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DOES EQUALITY PROMOTE GROWTH?

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Does Equality Promote Growth?*

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Abstract

Several recent articles claim that pre-tax income equality promotes growth. Equality is argued to dampen demand for redistributive economic policies that tax returns to growth-enhancing activities such as investment. These results rest heavily on the assumption that pre-tax income equality is an exogenous parameter. We suggest that taking account of endogenous influences on pre-tax income equality changes both theoretical and empirical conclusions significantly. First, we extend previous theoretical models by letting income equality be endogenously determined. This leads to the conclusion that equality does not cause growth, although there may be a positive or negative correlation. Second, it is shown that previously reported positive empirical relationships between equality and growth turn insignificant or weakly negative when the omitted variables suggested by our model are taken into account.

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1. Introduction

The role of income distribution in the growth process is an old question that has won renewed interest. A number of recent articles have taken a fresh look at these questions, combining insights from recent strands of literature on endogenous growth and endogenous policy. They suggest that greater pre-tax income equality is conducive to growth. Equality dampens political demands for redistribution financed by taxes on returns to growth-enhancing activities such as investment, education and R & D.

In these articles income equality is assumed to be exogenous. Here it is shown that endogenizing income equality can lead to quite different conclusions. Further, the empirical support for the equality-growth link evaporates once the consequences of this endogeneity are accounted for.

The argument put forth in articles by Persson and Tabellini (1994), Perotti (1993) and Alesina and Rodrik (1994) runs as follows.[1] Economic growth is largely determined by accumulation of capital, human capital and technological knowledge. Excessive taxes and regulatory policy can undermine incentives for such accumulation. High pre-tax inequality can lead to high demand for redistribution. This implies high taxes, but less accumulation and therefore lower growth. This idea is captured in general equilibrium models in which it is assumed that there is an exogenous distribution of factor endowments which influences the distribution of pre-tax incomes. Voters' choice of tax policy hinges on the distribution of pre-tax incomes, and the tax rate affects the sequence of growth rates in politico-economic equilibrium.[2]

In models such as these the pre-tax income distribution is predetermined by the exogenous distribution of initial endowments. In that sense the pre-tax income

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[1] This literature has been extended and qualified in a number of ways. For example, Alesina & Perotti (1993) and Perotti (1994a,b) consider political instability that can arise in non-democratic countries as a result of distributional conflict. Bertola (1993) examines the rate of growth preferred by the median voter under various tax systems. Saint-Paul & Verdier (1993) find a positive relationship between inequality and growth in a model with positive externalities of tax-financed public education.

[2] Another strand of literature assumes that capital market imperfections prevent people with low endowments from investing in education (e.g. Galor & Zeira, 1993; Torvik, 1993; Aghion & Bolton, 1992; Ferreira, 1995; Bénabou, 1996). A more unequal distribution of endowments may then imply that fewer can afford education and growth is retarded. Other mechanisms are suggested by Banerjee and Newman (1993), who link occupational choice to risk aversion; Fershtman, Murphy and Weiss (1996) who consider education as a quest for social status; and Murphy et al. (1989) who consider the effects of the distribution of income on the composition of demand and the techniques of production.

distribution is also exogenous. Our model, in contrast, builds on the view that individuals make active strategic investment choices which influence education levels and pre-tax incomes later in life. Thus endogenously determined income inequality can arise even if the exogenous endowments are equally distributed.

Many important elements of the previous models by Persson-Tabellini, Alesina-Rodrik and Perotti have been retained here. Our framework is an overlapping generations, general equilibrium model of endogenous growth in which each generation is represented by individuals acting as economic agents and voters. The model's politico-economic equilibrium determines economic growth at each date as a function of exogenous model parameters.

Individual decisions in our model are made in three stages: First, each individual decides whether to invest in skills or in the alternative asset which we call experience. Second, voters decide the tax policy. Third, each individual decides how much to invest in skills or experience. In this model choosing higher taxes, and more redistribution, implies that fewer will invest in skills. This by itself tends to increase the pre-tax return of those with skills which would leave the pre-tax income distribution less equal.

There is, however, a counteracting force. When fewer people invest in skills, the remaining population must take into calculation that there may be less aggregate redistribution from those with skills to those without. This reduces incentives to choose experience rather than skills, but increases aggregate returns from saving. This force tends to equalize pre-tax incomes. Thus, in this model, the choice of tax policy affects the pre-tax income distribution in either a positive or a negative direction depending largely on counteracting reactions in choices of investment type and investment volume.

Two (multiple) equilibria are analysed in our model: First, a "growth-enhancing" equilibrium in which taxes are set to zero and a high degree of pre-tax equality emerges. Second, a "growth-retarding" equilibrium with less pre-tax equality, compensated by positive redistribution.

In steady state of each equilibrium, there is no particular relationship between income equality and growth. Importantly, once the individual strategic investment choice is introduced, there is no clear relationship between growth and the exogenous distribution of individual endowments. More inequality of endowments can lead to higher growth under some circumstances. When exogenous technological shifts occur, e.g. skill-biased technological change, the model predicts correlations between growth and income equality that can easily be misinterpreted as causal relationships in empirical studies. Evidence of skill-biased technological change has been found by a number of recent studies.[3]

Yet, the model points to a more important empirical problem. A cross-section comparison of countries in growth-enhancing and growth-retarding equilibria would convey the impression that equality is correlated with growth. Yet, controlling for fixed country effects, including the type of equilibrium, might give quite a different result.

Indeed, when we re-examine the empirical evidence it appears doubtful whether any positive correlation between equality and growth can be established. First, we show that the specifications presented in previous studies are not robust, e.g. with respect to the choice of control variables for the level of education. Second, we expand the main data set, allowing us to take account of fixed country effects in a pooled time-series, cross-section analysis. This specification has greater power than previous cross-section country studies, and indicates a negative - in some specifications significantly negative - relationship between equality and growth. Further, we find evidence that shifts from growth-retarding to growth-enhancing equilibria strongly spur growth.

This has important policy implications. Previous articles convey the impression that a policy - or, say, a trade union strategy - that equalises pre-tax incomes could enhance growth. Our results imply the opposite. A policy that enhances growth also leads to more equal pre-tax incomes.

Section 2 presents the model. In section 3 the empirical analysis is presented.

[3] See for example Berman, Bound and Griliches (1993), Bound and Johnson (1992), Krueger (1993), Mincer (1989, 1991) and Lindbeck and Snower (1995).

2. Theory

Previous models concerning the relationship between equality and growth build on slightly varying assumptions.[4] Our model is most closely related to the overlapping-generations model by P-T (Persson and Tabellini, 1994), although it shares some features of the other models also.

We examine an overlapping generations model with a constant population where each generation lives two periods. Individuals have the same consumption preferences but they differ in their endowment. In the first period all individuals inelastically supply a unit of unskilled labor and receive equal wages. Also, they make all individual decisions in three stages during the first period of life. These decisions concern a) the choice of investment in skill versus experience, b) the political choice of tax- and redistribution policy, and c) the choice how much to invest.

The first stage concerns individuals' choice of investment type. This captures the often observed discrete feature of individual investments that influence the income distribution. For example, some individuals invest in an entrepreneurial venture and (often) become self-employed, while others remain employees and invest in, say, financial assets. Some people invest in formal university education, while others invest in on-the-job experience. In the model we use the human capital terminology and

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[4] Glomm and Ravikumar (1992) examine the dynamics of inequality and growth under public versus private education. Using the overlapping-generations model with human capital accumulation they demonstrate that income inequality declines more rapidly under public education, but per capita outputs are greater under private education. The evolution of inequality and growth in this model is predetermined by the exogenous distribution of knowledge among members of the initial generation. Perotti (1993) assumes three exogenous classes of population with different pre-tax incomes. Each individal invests in education and votes for the fiscal policy. The pattern of growth is determined through median voter preferences by the initial distribution of incomes. Alesina and Rodrik (1994) consider a model with infinitely-lived individuals endowed with different amounts of labor and capital. They deal with a policy which is used not only for redistributive purposes, but also to finance public services with an augmenting effect on inputs of labor. Due to the latter assumption endogenous fiscal policy has an ambiguous influence on growth.

assume that individuals acquire either skills or experience. One can think of experience investment in terms of jobs which pay less initially, and more once sufficient experience has been gained.

At the second stage, individuals make political decisions and vote for the fiscal policy to be adopted in the second period of life. As in P-T the fiscal policy consists of intra-generational redistribution among members of the old generation, with proportional taxes and lump sum social transfers. The policy is endogenous in the sense that the tax rate and, consequently, the rate of income redistribution for the second period is decided through voting and political equilibrium. Voting at time period t-1 determines the fiscal policy for the period t. As in P-T members of the old generation are indifferent to what will happen after they die and without loss of generality they are assumed not to participate in the election. The outcome of the election therefore rests on which type of human capital, experience versus skills, the majority of young people plan to choose.

At the third stage individuals of both types decide how much to consume and how much to invest in either experience or skills. Via the second-period, redistributive, fiscal policy there is an external effect of investments by one group on investments by the other group.

Decisions at all three stages are directly or indirectly affected by the distribution of exogenous endowments. Exactly how to model exogenous endowments is not a trivial question. For example, one might think of exogenous endowments in terms of innate intellectual capacity. Yet, there is no indication that the distribution of innate intellectual capacity differs between countries. Therefore this would not appear to be relevant for models aiming to explain relative country growth rates.

Other endowments such as economic bequests are subject to parental discretion. Parents make active choices of how much to consume as opposed to how much to transfer to their children. Further, the distribution of endowments has nothing to do with which parents transfer to which children, but only how many children receive high and low transfers respectively. Thus changes in the distribution occur when, at the margin, some relatively poor parents decide to invest much in their children or, vice versa, when relatively wealthy parents decide to invest less. The decision of groups at the margin to invest more or less should depend on the returns to such investment. Thus endowments that are subject to parental discretion are really endogenous.[5]

For these reasons we focus on an interpretation of endowments as the individual appreciation of, or preference for, education. This could reflect parental values that are conveyed, or the individual´s valuation of the social status that an education may give, or simply the non-monetary element of jobb satisfaction that an individual experiences after receiving an education.[6] These "education preferences" seem to differ significantly both between countries and individuals. Presumably they change over time, and are subject to some endogenous influences. But there is also strong evidence that social attitudes exhibit pronounced path dependency. Given our interpretation of endowments it seems reasonable to assume that individuals initially

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[5] Strictly speaking this endogenous parental choice should be included in a model of the relationship between income distribution and growth. Since parents' choice, as the individual investment choice in our model, would be determined by expected returns to skills, we believe this would give qualitatively similar results as our model.

[6] The importance of the social status of education is analysed by Fershtman, Murphy and Weiss (1996).

know the distribution of endowments, but gain knowledge of their own education preferences first when they actually invest in skills.[7]

A. The Model

For the sake of simplicity we choose a log-linear specification for the two-period consumption utility of the *i* th type individual born in period t-1[8]; the subscript i = 1 denotes the experienced individual and i = 2 is the skilled individual:

$$u(c_{it-1}, d_{it}, x_t) = \ln c_{it-1} + \beta \ln d_{it} + \tau_{it} \qquad (1)$$

where c_{it-1} is consumption in period t-1 by this individual and d_{it} is her consumption in the second period; x_t is the measure of the individual education preference ranked in the interval [0, 1]. The higher is x_t, the smaller are utility losses from acquiring skills. β is the discount factor which is common for both types, and $0 < \beta < 1$.

The exogenous distribution of education preferences is modelled as a distribution of utility gains or losses that arise when investing in skills. The term τ_{it} in (1) reflects utility losses for a skilled type 2 individual:

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[7] One may argue that parental values conveyed to the individual should be known already when the type of investment is chosen. But job satisfaction and valuation of social status is generally not known beforehand.

[8] The model can easily be extended to the case of isoelastic utility: $u(c, d) = (b-1)^{-1}(c^{b-1} + \beta d^{b-1})$. For comparison, A-R use a logarithmic utility function and P assumes a linear utility function. Only P-T allow a general homothetic utility function, but are then forced to assume that second-order conditions for the policy problem are met.

$$\tau_{it} = \begin{cases} 0, & \text{if } i = 1, \\ \tau(x_t), & \text{if } i = 2. \end{cases}$$

The subutility function $\tau(x_t)$ measures individual utility gains or losses from training. It is monotonously increasing and strictly concave. Individuals are endowed with the education preferences according to the exogenous probability distribution $F(x_t)$. As explained above it is assumed that only the distribution of education preferences is known initially, but that the individual preference is revealed when investing in skills at the third stage.[9] For the second stage decision, voting, it makes no formal difference whether individ education preference is assumed known or not.

Including the second period intragenerational redistribution of income, the individual budget constraints for individuals born in period t-1 are:

$$c_{it-1} + s_{it} = w_{t-1}, \qquad (2)$$

$$d_{it} = \theta_t R_{it} s_{it} + y_t, \qquad (3)$$

Here s_{it} is investment in skill, w_{t-1} is wage received in the first period of life, $1-\theta_t$ is the tax rate in the second period, R_{1t} is the return to experience-type human capital, and R_{2t} is the return to skill-type human capital. The social transfer that all individuals receive equally in the second period of life is $y_t = (1 - \theta_t)(n_{1t} R_{1t} s_{1t} + n_{2t} R_{2t} s_{2t})$ where n_{1t} is the weight of experienced individuals in the generation and $n_{2t} = 1 - n_{1t}$ is the weight of skilled individuals. It is assumed that borrowing in the first period of life is not possible and individual investments are non-negative:

[9] This assumption also simplifies the model, apparently without affecting the results much. Various versions of the model, including one without any exogenous distribution of endowments, have been tested, and they seem to lead to similar conclusions.

$$s_{it} \geq 0, \ i = 1, 2. \tag{4}$$

Individual economic and political decisions are made in three stages during the first period of life. Consider these decisions in backward fashion.

<u>The third stage consumption-investment decision</u>. Each individual of type i born in period t-1 chooses a consumption-investment plan (c_{it-1}, d_{it}, s_{it}) maximizing her consumption utility (1) subject to the budget constraints (2) - (3). The non-negativity constraint (4) holds at this stage, since it is taken account of in the previous stage, when the political decision is made and the tax rate for the next period $1 - \theta_t$ is determined. Thus, at the third stage, the individual of type i = 1, 2 solves the problem:

$$\max \ \ln c_{it-1} + \beta \ln d_{it} + \tau_{it} \tag{5}$$

$$c_{it-1} + s_{it} = w_{t-1}, \tag{6}$$

$$d_{it} = \theta_t R_{it} s_{it} + (1 - \theta_t)\,(n_{1t}\, R_{1t}\, s_{1t} + n_{2t}\, R_{2t}\, s_{2t}). \tag{7}$$

The individual education preference is known at this stage, but as easily seen, it does not influence the third-stage decision.[10] The consumption-investment plans of both types constitute a Nash equilibrium for the third stage. The endogenous model variables n_{2t}, R_{1t}, R_{2t} and θ_t are predetermined at this stage.

<u>The second stage political decision</u>. Suppose that either type i = 1 or 2 dominates among individuals born at time t-1 and the consumption-investment bundle (C_{it-1}, D_{it}, S_{it}) is the solution to the third-stage problem faced by this type. Then an individual of type i chooses the tax rate $1 - \theta_t$ which provides a maximum to the second-stage

[10] This fits our interpretation of the endowment as a utility gain or loss associated with being educated rather than with marginal increases in skill investment.

indirect consumption utility $v_{it}(S_{it}, S_{jt}) = \max [\ln c_{it-1} + \beta \ln d_{it} \mid \text{s.t. } (6), (7)]$, $j \neq i$, subject to non-negativity constraints on investment (4) and a constraint imposed on policy choice:

$$0 \leq \theta_t \leq 1. \tag{8}$$

The second-stage indirect expected utility $v_{it}(S_{it}, S_{jt})$ is represented as a function of investment because it internalises the budget constraints (6), (7). The constraint (8) means that the redistributive fiscal policy cannot take money from agents with lower income and give it to agents with higher income.

The political problem solved by the dominating type i is:

$$\max_{\theta_t} v_{it}(S_{it}, S_{jt}) \tag{9}$$

$$S_{kt} \geq 0, \; k = 1, 2. \tag{10}$$

$$\mu_t \geq 0 \tag{11}$$

where $\mu_t = (1 - \theta_t)/\theta_t$ is called in what follows *the rate of taxation*. Constraint (11) is equivalent to (8). The solution to the political problem (9)-(11) is a function of the endogenous model variables predetermined at the second stage of decision-making: R_{1t}, R_{2t} and n_{2t}.

The first stage choice of investment type. At the first stage all individuals choose their type. We assume that there are no other barriers to acquiring skills than the education preference, but this is revealed first when investment in skills is made at the third stage. This means that the following "free-entry" condition in terms of expected utilities holds:

$$V_{1t} = V_{2t} + E\tau(x_t) \quad (12)$$

where E is the expectation operator, $V_{it} = V_{it}(n_{2t}, R_{1t}, R_{2t}) = \max [v_{it}(S_{it}, S_{jt}) \mid$ s.t. (10),(11)] is the first-stage indirect consumption utility of type i = 1,2. These are functions of the endogenous model variables n_{2t}, R_{1t} and R_{2t} which are determined at the first stage. Indirect utilities V_{it} result from individual decisions about taxation and investment adopted at the second and third stages. Since the second-stage decision is made by the dominating type, indirect utility V_{jt} of the type j which is currently in minority depends on the optimal political choice made by the majority type. Expected utility losses from formal training $E\tau(x_t)$ are taken into account by all individuals at the first stage. Equation (12) determines the ratio of experienced to skilled n_{1t}/n_{2t} at which individuals are indifferent as to choice of type. The endogeneity of human capital means that second period pre-tax incomes $R_{1t}S_{1t}$ and $R_{2t}S_{2t}$ are distributed endogenously.

The returns R_{1t}, R_{2t} are predetermined at the first stage by the structure of production. Firms in the economy are homogenous in technology and size and their number is normalised to one. Physical capital is a constant factor of production. The firm's technology is represented by the homogenous Cobb-Douglas production function[11]:

$$q_t = h_{1t}^{\alpha_1} h_{2t}^{\alpha_2} (\bar{h}_{2t} l_t)^{1-\alpha_1-\alpha_2} \quad (13)$$

where q_t is a firm's output, h_{1t} and h_{2t} are volumes of low-quality (experience) and high quality (skill) human capital, α_1, α_2 are factor elasticities, $\alpha_1 < \alpha_2$, and l_t is input

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[11] We could easily utilize in our model the mixed CES - Cobb-Douglas homogenous production function: $q = (ah_1^{\eta} + (1-a)h_2^{\eta})^{\alpha/\eta}(\bar{h}_2 l)^{1-\alpha}$.

of unskilled labor. The economy-wide supply of skills $\bar{h}_{2t}$ is an external labor-augmenting factor of production. There are no unemployed among young people and thus $l_t = 1$ for a firm.

Human capital is supplied through individual investment decisions and distributed evenly among firms: $h_{1t} = n_{1t}S_{1t}$ and $h_{2t} = n_{2t}S_{2t}$. Returns to both types of human capital are determined through the marginal productivity conditions:

$$R_{1t} = \alpha_1 h_{1t}^{\alpha_1 - 1} h_{2t}^{\alpha_2} \bar{h}_{2t}^{\,1-\alpha_1-\alpha_2}, \tag{14}$$

$$R_{2t} = \alpha_2 h_{1t}^{\alpha_1} h_{2t}^{\alpha_2 - 1} \bar{h}_{2t}^{\,1-\alpha_1-\alpha_2}. \tag{15}$$

Dividing both parts of (15) by (14) implies that national income is distributed as the ratio of factor elasticities:

$$\frac{n_{2t}R_{2t}S_{2t}}{n_{1t}R_{1t}S_{1t}} = \frac{\alpha_2}{\alpha_1}. \tag{16}$$

Wage is paid to young people according to their marginal productivity:

$$w_t = (1-\alpha_1-\alpha_2) h_{1t}^{\alpha_1} h_{2t}^{\alpha_2} \bar{h}_{2t}^{\,1-\alpha_1-\alpha_2} = (1-\alpha_1-\alpha_2) q_t. \tag{17}$$

National income in period t is divided between three groups of population: unskilled, experienced and skilled people. In equilibrium $q_t = n_{1t}R_{1t}s_{1t} + n_{2t}\,R_{2t}s_{2t} + w_t$. The aggregate supply and demand is balanced at each period through wage setting to unskilled workers.

The sequence of individual decisions, the majority rule for adopting economic policy, and economic equilibrium conditions constitute a state of the society which can be called *politico-economic equilibrium*. As mentioned above, two cases are analysed in our model for the same set of parameters, with either experienced or skilled people dominating the vote for fiscal policy. The model thus describes multiple equilibria arising at the first stage in the process of the social structure determination which cannot be influenced by the individual choice. We contemplate two politico-economic equilibria: *growth-retarding* and *growth-enhancing*.

B. The Politico-Economic Equilibria

Consider investment decisions by individuals of both types born in period t-1. The first-order conditions for the problem (5)-(7) are:

$$(\theta_t + (1-\theta_t)n_{1t} + \beta\theta_t)R_{1t}\, s_{1t} + (1-\theta_t)\, n_{2t}\, R_{2t}\, s_{2t} = \beta\theta_t\, R_{1t}\, w_{t-1} \qquad (18)$$

for the individual of type 1 and

$$(\theta_t + (1-\theta_t)n_{2t} + \beta\theta_t)R_{2t}\, s_{2t} + (1-\theta_t)\, n_{1t}\, R_{1t}\, s_{1t} = \beta\theta_t R_{2t}\, w_{t-1} \qquad (19)$$

for the individual of type 2.

Equations (18)-(19) are solved by the investment functions:

$$S_{1t} = \frac{\beta w_{t-1}}{B} \times \frac{BR_{1t} - n_{2t}(R_{2t} - R_{1t})\mu_t}{(B+\mu_t)R_{1t}} \qquad (20)$$

for experienced individuals and

$$S_{2t} = \frac{\beta w_{t-1}}{B} \times \frac{BR_{2t} + n_{1t}(R_{2t} - R_{1t})\mu_t}{(B+\mu_t)R_{2t}} \qquad (21)$$

for skilled individuals, $B = 1 + \beta$. The properties of (20), (21) are stated in the following proposition.

Proposition 1. Investment functions (20)-(21) satisfy:

$$\partial S_{1t}/\partial R_{1t} > 0,\ \partial S_{1t}/\partial R_{2t} < 0,\ \partial S_{2t}/\partial R_{2t} > 0, \partial S_{2t}/\partial R_{1t} < 0$$

Investment of both types are decreasing with the rate of taxation μ_t. If $R_{2t} \geq R_{1t}$ then investments by skilled exceed those by experienced, $S_{2t} \geq S_{1t}$.

Proof: follows straightforwardly from (20) - (21).

In this proposition, and in the following we focus on the case where $R_{2t} \geq R_{1t}$.[12]

Consider the case when experienced people dominate in period t. The political problem solved by experienced people in the second stage of decision making is

$$\max_{\theta_t} v_{1t}(S_{1t}, S_{2t})$$

subject to (10)-(11). From Proposition 1 we have that $S_{1t} < S_{2t}$ for all positive μ_t. This means that $S_{2t} > 0$, and one only needs to consider the sign of S_{1t}.

Proposition 2. The internal solution for the political problem (9)-(11) of the experienced individual is given implicitly by the equations:

$$\lambda_t(B + \mu_t)^2 = \mu_t(1 + \mu_t), \tag{22}$$

$$\lambda_t = \frac{n_{2t}(R_{2t} - R_{1t})}{B(n_{1t}R_{1t} + n_{2t}R_{2t})} \tag{23}$$

Proof: in Appendix.

[12] We describe the case where $R_{2t} < R_{1t}$ in footnotes below but, for simplicity, not in the main analysis. In general, a third multiple equlibrium can arise when skilled people dominate, have lower return than experienced people, and vote for redistribution from experienced to skilled. This equilibrium may, however, be less interesting since it is inconsistent with the stylized fact that returns to skill are higher than returns to experience.

Equation (22) is quadratic with only one non-negative root. The derivative of the second-stage utility is (see equation A1 in the appendix)

$$\left.\frac{dv_{1t}(S_{1t},S_{2t})}{d\theta_t}\right|_{\mu_t=0} \geq 0$$

and negative for large μ_t. Hence, the non-negative root of (22) is the unique maximum point for the political problem of the experienced individual.[13] The corner solution $\mu_t = 0$ is not necessarily binding if $R_{1t} = R_{2t}$ or, equivalently, $\lambda_t = 0$.

As is demonstrated below, experienced individuals make positive investments in equilibrium. Therefore we do not consider the corner solution to (9)-(11) when they do not invest, $S_{1t} = 0$.

If skilled people dominate in period t, the problem for their political choice is:

$$\max_{\theta_t} v_{2t}(S_{2t}, S_{1t})$$

subject to the constraints (10) and (11). As is shown below, the constraints (10) are not binding and both types invest. Suppose that the constraint (11) on μ_t is not binding. Then applying the envelope theorem to the indirect utility $v_{2t}(S_{2t}, S_{1t})$ implies the first-order condition (see proof of proposition 2 in appendix):

$$-(n_{1t}/n_{2t})\lambda_t(B+\mu_t)^2 = (1+\mu_t)\mu_t \tag{24}$$

If $R_{1t} < R_{2t}$, the left-hand part of (24) is negative but the right-hand part is non-negative, and (24) does not hold. Hence in this case the constraint on taxation (11) is

[13] The indirect utility $v_{1t}(S_{1t}, S_{2t})$ is not a convex function of the tax rate. It is difficult to prove that the second-order conditions for the political problem are satisfied for general classes of consumer utility u(c, d). See also footnote 5.

binding and skilled individuals will vote for zero taxes, that is $\mu_t = 0$. There is still no taxation if $R_{1t} = R_{2t}$, but in this case the constraint (11) is not necessarily binding.

From (20) - (21) investment of both types are identical and satisfy:

$$S_{1t} = S_{2t} = \frac{\beta w_{t-1}}{B}, \tag{25}$$

Consequently, when skilled people dominate the outcome is always no income redistribution and a maximal investment rate.

The politico-economic equilibrium (PEE) at date t is defined as a bundle (μ_t, ν_t, ρ_t), where $\nu_t = n_{1t}/n_{2t}$ and $\rho_t = R_{2t}/R_{1t}$, that satisfies the following conditions: free entry (12), national income distribution (16), and the first-order condition for the political choice (22) or (24) depending on which type currently dominates. We also claim that production is positive in equilibrium. In what follows time subscripts are omitted if it is not misleading.

Consider first the PEE when skilled people dominate, $n_2 > n_1$. As follows from (24), skilled individuals vote for zero taxation. We call the PEE with zero taxation a *growth-enhancing* equilibrium. Inserting investment functions (25) into consumption utilities (9) we represent the free-entry equation (12) as:

$$\ln\frac{w_{-1}}{B} + \beta\ln\frac{R_1\beta w_{-1}}{B} = \ln\frac{w_{-1}}{B} + \beta\ln\frac{R_2\beta w_{-1}}{B} + E\tau(x). \tag{26}$$

where $w_{-1} = w_{t-1}$. This equation implies that $\rho = e^{-\psi/\beta}$, where $\psi = E\tau(x)$ is the expected utility gain or loss from training. Since $\tau(x)$ is concave and monotonously increasing, parameter $-\psi$ indicates the Rotschild-Stiglitz dispersion of individual education preferences.[14]

Since there is no income redistribution, investment by both types are identical and the distributional equation (16) implies:

$$\nu = \frac{\alpha_1 \rho}{\alpha_2} = \frac{\alpha_1}{\alpha_2} e^{-\psi/\beta}. \tag{27}$$

The growth-enhancing PEE is, thus, the bundle (0, $e^{-\psi/\beta}\alpha_1/\alpha_2$, $e^{-\psi/\beta}$). As follows from (27), in this equilibrium any mean-preserving spread of the distribution of education preferences F(x) indicated by an increase of $-\psi$ results in the decrease of the number of skilled individuals. Since investment by skilled people as given by (25) does not depend on returns, it implies a decrease of total investment in education n_2S_2 (but not necessarily lower growth). Note that the growth-enhancing PEE with a dominating number of skilled individuals exists only if $-\psi < \beta\ln(\alpha_2/\alpha_1)$, that is the dispersion of F(x) is not very high. Otherwise according to (27) skilled people do not dominate.

Consider now the other equilibrium when experienced people dominate in period t, that is $n_1 > n_2$. They will vote for positive taxes. If not, Proposition 2 would imply that returns R_1 and R_2 have to be equal. The free entry condition for the case of zero taxes is as (26), and it does not hold for equal returns. In this situation all individuals would prefer to remain experienced and there would be no equilibrium in

[14] The distribution of education preferences $F_1(x)$ is more dispersed than $F_2(x)$ in the sense of second degree stochastic dominance if both have the same mean, and $\int_0^x F_1(\xi)d\xi \geq \int_0^x F_2(\xi)d\xi$ for all $x \in [0, 1]$. The variance is larger for the more dispersed distribution, but the converse is not true. The expected utility $E\tau(x)$ is higher for the less dispersed distribution $F_2(x)$ than for $F_1(x)$. One can also consider the latter as representing less equally distributed education preferences compared to the former.

production.[15] We call the redistributive PEE (μ, ν, ρ) where $\mu > 0$ a *growth-retarding* equilibrium.

Experienced people will also avoid a very expansionist fiscal policy which might allow them not to invest at all, because zero investment in experience would lead to zero production in the next time period. From (20) investment in experience becomes zero for a finite rate of taxation μ. Consequently, there is an upper limit to this rate in politico-economic equilibrium.

Proposition 3. A growth-retarding politico-economic equilibrium (μ, ν, ρ) *is a solution to the system of equations:*

$$\nu = \frac{\alpha_1}{\alpha_2}\frac{\rho(1+\nu)B + (\rho - 1)\nu\mu}{(1+\nu)B - (\rho - 1)\mu}, \tag{28}$$

$$\nu = \left((e^{-\psi}\rho)^{1/B} - 1\right)\frac{B}{\mu} - 1, \tag{29}$$

$$\mu = \frac{(B+\mu)^2}{(1+\mu)B} - B\frac{(e^{-\psi}\rho)^{1/B} - 1}{\rho - 1} \tag{30}$$

Proof: in Appendix.

Equation (28) results from the distributional equation (16), equation (29) is an explicit representation for the free entry condition (12), and (30) is the transformed first-order condition (22) for the political problem solved by experienced individuals[16].

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[15] However, in the case, mentioned above, of a CES - Cobb-Douglas production function, and if there were no utility losses or gains from training for any individual ($\psi = 0$) a growth-enhancing PEE might exist when experienced individuals dominate.

[16] One can derive the equations for the redistributive equilibrium that can arise when skilled people dominate, and their returns are less than those for experienced individuals, $R_2 < R_1$ (see footnote 12). The distributional equation for this equilibrium is the same as (28). The free-entry condition is

The growth-retarding PEE bundle (μ, ν, ρ) depends only on exogenous parameters ψ, α_1/α_2 and B, expressing the dispersion of education preferences, production technology and individual time preferences. If these parameters are constant over time than the growth-retarding PEE bundle is also constant.

Equation (30) has a unique non-negative root in μ. Plugging it into (29) and then both those into (28) we obtain a scalar equation on the relative return ρ: Φ(ρ) = 0. Numerical analysis demonstrates that the function Φ(ρ) is monotonous for ρ above some level close to unity and changing the sign. As far as we can judge from the numerical analysis conducted for a broad domain of exogenous parameters, there exists a unique solution to the system (28)-(30) satisfying all constraints of the model. Note that if the growth-retarding PEE exists, then it *coexists* with the growth-enhancing PEE, given that the dispersion of education preferences (measured by -ψ) is not too large. The model, however, does not explain how the politico-economic equilibrium is chosen by society at any period of time.

C. Endogenous growth and endogenous inequality

Consider a sequence of politico-economic equilibria generated by the model. Since investment in period t (20)-(21) depends on wages received by unskilled people

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symmetric to (29): $\nu^{-1} = \left((e^{\psi}\rho^{-1})^{1/B} - 1\right)\frac{B}{\mu} - 1$. The first-order condition for the political problem solved by skilled people (24) is represented symmetrically to (30): $\mu = \frac{(B+\mu)^2}{(1+\mu)B} - B\frac{(e^{\psi}\rho^{-1})^{1/B} - 1}{\rho^{-1} - 1}$. It is possible to interprete this equilibrium as a situation when economy-wide skills are overaccumulated and skilled people vote for redistributive fiscal policy.

in period t-1, the economic dynamics are driven by the wage equation (17). Inserting investment functions (20), (21) into (17) we have the growth of wages as[17]

$$\frac{w_t}{w_{t-1}} = \frac{(1-\alpha_1-\alpha_2)(B-1)}{B(B+\mu)} z_1^{\alpha_1} z_2^{1-\alpha_1} \tag{31}$$

where $z_1 = \frac{\nu}{1+\nu}\left(B - \frac{(\rho-1)\mu}{1+\nu}\right)$, $z_2 = \frac{1}{1+\nu}\left(B + \frac{\nu(1-\rho^{-1})\mu}{1+\nu}\right)$

in the growth-retarding PEE and (accounting for (25), (27))

$$z_1 = \frac{\alpha_1 B}{\alpha_1 + e^{\psi/\beta}\alpha_2}, \quad z_2 = \frac{e^{\psi/\beta}\alpha_2 B}{\alpha_1 + e^{\psi/\beta}\alpha_2}$$

in the growth-enhancing PEE. The growth of wages (and output) depends on the PEE bundle at period t (μ, ν, ρ) and the exogenous parameters α_1, α_2, ψ and B. Hence *for any given* PEE the growth rate (31) is predetermined by these parameters.

Consider now how endogenous growth is related to income inequality. Since individuals initially have equal incomes we focus on intragenerational inequality of pre-tax incomes in the second period of life: R_1S_1 and R_2S_2. Income inequality is measured as the ratio of average to median income σ, a measure that is widely used in the endogenous policy literature. In the growth-retarding PEE the median income is R_1S_1 and this measure is $\sigma_r = n_1 + n_2R_2S_2/R_1S_1$ or, accounting for distributional equation (16)[18],

[17] We omitt a scale parameter in (13) and (31), that would guarantee non-negative growth in the long-run.

[18] Alternatively, one could consider the inequality of income distribution between three groups of population: unskilled, experienced and skilled. In this case however, the ratio of average to median income is not a suitable measure since it misses the second-period income differences. The median pre-tax income would be the wage w. The ratio of average to median income is $\sigma = (w + n_1R_1S_1 + n_2R_2S_2)/w = (1 - \alpha_1 - \alpha_2)^{-1}$.

$$\sigma_r = n_1(1+\frac{\alpha_2}{\alpha_1}) = \frac{\nu}{1+\nu}(1+\frac{\alpha_2}{\alpha_1}). \tag{32}$$

In the growth-enhancing PEE the median income is R_2S_2 and $\sigma_e = n_2 + n_1R_1S_1/R_2S_2$ or accounting for (16) and (27),

$$\sigma_e = n_2(1+\frac{\alpha_1}{\alpha_2}) = \frac{1}{1+\nu}(1+\frac{\alpha_1}{\alpha_2}) = \frac{\alpha_1+\alpha_2}{e^{-\psi/\beta}\alpha_1+\alpha_2}. \tag{33}$$

Actually $\sigma_e < 1$ and it measures income equality rather than inequality. The median income in this PEE is above the average and a higher ratio σ_e implies more equally distributed incomes.

Clearly, inequality is higher in the growth-retarding PEE than in the growth-enhancing PEE. As easily checked, growth (31) is lower in the former case than in the latter. Consequently, the growth-retarding equilibrium is pareto-inferior to the growth-enhancing equilibrium in terms of growth and equality criteria.

This conclusion differs significantly from those in the articles by P-T, A-R and others. Inequality, in our model, is the outcome of a political and economic choice that individuals make, a choice that also affects growth. Policy choices that maximize growth also promote equality. This has important implications for the empirical analysis below.

Further, within each equilibrium, a more equal distribution of the exogenous endowment does not automatically imply higher growth. The model is ambiguous on this question. In simulations it turns out to be easy to find parameter values where a less equal distribution of exogenous endowments increases growth.[19] [20]

If exogenous parameters are constant, than both growth (31) and inequality measures (32) - (33) do not change. One interesting aspect is what happens with the interrelation between endogenous inequality and growth as a response to persistent exogenous technological shifts.

As an example, we consider two simple patterns of technological change when the impact of unskilled labor on output decreases. First, we increase parameter α_1 while holding α_2 fixed. Simulations demonstrate that in this case the growth rate decreases in both PEE. The inequality measure σ_r decreases in the growth-retarding PEE implying more income equality. Second, we increase parameter α_2 and fix α_1. Again growth rates decrease in both PEE, but the ratio σ_e , and thus income distribution, rises in the growth-enhancing PEE (in fact this follows from (33)).[21] The simulation examples thus show that a negative link between equality and growth may occur in both PEE as a result of skill-biased technological change.

In conclusion, a more general model where the income distribution is endogenized implies that one should not expect a causal link or even a correlation between the pre-tax income distribution and growth. Importantly, the model points to

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[19] For example, if exogenous parameters are: $B = 1.3$, $\alpha_1 = 0.2$, $\alpha_2 = 0.5$ and $e^{-\Psi}$ increases from 1.005 to 1.3, then growth increases in both growth-retarding and growth-enhancing equilibria.
[20] An increase in $e^{-\Psi}$ leads to lower growth in the third equilibrium described in footnote 16 for the same set of parameters as used in footnote 20.

[21] The values of exogenous parameters are: $B = 1.3$, $e^{-\Psi} = 1.3$, $\alpha_2 = 0.5$ in the first pattern and $\alpha_1 = 0.2$ in the second pattern. The decrease of growth in both patterns is explained by the decline of the share of unskilled workers in the national income (see eq. (31)) The decrease of the first period income w_{t-1} reduces saving bases for both types and this counterweighs the positive growth effects from the shifts.

two potential problems in empirical analysis. First, different countries may be in different politico-economic equilibria that give rise to different combinations of growth and pre-tax income distributions. A simple cross-country analysis may then give a significant relationship between income distribution and growth simply because of fixed effects that determine the choice of equilibrium.

Second, specific skill-biased technological changes can result in correlations between the income distribution and growth. Again these correlations should not be confused with causation.

3. Empirical analysis

The main empirical support for the relationship between inequality and growth in both Alesina and Rodrik (A-R) as well as Persson and Tabellini (P-T) comes from a cross-section analysis of about 50 countries. This evidence is examined first. Later a panel database of nine countries and an analysis of 13 OECD countries submitted by P-T is re-examined.

A. Cross-section analysis

Our sample consists of 49 countries for which reliable data on income distribution and other variables is available.[22] Our data is virtually identical to that used by P-T, which also is fairly similar to that used by A-R. A closer description of the data and some small differences between P-T and A-R is provided in the appendix.

The dependent variable is the annual average per capita growth of GDP between 1960 and 1985, called GROWTH. The main independent variable is income equality, called MIDDLE, and is measured around 1965, close to the start of the sample period for GROWTH. We follow P-T in measuring MIDDLE in terms of the income share accruing to the third quintile (41st to 60th percentile of households). Replacing this measure by the Gini-coefficient leaves the regression results qualitatively unchanged. Further independent variables are initial GDP in the year 1960, called GDP60, and the percentage of the relevant age group attending primary school, called PSCHOOL.

The basic regression, reconstructing P-T's and A-R's main result, is shown in column (1) in table 1. Both sets of authors include the share attending primary school, but not the share attending secondary school, SECSCHOOL.[23] As columns (2) and (3) show the coefficient of MIDDLE becomes insignificant once

[22] P-T describe a sample of 56 countries, but use only the 49 in regressions for which the variable PSCHOOL , the share of the relevant age group in primary school, is available. A-T start with a sample of 70 countries, but define a sample of 46 countries as having high data quality. The high quality sample is virtually identical to the 49 country sample used here and in P-T. To be on the safe side we have rerun our regressions with A-T's 46 and 70 country samples and find quite similar results.

[23] In both studies, however, it is made clear that schooling is considered to be an exogenous variable, which is the justification for including PSCHOOL. P-T claim to have run regressions including also participation in secondary school, SECSCHOOL, but leave unexplained why they only report regressions containing PSCHOOL here, while reporting regressions using an educational index including SECSCHOOL in their analysis of panel data discussed further below.

participation in secondary schooling is controlled for. Column (4) reproduces an instrumental variables regression reported by P-T, using various instruments for MIDDLE.[24] Columns (5) and (6) shows that again MIDDLE is rendered insignificant once SECSCHOOL is controlled for.

P-T further suggest that income equality works through investment. They estimate an equation system with GROWTH and INVEST as the dependent variables. MIDDLE enters as an explanatory variable in the investment equation. Again we find that when secondary schooling is controlled for the effect of MIDDLE on INVEST becomes insignificant. [25]

All of this indicates that the effect of MIDDLE on GROWTH is not significant within the theoretical framework used by P-T and A-R, in which schooling is considered to be an exogenous variable. Further, these regressions would suggest that schooling may play some role in explaining the correlation between income equality and growth. It remains quite unclear, however, to what extent these results can be driven by other omitted variables.

P-T perform a weak test of omitted variable bias. They add dummies for continents (Asia, Africa and Latin America). A-R perform no test of omitted variable bias at all.

Our model emphasised the importance of controlling for the type of equilibrium that the electorate of each country has chosen. This can be done by taking account of fixed country effects. We do this by relating changes in income equality over time (MIDDIFF) to changes in the growth rate (GROWTHDIFF). This requires an extension of the data base with information on the same variables 20 years later. We measure GROWTH80 during the period 1980 to 1992. This is somewhat shorter than in the previous regression. The independent variables are measured in or around 1980. For some countries there are missing values for the income equality variable, which leaves the number of observations at only 34. In

[24] The instruments used are the percentage of the labor force in agriculture in 1965, male life expectancy in 1965, PSCHOOL, SECSCHOOL and GDP60.
[25] P-T also find support for the hypothesis that the effect of income equality on growth is confined to democracies, and does not occur in dictatorships. A-R however were unable to find this effect in their sample. We had some difficulty in reconstructing P-T's classification of country's into democracies and dictatorships. In our view several countries classified by P-T as democracies were really dictatorships for most of the period. Therefore we do not pursue the difference between democracies and dictatorships further here. However, even accepting P-T's definition of democracies, the effect of MIDDLE on GROWTH becomes insignificant once secondary schooling is controlled for.

spite of the smaller number of observations and the shorter period during which growth is measured, the cross-section regressions for the later period (1980-92) yield results that are quite similar to the regressions for the earlier period reported in table 1. Again the coefficient for MIDDLE becomes insignificant once secondary schooling is added.

We are now able to combine the two cross section samples in a panel in which fixed country effects can be controlled for. Table 2 shows a regression of the change in growth rates (GROWTHDIFF) over the change in explanatory variables. Strikingly, in columns (1) and (2) no variable is significant, and coefficients for changes in income equality and schooling are negative.[26]

In order to see whether the loss of observations from 49 to 34 makes a difference, we replace missing values of MIDDLE80 by the fitted values obtained by regressions on the independent variables (see G.S. Maddala, 1977).[27] Columns (3) and (4) show the results for the augmented data set, which confirm the result. This indicates that the positive correlation between income equality and growth found in the cross-section regressions is primarily due to omitted fixed effects.[28]

One problem whith these regressions is that all independent variables have low explanatory power, and R^2 is therefore extremely low. This implies a risk that important independent variables are omitted, which could bias coefficient estimates. Further it remains unclear exactly what the country-specific fixed effects could be. Our model suggest one important fixed effect, namely the choice of growth-enhancing or growth-retarding equilibrium. Unfortunately it is difficult to formulate clear empirical measures of growth-enhancing and growth-retarding policies, primarily because they can be pursued by quite different means. A few examples of policies that to some extent are substitutes are capital taxes, progressive income taxes, minimum wage laws, trade and capital restrictions, composition of government expenditures. It would be almost impossible to construct a meaningful cross-country index for the totatily of such measures.

[26] Since our model, in contrast to that of P-T and A-R takes education to be endogenous one might argue that PSCHOOL and SECSCHOOL should be left out of the regression. Doing so leaves the results qualitatively unchanged, and is therefore not reported.
[27] This method is also used by P-T in their panel data study of nine countries, discussed below.
[28] We have also run fixed and random effects time series regressions. They yield the same picture.

A simpler task, however, is to identify countries that have undergone dramatic policy shifts in a growth-enhancing direction. For some countries, such as the UK, Chile, and South Korea this should be fairly uncontroversial. For other countries such as India or Sri-lanka, this may be more controversial. We have used the World Banks classification of economic policy to define a dummy (POSDUMMY) capturing shifts toward growth-enhancing policies during the period 1965-1985. The countries included are listed in the appendix describing the data.[29] Further, we add a dummy for countries that have suffered war or internal conflict which one may interpret as an extreme version of a shift toward a growth-retarding policy. This contains 11 countries, and is denoted NEGDUMMY.

The results are shown in table 3. They indicate that a shift of equilibrium as measured by POSDUMMY and NEGDUMMY seems to have a large significant effect on growth. Of course this result should be viewed with caution, since the classification of countries is open to criticism.

The more important point here is that introducing these dummies, that have high explanatory power, hardly affects the negative coefficient of MIDDIFF. Thus controlling for these types of large policy shifts does not change the conclusion much. On a more formal note, we have conducted a Hausman specification test to check whether MIDDIFF in fact is independent of the error term. This indicates that MIDDIFF is uncorrelated with the error term after introduction of POSDUMMY and NEGDUMMY, but not before.[30]

B. Panel-data

P-T also consider panel data for nine countries for the period 1830 to 1985, where each observation comprises a period of 20 years, e.g. 1830-1850. This would give 72 observations, but data on income equality are available only for 38 observations.

[29] Construction of POSDUMMY uses World Bank policy classifications reported in Levine & Zeros (1993) and Easterly (1992).

[30] The Hausman specification test consists of entering a variable M consisting of the fitted values of the regressor MIDDIFF regressed over exogenous variables into the growth equation. After entering the policy shift dummies the coefficient of M has a t value of -0.72 and is not significant, indicating that MIDDIFF is not correlated with the disturbance term.

The basic regressions reported by P-T are reproduced in table 4. Income inequality is here defined as the share of personal income of the top quintile, so the expected sign of the coefficient is negative.

Using only the sample of 38 observations (column 1) the coefficient for INEQUALITY is not significant. However, P-T replace 18 missing observations with fitted values obtained by regressions on the independent variables and on GDP per capita.[31] After that operation the coefficient for income equality becomes significant, as shown in column (2).[32]

A key question in this procedure is whether GROWTH is independent of GDP. If not, the regressor INEQUALITY is correlated with the disturbance in the growth equation, and the coefficient estimate is inconsistent.

Our model suggests three ways in which GROWTH could be linked to GDP level. First, a high GDP level in any period t is an outcome of previous rapid growth. If previous rapid growth is the consequence of policies in growth-promoting equilibrium, and if this equilibrium tends to be stable over time, then current growth may be correlated with the current GDP-level.

Second, technological change may have occurred unevenly over time leading to more rapid growth at certain GDP (and production technology) levels. In particular, all countries in the sample experienced high growth in the period between 1950 and 1970, and all countries had roughly similar GDP levels prior to this period.

Third, higher GDP levels may, with decreasing marginal utility of income, imply a greater willingness to vote for growth-inhibiting policies. This would also indicate a link between GDP and growth that does not necessarily go via the income distribution.

To test whether these considerations are important several econometric tests can be performed. A Hausman specification test can be used to test whether the regressor INEQUALITY is not correlated with disturbance term u. The test

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[31] The level of GDP per capita in the first year of each 20-year period is used.

[32] One problem with this replacement of missing observations by first-order regression methods is that it is usually reserved for use in cross-section data sets. Use in time series data sets neglects the problem that values for successive time periods are not independent of each other (see e.g. Maddala, 1977, p. 205).

indicates that the specification does not yield consistent estimates.[33] Further a LR (likelihood ratio) test of whether GDP is an omitted variable in the growth equation indicates that this is indeed the case.[34]

Once GDP is included in the growth equation the Hausman specification test indicates no further correlation between INEQUALITY and the disturbance term. Column 3 in table 4 shows the regression with GDP included. Clearly, there is now no significant relationship between INEQUALITY and GROWTH.

P-T note that when time dummies are introduced the coefficient on income inequality turns insignificant. The dummy for the period 1950-70 becomes positive and strongly significant, and the dummy for the period 1970-85 becomes marginally significant. P-T claim that this indicates the existence of a possible omitted variables problem. Our argument is essentially that GDP is the omitted variable in the growth equation. In fact, once GDP is added the time dummies are no longer significant.

4 Conclusion

A number of attempts to use regressions at the country level have proven rather unstable (see e.g. Levine and Renelt, 1992). A conclusion from our empirical work is that even the relationship between equality and growth may be difficult to establish in country comparisons.

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[33] The Hausman specification test consists of entering a variable $\hat{I}$ consisting of the fitted values of the regressor INEQUALITY regressed over the exogenous variables (including GDP, using sample of 38 observations) into the growth equation (with the extended sample of 56 observations). The coefficient of $\hat{I}$ has a t value of -1.84 and is significant at the 7 percent level, indicating that INEQUALITY is not independent of the disturbance term.

[34] The LR test is based on the log of the ratio of the maximized likelihood including GDP to that excluding GDP. The test gives a likelihood ratio of 3.75, implying that GDP is an omitted variable with significance at the 0.05 level.

Yet the theoretical model implies a deeper problem. Income equality should, in our view, be treated as endogenous. In our model this implies that both income equality and growth are determined by the choice of political equilibrium, which could be determined by such things as ideology and political attitudes.

Our model is simple in several respects. We assume that there are two income groups or levels. Further we ignore random events that can determine high or low returns and thus changes in income distribution that people may want to insure against with the help of a redistributive system. Thus a number of questions remain for future research.

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APPENDIX

Proof of proposition 2.

The first order condition for the interior solution to the political problem is

$$\frac{dv_{1t}(S_{1t},S_{2t})}{d\theta_t} = \frac{d\ln(w_t - S_{1t})}{d\theta_t} + \beta\frac{d\ln(\theta_t R_{1t}S_{1t} + (1-\theta_t)(n_{1t}R_{1t}S_{1t} + n_{1t}R_{1t}S_{1t}))}{d\theta_t} = 0. \qquad \text{(A1)}$$

Using the envelope theorem, and acknowledging that R_{1t}, R_{2t} and n_{1t} are predetermined at this stage, we have:

$$(d\theta_t / d\mu_t)\, n_{2t}\, (R_{1t} S_{1t} - R_{2t} S_{2t}) + (1-\theta_t)\, (n_{1t} R_{1t} S'_{1t} + n_{2t} R_{2t} S'_{2t}) = 0 \qquad \text{(A2)}$$

where $$S'_{1t} = \frac{\partial S_{1t}}{\partial \mu_t} = -\beta w_{t-1}\frac{R_{1t} + n_{2t}(R_{2t} - R_{1t})}{(B+\mu_t)^2 R_{1t}} \qquad \text{(A3)}$$

and $$S'_{2t} = \frac{\partial S_{2t}}{\partial \mu_t} = -\beta w_{t-1}\frac{R_{2t} - n_{1t}(R_{2t} - R_{1t})}{(B+\mu_t)^2 R_{2t}} \qquad \text{(A4)}$$

The difference between second-period individual incomes is:

$$R_{2t}S_{2t} - R_{1t}S_{1t} = \frac{B(R_{2t} - R_{1t}) + (R_{2t} - R_{1t})\mu_t}{B+\mu_t} \times \frac{\beta w_{t-1}}{B} = (R_{2t} - R_{1t})\frac{\beta w_{t-1}}{B} \qquad \text{(A5)}$$

Inserting (A3)-(A5) into the first-order condition (A1), and taking into account that $d\theta_t / d\mu_t = -(1+\mu_t)^{-2} = -\theta_t^2$ we obtain:

$$n_{2t}(R_{2t} - R_{1t})(B + \mu_t)^2 = B\,(n_{1t} R_{1t} + n_{2t} R_{2t})\,(1+\mu_t)\mu_t\,.$$

This can be represented as (22)-(23) in the text. □

Proof of Proposition 3.

Free-entry condition (12) is written as:

$$C_1 D_1^{\beta} = C_2 D_2^{\beta} e^{\Psi}, \qquad \text{(B1)}$$

where $C_i = C_{it-1}$, $D_i = D_{it}$, $i = 1,2$. From (20) the first-period consumption by the first type is:

$$C_1 = w_{-1} - S_1 = \left(1 - \frac{\beta(BR_1 - n_2(R_2 - R_1)\mu)}{B(B+\mu)R_1}\right)w_{-1}$$
$$= \frac{B(1+\mu)R_1 + n_2(R_2 - R_1)\beta\mu}{B(B+\mu)R_1}w_{-1} \qquad \text{(B2)}$$

and as above $w_{-1} = w_{t-1}$. From (23) we have that

$$R_1 = (1 - B\lambda)(n_1R_1 + n_2R_2). \qquad \text{(B3)}$$

Plugging it into (B2) and accounting for (23) and the first-order condition (22) for the political problem imply

$$C_1 = \frac{(1+\mu)(1-B\lambda)+\lambda\beta\mu}{(B+\mu)R_1(n_1R_1+n_2R_2)^{-1}}w_{-1} = \frac{1+\mu-\lambda(\mu+B)}{(B+\mu)R_1(n_1R_1+n_2R_2)^{-1}}w_{-1} = \frac{(1+\mu)B(n_1R_1+n_2R_2)}{(B+\mu)^2R_1}w_{-1}$$

Similarly to (B3)

$$R_2 = (1 + B\nu\lambda)(n_1R_1 + n_2R_2). \qquad \text{(B4)}$$

Using (21), (22) and (23) the first-period consumption by the second type is obtained:

$$C_2 = w_{-1} - S_2 = \frac{(1+\mu)(B+(1+\nu)\mu)}{(B+\mu)^2R_2(n_1R_1+n_2R_2)^{-1}}w_{-1}$$

The ratio of the first-period consumptions is

$$\frac{C_1}{C_2} = \frac{B\rho}{B+(1+\nu)\mu}. \qquad \text{(B5)}$$

Consider the second-period consumption by the first type D_1. By (20)-(21) the social transfer is

$$y = (1-\theta)(n_1R_1S_1 + n_2R_2S_2) = (1-\theta)\frac{\beta(n_1R_1+n_2R_2)}{B(B+\mu)}w_{-1}$$

and, hence,

$$D_1 = \theta R_1S_1 + y = \theta\frac{\beta(R_1 - n_2(R_2-R_1)\mu)}{B(B+\mu)}w_{-1} + (1-\theta)\frac{\beta(n_1R_1+n_2R_2)}{B(B+\mu)}w_{-1}.$$

By (B3) and the first-order condition (22)

$$D_1 = \frac{\beta(n_1R_1+n_2R_2)\theta w_{-1}}{B(B+\mu)}(1 - B\lambda - \lambda\mu + \mu) = \frac{\beta(n_1R_1+n_2R_2)(1+\mu)\theta w_{-1}}{B(B+\mu)^2}B.$$

Similarly, by (B4) and (22) the second-period consumption by the second group is

$$D_2 = \theta R_2 S_2 + y = \theta \frac{\beta(R_2 + n_1(R_2 - R_1)\mu)}{B(B+\mu)} w_{-1} + (1-\theta)\frac{\beta(n_1 R_1 + n_2 R_2)}{B(B+\mu)} w_{-1}$$
$$= \frac{\beta(n_1 R_1 + n_2 R_2)\theta w_{-1}}{B(B+\mu)}(1 + B\nu\lambda + \nu\lambda\mu + \mu) = \frac{\beta(n_1 R_1 + n_2 R_2)(1+\mu)\theta w_{-1}}{B(B+\mu)^2}(B + (1+\nu)\mu)$$

Dividing D_1 by D_2 we have that

$$\frac{D_1}{D_2} = \frac{B}{B + (1+\nu)\mu}, \tag{B6}$$

and from (B5) and (B6) the free entry condition (B1) becomes

$$\rho = \left(1 + \frac{(1+\nu)\mu}{B}\right)^B$$

or, equivalently,

$$\nu = \left(\rho^{\frac{1}{B}} - 1\right)\frac{B}{\mu} - 1. \tag{B7}$$

One can express (23) as

$$\lambda = \frac{\rho - 1}{B(\nu + \rho)}. \tag{B8}$$

Inserting (B7) into (B8) implies:

$$\lambda = \frac{\rho - 1}{B\left((\rho^{\frac{1}{B}} - 1)\frac{B}{\mu} - 1 + \rho\right)} = \frac{\mu}{B\left(\frac{\rho^{\frac{1}{B}} - 1}{\rho - 1}B + \mu\right)}$$

Plugging λ into the first-order condition (22) we have that

$$\mu = \frac{(B+\mu)^2}{(1+\mu)B} - B\frac{\rho^{\frac{1}{B}} - 1}{\rho - 1} \tag{B9}$$

This is a square equation in μ with one positive root.

By (20)-(21) the distributional equation (16) can be expressed in terms of PEE variables (μ, ν, ρ) as

$$\nu = \frac{\alpha_1 R_2 S_2}{\alpha_2 R_1 S_1} = \frac{\alpha_1}{\alpha_2}\left(\frac{BR_2 + n_1(R_2 - R_1)\mu}{BR_1 - n_2(R_2 - R_1)\mu}\right) = \frac{\alpha_1}{\alpha_2}\left(\frac{B(1+\nu)\rho + (\rho - 1)\nu\mu}{B(1+\nu) - (\rho - 1)\mu}\right). \tag{B10}$$

Table 1 Regressions for GROWTH

Variable	Eq. (1)	Eq. (2)	Eq. (3)	Eq. (4)	Eq. (5)	Eq. (6)
Constant	-2.214 (-1.813)	-1.170 (-0.911)	1.049 (1.101)	-5.341 (-2.453)	-3.575 (-1.274)	1.836 (1.025)
MIDDLE	0.168 (2.128)	0.105 (1.275)	0.043 (0.519)	0.417 (2.581)	0.288 (1.398)	-0.031 (-0.186)
GDP	-2.0×10^{-4} (-1.670)	-3.7×10^{-4} (-2.614)	-3.4×10^{-4} (-2.271)	-4.0×10^{-4} (-2.342)	-4.3×10^{-4} (-2.665)	-3.2×10^{-4} (-2.019)
Pschool	0.031 (3.516)	0.023 (2.430)		0.037 (3.562)	0.030 (2.460)	
Secschool		0.031 (2.052)	0.046 (3.226)		0.018 (0.902)	0.050 (3.111)
Nr. of obs.	49	49	49	49	49	49
Adj. R^2	0.21	0.26	0.18	0.21	0.24	0.18

Notes: *t* values in parentheses.
Eq. (1) - (3) report OLS regressions, whereas eq. (4) - (6) apply 2SLS using instrumental variables for middle. The IV:s are: percentage of the labor force in the agricultural sector in 1965, male life expectancy (years) at birth in 1965, pschool, secschool and GDP.

Table 2. Regressions for GROWTHDIFF

Variable	Eq. (1)	Eq. (2)	Eq. (3)	Eq. (4)
Constant	-1.160 (-1.414)	-1.331 (-1.833)	-0.936 (-1.371)	-0.947 (-1.565)
Middiff	-0.111 (-0.865)	-0.115 (-0.917)	-0.253 (-2.116)	-0.258 (-2.169)
Pschooldiff	-5.2×10-4 (-0.030)	1.8×10 (0.011)	-0.022 (-1.410)	-0.022 (-1.441)
Secschooldiff	-0.023 (-0.888)	-0.028 (-1.063)	-0.033 (-1.403)	-0.037 (-1.414)
GDP60	2.1×10^{-5} (0.169)		2.0×10^{-5} (0.171)	
Growth		0.141 (0.646)		0.059 (0.318)
Nr. of obs.	34	34	49	49
Adj. R^2	-0.08	-0.07	0.09	0.09

Note: t values in parentheses. All values represent OLS regressions.

Table 3. Regressions for GROWTHDIFF incl. dummies for policy shift.

Variable	Eq. (1)	Eq. (2)	Eq. (3)	Eq. (4)
Constant	-1.441 (-3.317)	-1.441 (-3.317)	-0.749 (-1.392)	-0.724 (-1.568)
Middiff	-0.074 (-0.976)	-0.074 (-0.976)	-0.210 (-2.450)	-0.204 (-2.409)
Pschooldiff	0.003 (0.327)	0.003 (0.327)	-0.007 (-0.632)	-0.007 (-0.653)
Secschooldiff	-0.025 (-1.621)	-0.025 (-1.621)	-0.034 (-2.019)	-0.030 (-1.666)
GDP60	4.3×10^{-5} (0.571)		-2.1×10^{-5} (-0.237)	
Growth		0.093 (0.746)		-0.069 (-0.515)
Posdummy	2.765 (5.173)	2.685 (5.309)	2.223 (3.592)	2.232 (3.698)
Negdummy	-2.512 (-4.380)	-2.566 (-4.680)	-2.406 (-4.875)	-2.432 (-4.989)
Nr. of obs.	34	34	49	49
Adj R^2	0.65	0.65	0.55	0.55

Notes: *t* values in parentheses. All values represent OLS regressions.

Table 4. Regressions for GROWTH using a nine-country panel.

Variable	Eq. (1)	Eq. (2)	Eq. (3)
Constant	5.263 (2.659)	6.256 (4.066)	4.74 (2.75)
INEQUALITY	-3.481 (-1.017)	-6.107 (-2.234)	-2.81 (-0.86)
NOFRAN	-0.782 (-0.670)	-0.011 (-0.018)	-0.16 (-0.29)
SCHOOL	2.931 (0.913)	0.316 (0.204)	-2.03 (-1.06)
GDPGAP	-2.591 (-2.739)	-1.720 (-2.708)	-2.48 (-2.65)
GDP			0.00021 (1.84)
Nr. of obs.	38	56	56
Adj R^2	0.294	0.269	0.233

Notes: *t* values in parentheses. All values represent OLS regressions. INEQUALITY is the share in personal income of the top twenty percent of the population. NOFRAN is the share of the enfranchised age and sex group that is not in the electorate. SCHOOL is an index accountin for primary, secondary, higher-secondary and tertiary education. GDPGAP is the ratio between GDP per capita and the highest GDP per capita in the sample in each time period.

Data description

GDP60: Real GDP per capita, expressed in 1985 international prices.
Source: Penn World Table (PWT 5.6)

GROWTH: Average annual growth rate in real GDP per capita over 1960-1985.
Source: PWT 5.6

PSCHOOL: Percentage enrolled in primary school out of relevant age group (6-11 years) in 1965.
Source: World Bank (1990)

SECSCHOOL: Percentage enrolled in secondary school out of relevant age group (12-17 years) in 1965.
Source: World Bank (1990)

MIDDLE: Share of pretax income received by the third quintile of the population. Measured in the beginning of the GROWTH-period.
Source: Paukert (1973)

INVEST: Average real investment share of GDP over 1960-1985, expressed in 1985 international prices.
Source: PWT 5.6

GDP80: Real GDP per capita in 1980, expressed in 1985 international prices.
Source: PWT 5.6

NEWGROWTH: Average annual growth rate in real GDP per capita over 1980-1991. For a few countries the time span is 1980-1987/88.
Source: PWT 5.6

PSCHOOL80: The equivalent of PSCHOOL above; measured in 1980.
Source: World Bank (1993).

SECSCHOOL80: The equivalent of SECSCHOOL above, measured in 1980.
Source: World Bank (1993).

MIDDLE80: Share of household income received by the third quintile of the population. Measured in various years around 1980. For 15 observations this variable is estimated applying OLS on the information available through other variables, notably GROWTH, MIDDLE and PSCHOOL.
Source: World Bank (1990)

MIDDIFF = MIDDLE80 - MIDDLE

PSCHOOLDIFF = PSCHOOL80 - PSCHOOL

SECSCHOOLDIFF = SECSCHOOL80 - SECSCHOOL

GROWDIFF = NEWGROWTH - GROWTH

POSDUMMY and NEGDUMMY:
Dummy variables for positive and negative macroeconomic events, e.g. the adoption of deregulative policies directed towards liberalization on the one hand and severe politico-economic instability on the other. The relevant time period is late 1970's to early 1980's.
For the following countries POSDUMMY was assigned a value of 1:
Chile, India, S. Korea, Senegal, Sri Lanka, and UK.
For the following countries NEGDUMMY was assigned a value of 1:
Argentina, Bolivia, Brazil, Chad, Ecuador, Gabon, Iraq, Ivory Coast, Madagascar, Nigeria, and Panama,