transfers regressions.

Column (1), Table 9				
COUNTRY	$H_i$ (.517)	RSTUD (2.500)	DFFITS (1.246)	DFBETAS(MID) (.559)
ISRAEL	.12	.57	1.85	.38
VENEZUELA	.26	-.37	-1.00	-.22

This table displays those countries that exceed the cutoff points for the diagnostics  $H_i$ , RSTUD, DFFITS and DFBETAS(MID) and DFBETAS(GDP) (not reported). The cutoff points for each diagnostics are immediately after the name of the diagnostics, in parentheses.

Table 15: Krasker-Welsch estimator of govt. transfers equation, 2SLS.

Col. (1), Table 9		
	(1)	(2)
constant	-12.838 (-1.453)	-17.109 (-1.951)
<i>GDP</i>	.365 (.524)	.430 (.630)
$\Delta GDP$	1.122 (1.050)	2.289 (2.127)
<i>AGE</i>	.946 (1.850)	1.002 (2.007)
<i>MID</i>	.957 (1.307)	.977 (1.360)
<i>NOBS</i>	29	29
<i>SEE</i>	5.062	5.798

Dependent variable: Government transfers (*GTRAN*). t-statistics in parentheses. Column (1): 2SLS. Column(2): 2SLS, Krasker-Welsch robust estimator.

## Appendix 1: Description of the data.

This Appendix describes the data used in the regressions. All the data are from the Barro-Wolf [1990] data set, except for the income distribution data, which are from a variety of sources detailed in Appendix 2, or unless otherwise indicated.

*GDP*: GDP in thousands of 1980 dollars, from the Summers-Heston data set.

$\Delta GDP$ : rate of growth of *GDP* between years 1960-85 or 1970-85.

*SEC*: secondary school enrollment rate in year 1960 or 1970.

*PRIM*: primary school enrollment rate in year 1960 or 1970.

*MID*: share of the third quintile of the population in or around year 1960 or 1970.

Sources: see Appendix 2.

*TOP*: share of the fifth quintile of the population in or around year 1960 or 1970. Sources: see Appendix 2.

*MIDGDP*:  $MID \times GDP$ .

*TOPGDP*:  $TOP \times GDP$ .

$MID * *2$ :  $MID^2$

*REVCoup*: Number of revolutions and coups per year (1960 to 1985 or subperiods).

*URB*: Urban population as percentage of total in year 1960 or 1970. Source: World Bank Tables;

*AGE*: Percentage of population over age 65 in year 1960 or 1970. Source: World Bank Tables.

*GTRAN*: Nominal government transfer payments as ratio to nominal GDP (average from 1970 to 1985).

*PUBINV*: Ratio of gross real public domestic investment (using Heston-Summers deflator for investment) to real GDP (average from 1970 to 1985).

*PRIVINV*: Ratio of real private domestic investment to real GDP (average from 1970 to 1985);

*GOVED*: Ratio of nominal public expenditure on education to nominal GDP (average

from 1970 to 1985).

*PPPID*: Deviation of the deviation of the PPP value for the investment deflator from the sample mean, 1960;

*CRISIS*: Number of government crises per year (1960-85 or subperiods);

*NPC*: number of parties in ruling coalition. Average 1970-1982 (source: Edwards-Tabellini [1991]);

*COAL*: dummy variable taking the value of 1 if the government is made up of only one party and 2 if more than one party are in the government. Average 1970-82 (source: Edwards-Tabellini [1991]);

*MAJ*: dummy variable taking the value of 0 if the party or coalition in office do not have an absolute majority, and 1 if they do. Average 1970-81 (source: Edwards-Tabellini [1991]);

*PROTEST*: number of political demonstrations against the government, average 1970-85 (source: Alesina-Ozler-Roubini-Swagel [1992]);

*PSTRIKE*: number of political strikes, average 1970-85 (source: Alesina-Ozler-Roubini-Swagel [1992]);

*GCHANGE*: number of government changes, average 1970-85 (source: Alesina-Ozler-Roubini-Swagel [1992]);

*SPI*: index of political instability, average 1970-85 (source: Alesina-Perotti [1992] based on a formula developed in Venieris- Gupta [1986]).

## Appendix 2: Income Distribution Data.

This appendix lists the countries included in the dataset used in this paper, i.e.e those countries with a political right index not higher than 3 in the Barro-Wolf data set and for which income distribution data exist. Following each country in parentheses is the source of its income distribution data.

Botswana (J); India (J); Dominican Republic (J); Sri Lanka (J); Malaysia (J); Turkey (UN81); Colombia (J); Jamaica (J); Greece (J); Costa Rica (J); Japan (J); Spain (J, VGP); Ireland (WDR86, VGP); Israel (J, UN81); Italy (K, WDR79); Austria (F); Finland (J); France (J, WDR79); Netherlands (J, WDR79); U.K. (J); Norway (J, WDR79); Sweden (J, UN81); Australia (K); Germany (J); Venezuela (J, WDR79); Denmark (J); New Zealand (J); Canada (J, UN81); Switzerland (F, WDR86); U.S. (J).

Legend:

J: Jain [1975];

UN81: United Nations [1981];

VGP: Van Ginneken and Bak [1984];

WDR79: World Development Report [1979];

WDR86: World Development Report [1986];

F: Flora et al. [1987];

K: Kuznets [1963];

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