IS INEQUALITY HARMFUL FOR GROWTH?
THEORY AND EVIDENCE

Torsten Persson

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ABSTRACT

Is inequality harmful for growth? We suggest that it is. To summarize our main argument: in a society where distributional conflict is more important, political decisions are more likely to produce economic policies that allow private individuals to appropriate less of the returns to growth promoting activities, such as accumulation of capital and productive knowledge. In the paper we first formulate a theoretical model that formally captures this idea. The model has a politico-economic equilibrium, which determines a sequence of growth rates depending on structural parameters, political institutions, and initial conditions. We then confront the testable empirical implications with two sets of data. A first data set pools historical evidence-which goes back to the mid 19th century-from the US and eight European countries. A second data set contains post-war evidence from a broad cross-section of developed and less developed countries. In both samples we find a statistically significant and quantitatively important negative relation between inequality and growth. After a comprehensive sensitivity analysis, we conclude that our findings are not distorted by measurement error, reverse causation, hetroskedasticity, or other econometric problems.

Torsten Persson
Institute for International
Economic Studies
S-106 91 Stockholm, SWEDEN

Guido Tabellini
Department of Economics
University of California
 at Los Angeles
Los Angeles, CA 90024

1. Introduction

Why do different countries—or the same country in different periods—grow at such different rates? And what is the role of income distribution in the growth process? To answer these old questions, we belive one should explain why growth-promoting policies are or are not adopted. In this paper we try to do just that by combining insights from two recent strands of literature, namely the theory of endogenous growth and the theory of endogenous policy. We can summarize our tentative conclusion in a simple aphorism: inequality is harmful for growth.

The arguments that lead us to this aphorism run as follows. Economic growth is largely determined by the accumulation of knowledge usable in production. The incentives for such productive accumulation hinge on the ability of individuals to privately appropriate the fruits of their efforts, which in turn crucially hinges on what tax policies and regulatory policies are adopted. In a society where distributional conflict is more important, political decisions are likely to result in policies that allow less private appropriation and therefore less accumulation and less growth. But the growth rate also depends on political institutions, for it is through the political process that conflicting interests ultimately are aggregated into public policy decisions.

In the paper we first formulate a simple general equilibrium model that formally captures this idea. It is an overlapping generations model in which heterogeneous individuals are born in every period and act as economic agents and voters. The model's politico–economic equilibrium determines a sequence of growth rates as a function of parameters and initial conditions. We believe that the model is quite interesting in itself. However, we spend relatively little time pondering over theoretical issues. Instead, we spell out the model's empirical implications and confront them with two sets of data. The first sample contains historical evidence from a narrow cross–section of nine currently developed countries, the US and eight European countries. The second sample contains

current evidence from a broad cross–section of countries, both developed and less developed. The predictions of the model hold up in both samples. In particular, a strong negative relation between income inequality at the start of the period and growth in the subsequent period is present in both samples. We do not find as strong evidence for the predictions concerning political institutions. Adequate data either are not readily available or do not exhibit sufficient variation.

As we already mentioned, our work in this paper is related to both the theory of endogenous growth and the theory of endogenous policy. The work on endogenous growth has made clear the importance of policy for growth. But it has not yet made the link between distribution, politics and policy.[1] Analogously, the literature on endogenous policy has made clear the importance of distribution for policy. But it has not yet made the link between policy and growth.[2]

Obviously, our work is also related to the vast literature in economic history and in economic development about the relation between development and income distribution. This work, which is both theoretical and empirical, largely revolves around the so called *Kuznets curve*: the hypothesis that income inequality first increases and then decreases with development.[3] The Kuznets curve remains a controversial concept both theoretically and

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[1]   Romer (1989a) surveys the literature on endogenous growth. Barro and Sala i Martin (1990) and Rebelo (1990) discuss the growth consequences of alternative (exogenous) policies. Romer (1990) spells out the income distribution consequences of trade policies in an endogenous growth model of a small open economy and discusses informally how these distribution consequences may block growth–promoting policies from being pursued. Terrones (1990) models redistributive policy and growth endogenously, but in a representative–agent model that does not address issues of distribution and politics. Bertola (1990) studies the relationship between growth and the *functional*, rather than the *size*, distribution of income, but he also does not model how distribution interacts with policy formation.

[2]   Persson and Tabellini (1990a) survey the literature on endogenous policy. The classic papers on how income distribution affects the choice of tax policy in a statcic voting model are Meltzer and Richards (1981), Roberts (1977) and Romer (1975). Independently of this paper, Alesina and Rodrik (1990) and Perotti (1990) have also studied the determination of tax policy in the political equilibrium of an endogenous growth model.

[3]   As suggested by the name, the hypothesis is intimately associated with the writings of Simon Kuznets, notably Kuznets (1966). Lindert and Williamson (1985) provide a recent evaluation of the theoretical as well as the empirical work on the Kuznets curve, while Bourguignon and Morrison (1990) provide new cross country evidence on the effects of economic development on income distribution.

empirically. But the work on the Kuznets curve deals with the question of how the *level* of income affects income distribution, while our work instead addresses the question of how income distribution affects the *change* in income. Our theory, as well as our empirical tests, remain valid both in the presence and in the absence of a Kuznets curve.

In Section 2 of the paper we formulate our theoretical model of politico—economic equilibrium growth. We use the model to derive an equilibrium sequence of growth rates, and spell out its empirical implications. In Section 3 we describe our first data set with historical evidence from a narrow cross—section of countries and present results of regressions for per capita growth rates on variables suggested by our theory. Section 4 presents our empirical work based on the second data set with post—war evidence from a broad cross—section of countries. Section 5 concludes with a summary of the results and with suggestions for further work. An Appendix contains some algebra, precise definitions of our variables and details on our data sources.

2. Theory

2.1 The Model

We study an overlapping generations model with constant population, where individuals live for two periods.[4] Every individual has the same *preferences*. Let the utility of the ith individual born in period $t-1$, but indexed by t, be:

$$(2.1) \qquad v_t^i = U(c_{t-1}^i, d_t^i).$$

In (2.1) c denotes the consumption when young and d the consumption when old. The utility function $U(\cdot)$ is concave, well—behaved and homothetic or—without loss of

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[4] The model is a close relative of that in Persson and Tabellini (1990b). The overlapping generations structure enables us to disregard the effect of individual savings decisions on the whealth distribution of future generations, which considerably simplifies the analysis.

generality—linearly homogeneous.

Different individuals have different incomes. The *budget constraints* of the ith individual are;

(2.2a) $$c^i_{t-1} + k^i_t = y^i_{t-1}$$

(2.2b) $$d^i_t = r_t[(1 - \theta_t)k^i_t + \theta_t k_t].$$

where y^i is the ith individual's income when young (to be defined below), k^i and k are the individual and average accumulation, respectively, of an asset, r is the exogenous rate of return on that asset, and θ is a policy variable (throughout the paper we use superscripts to denote individual–specific variables and no superscripts to denote average variables). Thus in this model policy is purely redistributive: it takes from those who have invested more than the average and gives to those who have invested less than the average.

The income when young is defined as:

(2.3) $$y^i_{t-1} = (w_{t-1} + e^i_{t-1})k_{t-1}$$

where w is an exogenous average endowment of "basic skills" and e^i an exogenous individual–specific endowment of such skills. Thus the stock of k accumulated on average by the previous generation has a positive externality on the income of the newborn generation. The most straightforward interpretation of this externality is to think of k as physical or human capital, that has a "knowledge spillover" on the basic skills of the young—as in Arrow (1962) or Romer (1986). But it may be more relevant to think of k as a measure of knowledge that is useful in promoting technical progress. In this case, the owners of k earn monopoly rents from their previous investment in the accumulation of knowledge. The policy variable θ would then represent regulatory policy such as "patent legislation" or "protection of property rights", so that θ becomes an index of how well an individual can privately appropriate the returns on his investment. As a practical matter, of course, technical progress is largely embodied in new capital, so the two interpretations

need not be mutually exclusive.[5]

Throughout the paper we assume that e^i always has a zero mean and a non—positive median, but it is distributed according to a family of distribution functions $F(e^i, k)$ on the interval $(\underline{e}, \bar{e}, k)$. Different levels of k induce mean preserving spreads on some primitive distribution function. Thus, even though the model does not derive endogenously a law of motion of income distribution, it may nevertheless be consistent with the dynamics of the Kuznets curve. In particular, as will be seen below, different hypotheses about the function $F(e^i, k)$ have important implications for the equilibrium dynamics of growth.

Events unfold according to the following timing. At the start of period $t-1$ the eligible voters choose θ_t. Then investors choose k^i_{t-1}. Thus, we abstract from credibility problems and just assume that there is one period—ahead commitment of policy. Since the old generation in period $t-1$ is not affected by the policy enacted in period t, we assume

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[5]   It is possible to show that the second interpretation is formally consistent with our model. Following Romer (1987) and Bertola (1990), let aggregate output Y_t be produced with a continuum of intermediate goods $\{x_t(j)\}$:

$$Y_t = \int_0^{J_t} g(x_t(j))dj \; .$$

Here J_t is the range of intermediate goods available in period t and the function $g(\;)$ is twice continuosly differentiable, strictly concave for $x < \underline{x}$, $g(0) = 0$ and $g(x) = r + wx$ for $x \geq \underline{x}$, where r and w are positive and time—dependent parameters. Suppose that to produce the quantity $x(j)$ of good j one unit of previously accumulated "capital" k and $x(j)$ units of labor are required. Then, one unit of k may be interpreted as necessary "know—how" or technology, which once acquired makes it possible to produce a specific good j using labor according to a linear production function. Clearly, the higher the per—capita investment in k in period $t - 1$, the more "know—how" the economy posesses in period t. Suppose further that the existing legislation enables the owners of "know—how" to appropriate a fraction $(1—\theta)$ of the monopoly rents from their investment in knowledge acquisition, while the remaining fraction θ is an externality that benefits all the owners of the prodution technology. If all intermediate inputs are produced in the same quantity $x > \underline{x}$, then aggregate output at t is:

$$Y_t = \int_0^{k_t} [r_t + w_t x]dj \; = \; k_t r_t + k_t w_t x.$$

Suppose finally that labor is paid its marginal product and is supplied inelastically by young individuals in the quantity $1 + e^i$ for a young of type i and that we normalize aggregate labor supply at per capita labor supply, so that $x = 1$. In this set—up, we obtain precisely the budget constraints (2.2).

without loss of generality that only the young generation participates in the vote.

A politico–economic equilibrium is defined as a policy and a set of private economic decisions such that: (i) The economic decisions of all citizens are optimal, given policy, and markets clear; (ii) The policy cannot be defeated by any alternative in a majority vote among the citizens in the enfranchised section of the population. (Below we analyze the effects of constitutional limits on political participation).

2.2 Economic Equilibrium

With homothetic preferences, the ratio of consumption in the two periods is a function only of intertemporal prices and is independent of wealth: that is, for all i $d_t^i/c_{t-1}^i = D(r_t, \theta_t)$ with $D_r > 0$ and $D_\theta < 0$. Equivalently, every individual has the same "savings rate" so that individuals with more skills accumulate more k. Using this fact and the budget constraints (2.2), we can write the amounts consumed by the ith individual as :

(2.4) $c_{t-1}^i = r_t D(r_t, \theta_t)[(1-\theta_t)y_{t-1}^i + \theta_t k_t]/[D(r_t, \theta_t) + r_t(1-\theta_t)]$

(2.5) $d_t^i = r_t[(1-\theta_t)y_{t-1}^i + \theta_t k_t]/[D(r_t, \theta_t) + r_t(1-\theta_t)]$.

For the average individual, $k_t = y_{t-1} - c_{t-1}$. By repeated substitution and use of (2.2) and (2.3) we can therefore solve for the *per capita growth rate* of k, that we label g_t:

(2.6) $g_t = G(w_{t-1}, r_t, \theta_t) = k_t/k_{t-1} - 1 = w_{t-1}D(r_t, \theta_t)/(r_t + D(r_t, \theta_t)) - 1$.

In (2.6) $G_w > 0$, $G_r \gtrless 0$, and $G_\theta < 0$ (since $D_\theta < 0$). Thus, the higher are the average skills w, the higher is the growth rate of k. A higher gross rate of return may increase or decrease growth, depending on the usual balancing of substitution and income effects. But the more an individual can appropriate the fruits of his investment, the higher is the growth rate (on average a change in θ has only a substitution effect, since the average individual receives a lump sum transfer equal to the tax he pays).

Note that the economic model is recursive: given an initial condition for k and a sequence $\{\theta_t, w_t, r_t\}$ of policies and parameters, we can solve for a sequence of growth

rates.[6] Note also that GDP in period t is given by $(w_t + r_t)k_t$. In the empirical sections to follow we will clearly want to allow for time dependence in both w_t and r_t. But in the remainder of the theoretical discussion, we will adopt the simplifying assumption that $w_{t-1} = w_t = w$ and $r_{t-1} = r_t = r$ for all t. In that case g_t is the common growth rate of k, GDP and consumption.

2.3 Political Equilibrium

To characterize the political equilibrium we first study the ith individual's policy preferences. Consider his *indirect utility function* over the policy variable θ_t. Since preferences are linearly homogeneous, we know that $U(c^i_{t-1}, d^i_t) = c^i_{t-1} U(1, D(r, \theta_t))$. Using this property together with (2.3) − (2.6) we can write his indirect utility as

$$(2.7) \qquad v^i_t = V(r, \theta_t)[W(w, r, \theta_t) + e^i_{t-1}]k_{t-1},$$

where $V(r, \theta_t) \equiv [1 + D(r, \theta_t)/r(1 - \theta_t)]^{-1} U(1, D(r, \theta_t))$ and $W(w, r, \theta_t) \equiv w[1 + \theta_t D(r, \theta_t)/(1 - \theta_t)(r + D(r, \theta_t))]$. Below we exploit the facts that $V_\theta < 0$ (the indirect utility function is decreasing in the relative price of future goods, given wealth), $W_\theta > 0$ (if we use a Laffer−curve type assumption), $W_w = W/w > 0$, and $W_{w\theta} = W_\theta/w > 0$.

Since the preferences in (2.7) are linear in the individual−specific variable e^i, they belong to the class of *intermediate* preferences studied by Grandmont (1978). Provided that v^i_t has a unique maximum in θ_t, we therefore obtain a median−voter result: the equilibrium policy is the value of θ preferred by the median voter. Let e^m_{t-1} denote the individual endowment of whoever happens to be the median voter in period t−1. The equilibrium policy θ^*_t is then implicitly defined by the first−order condition

$$(2.8) \qquad V_\theta(W + e^m_{t-1}) + VW_\theta = 0.$$

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[6] For this reason we need not specify a law of motion for the exogenous parameters w and r, in order to solve for the equilibrium at any point in time. Naturally, however, the equilibrium dynamics will depend on these law of motions.

This condition reflects the trade off facing the voters. On the one hand, an increase in θ redistributes income and welfare from individuals with positive e^i and thus with $k^i > k$ to individuals with negative e^i and $k^i < k$. On the other hand, an increase in θ is costly in that it diminishes investment and therefore the base for redistribution. If the second—order condition is satisfied, (2.8) implicitly defines the equilibrium policy θ_t^* as a function: $\theta^*(w, r, e_{t-1}^m)$. Given the signs of the partials that we noted below (2.7), it is easy to verify that $\theta_t^* \gtrless 0$ as $e_{t-1}^m \lessgtr 0$, $\theta_e^* < 0$, $\theta_w^* \lessgtr 0$ as $e_{t-1}^m \lessgtr 0$, and $\theta_r^* \lessgtr 0$. Intuitively, if the median voter coincides with the average investor ($e_{t-1}^m = 0$), he prefers a non—redistributive policy ($\theta_t^* = 0$), whereas he prefers a tax (a subsidy) on investment if he is poorer (richer) than the average. More generally, a median voter with higher individual skills e^m and therefore a higher k^m prefers more private appropriability (a lower θ). A higher average skill level w gives higher average accumulation and hence increases the cost of redistribution, so that the voter prefers a less interventionist policy (a lower tax or a smaller subsidy). And a higher rate of return r may both increase and decrease the preferred level of θ.

We are interested in analyzing political institutions that potentially limit the franchise to a segment of the population. We shall introduce such constitutional limits in our model in a very simple way: only those individuals in generation $t - 1$ who have basic skills (and therefore income) within some bounded interval are allowed to vote on θ_t. Denote the upper and lower bounds on the franchise by $\bar{\epsilon}_{t-1}$ and $\underline{\epsilon}_{t-1}$. Then, the median voter is identified by the function $e_{t-1}^m = E(k_{t-1}, \bar{\epsilon}_{t-1}, \underline{\epsilon}_{t-1})$, defined implicitly by

(2.9) $\qquad F(e_{t-1}^m, k_{t-1}) - F(\underline{\epsilon}_{t-1}, k_{t-1}) = (F(\bar{\epsilon}_{t-1}, k_{t-1}) - F(\underline{\epsilon}_{t-1}, k_{t-1}))/2.$

Clearly, $E_{\bar{\epsilon}}, E_{\underline{\epsilon}} > 0$, since shifting either of the bounds upwards raises the median. But who is the median voter also depends on overall inequality, as manifested in the shape of F, which in turn, shifts with k. Thus, the sign of E_k is ambiguous and depends on whether

$e^m \gtrless 0$ as well as on how $F(\cdot)$ changes with k. For example, if a higher k leads to more inequality $(F_k > 0)$ and the old median is poorer than average $(e^m < 0)$, then the new median becomes even poorer $(E_k < 0)$.

This approach allows us to parameterize many different political constitutions in a simple way. Suppose that only the lower bound $\underline{\epsilon}$ is a binding constraint on electoral participation (because $\bar{e} < \bar{\epsilon}$). Then the model is broadly consistent with that period in the political history of virtually all Western democracies when only individuals with a minimum amount of human or financial capital were eligible to vote. Conversely, suppose that $\underline{\epsilon} < \underline{e}$ and only the upper bound $\bar{\epsilon}$ constitutes a binding constraint. Then the model captures some aspects of a socialist regime in which wealthy individuals have no political influence. Alternatively, in a democratic regime, the upper bound $\bar{\epsilon}$ could reflect constraints on campaign contributions that limit the political influence of wealthy individuals. More generally, what matters is not only how democratic a regime is, but also how it allocates political rights and political influence between wealthy and poor citizens.

Combining (2.8) and (2.9), we obtain that the equilibrium policy can be expressed as the function

$$(2.10) \qquad \theta_t^* = \theta^*(w, r, E(k_{t-1}, \bar{\epsilon}_{t-1}, \underline{\epsilon}_{t-1})).$$

And the growth rate in politico–economic equilibrium is given by (2.6) and (2.10):

$$(2.11) \qquad g_t = G(w, r, \theta^*(w, r, E(k_{t-1}, \bar{\epsilon}_{t-1}, \underline{\epsilon}_{t-1}))).$$

We can now derive some comparative statics results:

$$(2.12a) \qquad dg_t/d\epsilon_{t-1} = G_\theta \theta_e E_\epsilon > 0, \quad \epsilon_{t-1} = \bar{\epsilon}_{t-1} \text{ or } \underline{\epsilon}_{t-1}.$$

$$(2.12b) \qquad dg_t/dw = G_w + G_\theta \theta_w > 0 \text{ if } E < 0$$

$$(2.12c) \qquad dg_t/dk_{t-1} = G_\theta \theta_e E_k \lessgtr 0 \text{ as } E_k \lessgtr 0.$$

$$(2.12d) \qquad dg_t/dr = G_r + G_\theta \theta_r \lessgtr 0,$$

where the signs follow from the discussion above. Thus, extending the franchise to wealthier citizens, or restricting the participation of the poorest, increases equilibrium growth. The same is true for a permanent increase in average basic skills (if the median

voter is not too much richer than the average citizen the result holds unambigously, but if he is much richer the result may reverse depending on functional forms). But changes in the stock of technically useful knowledge (capital) can produce either higher or lower growth depending on what happens to overall inequality. Changes in the rate of return have an ambigous effect on the growth rate

2.4 Dynamics of Growth

The model allows for very different growth patterns. But since the model is recursive, the growth history of a given country is completely determined by the initial condition k_0, by the properties of $F(e^i, k)$, and by the history for $\bar{\epsilon}$ and $\underline{\epsilon}$ (and for w and r). It is relatively straightforward to characterize the qualitative dynamics of the model.

It is clear that the growth pattern crucially depends on how $F(\cdot)$ shifts with k. This question is not easy. In fact, it is the very question that the literature on the Kuznets curve, which we cited in the Introduction, is all about. How the distribution of skills and income evolves, clearly depends on many details of the development process such as the time patterns of sectoral change, education and urbanization. Suppose though, for the sake of the argument, that the hypothesis underlying the Kuznets curve is valid, so that inequality increases with development at low levels of income, but decreases at higher levels of income. Translated into the model, this would mean that—as long as E were negative and we held $(\bar{\epsilon}, \underline{\epsilon})$ constant at some level—E would be decreasing up to some point $\bar{k}$ and then increasing. If k_0 is below $\bar{k}$, then by (2.12) the time path of the growth rate is non—monotonic: g_t first falls until k_{t-1} reaches $\bar{k}$ and then accelerates again at higher level of development.

This non—monotonicity implies that the equilibrium dynamics can exhibit path dependence. *Figure* 2.1 illustrates the point. Consider a country with relatively high income inequality, and with a correspondingly low equilibrium growth path; suppose that this path is so low that it intersects the horizontal axis, as in Figure 2.1. If the economy

Figure 2.1
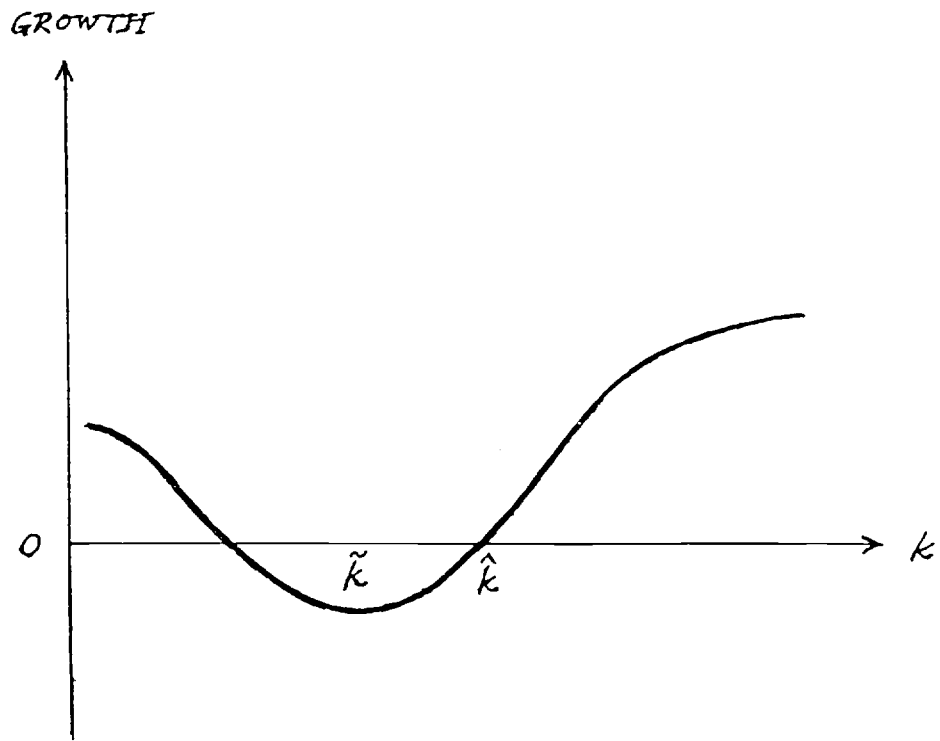
initially finds itself to the left of point $\hat{k}$, it is in a "growth trap", where income inequality is or becomes so pronounced that it discourages further accumulation and growth. In the growth trap, the only way the economy could take off again would be if the equilibrium growth path somehow was shifted upwards, so that it did not intersect the horizontal axis.

The model also suggests alternative ways in which growth could take off from a situation such as the one in Figure 2.1. One way could be through a policy of "depauperization", which reallocates property rights and redistributes wealth to the poor. By creating a political consensus for more private appropriation, this policy would foster growth. Another way could be through a policy of massive subsidization of primary and secondary education would at the same time increase the average skill level and reduce inequality, thereby shifting the equilibrium growth path upwards. Interestingly—according to observers such as Adelman (1978)—several of the countries that we now regard as successful (such as Korea, Taiwan, and Israel), engaged precisely in such redistributive and educational policies just before their growth take off in the early 1960s. Naturally, the question remains what events made these policy reversals politically feasible.

But widespread redistribution and education are not the only ways to fight a growth trap, according to the model. Another way is to restrict the political participation of the poor. Such restrictions were common in the political history of the Western democracies, where the franchise—and political participation in general—was originally restricted to the wealthiest individuals and only gradually extended to the entire population. A stiffer limit on political participation would prevent the distributional conflict from manifesting itself in policies that limit the incentives for accumulation, and could thus keep up growth even in the presence of acute inequality. A country could thus descend along the downward sloping part of the curve in Figure 2.1 without getting stuck in a growth trap. As development progresses and inequality is reduced, political rights could be extended to larger fractions of society without endangering growth.

These suggestions about alternative ways of avoiding a growth trap raise some important normative questions about intergenerational and intragenerational equity, as well as some difficult positive questions about the durability and sustainability of political institutions. But to analyze these questions, we would have to extend the model, so as to endogenize what is presently taken as exogenous. We discuss the necessary extensions in the concluding section, but they are clearly beyond the scope of this paper.

2.5 Empirical implications

Our theory has some clear—cut and testable *ceteris paribus* predictions for a given country, namely:

(1)   A more equal distribution of basic skills—a decreasing mean preserving spread on $F(e^i, k)$— increases growth.

(2)   A higher average level of basic skills—a higher w— increases growth.

(3)   Less political participation of the poor—a higher $\underline{\epsilon}$—or more political participation by the rich—a higher $\bar{\epsilon}$— increases growth.

The predictions regarding the effects on growth of the rate of return r are inconclusive. However, that may not be such a loss, since r in the model measures the gross (pre—tax or inclusive—of—externalities) return on accumulating productive knowledge, a variable that is notoriously difficult to observe empirically.

When going from the model to our empirical tests, we want to relax the simplifying assumption that w and r are constant over time. Doing that breaks the one—to—one link between the growth rate in k and the growth rate in GDP, which is what we ultimately observe. We make the following assumptions about the processes for w and r

(2.13a) $$\log w_t = \log w_{t-1} + \bar{g}_t + \eta_t^w$$

(2.13b) $$\log r_t = \log r + \eta_t^r,$$

where $\bar{g}$ is the growth rate of GDP and where, η^w and η^r are white—noise error terms. We also want to allow for variations in the income distribution function $F(e^i, k)$ across

countries and time. We thus assume that the idiosyncratic income component e^i_{t-1} is distributed in the population according to the function $\hat{F}(e^i, k_{t-1}, \lambda_{t-1})$, where λ is a parameter that captures factors (other than the level of development) which affect the distribution of income. As with k, we will think of changes in λ as inducing mean preserving spreads on $F(\cdot)$. Given these assumptions, we demonstrate in the Appendix how one can use the model to derive the following first—order approximation of $\bar{g}_t$

$$(2.14) \qquad \bar{g}_t = \alpha + \alpha^w w_{t-1} + \alpha^E (E_\lambda \lambda_{t-1} + E_k k_{t-1} + E_\epsilon \epsilon_{t-1}) + \eta_t.$$

In (2.14) the constant α captures the average effect on growth of the (unobservable) rate of return and the error term η_t captures the effects on growth of country—specific and time—specific variations in the (unobservable) level of r and the growth rate of w. The coefficients α^w and α^E are both positive.

The model is formulated in terms of per capita growth and abstracts from population growth and from short—run fluctuations. Given that the time unit of the model is a generation, equation (2.14) is relevant only for growth rates over relatively long periods of time. Further, it is relevant only in a given country with particular economic and political institutions.

Because usable data on relevant variables never goes back further than to the mid 19th century, we cannot realistically hope to test these implications on data from a single country. But we can try to combine the historical evidence of countries with a similar economic and political history. This is in fact the approach that we follow in Section 3, where we pool historical data from a narrow cross—section of nine currently developed countries. In Section 4, we take a bolder approach in looking at post—war data from a broad cross—section of countries, developed as well as developing. There we need to assume that the vast institutional differences between countries do not swamp the relations between growth and other variables that our model suggests.

3. Historical Evidence

3.1 Data

Our historical data set covers nine countries: Austria, Denmark, Finland, Germany, the
Netherlands, Norway, Sweden, Finland, the UK, and the US. We divide the time period
back to 1830 into subperiods of 20 years each, so that the first possible observation for each
country comprises the years 1830–50 and the last observation comprises the years 1970–85
(the last observation is the only one that has 15 years rather than 20). For each country
and variable, we go as far back as the data permits. Our data base is put together from a
variety of sources, which are detailed in the Appendix. But the most important sources are
Maddison (1982), Flora (1983), Flora, Kraus and Pfennig (1987), and Summers and Heston
(1988).

Per Capita Growth. The dependent variable in all our regressions is the annual
average growth rate of GDP per capita (continuously compounded and expressed as a
percentage) for each country and each 20 year episode. We have a total of 57 observations
for this variable, which we call *RTGROWTH.* The mean value in the sample is 1.88,
and the range goes from 0.17 (Austria 1910–30) to 5.05 (Germany 1950–70) Summary
statistics for this and for all other variables appear in *Table* 3.1.

For the independent variables, we try to find data that match our model as closely
as possible. In each case, we also follow the model in trying to find an observation as close
to the beginning of the time period as possible. Unless otherwise noted, the explanatory
variables described below are measured at the start of each of the 20 years periods.

Distribution. In our model the terms $E_\lambda \lambda$ and $E_k k$ reflect the effect of the shape
of the basic skills (and first–period income) distribution on the identity of the median
voter. It is hard to find an exact empirical counterpart, but the best available distribution
data for our purposes are based on personal income before tax. The basic variable we use
in our regressions, *INCSH,* is the share in personal income of the top 20% of the

Table 3.1: Summary statistics for historical sample

	# OBS	MEAN	STD. DEV	MIN	MAX
RTGROWTH	57	1.875	1.026	0.17	5.05
GDP	57	3005	2132	752	9459
INCSH	38	0.504	0.068	0.38	0.67
SCHOOL	52	0.140	0.081	0.017	0.362
NOFRAN	59	0.278	0.312	—0.01	0.89

CORRELATION MATRIX

	RTGROWTH	GDP	INCSH	SCHOOL
GDP	0.280			
INCSH	—0.472	—0.717		
SCHOOL	0.401	0.889	—0.622	
NOFRAN	—0.364	—0.580	0.754	—0.620

population.[7] We have 38 observations for this variable. The mean value is 0.50 , and the observations range from 0.38 (Sweden in 1970) to 0.67 (Finland in 1930).

Political participation. In our model, E_ϵ reflects the effect of a limited franchise on the identity of the median voter. The closest empirical counterpart we can think of is the share of the enfranchised age and sex group in the population that is *not* in the electorate. This measure corrects for political discrimination of women and for different age limits for voting across countries, factors that do not seem directly relevant in our context.[8] For this variable, *NOFRAN*, we have 59 observations, with a mean of 0.28 and a range from 0 (virtually all countries in the post—war period) to 0.89 (the UK in 1830 and the Netherlands in 1850 and 1870).

Average skills. In our model, w measures the average basic skills of the young generation. The empirical counterpart of this variable clearly has to do with the general education level.[9] To correct for any possible differences in the classification of schools across countries and to take the quality of education into account, we constructed an index of schooling. For each country and time period, we looked at how large a share of the relevant age group was enrolled in primary school, lower secondary school, higher secondary school and tertiary school, respectively, at the start of each period. Our index, *SCHOOL*, weighs these numbers together with weights that are increasing in the level of schooling. We have 52 observations for the index. Its mean is 0.14 and it ranges from 0.017 (England in 1850) to 0.362 (Finland in 1970).

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7   More comprehensive measures of inequality such as Gini—coefficients would preferable. But we think that *INCSH* is an inequality measure of about the same quality (whatever the absolute quality is). In fact, for the 27 observations where we have overlap, the correlation coefficient between the Gini—coeffient and *INCSH* is close to 0.8.

8   A wider measure of political participation, which is also available, is the number of votes in general elections as a share of the population above age 20.

9   According to the model, the average skills variable w measures the *flow* of new human capital associated with each new generation. Our observable counterpart, the percentage of the population enrolled at the start of the period, is also a flow measure of human capital, and in this respect corresponds well to the model.

The level of development. Our model has the strong implication that the growth rate is not systematically related to the level of development. Put differently, the model does not predict any convergence, so that poor countries grow faster than rich countries, once we control for other factors. However, this implication is not likely to survive slight variations in the theory. Moreover, the question of whether or not there is convergence, once we control for other variables identified by our theory, is interesting in its own right. For this reason, in some regressions we also include as an explanatory variable the level of development, measured by the level of GDP per capita, which we label *GDP*. We also use *GDP* when constructing fitted values to replace missing observations (see further below). To get real GDP levels comparable across countries, we used Summers and Heston's (1988) measures of GDP at international prices in 1950 and 1970. For earlier periods, we used the 1950 observations as a benchmark, and spliced them with the real GDP series for each country. This procedure effectively assumes constant international relative prices for earlier periods. Here too, we have 57 observations, which (expressed in 1980 international $) range from 752 (Sweden in 1870) to 9459 (The US in 1970).

For the variables we use as proxies above, we assume the following relationships between the variables in our model and the variables we observe:

$$\text{(3.1a)} \qquad w_{t-1} = \gamma^w + \gamma^S \, SCHOOL_{t-1} + \mu^S_{t-1}$$

$$\text{(3.1b)} \qquad E_\lambda \lambda_{t-1} + E_k k_{t-1} = \gamma^E - \gamma^I \, INCSH_{t-1} + \mu^I_{t-1}$$

$$\text{(3.1c)} \qquad E_\epsilon \epsilon_{t-1} = \gamma^\epsilon + \gamma^N \, NOFRAN_{t-1} + \mu^N_{t-1},$$

where $(\gamma^S, \gamma^I, \gamma^N)$ are positive constants, $(\gamma^w, \gamma^E, \gamma^\epsilon)$ are positive or negative constants and (μ^S, μ^I, μ^N) are *iid* measurement errors. In addition, our dependent variable *RTGROWTH*, as well as *GDP*, may also be measured with error. In Section 3.2, we shall proceed under the assumption that the measurement errors are negligible, but in Section 3.3 we explore whether the results are robust to measurement error. Plugging (3.1) into (2.14) we get the basic equation to estimate

$$\text{(3.2)} \qquad \bar{g}_t = \beta + \beta^w \, w_{t-1} + \beta^I \, INCSH_{t-1} + \beta^N \, NOFRAN_{t-1} + \mu_t,$$

According to our theory, (β^w, β^N) should be positive β^I should be negative and β can be either positive or negative.

3.2 Results

The first set of regressions for our historical sample, were all estimated by ordinary least squares. *Table* 3.2 reports on parameter estimates and summary statistics. Columns (1)–(6) in the table are based on the sample of 38 observations where we have observations for all our variables. The results in columns (7)–(12) are based on a larger sample, where we replaced missing values for *INCSH* (18 observations) and *SCHOOL* (3 observations) by the fitted values obtained by regressions on the independent variables and *GDP*.[10]

The most striking result in columns (1)–(6) is the effect of inequality on growth. Not only are the coefficients on *INCSH* of the expected negative sign and almost always statistically significant—despite the strong collinearity among the right–hand–side variables. But they are also economically significant: an increase by 0.07—one standard deviation in the sample—in the income share of the top 20% lowers the average annual growth rate just below half a percentage point. Differences in distribution alone explain about a fifth of the variance in growth rates across countries and time.

SCHOOL, our index for average skills, has the expected sign, but is never statistically significant.[11]

GDP, the level of per capita income at the start of the period, enters with a negative sign, but is significant only at the 20% level. If we interpret the regression results as a mere description of the data, rather than literally as a test of our theory, the negative coefficient indicates some tendency for growth rates to converge, once we control

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[10]   For *INCSH* the fitted values are $INCSH = 0.5698 - 0.4742SCHOOL + 0.1027NOFRAN$ and $INCSH = 0.5399 - 0.14E{-}04GDP + 0.1412NOFRAN$, and for *SCHOOL* they are $SCHOOL = 0.0552 + 0.030E{-}04GDP - 0.0438NOFRAN$.

[11]   Running the regressions replacing the index with its separate components produces little difference in the results.

Table 3.2: Regressions for *RTGROWTH*

	(1)	(2)	(3)	(4)	(5)	(6)
# OBS	38	38	38	38	38	38
CONSTANT	4.937 (2.290)	4.953 (3.480)	5.244 (2.446)	5.781 (4.675)	4.979 (2.342)	6.656 (3.613)
INCSH	−5.264 (−1.435)	−5.290 (−1.786)	−6.480 (−1.847)	−7.521 (−2.981)	−5.358 (−1.480)	−8.520 (−2.710)
NOFRAN	−1.374 (−1.099)	−1.377 (−1.158)			−1.389 (−1.126)	
SCHOOL	0.031 (0.011)		0.902 (0.309)		4.923 (1.080)	
GDP					−0.21E−03 (−1.415)	−0.62E−04 (−0.645)
$\bar{R}^2$	0.159	0.183	0.154	0.176	0.183	0.162
SEE	1.016	1.001	1.018	1.006	1.001	1.014

	(7)	(8)	(9)	(10)	(11)	(12)
# OBS	56	56	56	56	56	56
CONSTANT	5.051 (3.237)	5.336 (4.025)	5.127 (3.851)	5.458 (5.956)	5.512 (3.062)	5.877 (3.886)
INCSH	−6.077 (−2.100)	−6.458 (−2.245)	−6.256 (−2.839)	−6.729 (−3.934)	−6.760 (−2.117)	−7.350 (−2.969)
NOFRAN	−0.063 (−0.096)	−0.009 (−0.137)			−0.075 (−0.113)	
SCHOOL	0.537 (0.329)		0.556 (0.345)		0.903 (0.505)	
GDP					−0.49E−04 (−0.524)	−0.29E−04 (−0.350)
$\bar{R}^2$	0.180	0.194	0.195	0.208	0.168	0.195
SEE	0.934	0.927	0.926	0.918	0.941	0.926

Note: Ordinary—least—squares regressions, t—values in brackets.

for other factors.[12]

NOFRAN, our measure of political participation, is insignificant with the wrong sign.[13] However, that may just reflect the lack of variation in this variable in a large part of the sample: all observations for 1930 and later are close to zero for all countries. To study the effect of a limited franchise, it is therefore preferable to look at the regressions in columns (7)–(12), where we have an additional 18 observations from earlier periods. In these equations the coefficient on *NOFRAN* indeed drops considerably to take on a value around 0. We conjecture that if we had more observations from the 19th century, we would indeed pick up a significant positive sign.[14]

For the other variables, the results are slightly different to those in the smaller sample. The overall fit of the model now looks somewhat better. In particular, adding *GDP* to the right–hand side adds basically nothing, and there is no indication of convergence in growth rates in the larger sample that covers (on average) 40 extra years of each country's history. Indeed, it is likely that the stronger negative coefficient on *GDP* in the smaller sample largely reflects the effects of World War II. The three countries in our sample on the losing side of that war—Austria, Finland and Germany—have the three highest growth rates in 1950–70 (and in the sample)—4.62, 4.04 and 5.05—as well as the three lowest *GDP* levels in 1950 of all the nine countries.

3.3 Sensitivity analysis

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[12]   This finding is similar to the results found by Barro (1991) and by Mankiw, Romer and Weil (1990) for post–war growth across a broad cross–section of countries.

[13]   We also tried to interact the measure of political participation with the income inequality measure without much success.

[14]   If we run the regression equation (3.2) excluding all observations pertaining to the periods 1930—50, 1950—70, and 1970—85, we obtain (t—values in brackets):

$$RTGROWTH = \quad 4.17 \; - \; 5.48INCSH \; + \; 0.31SCHOOL \; + \; 0.75NOFRAN.$$
$$(1.60) \quad (-1.30) \qquad (0.24) \qquad\qquad (1.14)$$

But the overall fit of this equation is pretty bad: $R^2 = 0.05$.

A relevant question, given that we are dealing with data that go back to the mid 19th century, is how robust our results are to *measurement error*. In addressing this question, we make the conventional assumption in the errors—in—variables literature, namely that the measurement errors—the error terms in (3.2) and the measurement error in *GDP*—are orthogonal to each other and to the unobserved true regressors. We follow the approach of Klepper and Leamer (1984). We start by reestimating the coefficients in column (5) of Table 3.2 by four "reverse regressions", where in each regression we replace the independent variable *RTGROWTH* with one of the dependent variables *INCSH*, *NOFRAN*, *SCHOOL*, and *GDP*. We thus obtain five estimates for each coefficient that can be used as diagnostics. The results show that when we minimize in the direction of *INCSH* and *GDP*, the coefficients on these two variables retain their signs from Table 3.2. But if we minimize in the direction of *SCHOOL* and *NOFRAN* these and other coefficients change sign. Klepper and Leamer's results then imply that the *sign* of the estimated coefficients are robust to error in our measure of inequality (*INCSH*) and *GDP*, but not to measurement error in our measure of average skills (*SCHOOL*) and political participation (*NOFRAN*).

If we assume that only inequality and *GDP* are measured with error, we can compute consistent bounds on the true maximum likelihood estimates for the coefficients on these variables: [−5.35, −86.2] for *INCSH* and [−0.27E−05, −0.21E−03] for *GDP*. Note that the coefficient on *INCSH* in Table 3.2 coincides with the lower maximum—likelihood bound (in absolute value) and the coefficient on *GDP* in Table 3.2 coincides with the upper bound (in absolute value). Thus, if anything, measurement errors tend to bias the results against our theory.

Of the independent variables, income inequality and *GDP* are certainly those that are most likely to be measured with error. The *INCSH* data is based on tax statistics in each country. But different tax laws create problems for cross—country comparisons, both because the income *units* and the income *concepts* may differ. Furthermore, there are

problems with incomplete coverage, particularly in earlier years, imperfectly adjusted for by census data. The *GDP* data in earlier periods are probably mismesured already in the original national statistics. And to get *GDP* levels comparable across countries, we had to make the unbelievable assumption of no relative price movements before 1950.[15]

It is therefore reassuring that our results are robust to errors in these two variables. But are we willing to assume that average skills and political participation are measured correctly by *SCHOOL* and *NOFRAN*, respectively? In the case of *NOFRAN* we do not feel too bad about it, since it is obtained from detailed census data and unambiguous franchise requirements. But the assumption that the measurement error for *SCHOOL* is negligible relative to that in *INCSH* and *GDP* is perhaps stronger.

Note, however, that the formal results above, allow for arbitrarily large measurement errors. In particular, they assume that without measurement error the regression equation would have an R^2 of unity, and that the (squared) correlation coefficient between each observed measure and its true unobservable counterpart is zero. With less formidable prior assumptions about how serious the errors—in—variables problem is, our results become more robust to measurement error and the consistent bounds for the maximum—likelihood coefficients become tighter. For example, Theorem 6 in Klepper and Leamer (1984) implies that the true maximum—likelihood coefficients have the same signs as the coefficients in column (5) *if* the maximum R^2 we would get, once all variables were measured correctly, was less than 0.37. That is, if we are willing to attribute 63% of the variance in *RTGROWTH* to measurement error in that variable or to any unobservable omitted variable, such as the rate of return on the accumulation of knowledge (r in the model), then we can be confident about the sign of the coefficients.

One may also ask if our results are distorted by *simultaneity bias* due to reverse causation. In particular, would not a systematic relation between income inequality and

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[15]   In his discussion about measurement error in cross—country regressions for growth, Romer (1989b) stresses measurement error in GDP.

development—such as the Kuznets curve—give rise to a simultaneity problem? Let us first note that direct reverse causation is ruled out, because *INCSH* is measured in the beginning of each 20—year period, which makes it statistically predetermined relative to *RTGROWTH*. But a systematic relation between inequality and development would make our inequality measure correlated with lagged growth—indeed, our theoretical discussion about growth dynamics in Section 2.4 relied precisely on such a relation. Such a correlation does not cause any econometric problems *a priori*. However, if the residual of the regression is serially correlated, then *INCSH* as well as *GDP* become correlated with the error term, which could bias the estimated coefficients.

Let us explore this possibility in steps. First, is there a systematic relation between lagged growth and inequality? To answer that question, we regress *INCSH* in country i and in (the beginning of) period t on a constant and on *RTGROWTH* in country i and period t−1. This yields (*t*–values in brackets):

$$INCSH_t^i \quad = \quad 0.526 \quad - \quad 0.015 RTGROWTH_{t-1}^i$$

$$(25.507) \quad (-1.660)$$

with $\overline{R}^2 = 0.049$. So there is indeed a marginally significant indication of negative effect of lagged growth on inequality. But the effect is relatively weak: an increase in the growth rate by one standard deviation causes a fall in next periods inequality by a fifth of a standard deviation.

Second, are the growth residuals serially correlated? To answer that question we regress the growth residuals for country i and period t from the regression in column (1) of Table 3.2 on a constant and on the residuals for country i and period t−1.[16] This yields (*t*–values in brackets):

$$\eta_t^i \quad = \quad 0.227 \quad - \quad 0.111 \eta_{t-1}^i.$$

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[16]   We are thus investigating the possibility that the contemporaneous error term in the equation is uncorrelated across countries, but that it has first—order serial correlation with a common AR—1 coefficient across countries. It would be preferrable to consider a less restrictive error structure, but the small number of observations for each country and time period make meaningful generalizations difficult.

$$(1.381) \qquad (-0.729)$$

with $\bar{R}^2 = -0.019$. Thus it seems unlikely that serial correlation is important. A formal Lagrange—multiplier test for absence of serial correlation in the residuals is indecisive at conventional significance levels.[17]

Further evidence is presented in *Table* 3.3. Columns (1)–(3) show regression results when we add the lagged value of *RTGROWTH* (again country by country) on the right—hand—side of our earlier regressions. The coefficients on lagged growth are insignificant, and the other coefficients take on roughly the same values as in Table 3.2, which would be very unlikely if serial correlation was important. Finally, we also present results from two—stage—least—squares regressions, where the instruments are lagged values of *SCHOOL*, *GDP*, and *NOFRAN*. The parameter estimates in columns (4)–(6) again suggest that our results are not due to simultaneity bias.

The instrumental—variables estimates can also be taken as additional evidence on the importance of measurement error. Evidently, the results strengthen our previous conclusion that the estimates are robust to measurement error in *INCSH* and *GDP*.

Let us finally discuss the possible problem that there are *omitted variables* correlated with the regressors. To ask that question we look at whether the residuals show a particular pattern across countries or time. Consider first the variation across countries. When we add a set of country dummies to the regression in colunm (7) of Table 3.2, the coefficient on *INCSH* actually becomes even more negative (−10.50) and stays highly significant (*t*—value −2.76), while the other coefficients remain insignificant. Also, the country dummies add very little explanatory power (the *SSE* drops from 0.934 to 0.927). Only the dummy for Finland, which is positive, is statistically significant. Here, there is

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[17] The test is based on regressing η^i_t on η^i_{t-1} plus all the independent variables in the underlying regression. The $\chi^2(1)$—distributed test statistic is the number of observations times the R^2 of the regression. Its value is 4.725, which tells us to reject the null hypothesis of no serial correlation at the 5% significance level, but not at the 2,5% level.

Table 3.3: Regressions for *RTGROWTH*

	(1)	(2)	(3)	(4)	(5)	(6)
# OBS	35	35	35	35	35	35
CONSTANT	6.347 (4.039)	6.559 (3.241)	5.567 (3.401)	7.696 (3.937)	6.838 (0.936)	7.661 (2.756)
INCSH	—7.872 (—2.699)	—8.266 (—2.321)	—5.707 (—1.769)	—11.651 (—2.869)	—9.774 (—0.791)	—10.946 (—1.837)
NOFRAN			—2.053 (—1.461)			—0.416 (—0.162)
GDP		—0.26E—04 (—0.198)			0.50E—04 (0.161)	
RTGROW—1	—0.132 (—0.825)	—0.107 (—0.527)	—0.176 (—1.100)			
$\overline{R}^2$	0.135	0.107	0.126	0.077	0.048	0.072
SEE	1.055	1.071	1.061	1.090	1.106	1.092

Note: Columns (1)—(3) ordinary—least—squares regressions, columns (4)—(6) two—stage—least—squares regressions, t—values in brackets.

clearly no indication of a potential omitted—variable problem.

Consider next the variation across time. When we add a set of period dummies to the same regression, all coefficients in the regression turn insignificant and the coefficient on *INCSH* becomes positive. Furthermore, the time dummies add considerable explanatory power (the *SEE* drops to 0.749). The dummy for 1950—70 is strongly significant and positive and the dummy for 1970—85 is marginally significant and positive. Thus, our regressions in Table 3.2 seem to predominantly pick up the time variation in the data. Our model ascribes the higher average growth rates in the post—war period to a more equal distribution of income. But naturally, it is possible that income inequality is negatively correlated with some other growth—promoting variable, which is omitted in our model and in our regressions. For instance, the second world war brought about a more equal distribution of income as well as a set of important technological innovations. Our finding that growth is higher in the 1950s than in the 1930s, and that income inequality is lower in 1950 than in 1930, could thus simply reflect the effect of the war, rather than being evidence of a causal nexus betweeen inequality and growth.[18]

4. Current Evidence

4.1 Data

Our sample consists of 67 countries for which we could find reasonable data on income distribution. Each observation corresponds to a country.

Per capita growth. Here, as in Section 3, our dependent variable is the annual average growth rate of GDP per capita, which we call *GROWTH*. The time period

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[18]   It would have been desirable to investigate the cross—time and cross—country variation by random—effects estimation. But meaningful random—effects estimation is difficult because the number of countries and periods in our panel is small. On top of that data becomes available at different dates for different contries, which makes the panel unbalanced.

covered is 1960–85 and the source Summers and Heston (1988). For about half of the countries, the data go back to 1950. In Section 4.3 we report on the results when *GROWTH* is instead defined as the 1950–85 growth rate for those countries where data is available, and the 1960–85 growth rate for the rest. Over the 1960–85 period the mean value of *GROWTH* is 2.26 and it ranges from −2.83 (for Chad) to 7.45 (for Singapore). Summary statistics for this variable, as well as the other variables in the data set appear in *Table* 4.1

Distribution. Like in the historical data set, Gini–coefficients are available only for a small number of countries. We use the measure of income inequality for which we have the largest number of observations, namely the ratio of pre–tax income of the top 20% of the population to that of the bottom 40%. This measure, which we call *RATIO*, is put together from a variety of sources that we list in the Appendix. For about half the sample, we also observe the income share of the top 20% separately, and its correlation with *RATIO* is 0.9. The variable *RATIO* has a mean of 4.28, and it ranges from 1.60 (for Japan) to 13.28 (for Ecuador).

There are at least two problems with this measure. First, it comes from different sources and may thus be constructed on the basis of different criteria for different countries. Its international comparability may thus be questioned. We deal with this problem in the only way we can: we again do some sensitivity analysis of our results against measurement errors. Second, and unlike in the historical data set, *RATIO* is generally measured in the 70's, which is in the middle rather than at the beginning of the period for which we measure the growth rates. Hence, there is a potential problem of simultaneity bias. We deal with this problem by reestimating the model with instrumental variables, where the instruments are measured at the beginning of the relevant time period.

Average skills. Like in the historical data set, we proxy this variable with different measures of education. All observations are from 1960. In most regressions we use the share (in percent) of the relevant age group attending primary school, *PSCHOOL60*. This

Table 4.1: Summary statistics for current sample

	# OBS	MEAN	STD. DEV	MIN	MAX
GROWTH	67	2.256	1.918	−2.827	7.44
GDP60	67	1988	1897	208	7380
RATIO	67	4.284	2.458	1.597	13.846
PSCHOOL60	59	76.406	33.097	5	144
SSCHOOL60	58	24.793	22.153	1	86
URB60	63	39.889	26.300	4	100
IND60	53	26.962	13.664	7	63

CORRELATION MATRIX

	GROWTH	GDP60	RATIO	PSCHOOL60	SSCHOOL60	URB65
GDP60	0.101					
RATIO	−0.15	−0.287				
PSCHOOL	0.534	0.684	−0.119			
SSCHOOL	0.372	0.813	−0.406	0.732		
URB65	0.404	0.728	−0.237	0.748	0.743	
IND60	0.149	0.520	−0.005	0.530	0.415	0.580

measure is available for 59 countries. It has a mean of 16.3 and ranges from 5 (for Niger) to 144 (for France). But we also used another variable, the share attending secondary school, *SSCHOOL60*, and experimented with a weighted education index defined like in Section 3.

Political participation. Our theoretical model in Section 2 identifies the degree to which different income (skill) groups participate in political decisions as a central determinant of growth. Unfortunately, we have not been able to construct any empirical counterpart in the larger sample of countries with its wide span of political institutions. We have data on whether or not the regime is democratic. But according to the model this is not necessarily a correct institutional variable. In the case of a non–democratic regime, we need to now whether it is a dictatorship representing "right–wing" or "left–wing" groups. Moreover, the nature of a regime may be endogenous and may, in particular, depend on the past growth performance (see Londregan and Poole (1989)). Nevertheless, the spirit of our model is to capture policymaking in a democracy. So what we do below is to first run our regressions for the whole cross–section. Then we run them separately for the subsamples of democratic and non–democratic regimes to see if the nature of the regime makes a difference.

Other variables. This sample consist of countries which not only differ in their political institutions, but also in their economic structure and in their cultural traditions. In light of this, we don't want to take the theoretical model in Section 2 too literally in providing an exact empirical specification. To try and control for institutional differences that may explain cross–country differences in growth, we include alternative combinations of the following variables: (*i*) the level of GDP per capita in 1960, *GDP60*; (*ii*) the percentage of the population that lived in urban areas in the year 1965, *URB65*; and (*iii*) the percent of national income originating in the industrial sector in 1960, *IND60*.

To summarize, the regressions we estimate look pretty much like equation (3.2), with the addition of the variables just mentioned and with the exception of a variable (like

NOFRAN) that captures political participation. Like in Section 3, the error term in the regressions also captures unobservable country–specific differences in the rate of return, in addition to any omitted variables.

4.2 Results

Since the theory does not imply a unique specification, we estimated several alternative models. The results are reported in *Table* 4.2. All the regressions in this table were estimated by OLS and the number of observations ranges from 53 to 59, depending on which variables are included. A plot of the data reveals that a log specification may be more appropriate for the income inequality variable. In some regressions—marked by an asterisk in the table—*RATIO* is therfore measured in natural logs rather than in natural numbers.

The results are surprisingly good, given the large variety of countries in the sample. All the variables have the expected sign, they are significant most of the time, and explain up to 40% of the variance in growth.[19] In particular, *RATIO* always has a negative coefficient, as predicted by our model, which is generally significant at the 5% level. The effects of inequality on growth are also quantitatively significant. A one standard deviation increase in inequality decreases growth by just below half a percentage point. This is almost exactly the same number that we obtained in the historical sample of Section 3.

As mentioned above, many countries in this sample are ruled by non–democratic political institutions. In these there may be little relationship between income inequality in the population at large and the redistributive preferences of the government. For this reason, we reestimated the model, dropping from the sample the countries that were not democracies during a significant part of the sample period. The regressions in columns (1)

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[19]   Except for the results on the effects on growth of income inequality, these results are similar to those in Barro (1991), who does not include income inequality in his empirical study.

Table 4.2: Regressions for *GROWTH*

	(1)	(2)	(3)	(4)	(5)
# OBS	59	53	59	59	57
CONSTANT	−0.041	−0.106	0.620	0.424	0.565
	(−0.063)	(−3.475)	(0.800)	(0.567)	(0.827)
RATIO	−0.141	−0.144	−0.923*	−0.807*	−0.698*
	(−1.676)	(−1.633)	(−2.219)	(−2.009)	(−1.628)
GDP60	−0.45E−03	−0.40E−03	−0.49E−03	−0.62E−03	−0.71E−03
	(−3.148)	(−2.398)	(−3.401)	(−4.199)	(−4.345)
PSCHOOL60	0.048	0.520	0.048	0.037	0.031
	(5.794)	(5.498)	(5.951)	(4.096)	(3.306)
SSCHOOL60					0.019
					(1.172)
URB65				0.028	0.025
				(2.405)	(2.159)
IND60		−0.014			
		(−0.721)			
$\bar{R}^2$	0.367	0.369	0.389	0.438	0.438
SEE	1.513	1.553	1.486	1.426	1.363

Note: Ordinary—least—squares regressions; *t*—values in brackets;
a * means that variable is measured in natural logs.

and (2) of *Table* 4.3 are based on a subsample, which consists only of those countries that were democracies for at least 75% of the years between 1960 and 1985. The results are very similar to those obtained for the full sample (see the results in Table 4.2), except that the coefficient on income inequality rises in absolute value and becomes strongly significant. Columns (3) amd (4) report the results when we reestimate the same regressions for the subsample of non–democratic countries. Now the coefficient on income inequality instead drops considerably and becomes insignificant. But the coefficients on all other variables remain unaffected. Similar results are obtained for specifications other than those reported in the table. The results are also similar if we use a less restrictive criterion for being in the sample of democratic countries (such as being a democracy for at least 50% of the period). These results are clearly in line with our model: being a democracy should make a difference for the effect of income inequality on growth, but not for the other variables which refer to features of the economy. This different effect of inequality on growth between democratic and non–democratic countries also indicates that our findings are not due to reverse causation or to some other non–political mechanism. But more on this in the next subsection.

4.3 Sensitivity analysis

We mentioned in Section 4.1 that *RATIO* is often measured in the middle of the period 1960–85. To remove any *simultaneity bias*, we reestimated the regressions in Table 4.2 by two–stage least squares (2SLS). In all specifications, our instruments for *RATIO* were: the percentage of the labor force in the agricultural sector in 1960, the male life expectancy ratio in 1960, and the independent variables *GDP60*, *PSCHOOL60*, and *SSCHOOL60*. We believe these are pretty good instruments. They capture different aspects of the economic and social structure of a country and are likely to be correlated with income inequality. On the other hand, since the instruments are all measured in 1960 and most of them belong to the regressors in the *GROWTH*–equation, they are unlikely to be

Table 4.3: Regressions for *GROWTH*

	(1)	(2)	(3)	(4)
# OBS	37	34	22	22
CONSTANT	0.645 (0.624)	0.644 (0.572)	—0.261 (—0.340)	—0.025 (—0.265)
RATIO	—0.273 (—2.450)	—0.294 (—2.402)	—0.017 (—0.136)	—0.055 (—0.409)
GDP60	—0.46E—03 (—3.283)	—0.45E—03 (—2.402)	—0.19E—02 (—3.009)	—0.18E—02 (—2.538)
PSCHOOL60	0.048 (4.721)	0.045 (3.857)	0.062 (3.406)	0.071 (3.372)
IND60		0.012 (0.504)		—0.026 (—0.837)
$\bar{R}^2$	0.490	0.428	0.353	0.349
SEE	1.394	1.459	1.445	1.496

Note: Ordinary—least—squares regressions; *t*—values in brackets.

correlated with the error term of that equation.

The first three columns in *Table* 4.4 report on the 2SLS–estimates. We see that the results are very similar to those in Table 4.2, except that the variable *RATIO* has an even higher *t*–statistic. The results are very robust to changing the set of instruments and to other specifications of the *GROWTH*–equation. As before, measuring *RATIO* in logs improves the fit. The last column in Table 4.4 restimates the regression of column (2) for the restricted sample of countries that were democracies for at least 75% of the time. Here, the results do not change. But for the sample of excluded non–democratic countries (not reported in the table) the estimated coefficient of income inequality drops and becomes insignificantly different from zero, whereas the other coefficients remain the same. Similar results are obtained if we redefine this sample as consisting of countries that were democracies for 50% (as opposed to 75%) of the time.

An examination of the residuals reveals that there are no critical outliers.[20] However, the estimated residuals tend to be larger in absolute value for the countries with lower per capita income in 1960. Performing the White (1980) test, indeed reveals that *heteroskadasticity* is present. We therefore reestimated the model, still by 2SLS, but weighting each observation with *GDP60*. The results for two such specifications appear in columns (4) and (5) of Table 4.4. The results are now even more supportive of the theoretical model: the *t*–statistics increase further in absolute value. Other specifications, not reported in the table, share the same features.

Like in section 3, it is likely that several regressors and particularly *RATIO* are measured with error. Even though the instrumental–variables results suggest that *measurement error* in *RATIO* is not a significant problem, we nevertheless apply the techniques of Klepper and Leamer (1984) to check the robustness of our results. Consider

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[20]   Except for Hongkong and Singapore that have an exceptionally large value for *URB65*. But there is no good reason for dropping these two countries and in any event they do not affect the estimated coeffiecient on the variable of most interest, *RATIO*.

Table 4.4: Regressions for *GROWTH*

	(1)	(2)	(3)	(4)	(5)	(6)
# OBS	56	50	50	50	50	34
CONSTANT	2.540 (1.393)	3.421 (2.098)	4.182 (2.020)	5.340 (2.257)	5.164 (2.385)	2.823 (1.388)
RATIO	—0.621 (—1.936)	—0.767 (—2.195)	—3.050* (—2.626)	—0.778 (—2.751)	—2.729* (—2.789)	—0.667 (—2.200)
GDP60	—0.81E—03 (—3.460)	—0.73E—03 (—2.486)	—0.66E—03 (—2.937)	—0.58E—03 (—2.891)	—0.49E—03 (—3.298)	—0.63E—03 (—2.706)
PSCHOOL60	0.041 (3.201)	0.050 (3.450)	0.012 (4.125)	0.026 (1.776)	0.032 (2.597)	0.037 (2.482)
URB65	0.022 (1.383)					—0.71E—03 (—0.050)
IND60		0.028 (0.038)	—0.007 (—0.297)	—0.010 (—0.491)	—0.017 (—0.007)	0.033 (1.053)
$\bar{R}^2$	0.296	0.225	0.323	0.253	0.336	0.355
SEE	1.842	2.180	1.768	82.989	66.106	1.676

Note: Two—stage—least—squares regressions; in columns (4) and (5) observations are weighted
with *GDP*; *t*—values in brackets; a * means that variable is measured in natural logs;
Column (6) refers to countries that were democracies at least 75 % of the period.

first the most parsimonious specification in Table 4.2 (columns (1) and (3)). When we regress the equations in all directions, as in Section 3, all the variables retain their signs. We can therefore conclude that the true maximum—likelihood estimators lie in the convex hull of the estimates so obtained. In particular, the coefficient on *RATIO* lies in the intervals:

(1)	(3)
[−2.908, −0.141]	[−11.228, −0.929],

where the number in brackets refer to the columns of Table 4.2. Note that in both cases the least—squares estimator coincides with the upper bound (algebraically). Thus if anything, the measurement error tends to bias the coefficient on *RATIO* towards zero and thus against our theory. We obtain similar results for the other specifications in Table 4.2, provided that we maintain the assumption that only *RATIO*, *PSCHOOL60*, and *GDP60* are measured with error.

For about half the countries in the sample, we have GDP—data from 1950. For these countries, we redefined *GROWTH* to be the average growth rate over the period 1950—85 and replaced *GDP60* with per capita GDP in 1950. For the remaining countries these variables remained as before. When we pooled all the countries and reestimated the equations in Tables 4.2 and 4.4, the results were very similar. Again the coefficient on *RATIO* was always negative and often significant at the 5% level.

To gain observations, we also added to our sample 12 countries for which *RATIO* is available only for post—tax income. We then interacted *RATIO* with a dummy that takes a value of unity for the added countries and zero for the original countries. Again the results were similar to those reported above, and the interacted dummy was always insignificantly different from zero.

The results are also robust to slight variations in the sample of countries and to redefining the measure of income inequality as *INCSH* in the previous section.

All this sensitivity analysis strongly indicates that our results are not due to

measurement error, to particular features of the sample, or to reverse causation. We are left, however, with one possibility. We have already stressed that our sample includes countries with very different institutions, and despite our attempts to control for these differences *RATIO* may pick up the effect of some *omitted variable.* Indeed, a careful examination of the residuals reveals a systematic pattern: the Latin American countries tend to have negative residuals, while the Asian countries tend to have positive residuals. So the wide social, political and economic differences between these continents may not be adequately captured by the variables we have included on the right–hand side of our regressions.

For this reason, we added three continental dummies—for Asia, Africa and Latin America—to the previous regressions. Their effect depends on the method of estimation. In the OLS estimations the dummy variables are generally significant. The coefficient on *RATIO* remains negative, but its t–statistic drops to a value close to zero. This is because our inequality measure is higher in Latin America and lower in Asia, compared to the rest of the sample. On the other hand, in the 2SLS estimations the results remain supportive of our hypothesis: even though the t–statistics on *RATIO* drop relative to Table 4.3, they remain significant at the 10% level.

5. Discussion

5.1 Main results

Drawing on the theories of endogenous economic growth and endogenous economic policy, we formulated a model that relates equilibrium growth to income inequality and political institutions. The main theoretical result is that income inequality is harmful for growth, because it leads to policies that do not protect property rights and do not allow full private appropriation of returns from investment. This implication is strongly supported by the

historical evidence of a narrow cross—section of countries, and by the post—war evidence from a broad cross—section of countries.

5.2 Possible extensions

This paper may serve as a stepping stone for further theoretical and empirical work along similar lines. Natural theoretical extensions include: (1) A richer political structure: it would be desirable to let both young and old vote each period. This would require that the youngs' behavior were affected by policy in some additional way. (2) A richer policy problem: it would be interesting to add incentive problems in policy due to lack of commitment in capital taxation or patent legislation, as well as to allow the government to spend the tax proceeds in other ways besides lump sum redistribution.[21] (3) A richer savings behavior: suppose that the individual savings rate depend on the individual income level, so that people with with sufficiently low income do not accumulate any k. This may change the prediction that income inequality is monotonically related to growth: at very low levels of development, redistributing income towards the rich may increase aggregate savings and hence lead to more rapid growth, if the rich have a higher marginal propensity to save than the poor.[22] (4) A richer intertemporal structure: suppose that the voters' horizon extends beyond two periods (because they are altruistic or because of a different intergenerational structure). Suppose further that the current policy affects the future distribution of income, by changing the distribution $F(\cdot)$ in the model. Then the voters would face an interesting intertemporal tradeoff: more redistribution today, by changing the preferences and possibly the identity of the future political majorities, could lead to policies more conducive to growth in the future. Thus there would be a tradeoff between slower growth today in exchange for more rapid growth in the future. This

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[21] Alesina and Rodrik (1990) study how a social planner with redistributive objectives chooses among redistribution and public investment in a model related to ours.

[22] Perotti (1990) addresses this question in a model with three different kinds of agents who vote on tax policy.

extension would be technically demanding. But it would enable one to tackle the difficult normative questions raised at the end of Section 2.4, about how to induce a growth take off and how to design beneficial political institutions.

Finally, the natural extensions of the empirical analysis include: (5) Allowing for population growth; this would be straightforward in the theoretical part, but it could lead to different empirical predictions. (6) Adding more countries, particularly in the historical sample. While we think we have exhausted the available data for Europe and the US, it may be feasible to add Canada, Australia and Japan to our historical sample. (7) Attempting to discriminate between our hypothesis, that income inequality affects growth through a political mechanism, with other competing hypotheses. We believe that our statistical evidence is robust, in the sense that the causality runs from inequality to growth and that our results are not due to reverse causation. But there may be other purely economic reasons why inequality is harmful for growth.[23]

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[23]   Alternative, purely economic, reasons for why inequality might be harmful for growth have been analysed in Murphy, Vishny and Shleifer (1989)—who look at the composition of demand—and Galor and Zeira (1990)—who look at imperfect credit markets. In the ambitious model of Greenwood and Jovanovich (1990) income distribution and growth become correlated over time due to financial development.

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Appendix

A.1 Going from the model to testable hypotheses

Given the definition of GDP in the text, the gross growth rate of GDP is

$$(A.1) \qquad 1 + \bar{g}_t = (w_t + r_t)k_t/(w_{t-1} + r_{t-1})k_{t-1}.$$

To get an approximation of the net growth rate $\bar{g}_t$, first take logs in (A.1) to get

$$(A.2) \qquad \bar{g}_t = (w_t/(w_t + r_t))\ln w_t - (w_{t-1}/(w_{t-1} + r_{t-1}))\ln w_{t-1}$$
$$+ (r_t/(w_t + r_t))\ln r_t - (r_{t-1}/(w_{t-1} + r_{t-1}))\ln r_{t-1} + g_t.$$

Then make a first—order approximation of (2.11) to get:

$$(A.3) \qquad g_t = (G_w + G_\theta \theta_w)w_{t-1} + (G_r + G_\theta \theta_r)r_t + G_\theta \theta_E(E_k k_{t-1} + E_\lambda \lambda_{t-1} + E_\epsilon \epsilon_{t-1}).$$

Now, given the assumptions in (2.13), we can use (A.2) and (A.3) to derive

$$(A.4) \qquad \bar{g}_t = \alpha_{0t} + \alpha_{wt} w_{t-1} + \alpha_{Et}(E_k k_{t-1} + E_\lambda \lambda_{t-1} + E_\epsilon \epsilon_{t-1}) + \eta_t,$$

where

$$\alpha_{0t} = (r_{t-1}/(w_{t-1} + r_{t-1}))^{-1}(G_r + G_\theta \theta_r)\exp(\ln \bar{r})$$

$$\alpha_{wt} = (r_{t-1}/(w_{t-1} + r_{t-1}))^{-1}(1 + G_\theta \theta_w)$$

$$\alpha_{Et} = (r_{t-1}/(w_{t-1} + r_{t-1}))^{-1} G_\theta \theta_E$$

$$\eta_t = (r_{t-1}/(w_{t-1} + r_{t-1}))^{-1} \{(w_{t-1}/(w_{t-1} + r_{t-1})\eta_t^w + (r_t/(w_t + r_t))\eta_t^r -$$
$$(r_{t-1}/(w_{t-1} + r_{t-1}))\eta_{t-1}^r + [(r_t/(w_t + r_t)) - (r_{t-1}/(w_{t-1} + r_{t-1})]\exp(\ln \bar{r})$$
$$+ (G_r + G_\theta \theta_r)\exp(\eta_t^T) + [(w_t/(w_t + r_t)) - (w_{t-1}/(w_{t-1} + r_{t-1}))]\ln w_t.$$

If we ignore the (unobservable) time variation in the coefficients and in the variance structure of the error term in (A.4) we obtain equation (2.14)

A.2 Sources for the historical data set

RTGROWTH: Average rate of growth of real GDP over 20—year periods, continuously compounded. *Sources:* Maddison (1982) for the period 1830—1950 and Summers and Heston for the period 1950—85.

GDP: Level of GDP per capita in the first year of each 20—year period. *Sources:* Maddison (1982) for the period 1830—1950 and Summers and Heston for the period 1950—85. The 1950—indexes computed from Maddison were spliced with the 1950—values from Summers and Heston to get compatible series.

INCSH: Share of pre—tax income received by the top 20% of the population. Computed from tax statistics and sometimes adjusted for incomplete coverage on the basis of census data. We only used sources with a wide original coverage, however. The income units and income concepts may vary across countries due to different tax laws. All observations except a few are close (5 years or less) from the beginning of the relevant 20—year period. *Sources:* For UK 1870, 1890, 1910, Lindert and Williamson (1985); for the Netherlands 1910, 1930, 1950, 1970, Hartog and Veenbergen (1978), for the US 1930, 1950, Department of Commerce (1975); US 1970, Jain (1975); for all other observations, Flora, Kraus and Pfennig (1987, Ch. 6)

NOFRAN: Share of the enfranchised sex and age group not in the electorate at the year of the election closest to the beginning of the relevant time period. Computed from data on electoral rules and from censuses. *Sources*: for the US (presidential elections), Mackie and Rose (1982) and Department of Commerce (1975); for all other countries (parlamentiary elections) Flora (1983, Ch. 3)

SCHOOL: Index of education computed as

$$0.1PSCHOOL + 0.2LSSCHOOL + 0.3HSSCHOOL + 0.4UNIV,$$

where each component of the index and their sources are described below.

PSCHOOL: Share of 5—14 age group enrolled in primary school. Computed from detailed data on different types of schools and population data from censuses. *Sources*: for the US, Department of Commerce (1975), for all other countries Flora (1983, Ch. 10)

LSSCHOOL: Share of 10—14 age group enrolled in post—primary school and lower secondary school. Computed from detailed data on different types of schools and population data from censuses. *Sources*: for the US, Department of Commerce (1975), for all other countries Flora (1983, Ch. 10)

HSSCHOOL: Share of 15—19 age group enrolled in higher secondary school. Computed from detailed data on different types of schools and population data from censuses. *Sources*: for the US, Department of Commerce (1975), for all other countries Flora (1983, Ch. 10)

UNIV: Share of 20—24 age group in universities and institutes for higher education. Computed from detailed data on different types of schools and population data from censuses. *Sources*: for the US, Department of Commerce (1975), for all other countries Flora (1983, Ch. 10)

A.3 Sources for the current data set

GROWTH: Average rate of growth in real GDP per capita over 1960—85, continuously compounded. *Source*: Summers and Heston (1988)

GDP60: Real GDP per capita in 1960, expressed in "international $". *Source*: Summers and Heston (1988)

PSCHOOL60: Percentage enrolled in primary school out of relevant age group in 1960. *Source*: World Bank (1984).

SSCHOOL60: Percentage enrolled in secondary school out of relevant age group in 1960. *Source*: World Bank (1984).

URB65: Urban population as a percentage of total population in 1965. *Source*: World Bank (1984).

IND60: Percentage of GDP originating in the industrial sector in 1960. *Source*: World Bank (1984).

RATIO: Ratio of pre—tax income received by the richest 20% of the population to the pre—tax income received by the poorest 40% of the population. It is computed from several sources: UN (1981), UN (1985), Jodice and Taylor (1983), Jain (1975) and World Bank (1987). This ratio generally refers to different years for different countries. Most often it refers to households, but sometimes to individuals. Also, in some cases it was not reported whether it refers to income before or after tax.

In the instrumental—variables regressions we also used the following variables taken from World Bank (1984): Male life expectancy ratio in 1960, Percentage of labor force in the agricultural sector in 1960.

</ref_section>