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INEQUALITY AND GROWTH: A NOTE ON RECENT THEORIES

Cecilia GARCIA PEÑALOSA*
Oxford University

In this paper I review a series of articles that examine whether there exists a causal relationship between income or wealth inequality and long-run output growth. There have been two different approaches. One of them concentrates on political decisions about redistribution (the political mechanism). The other examines how inequality affects individuals' opportunities to invest in education and how these investments, in turn, determine growth rates (the educational mechanism). The first group of models obtains an inverse relationship between inequality and growth, while the human capital models find less clear-cut results.

1. Introduction

There is a strand of economics, started by Kuznets in 1955, which has not received the attention that its political and social implications would seem to demand. Growth and equality are probably the most desirable economic attainments for any society. The questions are, then, how do they interact? Is there a tradeoff between the two or are they brought about by the same policy choices? Can we explain the bell-shaped relationship between inequality and growth found by Kuznets? Which way does causality run?

Orthodox growth theory did not address these questions, probably due to the absence of formal models in which to examine them. Many of the ideas used by current authors were already in the literature: different saving ratios for workers and capitalists [Kaldor (1961)], the role of population composition and growth [Kaldor (1966)], technical change [Arrow (1962)] or R&D [Shell (1973)]. It has been the formalization of endogenous growth theories in recent years what has provided us with the necessary framework. In these models saving decisions and the level of education of workers play a fundamental role, and thus allow us to examine the channels through which the degree of income and wealth inequality in an economy can influence its long run rate of growth.

Recent literature on distribution and growth has examined two possible links between them: redistributive taxation and investment in education.

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These studies combine the theories of endogenous growth and endogenous policy[1]. Endogenous policy theory specifies a government's objective function and defines equilibrium policy as the optimal choice given its objective and a set of constraints. The concept of endogenous growth has given rise to models where there is a feedback from economic activity to technical progress and knowledge, so that growth can be sustained in the absence of an exogenous productivity trend. As a result, a reduction in capital accumulation typically results in a lower rate of growth, rather than simply a lower level of activity as predicted by traditional growth models. The other important feature of the new growth theories is the role played by the accumulation of knowledge and skills. The models here reviewed see capital accumulation or education as the channels through which inequality may affect growth.

We first of all present a model that will serve as the framework in which to discuss the various theories. Section 3 examines the papers that analyze the interaction of politics and economics when there is a conflict over the size distribution of income. This is what we call the «political mechanism». The two models in the area, Alesina and Rodrik (1991) and Persson and Tabellini (1992a, 1992b), show that, in so far as taxation has a negative impact on capital accumulation, inequality will harm growth. Section 4 reviews the human capital models (the «educational mechanism»), where the conclusions are not so clear-cut. We consider the work by Galor and Zeira (1993), Glomm and Ravikumar (1992), Saint-Paul and Verdier (1992a, b, c), García Peñalosa (1993) and Perotti (1993). These models emphasise the role of capital market imperfections and their effect on education opportunities. When individuals are allowed to vote on whether to have a public or a private education system, a U-shaped relationship between inequality and growth results. Section 5 examines the two existing pieces of empirical evidence. Section 6 concludes.

2. A Simple Model

In this section we sketch a model in which both the political and the educational mechanisms can be analyzed[2]. The starting point is Romer (1990). This is an endogenous growth model, in which both consumption decisions and the stock of human capital play a major role in the determination of the rate of growth.

The basic idea in the model is that growth is driven by technological change that arises from intentional investment decisions made by agents who respond to market incentives. It is in this sense that technological change, and therefore growth, are endogenous. The technology is, on the

[1] See Romer (1989) and Sala-i-Martin (1990) for reviews of endogenous growth theory, and Persson and Tabellini (1990) for a survey on endogenous policy.

[2] The model is fully developed in García Peñalosa (1993), and the two channels of influence of inequality on growth are examined.

one hand, an output from resources (human capital) put into the R&D process. On the other, it is an input in the research process (see equation [1] below), with the distinguishing feature that it is a nonrival good. This nonrivalry stems from the fact that once something has been invented, there is no cost in making use of it. In Romer's model, new knowledge takes the form of new designs for capital goods, which are then used in the production process. Each design increases our knowledge of the world and thus makes it easier to invent new designs[3]. Nonrivalry implies knowledge spillovers and therefore increasing returns to scale, which is what makes unbounded growth possible.

The driving force of the model is thus that human capital is employed in the R&D sector in order to produce new designs, D. Designs evolve according to the following equation:

$$\dot{D} = zH_1D \qquad [1]$$

where z is the productivity of researchers, and H_1 the number of researchers, i.e. the human capital employed in the R&D sector.

The final-output sector is competitive and has a Cobb-Douglas production function

$$Y = H_2^a L^b \int_0^D x_i^{1-a-b}\, di \qquad [2]$$

with $a + b < 1$. L is the stock of unskilled labour, which is exogenous and fixed. H_2 is the human capital employed in the final output sector. The total stock of human capital, H, is divided between the two sectors so that $H = H_1 + H_2$. H is also exogenous, but the level of employment in each sector is determined within the model by equality of the marginal product of human capital in research and production. The x_i's are the different capital goods. Each i corresponds to a different design. The new designs do not make previous ones obsolete. In fact, at each point in time new and old designs are simultaneously being used, and consequently there are D types of capital goods. It is this variety of techniques that makes the economy grow. For simplicity, we assume that for each design i the same amount of capital goods is produced. Then we can write the total stock of capital as $K = Dx$, and think of the term under the integral sign as a measure of the capital stock adjusted for the number of different designs. The aggregate production function can be written as

$$Y = H_2^a L^b Dx^{1-a-b} = (DH_2)^a (DL)^b K^{1-a-b} \qquad [3]$$

Given that the capital stock is proportional to the stock of designs, they both grow at the same rate, the rate of creation of knowledge. Moreover, from equation [3] we see that output will also grow at this rate. This means that the rate of growth of output will be proportional to the stock of human capital employed in the research sector

[3] «The inventor of the widget has no ability to stop the inventor of the wodget from learning from the design of the widget», Romer (1990), p. S84.

$$\hat{Y} = \hat{D} = zH_1 \qquad [4]$$

where the hat indicates the proportional rate of change.

To solve the model we need to find the division of total human capital between the two sectors. This is done by imposing the labour-market equilibrium condition that skilled wages be the same in the two sectors (see the original article for the formal derivation). We then obtain the following expression for the rate of growth of output:

$$\hat{Y} = zH - \theta r \qquad [5]$$

Growth is faster the greater the productivity of researchers and the larger the stock of human capital. It falls with the interest rate, as a higher interest rate increases the cost of borrowing to purchase a new design. This will result in the substitution of capital for skilled labour, hence increasing employment in the final output sector and reducing it in the R&D sector. θ is a parameter that depends on a and b.

On the consumption side of the economy, agents maximize their utility over an infinite lifetime subject to their budget constraint. The utility function is assumed to be logarithmic, $U(c_i) = log(c_i)$. Let ε be the rate of time preference. Then the optimisation problem for individual i is

$$\max \int_0^\infty U(c_{it})\, e^{-\varepsilon t}\, dt \qquad [6]$$

subject to

$$c_{it} + \dot{k}_{it} = w_{it} + rk_{it}$$

Hence, the optimal rate of growth of consumption is given by the Ramsey equation

$$\hat{c} = r - \varepsilon \qquad [7]$$

Equation [7] tells us that the rate of growth of consumption is equal to the difference between the return on savings, r, and the rate of time preference.

In the steady state, consumption and output must grow at the same rate, hence equating [5] and [7] we obtain the equilibrium rates of growth and interest

$$g^* = \frac{zH - \theta\varepsilon}{1 + \theta} \qquad [8a]$$

$$r^* = \frac{zH + \varepsilon}{1 + \theta} \qquad [8b]$$

Graphically we can depict the consumption and output growth schedules in the (r, g) space. The steady state will be the point of intersection between the two. Each of the two mechanisms that we are going to examine will have an impact on one of the schedules: the political mechanism operates through

the impact of taxes on the path of consumption (equation [7]), while the educational mechanism is going to determine the total stock of human capital and thus shift the output growth schedule (equation [5]).

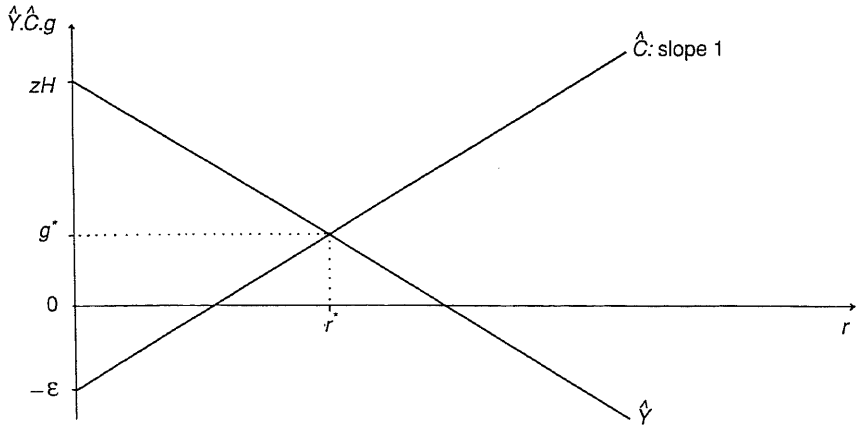

Figure 1
The Steady State Growth Rate

3. The Political Mechanism

Alesina and Rodrik (1991) study the relationship between distributive conflicts and economic growth. In the simplest version of the model there are three sorts of agents: workers (who do not save), capitalists, and the government. The aggregate production function includes government investment in infrastructure as a factor of production[4]. The government sets a tax rate on capital, τ, and decides what proportion, λ, of the revenue to transfer to workers and how much to devote to the provision of infrastructure. The rate of growth of output is decreasing in λ and a concave function of the tax rate. Concavity is due to two opposing effects: a higher tax reduces capital accumulation and hence the income of capitalists, but a lower capital stock increases the marginal product of capital and partially offsets the reduction in their income. Alesina and Rodrik show that there exists a positive tax rate τ^* that maximizes growth.

Workers prefer a tax above τ^* and transfers, even when they fully internalize the future benefits of capital accumulation. The reason is that a slight increase in the tax rate from τ^* has a first-order effect on the level of consumption of workers and only a second-order effect on the rate of growth. The analysis implies that welfare and growth are not equivalent as long as the government cares about workers' utility. Hence, maximizing welfare requires a tax rate higher than τ^*. The greater the weight given to workers' welfare the more the growth rate deviates from its maximum.

[4] As in Barro (1990).

They extend the model to a continuous distribution of wage and capital incomes. Each individual's preferred tax depends on the ratio of its share of labour income to its share of capital income, the preferred tax being higher the lower the ratio is. Assuming the tax is chosen by majority voting, the median voter result holds and the tax rate depends on how much below the average share the median share is. Alesina and Rodrik conclude that in a democracy, there is an inverse relationship between wealth inequality (defined as the distance between the median and the mean) and the rate of growth of the economy.

Persson and Tabellini (1992a, 1992b) obtain a similar result using the distribution of income rather than of wealth. They assume overlapping generations that live for two periods. Individuals work on the first period and accumulate an asset k, that pays an exogenous rate of return r on the second period. Income inequality stems from the fact that an individual's skill endowment deviates from average skills by an individual specific term, e_i. e_i has mean zero and median less than zero. The utility function is assumed to be homothetic, which implies that individuals accumulate capital in direct proportion to their first-period income. A proportional tax is levied on the capital income received when old, all the revenue being used for redistribution. Individuals with above-average capital (i.e. above-average income when young) face a net tax, those with below-average income face a net transfer. Consequently, the lower his income relative to the average, the more the individual benefits from the tax. Growth is endogenous because the capital accumulated by the previous generation, k_t, affects the income of the generation born at time t.

Consider a democracy where the tax rate is chosen by majority voting. If preferences are single-peaked, the political equilibrium will be determined by the preferences of the median voter. The lower the median individual's income relative to mean income the more he gains from redistribution and the higher the equilibrium tax. The rate of capital accumulation is strictly decreasing in the tax rate because, since the rate of return is now exogenous, the offsetting effect studied by Alesina and Rodrik is absent. The equilibrium growth rate is, thus, a decreasing function of income inequality.

In our model, the political mechanism operates through the impact of redistributive policies on the budget constraint. Suppose that all income is taxed at rate τ, and that the revenue is distributed equally among all individuals. Then, if w and k are the average wage and capital holdings, the budget constraint in [7] becomes

$$c_i + \dot{k}_i = (w_i + rk_i)(1 - \tau) + \tau (w + rk) \qquad [9]$$

Under the assumption of an inelastic labour supply, the resulting dynamic equation for consumption is

$$\hat{c} = r(1 - \tau) - \varepsilon \qquad [10]$$

The tax on capital income reduces the return to saving and hence discourages capital accumulation, which in turn reduces the rate of growth[5]. The new steady state rate of growth is

$$g^* = \frac{zH(1 - \tau) - \theta\varepsilon}{1 + \theta} \qquad [11]$$

Graphically the effect of the tax is to tilt downwards the consumption growth schedule, leading to slower growth.

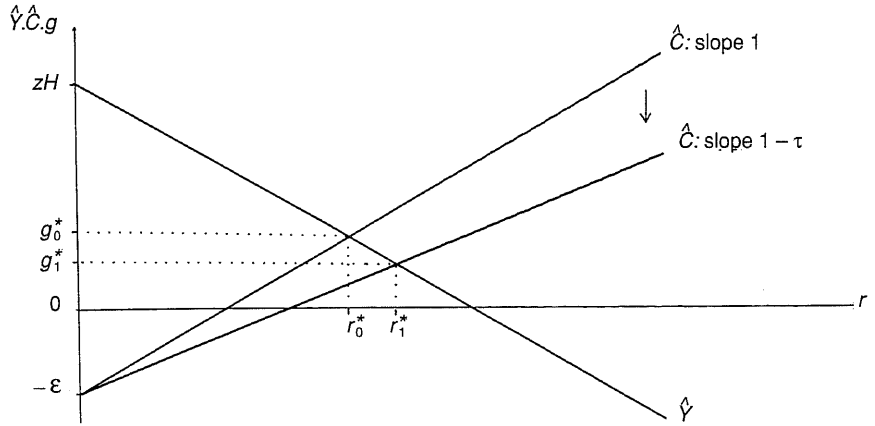

Figure 2
The Political Mechanism.

Majority voting over only one tax rate implies single peaked preferences and the median voter result. Hence the equilibrium tax rate is determined by the median individual's «preferred tax rate». What the political-mechanism models do is to assume that individuals maximize their utility with respect to τ, subject to the budget constraint. This results in a preferred tax rate which is greater the lower the individual's income relative to average income. Both Alesina and Rodrik (1991) and Persson and Tabellini (1992b), argue that since a possible measure of inequality is the median to mean ratio, there exists an inverse relationship between inequality and growth.

The two models attain the same result. Note that in both of them only wealth is taxed, hence the link that Persson and Tabellini make between taxes and income is due to wealth always being proportional to income. Moreover, the real damage in the two models comes from not definig the tax base as expenditure. The major discrepancy between the two papers is the possibility of forms of government spending other than redistribution

[5] We assume that the individual's supply of labour is given and independent of the net wage.

in Alesina and Rodrik, which changes the value of the equilibrium tax rate but has no policy implications whatsoever. A second difference is the absence of an aggregate production function in the Persson and Tabellini model. Income and wealth distributions are exogenously given and invariant in both analyses. None of them considers the dynamics of income distribution, which is something that some of the human capital models try to explain.

4. The Educational Mechanism

Human capital models draw on the emphasis placed by the endogenous growth literature on skill and knowledge acquisition. The impact of inequality on growth via human capital investment has been studied from two, related, points of view. When individuals vote on whether or not to have a public education system, greater inequality may lead to more public education, increased human capital and faster growth. The difference with the political-mechanism models is that now the type of redistribution implemented is growth-enhancing, while income transfers per se had no impact on growth rates. When education is privately purchased, the degree of inequality determines the number of people that can afford education. Generally, these models predict a negative correlation between inequality and growth, although García Peñalosa (1993) and Perotti (1993) point out the cases in which the reverse may hold.

The educational mechanism is concerned with the $\hat{Y}$ equation in our model. Suppose that only the total stock of labour, L, is fixed, and that this labour force is divided into skilled and unskilled workers, L_s and L_u respectively. Then the human capital stock will be

$$H = hL_s \qquad [12]$$

where h is the level of skills of an educated worker[6]. Clearly, the larger L_s and h are, the faster growth will be. In the diagram, an increase in human capital is represented by an upward shift of the $\hat{Y}$ schedule (see Figure 3). The introduction of finite lives and bequests does no affect the dynamic consumption path, as the concern about their offsprings and the bequest motives makes individuals behave *as if* they were infinitely lived, which is all we need for the Ramsey equation to hold.

The relevant question is how the number of skilled workers and their level of skills are determined. Because education is costly, parents' wealth is going to affect a child's education. If it is possible to vote on whether to have a public or a private education system, the distribution of wealth will determine the society's choice between the two systems.

Glomm and Ravikumar (1992) examine the different outcomes under private and public education systems, and when would each be chosen. It is a

[6] We assume that skills are acquired only through formal education.

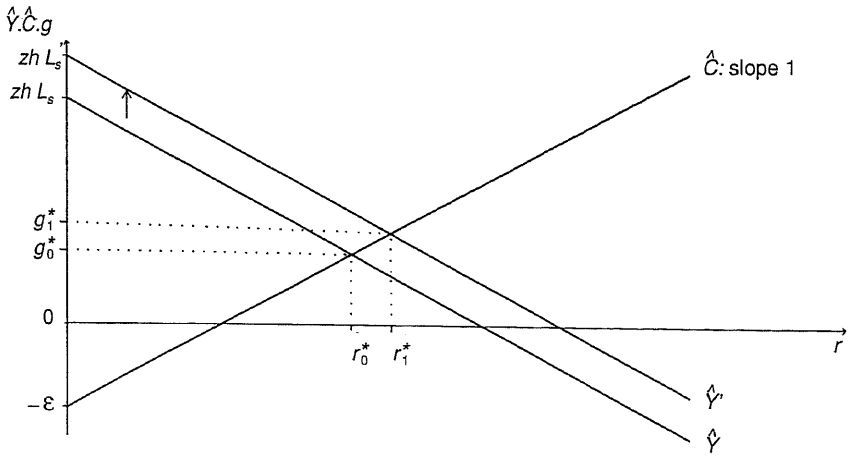

Figure 3
The Educational Mechanism.

partial equilibrium analysis with no specific production fuction. Aggregate output is simply equal to the total stock of human capital. Like in all the models here reviewed, learning occurs solely through formal schooling. Their crucial assumption is a function of the accumulation of human capital in which an individual's human capital depends on the amount of leisure he takes when young, n_t, his parent human capital, h_t, and the school quality, e_t. Then

$$h_{t+1} = \alpha (1 - n_t)^{\beta} e_t^{\gamma} h_t^{\delta} \qquad [13]$$

The necessary condition for persistent growth is that the learning technology must exhibit non-decreasing returns to the last two inputs.

The bequest in this economy is school quality. The individual has an income h_t, which he divides between consumption and paying for a school for his offspring (the better the school the higher its cost). Hence, there are two incentives to accumulate human capital: a direct one and an indirect one through e_t, as the more time an individual spends in education the greater the bequest to his offspring is. Under public education, all individuals have access to the same school quality, hence the indirect effect disappears and individuals have less incentives to accumulate human capital. The resulting aggregate stock of human capital is lower and this reduces the rate of growth under public education, relative to a private education system. However, such an effect is partially offset since public education has a strong redistributive impact that allows poor individuals to get better school quality than otherwise. This could lead to a higher average school quality than the one that would have been chosen under private education, and thus to faster growth. In general, private education leads to faster growth. Only if the initial income inequality is sufficiently high will the public-education economy yield higher per capita income than the private education economy.

In a democratic society, the choice of educational regime is determined by parents voting on the regime and the tax rate imposed to finance it. Societies in which the median voter is below the mean will choose a public education system. The resulting relationship between inequality and growth is U-shaped: very unequal societies will choose public education, which will accelerate growth relative to the private education situation; less unequal societies where the median is still below the mean will choose public education but, in this case, it will reduce the rate of growth; very equal societies will have a private education system that will achieve the maximum rate of growth. Saint-Paul and Verdier (1992a,b) and García Peñalosa (1993) obtain a similar result (see below), although in these models slower growth is brought about by a tax distortion rather than by reduced incentives to invest in education.

The simplicity of the Glomm and Ravikumar model makes it possible to illustrate the long-run differences between the two education systems and the joint dynamics of growth and distribution. However, it fails to take account of some important issues. Because it is a partial equilibrium analysis, tax distortions are ignored. A second problem is that the superiority of the private education system stems solely from the fact that it makes people spend more time in education, which is a questionable result.

The models by Saint-Paul and Verdier (1992a,b,c) develop various aspects of the link between distributional conflict, education and growth. Their analysis is close to that of Glomm and Ravikumar: aggregate output is equal to total human capital and the learning technology has a hereditary component. In their paper «Education, Democracy and Growth», they study an economy in which the only source of income inequality is that people differ in their endowment of human capital. Public education is provided in an egalitarian way and financed by proportional taxation of labour income. Public education is favourable for growth as it increases a generation's human capital relative to that of the previous generation, and at the same time it tends to make income distribution more even.

The tax rate is chosen every period by majority voting, hence the equilibrium tax is the one preferred by the median voter. Because of the redistributive character of public education, relatively poorer people prefer a higher tax rate. Hence a relatively poor median voter results in a high tax rate being chosen. In the absence of tax distortions, this implies a high rate of growth and equalisation of the distribution of income. The gradual erosion of the distributional conflict means that growth rates fall over time. Saint-Paul and Verdier relax the assumption of an inelastic labour supply. Taxes become distortionary as they reduce the supply of labour and, thus, the growth rate. In this case the distortion caused by public education is due to the tax imposed to finance it. In our diagram this means that public education increases the human capital stock and hence shifts the $\hat{\gamma}$ schedule upwards, while the effect of the tax tilts the $\hat{C}$ schedule downwards. Either effect may dominate, thus the effect on the growth rate is ambiguous.

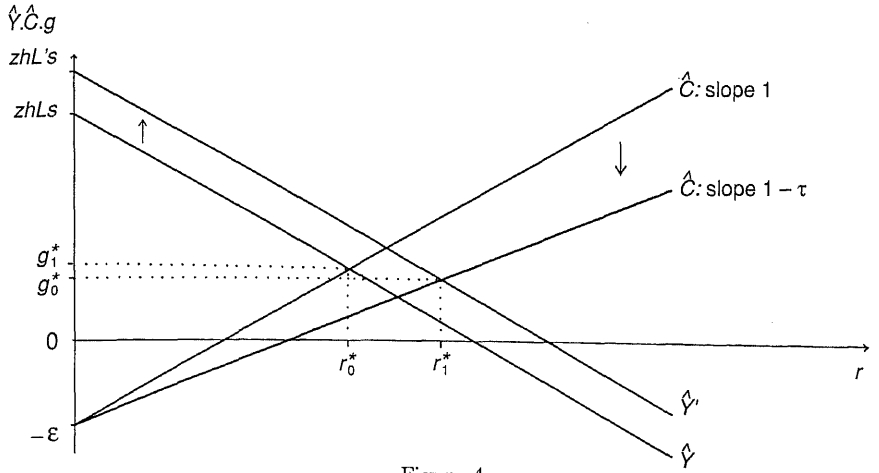

Figure 4
The Effect of Public Education Financed by Distortionary Taxes

The combination of the growth-enhancing and the growth-reducing effects of taxes results again in a U-shaped relationship between inequality and growth. The strongest implication of this analysis is that, in contrast to the Alesina-Rodrik and Persson-Tabellini models, redistribution and the democratization of a society do not necessarily have adverse effects on growth.

The last three models we discuss (Galor-Zeira, García Peñalosa, and Perotti) examine the case where education is privately funded and capital markets are imperfect or absent. In this case the distribution of wealth determines private education decisions, and hence aggregate output and investment. The basic idea is that there exists a limiting level of wealth, ω^*, determined by the cost of education and the degree of capital market imperfection, so that only individuals with wealth, above this level can afford education. The distribution of wealth, $F(\omega)$, then determines the proportion of the population that can reach this threshold, call it ρ. Then

$$\rho = 1 - F(\omega^*) \qquad [14]$$

The skilled labour force is thus $L_s = \rho L$, which is a function of the distribution of wealth. Changes in ρ will shift upwards and downwards the $\hat{Y}$ schedule and affect equilibrium growth rates.

Galor and Zeira (1993) develop an overlapping generations model, in which individuals differ only with respect to their inherited wealth. Due to capital market imperfections (higher interest rate for borrowers), inheritance determines whether or not an individual invests in human capital. The distribution of wealth therefore establishes how the labour force is divided between skilled and unskilled workers. There is a single good that can be produced by two different tecnologies, which use skilled and unskilled labour respectively. Because the productivity of skilled labour is greater than that of

unskilled labour, the larger the proportion of skilled workers the higher the output level.

The impact of wealth is not only short-run. Different investments in human capital one period determine the distribution of wealth the next period and thus the new skilled labour force. Galor and Zeira assume that investment in human capital is indivisible: either you become educated or you do not. As a result, there will be two types of dynasties in the steady state. Rich dynasties work as skilled workers and leave their children bequests large enough to finance their education. Poor dynasties remain unskilled and can never afford their children's education. The initial distribution of wealth determines how big these two dynasties are, and hence the rate of long-run growth of the economy. A country with a large middle class will have better growth prospects than one where a large proportion of wealth is held by few.

García Peñalosa (1993) and Perotti (1993) elaborate on the above idea that a large middle class is beneficial for growth. Independently and in quite different models, both authors obtain the same result: that the sign of the effect of inequality on growth rates depends on the level of development of the country. The basic idea is that with a two-tailed distribution of wealth (as is usually found), greater inequality reduces ρ, and thus the growth rate, if ω^* is small relative to average wealth, and it increases ρ if ω^* is relatively large. They then relate the relative cost of education to the country's income level.

García Peñalosa considers a general equilibrium model, based on Romer (1990), rather than a partial equilibrium analysis, as the rest of the papers here reviewed do. This makes the model rich and allows the examination of both the political and the educational mechanism in the same framework, but it cannot be used for the more complex dynamic analysis that the simpler models do. Some of the ideas are quite close to the Galor and Zeira paper. The indivisibility of human capital investments, the use of two types of labour in the production process, the transmission of wealth between successive members of a dynasty, and the role of capital market imperfections, are features common to both models. García Peñalosa considers, to start with, how private education decisions are made. The equilibrium division of the labour force is, in principle, obtained when the present values of being skilled and unskilled are equalized. However, because of capital market imperfections only rich individuals will be able to afford education. Galor and Zeira argue that a country with a large middle class has better growth prospects than one with greater inequality. García Peñalosa takes this idea further by endogenizing the cost of education. The basic point is that education is a human capital intensive activity. In a rich country the proportion of the labour force which is educated is large. Consequently skilled labour, and therefore education, is relatively cheap. Suppose that education is privately purchased. Because a lot of people can afford education, increasing inequality would reduce growth as wealth is redistributed away from the poorest people who can no longer study. The

opposite holds for a poor country: the lack of skilled labour makes education relatively expensive, and only the very rich can purchase it. Increasing inequality may, thus, accelerate growth since more people can afford education.

When the possibility of public education is introduced, the results are very similar to those obtained by Saint-Paul and Verdier. Public education increases the human capital stock and therefore growth, but because it has to be financed by a distortionary tax there is an offsetting effect. Individuals vote on whether they want a public or a private education system. The model obtains the U-shaped relationship between inequality and growth: growth is lowest for middle ranges of inequality, as individuals vote for a public education system but the tax distortion on growth is larger than the effect of increased human capital.

Perotti (1993) presents a model in which the source of growth is that investments in human capital by one income group «trickle down» and increase the productivity of other groups, thus potentially enabling them to invest in human capital. Whether the transmission of this externality is enhanced, hence increasing growth rates, or jeopardized depends on the initial distribution of income. It is a two period model, with no capital markets. As a result individuals can only become educated if their inherited wealth is greater than the exogenously given cost of education. However, they vote over the degree of redistribution in the economy, and this redistribution may allow some individuals to go over the threshold and become educated. The cost of education is assumed to be exogenous and the same in all economies. Therefore, in rich countries a large proportion of the population is rich enough to become educated, and only the poorest cannot afford it. The median voter –who can afford education without an income transfer– faces a tradeoff in his choice of income tax: a high tax reduces his current income, but by allowing the lower-income individuals to become educated, it increases his own productivity in the second period and thus his future income. In such an economy the distribution pattern that most favours growth is a very equal one, in which most agents can afford education and only a low tax is necessary to allow the lower income group to study. The opposite holds for poor economies. In this case growth can only occur if the distribution of income is sufficiently unequal, so that at least the higher income group has wealth greater than the cost of education. The model implies an inverted-U relationship between inequality and growth for cross-sections of countries.

The last two models differ in the aspects each wants to examine. Perotti presents a much simpler model that allows him to do simulations and examine long-run behaviour. García Peñalosa tries to explain and endogenize many of the variables in the model. The Cobb-Douglas aggregate production function she uses implies that relative wages may make it profitable to use unskilled labour as well as skilled labour, even if the latter is abundant. As a result, there is an optimal division of the labour force between educated and uneducated workers, and a certain degree of wage inequality will always

prevail. The analysis also takes account of the need to devote some human capital to the education of other workers, which means that a large skilled labour force may require devoting too much skilled labour to education and too little to production. Hence there is an equilibrium proportion of skilled labour. In contrast to this, Perotti –and the rest of the human capital models here reviewed– argue that there is no limit to either the number of skilled workers or the skill level. The other major difference between the two models is that in Perotti's model the cost of education is exogenous and equal for all countries. By endogenizing it, García Peñalosa allows education costs to be higher in *absolute* terms in rich countries, while maintaining the *relative* cost of education lower than in poor countries.

5. Existing Empirical Evidence

The ultimate test of a theory is to confront it with the data. The models here reviewed have strong empirical implications. We would expect to find:

1. For developed countries, reduced-form equations should show a negative correlation between inequality and per capita growth rates, the correlation being stronger for democracies than for non-democracies. If the political mechanism is important, we would find a link between inequality and the extent of redistribution and/or tax rates, and between the later and growth. In countries where redistribution is done mainly via public education the negative impact of inequality on growth should not be as strong as when it consists of transfers.

2. In poor countries, if there is a democratic regime, inequality has an ambiguous effect on growth, as taxation has a negative impact while increased education possibilities tend to enhance growth. For non-democracies the correlation should be negative, as only the educational mechanism is in operation.

The first to regress growth rates on inequality were Berg and Sachs (1988), who, as a minor result in their work, point out the existence of a negative correlation between growth and inequality. The analysis is too simple to provide more than vague support for the hypothesis. Alesina and Rodrik (1991) and Persson and Tabellini (1992a, 1992b) constitute the main works on the subject. Both concentrate on the political mechanism.

Alesina and Rodrik regress average per capita GNP growth rates for the period 1960-1985 on the level of per capita income (in 1960 or 1980, depending on the data set), the primary-school enrolment ratio for 1960, and an income distribution variable. The distribution variables used are the share of income held by each quintile of the population and the share held by the richest 5 %. Their first sample includes 67 countries, 24 of which are democracies; the second one is substantially smaller but adds two democracies. They run regressions for the entire sample and for the democracies and non-democracies subsamples. The results are consistent

with the predictions of their model: inequality has a negative effect on growth rates, initial income presents a negative coefficient (indicating convergence) and school enrolment ratios have a positive one. For non-democracies, the coefficients on the income distribution variables are insignificant. For democracies, the effect of distribution on growth is much stronger than for the sample as a whole. The pattern of coefficients suggests an interesting result: increases in the income share of the middle class at the expense of the richest group raises growth rates, while income transfers from the middle class to the poorest quintile may not have such an effect.

The way Alesina and Rodrik set up their analysis does not indicate wether the negative correlation between inequality and growth is caused through tax choices and redistribution or through some alternative mechanism. Two-equation systems would be desirable (see below). Of course, the substantial differences found between democracies and non-democracies imply that their theory is a possible explanation. However, some of the results can be interpreted under the human-capital hypothesis. All the non-democracies in their sample are poor or less-developed countries, while most of the democratic ones are developed countries. This is consistent with the hypothesis that investments in education establish a negative correlation between inequality and growth only in rich countries. The fact that transferring income from the middle class to poorer groups does not necessarily increase growth supports the importance of the education mechanism. Redistribution towards the middle class helps this group, which already had a certain amount of wealth, to accumulate enough to afford education. On the other hand, because the poorest individuals are so far from this threshold, increasing moderately their income has no substantial effect. The evidence thus agrees with the idea, argued by Galor and Zeira (1993) and by García Peñalosa (1993), that having a large and wealthy middle class is beneficial for growth.

This piece of work presents some econometric problems. The most important one concerns the correlation between the education variable and inequality. The correlation coefficient between the primary-school enrolment ratio and the various inequality measures is about 0.3 in absolute value[7]. This collinearity affects the estimates of the variances of the coefficients, making hypothesis testing unreliable. The problem is particularly acute given that most of the estimates reported by Alesina and Rodrik are «just significant» at conventional significance levels. The use of the primary-school enrolment ratio as a measure of human capital is questionable, especially since endogenous growth theories advocate the importance of highly skilled labour. However, when we run regressions using the same sample as Alesina and Rodrik (own work in progress), secondary-school and higher-education enrolment ratios and literacy rates have a much weaker impact on growth than primary-school enrolment ratios, and give

[7] This problem is also present in the regressions of Persson and Tabellini, where the correlation between inequality and the education variable is even stronger.

a worse fit of the equation. This may be the reason why the authors only report the effects of primary schooling. Person and Tabellini deal with this issue by constructing a weighted index of enrolment ratios in the various categories. Because schooling affects growth with quite a substantial lag, we would like to use education measures for, say, 1950 to explain growth in the 60s and 70s. Unfortunately these measures exist only for a very limited number of countries.

Persson and Tabellini (1992b) examine historical and cross-country evidence. Their historical sample comprises nine developed countries during the period 1830-1985, grouped in 20-year observations. They regress the average annual rate of growth of per capita GDP for each of these periods on the share in pre-tax personal income of the top quintile. The other variables they use are a measure of political participation, a schooling index[8] and a GDP gap measure. The regression results report a negative coefficient on inequality, which is almost always significant and of economically relevant size. Differences in distribution explain about a fifth of the variance in growth rates across countries and over time. The coefficients on political participation and the schooling variable are insignificant. However, Persson and Tabellini report a correlation coefficient of −0.71 between inequality and educational attainments. García Peñalosa and Perotti predict that such negative correlation exists in developed countries.

Their second sample comprises a cross-section of 56 countries for 1960 to 1985. The dependent variable is the average growth rate over the period. They measure income distribution by the share of pre-tax income accruing to the third quintile. This equality variable is appropriate as it gives a measure of the distance between the median and the mean. The expected sign is positive. The sampling date is around 1965 for most countries. Other variables included in the regressions are the primary school enrolment ratio, the level of per capita GDP in 1960, urban population share and the proportion of industrial output over the total. In the regressions for the entire sample, all variables have the expected sign and are significant most of the time. The effects of inequality on growth are quantitatively significant, and of a similar size to those in the historical sample. When they divide the sample into democracies and non-democracies, they find that, on average, democracies grow faster and have a higher level of per capita income. Hence, as in the Alesina-Rodrik paper, democracies tend to be rich countries and non-democracies poorer ones. The correlation coefficients between equality and growth that they estimate are 0.401 for democracies and −0.309 for non-democracies. The separate regressions for the two subsamples find a quite large and significant coefficient for democratic countries and a lower and insignificant one for non-democracies. This means that the mechanism operating between inequality and growth may be political, i.e. dependent on the political regime, or educational, in which case the decisive factor is the level of development. Persson and Tabellini

[8] The index is a weighted average of school enrolment ratios at the various levels of education.

examine this issue by splitting the sample into two halves according to national income levels in 1960: rich and poor economies. They reestimate the regressions but do not report the results. They just argue that «these results suggest that there are considerable differences between democracies and dictatorships *within* the groups of rich and poor countries».

Their last piece of evidence attempts to separate the links between inequality and redistribution and between the later and growth. They quote two recent studies that support these relationships. Kristov, Lindert and McClelland (1992) examine the impact of inequality on the size of government transfers in OECD countries in the period 1960-1981, and they find that pre-tax income inequality is a major explanatory factor. Nordstrom (1992) shows a negative correlation between government transfers as a proportion of GDP and average growth rates for the OECD between 1970 and 1985. Persson and Tabellini examine OECD post-war data. They regress government transfers as a fraction of GDP on equality –income share of the third quintile– and find that the coefficient has the expected negative sign but is insignificant. Regressing growth rates on transfers yields a negative estimated coefficient, as the theory predicts, but it is also statistically insignificant. The results provide only weak support for the political mechanism, and indicate that there are other channels of influence. The main problem of these analyses is measuring transfers, as there exist many indirect mechanisms, education amongst them, which are not recorded as transfers. It would also be necessary to look at taxation, ideally using both average and marginal tax rates.

The two studies here reported present two drawbacks as an explanation of cross-country differences in growth rates. Firstly, the specification of the equations omits variables which have proved important in other empirical studies on growth, even if they are not directly relevant to the theories they are testing. The most important one is probably a measure of the investment to GDP ratio. In fact, once, this variable is included the fit of the growth equations improves substantially, while the inequality variables remain significant (own work in progress). Government investment and consumption have also proved to be significant explanatory variables[9]. Secondly, the inequality measures used are questionable. It would be interesting to use aggregate indices, such as the Gini coefficient, or even a measure of the share of profits on GDP. The idea behind this last measure is that capital, and thus profits, are much more unequally distributed than labour income, hence a large share of profits would indicate greater inequality.

6. Conclusions

We have reviewed two types of models. The ones examining the political link between inequality and growth reach a single conclusion: greater ine-

[9] See, for example, Barro (1989) and Mankiw *et al.* (1992) for recent empirical work on the determinants of growth rates across countries.

quality reduces a country's growth rate in so far as individuals are allowed to vote on the income tax rate (or equivalently on an electoral programme which includes a certain fiscal policy). The relevant variable in these models is the income of the median individual relative to mean income: the lower it is, the higher the tax rate he will vote for. A high tax on property income reduces the net rate of return, thus discouraging investment and reducing growth.

The second group of papers examines how inequality affects education decisions and thus the stock of human capital in the economy, which in turn determines the growth rate. The various models differ substantially and focus on different issues: private education and capital-market imperfections, the choice between a public and a private education system, incentives to spend time in education, the tax rate for financing education preferred by voters... However, there are some important results that are quite general. Galor and Zeira (1993), García Peñalosa (1993) and Perotti (1993) emphasise the role of the distribution of wealth when education is privately purchased and capital markets are imperfect. The later two papers argue that in rich countries inequality has a negative effect on growth as less people can afford education. On the contrary, because in poor countries education is relatively expensive and only a minority can afford it, greater inequality increases the proportion of rich individuals and thus the number of people that can become educated. Thus inequality may have a *positive* effect on growth.

Glomm and Ravikumar (1992), Saint-Paul and Verdier (1992a) and García Peñalosa (1993) examine the effect on growth of the choice between a private– and a public– education system in a democracy. The crucial issue in these analyses is that the type of redistribution implemented by the government is growth-enhancing, while under the political mechanism the transfer of income had no impact on growth rates. The negative effect of the tax distortion is, consequently, partially offset by the increase in human capital. As a result, there is a U-shaped relationship between inequality and growth: low inequality leads to a private education system and fast growth, medium inequality results in public education but the tax distortion effect is stronger and reduces the growth rate, while when inequality is very high the impact on the stock of human capital will be large enough to offset the tax distortion.

The papers by Saint-Paul and Verdier and Glomm and Ravikumar have the disturbing implication that because inequality falls over time, so does the tax rate and thus the rate of growth. This is a characteristic prediction of the traditional neoclassical models obtained in an endogenous growth framework! Both models explain the joint dynamics of growth and distribution, but they do not capture a dynamic circular causality between the two variables, as they claim[10]. The degree of initial inequality determines the amount of public education, which simultaneously affects growth and

[10] Saint-Paul and Verdier 1992a, pg. 3.

next period's inequality. But there is no feedback from growth into inequality, as such. This is clearly a promising area of research.

The existing empirical evidence shows that inequality has a strong negative impact on growth rates in rich, democratic countries. For poor, non-democratic economies the effect is ambiguous and not statistically different from zero. Existing studies cannot discriminate between the alternative mechanisms that bring about this correlation. The little evidence available on the political mechanism vaguely supports it, though it indicates that there are as well other links. Some support for the human capital hypothesis stems from the evidence that it is redistribution towards the middle class what tends to have the greater impact on growth, and from the correlation between inequality and schooling variables. The major problem of this work is that it mainly estimates reduced-form equations, which makes it impossible to assess whether the political or the educational mechanisms are in operation, or their relative strength. It would be interesting to further examine two equation systems, using a wider number of variables, as well as to examine whether the differences found between groups of countries are due to a political or to a level-of-income classification.

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Resumen

En este artículo se examinan una serie de trabajos recientes que estudian como la distribución de la renta afecta a la tasa de crecimiento económico. Ha habido dos enfoques distintos. Uno de ellos se centra en el proceso político que determina la tasa impositiva y el grado de redistribución. El otro analiza el efecto de la desigualdad sobre las posibilidades de los individuos para invertir en educación, y como éstas inversiones afectan al crecimiento. El primer grupo de modelos concluye que existe una relación inversa entre desigualdad y crecimiento, mientras que los modelos de capital humano obtienen resultados ambiguos.

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