Three Essays in Political Economics

by

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Submitted to the Department of Economics
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Abstract

The common element of the essays of this thesis is the interaction between economic and political factors.

The first essay, "Political equilibrium, income distribution, and growth" analyzes the impact of income distribution on growth when investment in human capital is the source of growth and individuals vote over the level of redistribution in the economy. The model has three main features. First, very different patterns of income distribution are most favorable to growth at different levels of per capita income. Second, growth is associated with an intertemporal externality whereby investment in human capital by one group increases the resources available for redistribution in the future, thus enabling other groups to invest in human capital. Third, the initial pattern of income distribution and the resulting political equilibrium are crucial in determining whether the transmission of this externality is promoted, in which case growth is enhanced, or prevented, in which case growth is stopped.

Using an overlapping generations model with voting and full rationality of agents, I derive several empirical implications. In particular, the model implies an inverted-U relation between levels of inequality and levels of income in cross sections, but not necessarily in time series, a result that seems consistent with a number of empirical studies.

The second chapter, " Income distribution and growth: some empirical evidence", is an attempt at estimating the main implications of the model of Chapter 1. It first presents a test of the two most direct implications of the model, the relation between income distribution and redistribution and that between income distribution and investment in human capital. Like all models with majority voting over the level of redistribution, the model predicts an inverse relation between the income of the median voter relative to the average income. A more specific feature of the model is that the way income distribution affects accumulation of human capital depends strongly on the average income of the economy.

The chapter then proceeds to test other implications of the model that can be obtained from a somewhat looser interpretation of it. In particular, it estimates a

recursive system of equations in which income distribution affects the rate of change of enrollment and the latter affects growth. As before, the existence of an asymmetry between poor and rich countries in the operation of the link between income distribution and growth is the main implication of the model.

The purpose of this test is to allow a comparison of the model of Chapter 1 with other recent model of income distribution and growth. While the model of Chapter 1 implies that the average income of an economy is an important determinant of how income distribution affects growth, other models imply that the most important element is whether is a democracy or not. The two different views are tested against each other.

Overall, the results of the test tend to be little supportive of the mechanism of income distribution and growth described in Chapter 1.

The third chapter, "Increasing returns to scale, politics, and the timing of stabilizations" deals with the problem of delays in stabilizations: why do governments postpone the stabilization of an economy when fiscal and monetary policy are at clearly unsustainable levels in the long run? The starting point of the model of this chapter is similar to that of Chapter 1. The agents of the economy can belong to one of three classes: members of the first two own a given endowment of labor, while each member of the third class owns an increasing returns to scale technology for the production of one non-traded good. This technology can be moved abroad in the long run (the second period in the model) if demand is low enough that profits are below the level that can be earned abroad. There is a given amount of external debt to be repaid.

In each period, all agents vote over two issues: the level of redistribution of labor income and the fraction of external debt to be repaid (redistribution of profit income is given at some fixed level). Given the presence of decreasing average costs, a lower repayment of debt in a given period means a higher level of demand and of profits, and therefore a high level of redistribution of profit income. Under normal circumstances the view of the middle class prevails and exactly half of the debt is repaid in each period (under the assumption that both the interest rate and the discount rate are equal to one). Thus, the standard textbook result of perfect consumption smoothing obtains. When a sufficiently strong shock hits the economy, however, both the owners of the increasing returns to scale technology and the low income class have an incentive to postpone the adjustment (i.e., the repayment of the debt) completely to the second period. The reason is that the former will move their increasing returns to scale technology abroad anyway, so that they prefer to have as high a demand as possible in the first period since they will not bear any cost of the adjustment in the second period. The low income class wants to postpone the adjustment because, by keeping activity high in the first period it can achieve *some* redistribution, which is precluded anyway in the second period given that there will be no profits then and the middle class will oppose any redistribution of labor income.

This theoretical mechanism of delays in stabilization is then illustrated with an analysis of the peruvian populist experience of 1985-1988.

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Acknowledgments

I came to MIT because I thought that I would find an outstanding group of teachers, and I did. But I would have never imagined that they would also be so friendly, encouraging and supportive. And after four years, I realize that this is what really makes this place special.

Rudi helped me in innumerable ways throughout all my years at MIT. He began to surprise me with his warmth and generosity in the summer of my first year, and somehow he managed to keep surprising me ever since. He always encouraged me, sometimes directly, sometimes simply with his contagious good mood. In all these years, I knew that his door would always be open, maybe just for a chat. He changed radically my ideas of the interactions between a student and a professor, and made these four years much lighter than they would have been without him: I will miss the lectures, the International Lunches, the conversations which were full of his good humour and insightfulness. I leave MIT knowing that I will try to imitate him in many ways, and not only in my academic life.

Olivier began to surprise me later, when I came to know him during my thesis years. During the first two years, I had the opportunity to see what a great teacher he is, but later I was surprised by how friendly and supportive he was. Maybe without him even realizing it, his calm attitude and constant smile gave me confidence in my third year, when I just couldn't write a line for months and months. His "you *will* find a topic" helped me a lot when I was discouraged. He constantly reassured me, showed his support even outside academic life, and always advised me in the right direction. His door too was always open to me, and I know that he too will be an example for me in the future.

If I have concentrated so far on the personal aspects of Rudi and Olivier, it'a only because the professional side of an MIT professor is usually taken for granted. But even here they surprised me: looking back, I realize how much I have learnt from them, little by little, one Macro or International Lunch after another, and in so many conversations with them. They taught me how to distinguish a relevant topic from what might just be a nice model, and I think nothing could be more valuable than this.

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Roland Benabou, Peter Diamond, and Stanley Fischer also helped me to clarify my ideas by taking the time to read my papers and by providing insightful comments on many points. I am grateful to them for this.

During my stay at MIT, I was fortunate to meet and interact with many fellow students: Luigi, Alessandro, Miguel, Alun and especially my dearest friends at MIT, Freddie and Sugato, with whom I shared at different times the apartment, the stress before the exams, the office, and many laughters. I will remember them, and I hope we'll stay in contact in the future.

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My greatest debts are the ones that go back the longest: to my parents and to Tissa. During my four years at MIT, my parents never let me feel lonely: at any moment I knew that they were there, just one phone call away.

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This thesis is dedicated to her.

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Chapter 1

Income distribution, political equilibrium, and growth.

1.1 Introduction.

In the voluminous literature on income distribution and growth, two basic frameworks can be identified. A tradition going back at least to Kaldor [1956] emphasizes the causal effect of income distribution on capital accumulation and therefore on growth. The development economic literature that flourished in the '60's and '70's following the seminal work of Kuznets [1955] concentrated mainly on the opposite causal link, from growth to income distribution.

This chapter is logically close to the first approach. However, the focus here is not on capital accumulation, but on the effects of redistribution on investment in human capital. Specifically, this chapter starts from the observation that income distribution is not a given, but it can be modified to some extent in an economy where the tax system redistributes income. By affecting the post-tax income of the various income groups, redistribution determines which groups will be able to invest in human capital and which groups will remain unskilled. In turn, this affects growth and how income distribution evolves over time.

If the degree of redistribution in the economy is determined by majority voting, the initial pattern of income distribution plays a crucial role in the mechanism outlined above. The reason is that when individuals vote over the structure of the tax system, the *relative* position of the different income groups determines the extent to which resources are redistributed from the rich to the poor. In a static setting, this mechanism has been analyzed by Romer [1975], Roberts [1977], Meltzer-Richard [1981]. The main result common to these papers is that the higher the pre-tax income of the median voter relative to the average income the lower is the progressivity of the tax system resulting from the voting process.

By extending this framework to a dynamic context, this chapter points out some interesting interactions between income distribution, redistribution and growth. Previous work in this area has been almost exclusively empirical, as exemplified by the best known contributions, i.e. Adelman-Morris [1967], [1973]. With hindsight, however, it is evident that a theoretical framework is needed if one wants to disentangle the relevant processes behind the wealth of tables and correlations. In fact, this chapter has two main goals: first, to perform a *positive* analysis of a possible channel through which income distribution and political factors may affect growth. Second, to show how this analysis can be used to interpret some of the empirical regularities that characterize these variables.

The essence of the model is very simple. Consider an economy whose agents belong to one of three different income groups. Growth and changes in pre-tax income distribution are the effect of investment in education, which increases the human capital stock of the economy[1]. As in Galor-Zeira [1989] and Bannerjee-Newman [1988], in the absence of perfect capital markets those individuals whose post-tax income is below the cost of acquiring education will be unable to invest in human capital, and the next period will earn the same pre-tax income. By contrast, those who can afford the expenditure needed to obtain education will have a higher income.

Assuming that income can be redistributed has an important consequence in this framework. Specifically, when a certain group invests in education there is a positive externality on the rest of the society, because resources available for redistribution in

[1] For a review of empirical studies on the effects of education on growth and income distribution, see Tilak [1989].

the future are increased.

This simple structure has a first important implication, which is also potentially testable. Essentially, economies with different per capita incomes have very different patterns of income distribution that are most favorable to growth.

If the cost of investment in education is proportionally higher in poorer countries, as it seems to be the case at least for post-primary education[2], in a very poor economy *total* resources may be so scarce that at most the upper class can invest. Thus, in this case only a very unequal income distribution that concentrates resources in the upper class may be consistent with growth. Alternatively, given the share of the upper class in total pre-tax income, the median voter should not have too large an incentive to set a very progressive tax rate, which would drive the post-tax income of the only potential investor of the economy below the minimum amount required for investment. This requires that the middle class should not be so distant from the upper class that the incentive to expropriate it now exceeds the positive future externality.

The configuration that maximizes income growth in a rich economy is exactly the opposite (with some qualifications spelled out in the formal analysis of the model). Here, redistribution might matter only for the investment of the lower class. In this case, a first precondition of growth is that the lower class should not be so poor that any feasible degree of redistribution would be insufficient to make it invest. A second precondition is that the middle and the lower class should not be so distant that the short run cost to the decisive voter from high redistribution exceeds the long period gain. In short, equality at the bottom and possibly even at the top is most favorable to growth in a rich economy.

The fundamental reason for this asymmetry between poor and rich economies is that, for any given tax rate, poorer economies transfer fewer resources through the tax system[3]. This observation leads to the second implication of the model sketched so far: richer economies should be less sensitive to deviations from the pattern of

[2]See, among others, Psacharapoulos [1973]. For simplicity, the model assumes that the cost of acquiring education is a constant across levels of income.

[3]Although in a different context, Kaldor [1962], [1967] analyze the implications of this fact.

income distribution that is *a priori* most favorable to growth. This intuitive notion is made formally precise in the formal treatment of the model.

The issues touched upon so far can be illustrated through a simple two period model. The next results require an overlapping generations extension of the two period framework. The reason is the following: as outlined above, when a poor economy grows and becomes progressively richer, the best pattern of income distribution from the point of view of growth changes drastically. However, income distribution has the dimension of a state variable, highly dependent on initial conditions. Thus, it might not be politically feasible to adapt the pattern of income distribution along the way so as to best satisfy the preconditions for growth at the different levels of income. Intuitively, the channel through which income distribution affects growth presents a strong *path dependence*, in the sense that the steady state reached by an economy is very sensitive to the initial configuration of relative income shares of the three classes. This intuition is made formally precise in the overlapping generations model.

Aside from a possible theoretical interest on its own, this property of the model may be relevant in relation to a well known empirical regularity concerning income inequality and levels of income, Kuznets' inverted-U curve. Essentially, a number of cross-section studies in the last three decades seem to lend support to the old idea that income inequality initially raises with per capita income and then declines as growth proceeds further. However, time series studies tend to be much less supportive of this finding. The overlapping generations model of this chapter may suggest a possible explanation of this discrepancy.

It was seen above that a very egalitarian poor economy will not be able to start the growth process. By contrast, an economy with a very unequal income distribution is in the best position to achieve a high initial rate of growth. However, once this economy reaches a higher level of per capita income, the very same income distribution pattern that fuelled the initial spurt of growth will hamper further growth. Thus, a very unequal society will get stuck at an intermediate level of income, because the extreme concentration of resources in the hands of the upper class prevents the lower class and possibly even the middle class from reaching a post-tax income that allows investment in education. In a more equal society all classes will eventually invest in education, so that inequality will decrease as per capita income reaches its highest level. In a cross section, this will generate an inverted-U curve, even though only a subset of all countries will present an inverted-U pattern in time-series. In fact, the first group of countries never experienced any change in per capita income or income distribution and the second group never experienced a reduction in inequality.

The mechanism of growth implicit in the analysis above is essentially a "trickle down" process by which investment by one class increases the resources available for redistribution in the future to the other classes, thus enabling an increasing number of classes to invest in education. This important externality and the mechanism of growth that it generates are formalized precisely in the overlapping generations model. The basic message is that in the absence of a central planner the transmission of the positive externalities of growth can stop if it is too costly to the median voter to bring them about. Consider for instance an intermediate income economy. If the low income group is very poor, it will invest only if the tax system is highly progressive. If however the middle class has a very high pre-tax income, the tax rate preferred by the median voter will be rather low. In this situation, the median voter might face an intertemporal trade-off: by setting a high tax rate, she will incur a loss because her preferrred tax rate is low. On the other hand, this temporary loss is necessary to bring about the increase in future income which occurs when the low income group invests in education. However, if the distance between the median voter and the low income group is large, it is likely that the short term loss will outweigh the long term gain. If this happens, the low income group will not invest in education and growth will stop. Thus, the political outcome generated by the initial pattern of income distribution is crucial in determining whether the "trickle down" process of growth will be stopped before the economy has reached the highest possible steady-state where all classes have invested in education.

This mechanism also provides potentially testable implications on the behavior of the relative shares of the different income groups (such as quintiles) during the different stages of growth. For instance, the share of the upper quintile should increase in the initial phases of development, while the share of the lower class (bottom two quintiles) and of the middle class (middle two quintiles) should decrease. The opposite should be true when an intermediate income economy experiences high growth.

From a more technical point of view, the overlapping generations model is characterized by a solution method that allows for full rationality of voters. In particular, when agents vote they take into account the effects of their proposals (if accepted) on the future tax rates and therefore on the future path of the economy. This is obtained by assuming that agents can make only "Markov proposals", i.e. the tax rate they propose is a function of contemporaneous state variables only. The optimal proposals in the steady states of the economy are therefore found essentially as a fixed point in the mapping from future proposals into current proposals. In the others states, the optimal proposals are obtained through a backward procedure starting from the steady states. This procedure also allows one to show that the median voter is the decisive voter in each period[4].

The rest of the chapter is organized as follows. Section 2 introduces the basic two period model. Section 3 analyzes the existence of a non cycling majority and proves that the median voter is the decisive voter even if preferences are not single-peaked. Section 4 characterizes the political equilibrium and studies its effects on growth depending on the initial income distribution and on the level of income. Section 5 analyzes systematically the theoretical and empirical implications of the two period model. After sketching the overlapping generations model, Section 6 illustrates why it might be relevant in discussing the issues outlined in this introduction. Section 7 concludes. Since the formal treatment of the model is rather notation-intensive and in order not to hamper the intuition behind the results, almost all the proofs appear in separate appendices.

[4]Although in a very different context, Cukierman-Meltzer [1989] too have an overlapping generation model with voting and majority rule. However, in their model voters in each period do not take into account the effects of their vote on future political outcomes.

1.2 The model.

There are two periods, 1 and 2 and three groups of agents, characterized by different earning abilities, i.e. different pre-tax incomes. Let ${}_jn_i$ be the earning ability of an agent belonging to pre-tax income class i in period j. In period 1, pre-tax incomes can assume one of the following three values (relative frequencies in parentheses): ${}_1n_1$ (p_1), ${}_1n_2$ (p_2), ${}_1n_3$ (p_3), where $0 \leq {}_1n_1 \leq {}_1n_2 \leq {}_1n_3$.

Let ${}_j\bar{n}$ represent the mean of the distribution of pre-tax incomes in period j. There are three conditions on the distribution of pre-tax incomes:

(i) $p_i < .5$, $i = 1, 2, 3$

(ii) $p_1 + p_2 > .5$

(iii) ${}_1n_2 \leq {}_1\bar{n}$

By preventing a single class from having more than half the agents of the economy, assumption (i) is a necessary condition for the existence of non trivial majorities. Assumption (ii) implies that the median voter is in the middle class, while assumption (iii) ensures that the median is initially below the mean[5].

If an agent with productivity n_i invests e in education in period 1, her productivity in period 2 is ${}_2n_i = n_i + Re$. The only choice is between investing in education, which costs e, and not investing[6].

There is no capital market, no uncertainty, no discounting.

Taxes are proportional to pre-tax income. Taxes collected in this way are redistributed as a per capita subsidy, constant across individuals. The government budget is always balanced. However, there are convex costs in collecting taxes: thus, if t is the tax rate, $t\bar{n}$ is collected in taxes, but only $(t - t^2)\bar{n}$ can be redistributed to each individual.[7]Note that, as usual, a higher tax rate implies a more progressive tax

[5]From now on, whenever a first period variable is considered, the subscript indicating the time period will be omitted if no ambiguity can result. Thus, $\bar{n}$ stands for ${}_1\bar{n}$, n_1 for ${}_1n_1$ and so on.

[6]This specification of the effects of education on earning ability is not an orthodox one in the human capital literature. A multiplicative rather than an additive effect is usually assumed. An example of a paper using the specification adopted here is Chiswick [1971].

[7]Without convex costs of collecting taxes, it is a standard result that, when labor is supplied inelastically, all voters below the mean prefer $t = 1$ while all voters above the mean prefer $t = 0$. Introducing a convex cost of collecting taxes allows one to avoid these corner solutions.

system.

Utility is linear in consumption. Let ${}_1c_i$ and ${}_2c_i$ represent consumption in period 1 and 2 of an agent belonging to class i, respectively, and let ${}_2\bar{n}$ represent the per capita income in period 2. Finally, let ${}_jt$ denote the tax rate implemented in period j. Total consumption for an agent belonging to group i is:

$$ {}_1c_i + {}_2c_i = n_i(1 - {}_1t) + ({}_1t - {}_1t^2)\bar{n} - e + (n_i + Re)(1 - {}_2t) + ({}_2t - {}_2t^2)_2\bar{n} \qquad (1.1) $$

if agent n_i invested in education and

$$ {}_1c_i + {}_2c_i = n_i(1 - {}_1t) + ({}_1t - {}_1t^2)\bar{n} + n_i(1 - {}_2t) + ({}_2t - {}_2t^2)_2\bar{n} \qquad (1.2) $$

if the same agent did not invest.

It is easy to show that an agent will want to invest in education if

$$ R(1 - {}_2t) \geq 1 \qquad (1.3) $$

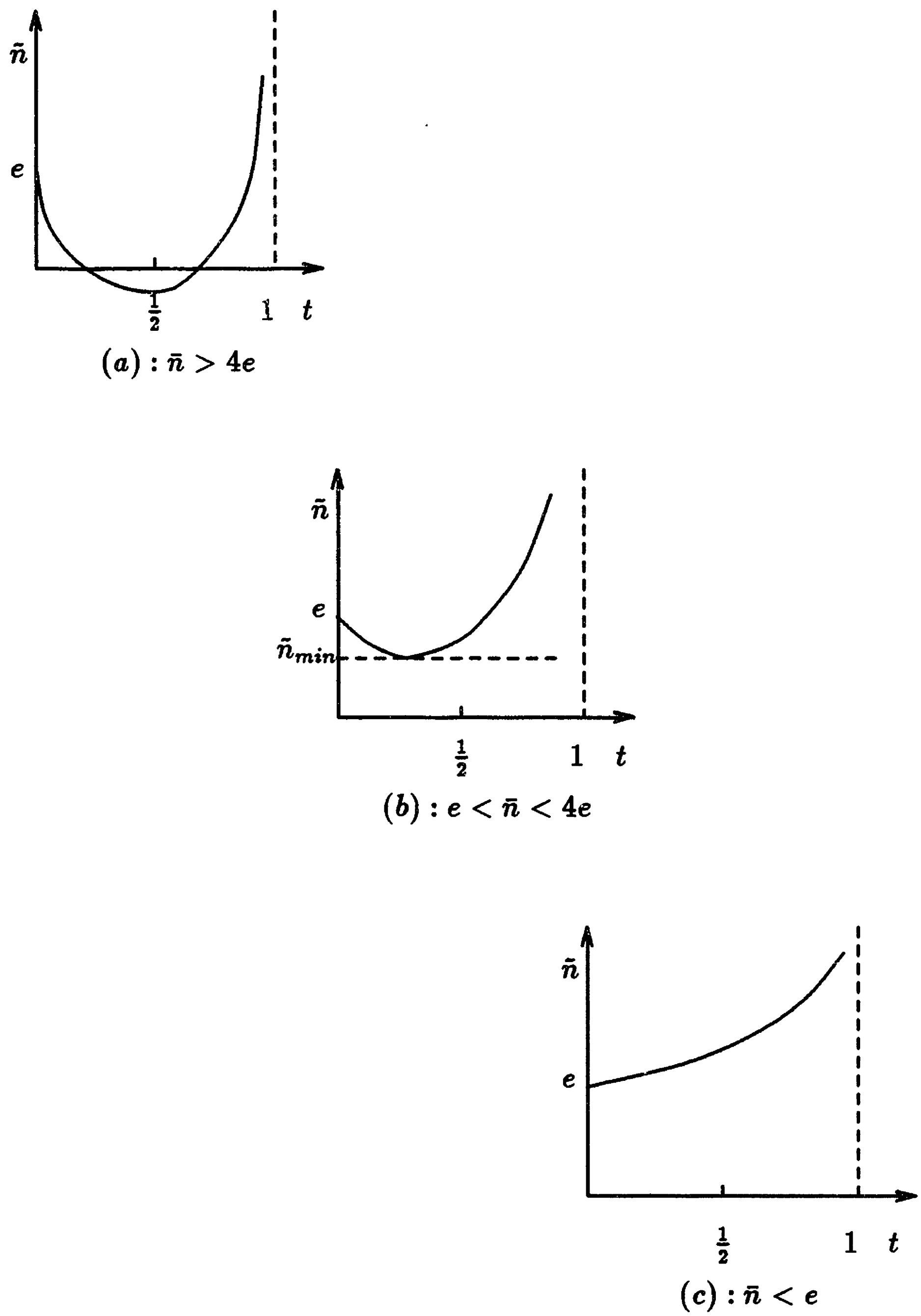
Assume that $R \geq 2$: since it will be shown that ${}_2t < \frac{1}{2}$, this condition ensures that all agents would like to invest in education.

However, if $n_i(1 - {}_1t) + ({}_1t - {}_1t^2)\bar{n} < e$, agent n_i is liquidity constrained and cannot invest in education. Let $\tilde{n}$ denote an agent whose after-tax income is exactly e. Then $\tilde{n}$ is defined implicitly by:

$$ \tilde{n}(1 - {}_1t) + ({}_1t - {}_1t^2)\bar{n} - e = 0 \qquad (1.4) $$

Thus, all agents with pre-tax income $n_i < \tilde{n}$ are liquidity constrained at ${}_1t$ and cannot invest in education. $\tilde{n}$ as a function of ${}_1t$ is depicted in Figures 1 (a), (b) and (c), which show that the function has very different qualitative behavior depending on whether $\bar{n} > 4e$ (a "rich" economy), $e < \bar{n} < 4e$ (an "intermediate income" economy), or $\bar{n} < e$ (a "poor economy"). Since the behavior of $\tilde{n}({}_1t)$ is crucial for the results of the model, it is important to obtain some intuition of its shape.

Figure 1-1: Redistribution and post-tax income.



Consider first a rich economy. At each tax rate, a large amount of resources are redistributed. Thus, however poor an agent is, there will always be a tax rate t, $t \leq \frac{1}{2}$, such that her post-tax income exceeds e. When per capita income is at an intermediate level, there might be a situation where an agent's pre-tax income is so small ($n < \tilde{n}_{min}$ in Figure 1 (b)) that no tax rate will raise her post-tax income to e before the convexity of the cost of collecting taxes takes over. Finally, consider a very poor economy. If an agent starts with a pre-tax income below e, no tax rate will ever enable her to invest in education: even in the absence of costs of collecting taxes she could reach at most a post-tax income equal to $\bar{n}$, which is less than e. Moreover, by reducing the post-tax income of all agents with a pre-tax income above $\bar{n}$, income redistribution hurts all agents with pre-tax income above e, and the more so the higher is the tax-rate.

1.3 Existence of a stable majority.

Assume now that in both periods the inhabitants of this economy vote over the parameter ${}_jt$ of the tax schedule described above, i.e. they vote over the progressivity of the tax rate. As in Tabellini-Alesina [1990], in the first period all voters take fully into account the effects of their proposal (if accepted) on the tax rate in the second period.

In this section, I will prove that the median voter is the decisive voter in all possible states of the economy. The reason why a whole section is needed to establish this result is that, due to the abundance of discontinuities in the model, preferences are not single-peaked and therefore the usual sufficient conditions for the existence of a stable majority cannot be applied directly. However, it will be proved that another sufficient condition on preferences, called Order Restrictedness, is satisfied in this model.

Since the next sections develop all the important conceptual issues, the reader uninterested in technical details can skip this section without missing any important intuition of the model.

Since no precommitment is possible, the political equilibrium will be determined by finding first the equilibrium in period 2 and then working backward. It is clear that no investment in education will take place in period 2. It is then straightforward to show that n_2 is the decisive agent in this period, so that the tax rate is:

$$ {}_2t = {}_2t_2^\star = max\left\{0, argmax\left\{({}_2n_2)(1 - {}_2t) + ({}_2t - {}_2t^2)_2\bar{n}\right\}\right\} \tag{1.5} $$

Therefore:

$$ {}_2t_2^\star = max\left\{0, \frac{1}{2}\left(1 - \frac{{}_2n_2}{{}_2\bar{n}}\right)\right\} \tag{1.6} $$

Given this, consider now the problem solved by agent i in period 1. Her proposal will be:

$$ {}_1t_i = max\left\{0, argmax\left\{{}_1c_i + {}_2c_i({}_2t_2^\star)\right\}\right\} \tag{1.7} $$

where ${}_2c_i({}_2t_2^\star)$ is consumption by agent i in period 2 given that the tax rate will be the one preferred by the median voter in period 2.

Now consider the term $argmax\ \{.\}$ in equation (7). In the points where ${}_2\bar{n}$ and ${}_2t^\star(n_2)$ are differentiable with respect to ${}_1t$, this term is found by solving[8]:

$$ \frac{d\left[{}_1c_i + {}_2c_i({}_2t_2^\star)\right]}{d_1t} = 0 \tag{1.8} $$

i.e.

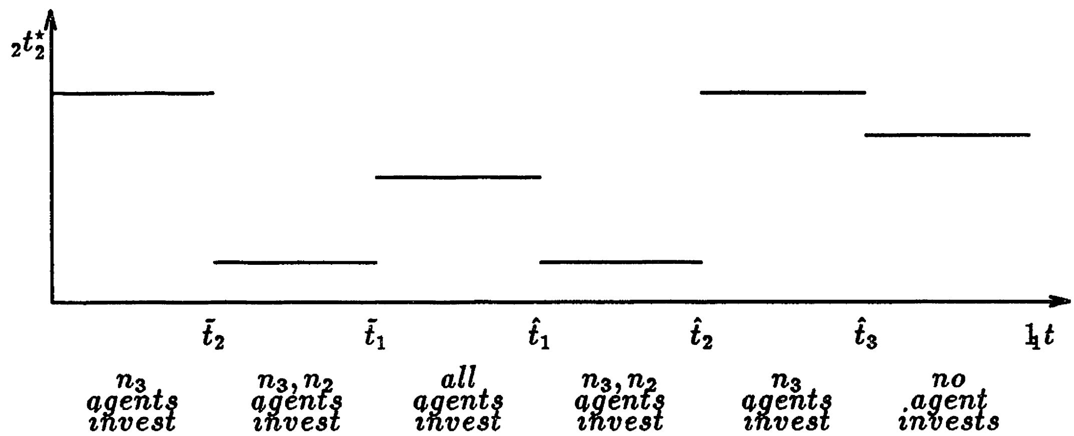
$$ \begin{aligned} 0 \quad = \quad & -n_i + (1 - 2_1t)\bar{n} - {}_2n_i\frac{d_2t_2^\star}{d_1t} + \left[1 - {}_2t_2^\star\right]\frac{d_2n_i}{d_1t} \\ & + \left[1 - 2_2t_2^\star\right]{}_2\bar{n}\frac{d_2t_2^\star}{d_1t} + \left[{}_2t_2^\star - {}_2t_2^\star\right]\frac{d_2\bar{n}}{d_1t} \end{aligned} \tag{1.9} $$

Clearly, $\frac{d_2t_2^\star}{d_1t} = 0$, $\frac{d_2\bar{n}}{d_1t} = 0$ whenever these derivatives exist. Therefore, over all the points where ${}_2t_2^\star$ and ${}_2\bar{n}$ are differentiable, the tax rate proposed by agent i will be

$$ {}_1t_i^\star = max\left\{0, \frac{1}{2}\left(1 - \frac{n_i}{\bar{n}}\right)\right\} \tag{1.10} $$

[8]It is easy to verify that the second order conditions for a maximum are satisfied.

Figure 1-2: Redistribution and investment in education.



i.e., in all points where $_2t_2^*$, $_2\bar{n}$ and $_2n_i$ as a function of $_1t$ are differentiable, the optimal tax rate in period 1 for agent i is the tax rate that maximizes her post-tax income in the same period.

Now consider the values of $_1t$ at which agent n_i's post-tax income is equal to e[9].

It is clear that there are several points of discontinuity of $_2t_2^*$ and $_2\bar{n}$ as a function of $_1t$. The exact number depends on the values of n_1, n_2, n_3 and $\bar{n}$. Figure 2 illustrates the case of $\bar{n} > 4e$, $n_2 < e$, $n_1 < e$, i.e. the case with the largest number of discontinuities. $_1\bar{t}_1$ and $_1\hat{t}_1$ are the smaller and larger root of $n_1(1-{}_1t)+({}_1t-{}_1t^2)\bar{n}-e = 0$, while $_1\bar{t}_2$ and $_1\hat{t}_2$ are defined similarly with n_2 replacing n_1 in the previous equation.

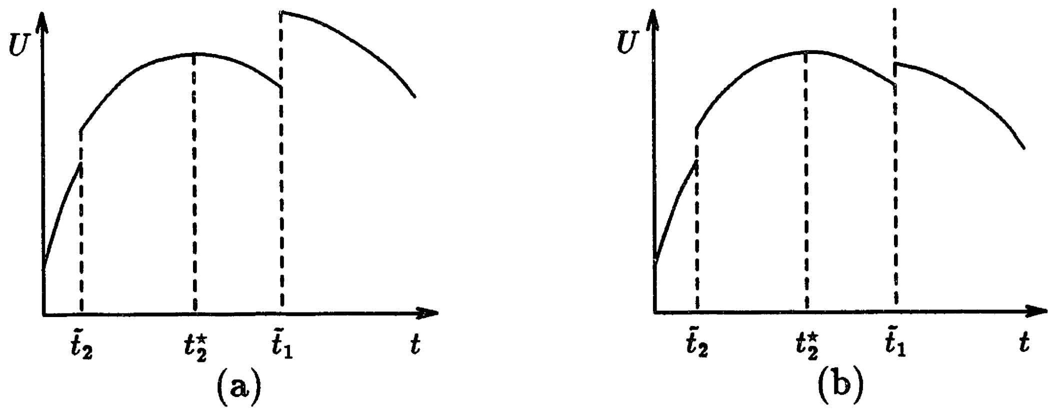
Since necessarily $n_3 > e$, there is only one value of $_1t$, $_1\hat{t}_3$, such that $n_3(1 - {}_1t) + ({}_1t - {}_1t^2)\bar{n} - e = 0$. From Figure 1(a) $_1\hat{t}_1$, $_1\hat{t}_2$ and $_1\hat{t}_3$ are all larger than $\frac{1}{2}$.

When making her proposal in period 1, each voter must compare the value of her overall utility when $_1t_i = {}_1t_i^*$ to its value when $_1t_i$ is such that $_2t_2^*$ and $_2\bar{n}$ change discretely.

For example, when $_1t_2^*$ is between $_1\bar{t}_2$ and $_1\bar{t}_1$ in Figure 2, n_1 agents cannot invest at the tax rate that maximizes n_2 agents' post-tax income in period 1. In this case, n_2 agent's *overall* utility may be higher when $_1t = {}_1\bar{t}_1$ than when $_1t = {}_1t_2^*$,because in

[9]Note that the existence of such values requires $n_i \leq \bar{n}_{min}$. This is defined implicitly by eq. (4), with $\bar{n}$ replaced by n_i.

Figure 1-3: The indirect utility function and the tax rate.



the former case n_1 agents can invest in education and therefore next period's average income will be higher[10].

It is now clear that in this model indirect utility functions are not single peaked as a function of ${}_1t$. Figure 3 illustrates the two possible qualitative behavior of n_2 agents' indirect utility in the case considered in Figure 2 and ${}_1t_2^* < {}_1\tilde{t}_1$ (the indirect utility is plotted only for $0 < {}_1t < \frac{1}{2}$ which will turn out to be the relevant range in equilibrium).

The standard sufficient conditions for the existence of a stable majority with the median voter as the decisive voter (see Black [1948] and, for a more general proof, Grandmont [1978]) fail to apply. However, it is still possible to show that the median voter is the decisive voter in this problem.

Let $\mathcal{T}$ be the set of all possible triples of proposals, and let $T_s \in \mathcal{T}$ be one of these triples. Then one can define a sufficient condition on preferences, called Order Restrictedness., which, if satisfied on the set $\mathcal{T}$, will ensure that the economy under consideration will have a stable majority, with the median voter as the decisive voter.

Definition: Preferences are Order Restricted on $T_s \in \mathcal{T}$ if there is *a* renumbering of the agents such that, for each distinct pair of proposals $(t_{i_s}, t_{k_s}) \in T_s$, all the agents

[10]A more systematic discussion of this crucial point is left for Appendix A and Sections 4 and 5.

who prefer t_{i_s} to t_{k_s} have a lower number than those who are indifferent beteween the two, and these have a lower number than those who prefer t_{k_s} to t_{i_s} (Rothstein [1989]).

Theorem: If preferences are Order Restricted over all triples of proposals, a stable majority exists and the median voter is the decisive voter.

Proof: See Rothstein [1989]. □

It is relatively easy to show the following

Result 1: Under Assumption A.2 (see Appendix A), preferences are Order Restricted on all triples $T_s \in \mathcal{T}$.

Proof: See Appendix A[11]. □

1.4 Redistribution and growth.

In this section I will investigate how the initial distribution of income affects the degree of redistribution and, through this, the growth potential of an economy. The analysis of the previous section established that the median voter is the decisive voter in all possible states: therefore, in what follows it is sufficient to analyze the optimal policies of the median voter in order to determine the equilibrium outcomes.

The next two subsections consider the two cases of a rich and a poor economy respectively. It will be shown that they have very different patterns of income distribution that are most favorable to growth. The dynamic implications of this simple fact will be more fully developed in Sections 5 and 6.

[11] Notice that the proof of Order Restriction requires a finite number of alternatives: it is here that the importance of assuming a finite number of classes can be appreciated.

1.4.1 The cases of a rich and an intermediate income economy.

Consider first an economy with a high per capita income, $\bar{n} \geq 4e$ (see Figure 1 (a)). By Result A.2, ${}_1t_2^* < {}_1\hat{t}_3$ when $\bar{n} \geq e$; this means that n_3 agents can always invest in education at the tax rate that maximizes the median voter post-tax income in period 1. Thus, the only situation in which the median voter might want to propose a different tax rate from ${}_1t_2^*$ is when ${}_1t_2^* < {}_1\tilde{t}_1$, in which case n_1 agents cannot invest in education at ${}_1t_2^*$ because their post-tax income is below e.

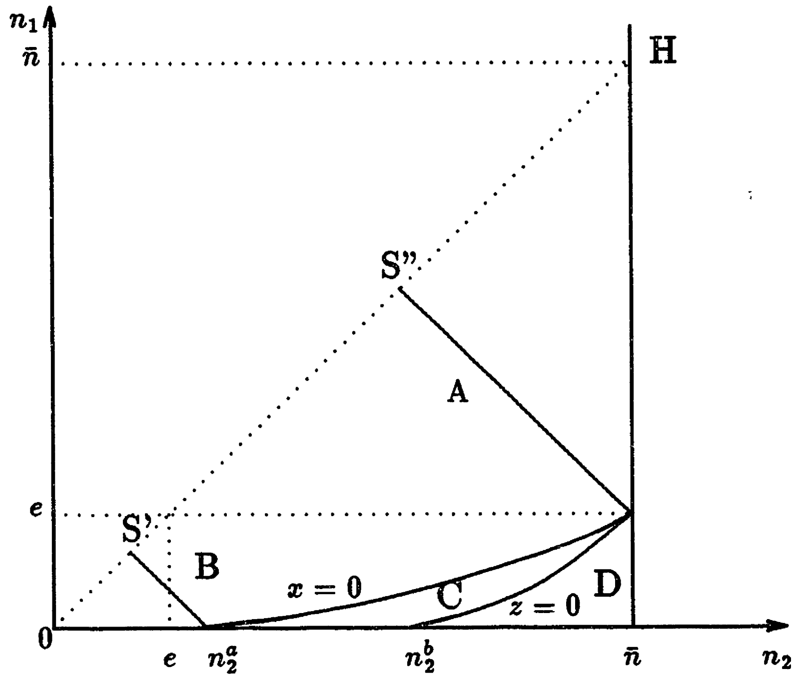
When ${}_1t_2^* < {}_1\tilde{t}_1$ the median voter faces an intertemporal trade-off. If she sets ${}_1t = {}_1\tilde{t}_1$ she loses something in the first period[12] relative to ${}_1t = {}_1t_2^*$, but clearly will gain something in period 2, since ${}_2\bar{n}$ increases if n_1 agents invested, so that more resources will be available for redistribution in period 2. How the trade-off is resolved by the median voter has important implications for growth: if ${}_1t = {}_1\tilde{t}_1$, high growth will result. Otherwise, growth will be low.

Thus, in order to study the effects of income distribution on growth one must analyze two questions: (a) under what configurations of the relative shares of the low-income and middle-income groups will the median voter face an intertemporal trade-off? (b) if there is indeed a trade-off, what configurations of income will induce the median voter to set a high tax rate, so that the low-income group will invest and high growth will obtain?

Let $x(n_2, n_1)$ and $y(n_2, n_1)$ be the first period loss and second period gain to the median voter respectively from setting the tax rate at ${}_1\tilde{t}_1$ instead of ${}_1t_2^*$. Let $z(n_2, n_1) = y(n_2, n_1) - x(n_2, n_1)$ be the overall gain (if positive) or loss (if negative). Then, question (a) above is equivalent to finding the shape of the $x = 0$ locus in the (n_1, n_2) space (see Figure 4). Above this locus (regions A and B in Figure 4) n_1 is sufficiently close to n_2 that ${}_1t_2^* \geq {}_1\tilde{t}_1$ and the median voter does not face a conflict beteween the short run and the long run. Below this locus (regions C and D) there is indeed a conflict because ${}_1t_2^* < {}_1\tilde{t}_1$.

[12]Recall that ${}_1t_2^*$ is defined as the tax rate that maximizes the median voter's post-tax income in

Figure 1-4: Patterns of investment in education, $\bar{n} = 5e$.



Question (b) therefore corresponds to finding the locus $z = 0$ in the region below the $x = 0$ locus. Above the $z = 0$ locus (region C) n_1 is sufficiently close to n_2 that the extra progressivity of the tax system required to enable the low income group to invest is small compared to the second period gain; consequently, $z > 0$ in region C. Thus, the median voter will set the tax rate at ${}_1\tilde{t}_1$ and high growth will follow. Below the $z = 0$ locus (region D) $z < 0$ and the median voter sets the tax rate at ${}_1t_2^*$ so that the low income class cannot invest in education and lower growth will follow.

The following result formalizes this argument:

Result 2: For an economy with $\bar{n} \geq 4e$:

- the $x = 0$ locus is upward sloping and is defined for $n_1 \in [\tilde{n}_{min}, e]$ and $n_2 \in [n_2^a, \bar{n}]$, where n_2^a is a function of $\bar{n}$;

- the $z = 0$ locus is upward sloping and is everywhere below the $x = 0$ locus;

---

the first period.

- $z < 0$ in the region comprised between the locus $z = 0$ and $n_1 = 0$.

Proof: See Appendix B. □

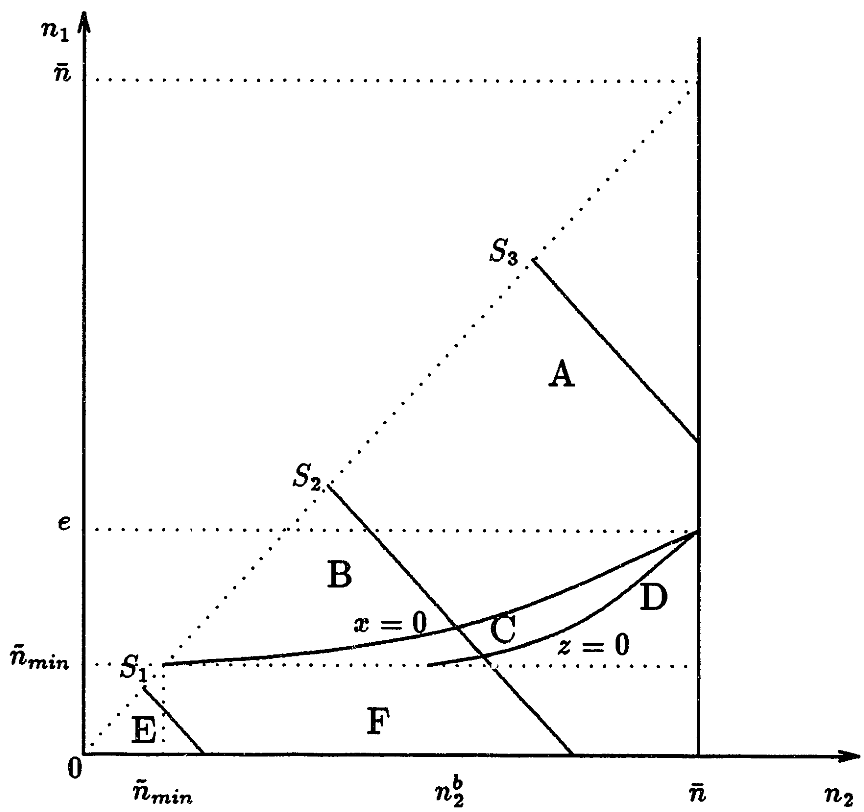
Result 2 implies that the $x = 0$ locus and the $z = 0$ locus have the shapes depicted in Figures 4. The intuition behind it is straightforward. There are two relevant regions, $n_1 > e$ and $n_1 < e$. When $n_1 > e$ (Region A), the median voter does not face any intertemporal trade-off, since the low income group can afford investment in education even when there is no redistribution. When $n_1 < e$, whether the low income group invests depends on its position relative to the middle group. Consider fixing a value for n_1 on the vertical axis; if n_2 is not too distant from n_1 (regions B and C) the low income group will be able to invest in education; in region B, because the distance between n_2 and n_1 is so low that ${}_1t_2^* \geq {}_1\bar{t}_1$, in region C, because it is not too costly for the median voter to deviate from ${}_1t_2^*$. However, if n_2 is large relative to n_1 (region D) then $z(n_2, n_1) < 0$, so that the short run cost to the median voter from high redistribution outweighs the long run gain. This occurs for two reasons: first, since the distance between n_2 and n_1 is large, the difference between ${}_1t_2^*$ and ${}_1\bar{t}_1$ is large, so that the movement away from the optimal tax rate ${}_1t_2^*$ is costly; second, since n_2 is relatively large, the median voter does not want high redistribution anyway, and therefore she benefits relatively little from the increase in second period's income.

A result similar to Result 2 holds for an intermediate income economy too, with $e < \bar{n} < 4e$. Consider Figure 5.

Now there are three relevant regions for n_1: $n_1 > e$, $\tilde{n}_{min} < n_1 < \bar{n}$, and $n_1 < \tilde{n}_{min}$. The same considerations made about the two ranges of n_1 in Figure 4 apply to the first two regions of n_1 in Figure 5. However, now the economy is poorer than the economy sketched in Figure 4. In particular, if $n_1 < \tilde{n}_{min}$ no level of redistribution enables the low income group to invest[13], and the same is true if $n_2 < \tilde{n}_{min}$. Thus, for $n_1 < \tilde{n}_{min}$ and $n_2 < \tilde{n}_{min}$, only the high income group will invest in education, while for $n_1 < \tilde{n}_{min}$, $n_2 > \tilde{n}_{min}$ the high and middle income groups will invest in education.

[13] Note that this feature of the model depends crucially on the existence of convex costs of collecting taxes.

Figure 1-5: Patterns of investment in education, $\bar{n} = 3e$.



Apart from these differences, the logical structure of the problem remains the same as in the case of a rich economy. In particular, the shapes of the $x = 0$ and $z = 0$ loci can be explained by exactly the same considerations made above.

1.4.2 The case of a poor economy.

Consider now the case of a poor economy, with $\bar{n} < e$. Only n_3 agents can now possibly invest in education: any agent starting with a pre-tax income below $\bar{n}$ and therefore below e will never be able to reach a post tax income of at least e (see Figure 1 (c)). It is then clear that when $n_3 < e$ no agent can invest in education, and therefore no growth can take place. Therefore, assume from now on that $n_3 \geq e$.

Now the only potential investors in the economy, i.e. n_3 agents, are hurt by high tax rates. It is then intuitive that the median voter will face two relevant situations. If n_2 is large given n_3 (so that ${}_1t_2^*$ is small) or n_3 is large given n_2 (so that ${}_1\hat{t}_3$ is large) the economy will be in region A in Figure 6: here, ${}_1t_2^* \leq {}_1\hat{t}_3$ and n_3 agents will be able to invest in education at the tax rate preferred by the median voter[14].

In contrast, if n_2 is low given n_3 or n_3 is low given n_2, the economy will be in region B, where ${}_1t_2^* > {}_1\hat{t}_3$. Now n_3 agents will not be able to invest in education at ${}_1t_2^*$ and the median voter faces the familiar intertemporal trade-off. The only difference is that now she must trade *less* redistribution in period 1 for a higher per capita income in period 2.

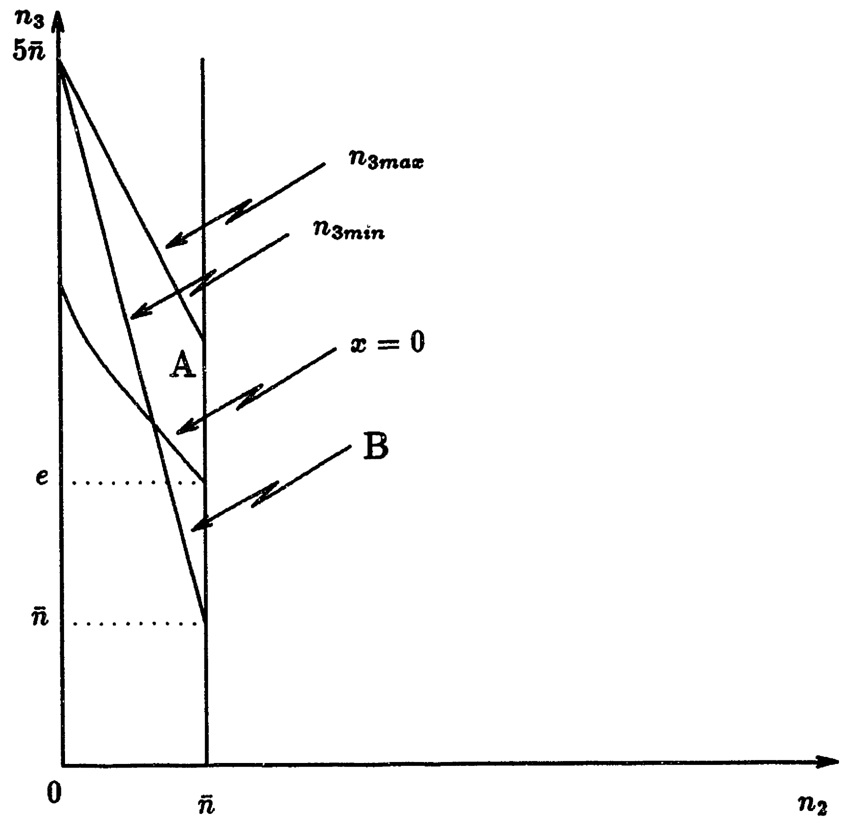
One can therefore define two loci $x(n_2, n_3) = 0$ and $z(n_2, n_3) = 0$ in the (n_2, n_3) space in exact analogy to the case of a rich economy analyzed above. Thus, below the $x = 0$ locus n_3 agents cannot invest at ${}_1t_2^*$, while below the $z = 0$ locus the short period loss to the median voter from deviating from the optimal tax rate outweighs the long run gain deriving from a higher second period per capita income.

It is therefore relatively easy to prove the following

Result 3: For an economy with $\bar{n} < e$:

[14] In Figure 6 note that, for a given n_2, n_3 can only take a value comprised between $n_{3max}(n_2)$ and $n_{3min}(n_2)$, where n_{3max} is the value of n_3 when $n_1 = 0$ and n_{3min} is the value of n_3 when $n_1 = n_2$.

Figure 1-6: Patterns of investment in education, $\bar{n} = .5e$.



- the $x = 0$ locus is downward sloping;

- $z > 0$ always at $n_2 = \bar{n}$;

- $z > 0$ everywhere for $\bar{n} < 2p_3e$;

- for $\bar{n} > 2p_3e$, if $z > 0$ for admissible values of n_2 and n_3, this will occur in a region comprised between the n_{3min} curve and the $x = 0$ locus;

- for p_3 sufficiently small, there exists a region below the $x = 0$ locus where $z < 0$;

- for p_3 sufficiently large, there is no region below the $x = 0$ locus where $z < 0$.

Proof: See Appendix B. □

While the first four points in Result 3 merely formalize the intuitions developed above, the last two points deserve some further comments. It is intuitive that, when the high income group is numerically large (p_3 is large), the gain to the median voter deriving from the investment of the high income group is large, and if p_3 is sufficiently large it certainly outweighs the first period loss. The reason is that the first period loss depends only on the distance between n_2 and n_3 and not on p_3. Conversely, it is clear that when p_3 is negligible the second period gain is negligible too, so that the median voter will resolve the trade off always in the less favorable way to growth. It is also intuitive that when per capita income is very small ($\bar{n} < 2p_3e$) the marginal cost to the median voter from renouncing redistribution in period 1 is low, while the marginal second period benefit from letting the high income group invest is high, since the increase in per capita income is large relative to the initial income. Thus, in this case the median voter will always have an incentive to renounce redistribution in period 1 in order to enable the high income group to invest.

1.5 Implications of the model.

1.5.1 Income shares, levels of income and growth.

The model developed so far delivers a clear message: economies with different per-capita incomes have very different patterns of income distribution (i.e. relative shares) that are most favorable to growth. In particular, income distribution affects growth through two channels.

First, in a very poor economy growth can occur only if the distribution of income is sufficiently unequal, so that $n_3 > e$. Similarly, in an intermediate income economy income distribution determines whether there is a tax rate at which the low income group and the middle income group can invest in education.

Second, income distribution affects the share of the median voter *relative* to the potentially liquidity contrained group (n_3 in a poor economy, n_1 in a rich economy). This relative share in turn determines whether an intertemporal trade-off exists and, when it exists, whether the median voter has an incentive to set a tax system that promotes growth.

In rich and an intermediate economy the best preconditions for high growth (in the sense that both n_1 and n_2 invest) are a low share of n_3 and/or very similar shares of n_1 and n_2 (the region along the 45° line). When the share of the high income group is relatively low, the two remaining group will start with a relatively high pre-tax income. When n_1 is close to n_2, either ${}_1t_2^* \geq {}_1\tilde{t}_1$ or the median voter has relatively high incentives to let the low income class invest through high redistribution in case ${}_1t_2^* < {}_1\tilde{t}_1$.

Exactly the opposite configuration of income distribution favors high growth (i.e. investment by n_3 agents) in a poor economy with $\bar{n} < e$. Here, if the share of the high income group is very low, the economy will be below the $n_3 = e$ line, so that no tax rate will allow n_3 agents to invest. Also, if n_1 is very close to n_2 (along and close to the n_{3min} line[15]) then the economy will be more likely to be in the region

[15]Recall that the n_{3min} line in the (n_2, n_3) space represents the same points as the 45° line in the (n_1, n_2) space.

where $z < 0$, if it exists. The intuition for this result is obvious: in a poor economy, not even a very progressive tax system will allow low income agents to invest, so that only n_3 agents can potentially invest. Thus, any pattern of income distribution that endangers the investment ability of the high income agents can harm growth.

1.5.2 The information in the measures of inequality.

The argument developed in the previous subsection has a first potentially important empirical implication. Because it is essentially the *relative* shares of the three classes that determine the political outcome and through this the rate of growth of the economy, the usual measures of inequality utilized in empirical work, like the Gini coefficient and the shares of the top quintile or bottom quintile, may not be sufficient, *when taken individually*, to study the relation between income distribution and growth.

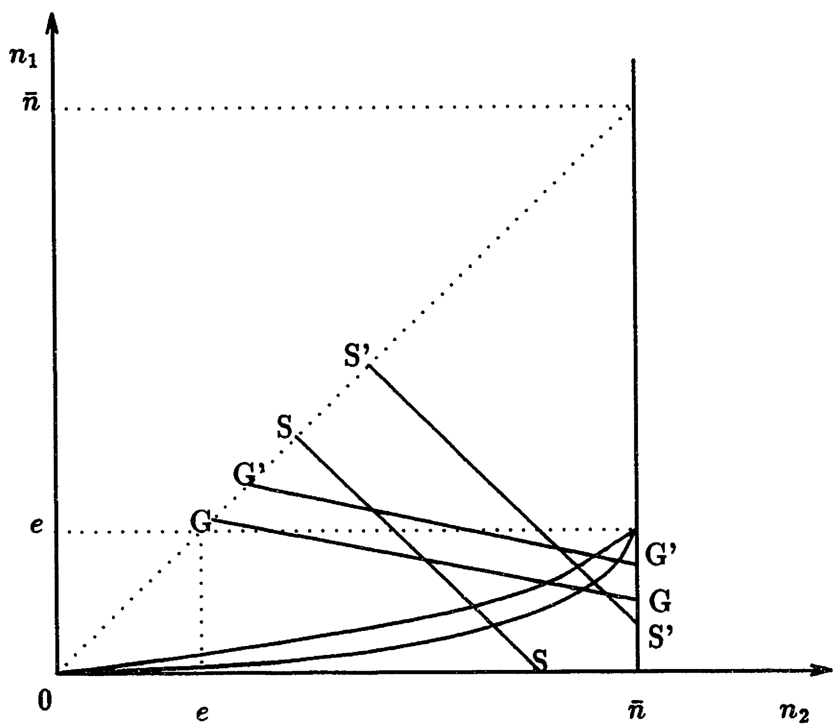
Of course, researchers have always been keenly aware of the inherent drawbacks of the Gini coefficient. For instance, whenever this measure is used, it is commonplace to caution readers that its movements do not say much about underlying movements in the Lorenz curve.

However, when one is interested in studying the relation between income distribution and growth, the model points to other types of problems. Figure 7 illustrates the nature of the problem[16].

Along SS and S'S' the share of n_3 agents in total income is constant, a higher curve representing a lower share of n_3. Along GG and G'G' the Gini coefficient is constant, a higher curve representing a smaller Gini coefficient. It is clear that just knowing that the economy is, say, on the curve GG is not enough. This information is consistent both with high growth, if the economy is on S'S' (low share of n_3), or low growth, if the economy is on SS (high share of n_3). A similar argument shows that just knowing that the economy is on S'S' (i.e., just knowing the share of the top twentieth percentile of the population) is not enough to determine its growth

[16] As usual, it is assumed in Figure 7 that $p_1 = p_2 = .4$ and $p_3 = .2$.

Figure 1-7: The information in the measures of inequality.



potential.

1.5.3 The sensitivity of growth to income shares.

A second important implication of the model is that, as per capita income increases, high growth becomes less sensitive to income distribution. This statement can be made formally precise. Let s_i indicate the share of income class i in total income. Consider first the share of the high income group, s_3, on growth. In a rich economy, the range of values of s_3 for which high growth will occur whatever the value of $\frac{s_1}{s_2}$ increases as $\bar{n}$ increases. In Figure 4, this range is represented by the sum of the lengths of the two segments HS_3'' and OS_3' as a proportion of the total length OH. Since the length of the segment $e\bar{n}$ in Figure 4 remains constant as $\bar{n}$ increases, the ratio HS_3''/OH increases. Moreover, it can be shown that $\frac{dn_2^e}{d\bar{n}} > 1$, which implies that OS_3'/OH increases as $\bar{n}$ increases.

A similar argument can be applied to the cases of an intermediate income economy economy and of a poor economy.

Consider now the relation between growth and the relative share of the middle income group to the share of the groups whose investment may depend on the tax rate set by the median voter (the low income group in a rich economy, and the high income group in the case of a poor economy). By just looking at Figures 4 through 6, it is clear that in a high (intermediate) income economy the range of values of $\frac{s_1}{s_2}$ for which high (intermediate or high) growth will occur increases with per capita income for a given s_3. Likewise, in a poor economy the range of values of $\frac{s_2}{s_3}$ that allows growth increases with per capita income.

The intuition behind these results is simple: since a rich economy redistributes more resources for a given tax rate, it is less sensitive to deviations from the "optimal" pattern of relative shares. Consider for instance the case of two economies, both with $\bar{n} > e$, and let n_1 have the same value in both. Then n_1 agents will invest in education for a wider set of values of n_2: this is because the marginal benefit to n_2 of an increase in the tax rate is higher when $\bar{n}$ is higher, while the marginal cost depends only on n_2. A symmetrical argument applies to the case of a poor economy.

1.5.4 Movements of relative shares in the growth process.

The model provides testable implications about which income groups benefit the most from the different rates of growth at the different levels of per capita income.

In a high income economy, when low growth occurs the low-income group experiences a drastic fall in its share, while the opposite is true for the middle income group. The high income group can increase or decrease its share, depending on wheter the initial share is low or high. When high growth occurs, s_1 and s_2 increase, and s_1 more than s_2, while s_3 certainly decreases. Thus, in a rich economy, the middle income group always benefits from growth, while the low income group benefits only from high growth. The high income group will not benefit from high growth, and might increase its share only in the case of low growth.

In an intermediate income economy, the high income group will benefit from low growth, while the low and middle income groups will be hurt. In the case of intermediate or high growth, the behavior of the shares of different income groups is the same as in the corresponding cases for a high income economy.

Finally, when growth occurs in a poor economy, only the high income group will benefit from it, while the two other groups will be hurt.

In the past, there has been some empirical work on the behavior of the different quintiles during the development process (see for instance Adelmann-Morris [1973]), and several descriptive contributions. The results of this model might be useful in connection with this literature.

1.6 An overlapping generations model with voting.

1.6.1 The model.

In this section, I will develop an overlapping generations extension of the two period model of Sections 3 and 4. This is necessary to study the effects of the mechanism analyzed so far on the dynamic path of the economy. In fact, by considering an explicitly dynamic economy, this section has three main objectives: (i) to analyze the degree of persistence in the evolution of the economy stemming from the initial pattern of income distribution; (ii) to relate the result of the analysis in (i) to the empirical evidence on the relation between income distribution and growth; (iii) finally, to formalize a process of growth, implicit in the two period model, whereby a class investing in education increases the resources available for redistribution in the future and therefore may enable the classes further down the ladder to invest in education as well.

The mechanisms at work in the overlapping generations model are essentially a straightforward extension of those operating in the two period model. However, since agents are fully rational and take into account the effects of their current decisions on future outcomes, the formal analysis of the model requires a rather involved algebraic structure. In order to concentrate on the conceptual issues, in this section I will only set up the model, outline the method of solution and then discuss its implications for the three issues listed above. A full formal treatment of the model is left for Appendices C and D.

In each period of time, there are two generations alive, the old and the young. Each household is composed of two members, an old agent and her young offspring. As before, a household can belong to one of the three classes of pre-tax income. For simplicity, all agents work, consume, pay taxes and receive subsidies only in the second period of their lives. In the first period of her life an individual can acquire education if her parent decides so. This can occur because there is one-sided altruism, so that the utility of an old agent in income group i at time j is

$$_jU_i = {_jc_i} + \delta_{j+1}U_i \tag{1.11}$$

where $_jc_i$ denotes the consumption of an old agent belonging to class i in period j and $\delta < 1$ indicates the degree of altruism.Therefore:

$$_jU_i^O = {_jc_i} + \sum_{k=1}^{\infty} \delta_{j+k}^{k} c_i \tag{1.12}$$

A young agent belonging to income group i inherits the innate ability to earn n_i but not the component acquired through formal education, Re. Thus, investment in education is now like an *intra vivos* transfer that increases the consumption of future generations. Each period, the old vote over the progressivity of the tax system.

The equilibrium of the economy in each period and its dynamics are found as follows. First, I find a sufficient condition on the returns to education R and the coefficient of altruism δ, roughly equivalent to condition (3) in the two period model, which ensures that whenever the post-tax income of an old agent exceeds e she will want to invest in the education of her offspring. Next, note that in this model it is still true that taxation has an intertemporal effect only when there are agents whose investment decisions depend on the degree of redistribution. Also, in each period the region where the median voter faces an intertemporal trade-off is exactly the same as in the two period case, since the first period cost of a deviation from the optimal pattern is obviously the same[17]. Finally, the region where the trade-off is resolved by deviating from the optimal tax rate of the static problem has the same qualitative behavior and is found using a conceptually equivalent procedure as in the two period model.

Given these features of the model, computing the equilibrium in each state of the economy does not involve any substantially new conceptual issue. The first step consists in deriving the possible steady-states of the economy. Given the sufficient condition outlined above, it is intuitive that a steady-state is a situation in which either all agents have invested or some classes have not invested but there is no incentive or it is impossible for the median voter to implement a tax system that would enable these classes to invest. However, since agents are forward-looking, in deriving the optimal proposals for each agent in each period something must be assumed about the behavior of future voters. Since the pre-tax incomes of the various classes fully characterize the state of an economy, future voters are assumed to behave according to Markov strategies, i.e. their proposals in each future period are a function only of pre-

[17]In other words, the $x = 0$ locus is the same as in a two period version with the same values of n_1, n_2 and n_3.

tax incomes of the three classes in that period[18]. *Given* these *future* Markov proposals, I show that in the *current* period it is indeed optimal for the members of each class to propose the same tax rates assumed to be proposed by their descendants. Essentially, the current steady-state equilibrium is derived as a fixed point of the mapping from the future given Markov proposals and the current optimal proposals. Once the steady-states of the economy are characterized, it is possible to work backward and find all possible dynamic paths depending on the initial conditions. In every state, it is also possible to show that the median voter is indeed the decisive voter.

1.6.2 Time series and cross-section implications.

An important limitation of the two period model concerns its ability to track the development of an economy over time. Section 4 showed that to different levels of income there correspond different and sometimes opposite patterns of growth maximizing income distribution. If one considers an economy in which investment in education can take place in more than one period, this property of the model has rather important implications.

Essentially, a given pattern of income distribution can be extremely appropriate for growth at a certain level of income; once the economy has reached a higher level of income, however, that same pattern of income distribution might hamper or, in extreme cases, prevent growth. This is so because pre-tax income distribution is essentially a state variable, and highly dependent on initial conditions. Also, the feasibility of changing the post-tax income distribution depends on the characteristics of the political equilibrium resulting from the pattern of pre-tax income distribution.

Thus, the model displays a strong *path-dependence*, in the sense that the steady-state reached by the economy is highly sensitive to the initial distribution of income. In particular, an economy that starts out at a very low level of income ($\bar{n} < e$) with a very unequal income distribution certainly satisfies the preconditions for growth

[18] It is intuitively clear that in a steady-state the optimal proposal of each voter must be the tax rate that maximizes her post-tax incomes in each period. Indeed, this is the Markov tax proposal postulated for the future generations.

at that level of income, as described in Section 4. However, growth at the next level of income ($e < \bar{n} < 4e$) requires exactly the opposite configuration of income distribution. As a consequence, after an initial spurt of high growth a very unequal society might get stuck at a relatively low level of income with an even worse income distribution than the initial one.

This mechanism may be potentially relevant in connection to the longstanding debate on the existence of an inverted-U relation between inequality and per capita income. Empirically, this relation seems to be quite robust in cross-section studies, and has been consistently obtained for more than three decades[19]. However, time series studies tend to cast doubts on the shape of the relation[20]. Essentially, the growth process seems to be consistent with a wide variety of behaviors of income distribution measures over time. While an initial worsening in income distribution at the first stages of growth seems quite widespread[21], further growth can be associated with declining or increasing inequality. Moreover, a recent literature on Latin America has emphasized that the pattern of development in several countries of that area seems to have been characterized by a high and increasing inequality during the first phases of development, after which growth essentially stopped at the top of the inverted-U curve[22].

The path-dependence displayed by the overlapping generations model of this section might explain these empirical regularities. The point is best made by way of an example[23]. Appendix D proves that the result holds more generally for any value of $\bar{n}$, n_1, n_2 and n_3.

Consider three economies, A, B and C with the same per capita income $\bar{n} = .98e$

[19]The story of the inverted-U curve dates back to Kuznets [1955]. Subsequent contributions supporting Kuznets' hypothesis to different degrees include Paukert [1973], Alhuwalia [1974], Chenery-Syrquin [1975] and more recently Campano-Salvatore [1988]. For less simpathetic views on the existence of an inverted-U relation in cross-sections, see Saith [1983] and Ram [1988].

[20]See especially Fields-Jakubson [1990].

[21]Williamson [1985] and Adelman-Morris[1983] document the increase in inequality that characterized the Industrial Revolution in Europe. Korea and Taiwan are frequently cited as counterexamples to this statements. However, the case of Taiwan is rather special, because of the large, sudden inflow of refugees from the civil war, while the case of Korea is more controversial: see for instance Papanek [1978].

[22]See for instance Bacha [1979] and Cardoso-Fishlow [1989].

[23]It is assumed here that $p_1 = p_2 = .4, p_3 = .2$ and $R = 4$. Also, $n_1 = n_2$ only for simplicity.

in period 1 but two very different initial Gini coefficients, denoted by ${}_jG_S$, $j = 1,2,3$ and $S = A, B, C$:

Country A

$$
\begin{array}{lllll}
j=1 & {}_1\bar{n} = .98e & {}_1n_1 = .98e & {}_1n_2 = .98e & {}_1n_3 = .98e \\
j=2 & {}_2\bar{n} = .98e & {}_2n_1 = .98e & {}_2n_2 = .98e & {}_2n_3 = .98e \\
j=3 & {}_3\bar{n} = .98e & {}_3n_1 = .98e & {}_3n_2 = .98e & {}_3n_3 = .98e
\end{array}
$$

Country B

$$
\begin{array}{lllll}
j=1 & {}_1\bar{n} = .98e & {}_1n_1 = .925e & {}_1n_2 = .925e & {}_1n_3 = 1.2e \\
j=2 & {}_2\bar{n} = 1.78e & {}_2n_1 = .925e & {}_2n_2 = .925e & {}_2n_3 = 5.2e \\
j=3 & {}_3\bar{n} = 4.98e & {}_3n_1 = 4.925e & {}_3n_2 = 4.925e & {}_3n_3 = 5.2e
\end{array}
$$

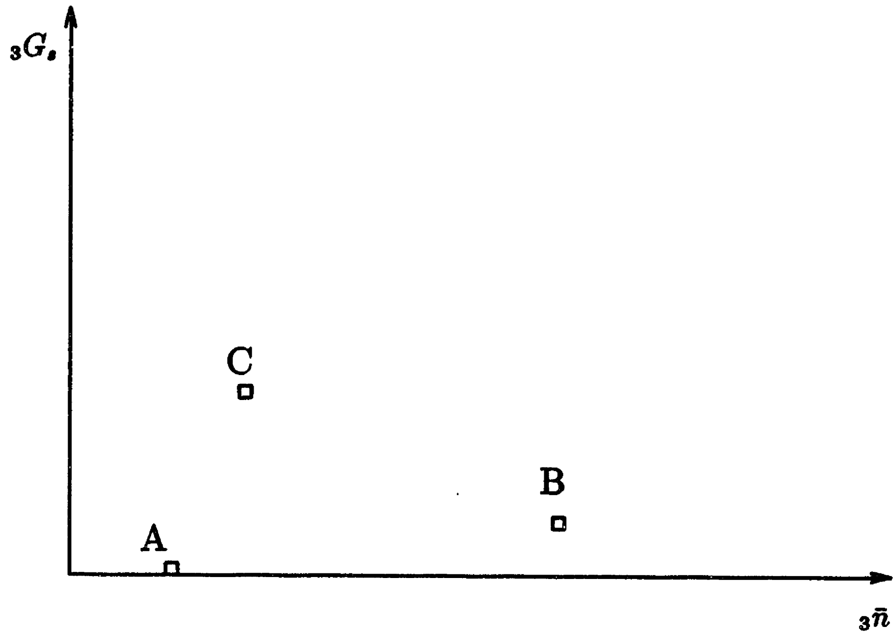
Country C

$$
\begin{array}{lllll}
j=1 & {}_1\bar{n} = .98e & {}_1n_1 = 0.0e & {}_1n_2 = 0.0e & {}_1n_3 = 4.9e \\
j=2 & {}_2\bar{n} = 1.78e & {}_2n_1 = 0.0e & {}_2n_2 = 0.0e & {}_2n_3 = 8.9e \\
j=3 & {}_3\bar{n} = 1.78e & {}_3n_1 = 0.0e & {}_3n_2 = 0.0e & {}_3n_3 = 8.9e
\end{array}
$$

Economy A has a completely egalitarian income distribution, so that ${}_1G_A = 0$. Economy B is only slightly more unequal: ${}_1G_B = .228$. Finally, economy C is characterized by a very unequal income distribution: ${}_1G_C = .8$. As shown above, economy A cannot grow; between B and C, B is clearly worse equipped for growth: in fact, it barely succeeds in starting the development process. However, once the process has started, B is in a better position to continue growth than C. Indeed, in the second period C reaches a steady-state where only the high income class is investing in education[24], and therefore income distribution is even more unequal than initially. By contrast, economy A reaches the steady state in the third period, with all classes investing. Thus, income distribution has improved after the first increase in inequality *and* steady-state income is higher than C's steady-state income.

[24]Note that for both B and C $\tilde{n}_{min}({}_2\bar{n}) = .888$.

Figure 1-8: The inverted-U relation.



Now suppose an econometrician observes these economies after they have reached their steady-states and tries to fit the best curve in the $(G, \bar{n})$ space: *such a curve will be an inverted-U* (see Figure 8).

The reason is simple: the economies that in steady-state have a higher income level are those whose initial income distribution enabled them to deal best with the different phases of economic development. In very egalitarian economies, like A, no investment in human capital could ever take place. In economies with a very unequal income dstribution, like C, the middle and/or the lower class are so poor that not even the maximum feasible level of redistribution will enable them to invest in education. Only economies that started out sufficiently equal, but not excessively so, have the ability both to start growth and to keep growing once an intermediate level of income is reached.

Note however that the time series behavior of the Gini coefficient presents an inverted-U pattern only in the case of economy B, while in country C it only increases and in country A it never moves. This seems to be consistent with the available empirical evidence in two respects. First, as mentioned above, the time series behavior of inequality measures is known to follow a variety of patterns. Second, the presence of an inverted-U pattern in time series has been documented quite convincingly for several currently industrialized countries, including U.S., Great Britain, Germany, Norway, Denmark, the Netherlands,[25] while high and increasing levels of inequality are more common among intermediate income economies[26].

1.6.3 Growth as a "trickle-down" process.

In an overlapping generations model, one can exploit fully the "trickle down" process of growth that is only implicit in the two period model. By increasing total resources available for redistribution, investment by the upper class in the first period allows the other classes to invest in the following period. A comparison of economies B and C reveals what is a precondition for this "trickle-down" mechanism to operate: the pre-tax income of the groups that rely on this mechanism should be above a certain threshold level, below which there is no level of redistribution that allow investment in education. Similarly, under some circumstances investment in education by the middle class will enable the low income group to invest in the next period.

In particular, consider fixing the pre-tax income of, say, the low income class in period j at ${}_jn_1 < \tilde{n}_{min}({}_j\bar{n})$, so that in period j it cannot invest in education at any level of redistribution. If the middle class invests in education in period j, per capita income in period j will increase, and it might now be the case that $n_1 > \tilde{n}_{min}({}_{j+1}\bar{n})$ and the low income class invests in education in period $j+1$. It can be shown that this will occur if both p_2 is sufficiently large, so that the positive externality from investment by the middle class in period j on per capita income in period $j+1$ is large, and p_1 is sufficiently large, so that the effects of investment by the low income class in period $j+1$ on per capita income in the following periods is large enough,

[25]See Lindert-Williamson [1985] for a brief review of the time series experience of currently industrialized countries.

[26]The time span covered by income distribution data for developing countries is much shorter than in the case of currently industrialized countries. However, as pointed out before, Brazil and Mexico are examples of countries where income distribution kept deteriorating during the development process and does not show signs of improvement: see Van Ginneken [1980] and Bacha-Klein [1989].

thus providing the median voter with the adequate incentives to deviate temporarily from her preferred tax structure.

This also illustrates the crucial role played by political factors in the growth process. Essentially, the political outcome resulting from a given income distribution determines whether the intertemporal transmission of the externality outlined above goes on until all classes have invested or it stops before this occurs.

1.7 Conclusions.

This chapter has focused on a possible mechanism by which income distribution affects growth: the degree of redistribution resulting from the political equilibrium generated by the initial pattern of relative shares. It has been shown that this effect operates very differently at different levels of income. Once this mechanism is incorporated in an overlapping generation model with voting, two interesting implications arise.

At a theoretical level, growth occurs through a "trickle-down" phenomenon: investment in education by one class increases the resources available for redistribution to other classes in the future. However, this intertemporal transmission of externalities can stop if the initial income distribution is characterized by high inequality, so that the resulting political equilibrium does not redistribute enough resources. Thus, countries that start the growth process with high inequality can get stuck at intermediate levels of income with even more inequality.

In turn, this generates the second interesting implication of the model, this time at an empirical level. Because of the persistent effects of the initial pattern of income distribution on the level of income reached in steady state, it is shown that the model has the potential for explaining the inverted-U relation between inequality and levels of income which is frequently obtained in cross-section studies. At the same time, the model can explain why the same relation is less frequent in time-series studies.

Chapter 2

Income distribution and growth: some empirical evidence.

2.1 Introduction.

This chapter presents some empirical evidence on the model developed in Chapter 1. As briefly discussed there, the model is consistent with a well-known empirical result, the cross-section Kuznets' curve. It is also consistent with the time-series behavior of income distribution and per-capita income that has been observed in some countries for which data were available. It is obvious, however, that the existence of a Kuznets' curve does not *per se* provide immediate support for the mechanism of income distribution and growth described in the model: the same observed relation between income distribution and per-capita income in steady-state might have been caused by many other equally plausible mechanisms. Therefore, empirical evidence on the specific approach of Chapter 1 is needed in order to assess its relevance.

A test of the model of Chapter 1 is also interesting because of the comparison it allows with other recent models on income distribution and growth, notably Alesina-Rodrik [1991] and Persson-Tabellini [1991]. Contrasting their empirical evidence with that of this chapter, besides being of interest in itself, can shed further light on the validity of the approach developed here.

There is an immediate difficulty in providing empirical evidence on the model of

Chapter 1. On one hand, its basic message is quite clear: the way income distribution affects growth varies drastically with the average income of the economy. On the other hand, exactly how to test this prediction is not immediately evident. Indeed, the assumption that education is not a continuous variable precludes testing the model at its face value. Also, the model does not provide unambigous specifications that should be estimated. For these and other reasons the specification of the estimated model must be carefully motivated. This task is taken up in the next sections.

Specifically, the plan of the chapter is as follows. Section 2 sets up the most reasonable specification of the equations to be estimated, on the basis of the main *qualitative* implications that can be derived from the theoretical model. Two mechanisms are particularly important in driving the model: the relation between school enrollment (as a proxy for investment in human capital) and income distribution, and the relation between redistribution and income distribution. Section 3 presents the results of the estimates of these relations. In order to allow an interesting comparison with other recent models of income distribution and growth, Section 4 sets up a system of equation that relates income distribution to the *growth* of school enrollment and the latter variable to the subsequent growth of GDP. The effects of income distribution under the null hypothesis are derived from the theoretical analysis of the model. Although this is probably not the best specification to test the model of Chapter 1, it is the most interesting in view of the recent literature on growth. Because of current data availability, the most natural way to estimate the bivariate recursive system set up above presents several problems, due to the fact the both rates of change used are measured over a short period. Therefore, in Section 6 other specifications are tested, relating directly the rates of growth of GDP and of school enrollment to income distribution. The problem of a presence of a strong cyclical component when this variables are measured over short periods is thus attenuated. Section 7 draws the main conclusions of this Chapter.

Consequently, in Section 4 other tests are carried out that try to strike a balance between adherence to the model and econometric fesibility. Section 5 compares the implications of the model of Chapter 1 to those of other models of income distribution and growth, in particular Alesina-Rodrik [1991], and sets up a test of the two theories. Section 6 tests the implications of the model regarding the relation between income distribution and the degree of redistribution in teh economy. Section 7 concludes.

2.2 A reassessment of the model of Chapter 1.

This section reviews the empirical implications of the two-period model developed in Chapter 1 and sets up the equations to be estimated.

Since the model hinges on a crucial discontinuity, namely that education is a discrete variable, it would be hopeless to test it in its original form. It seems more reasonable to derive its most important *qualitative* implications and test those.

The model is based on two important assumptions: first, there is a tax system in place that can be used to redistribute resources; second, the agents of the economy can vote over the level of redistribution through the tax-subsidy system. It is clear that in the real world both these assumptions can fail.

In principle, both problems can be handled. When no income tax system is in place most of the *qualitative* results of the *two-period* model remain valid. The absence of a tax system can be reinterpreted as a situation where very large collection costs exist. In fact, if the per capita subsidy is equal to $(t - \gamma t^2)\bar{n}$, where γt^2 represents the collection costs, the maximum tax rate will be $1/2\gamma$, which is obviously decreasing in γ. As to the second assumption, when political participation is prevented somehow, this can be interpreted merely as a shift in the position of the median voter.

In practice, however, the problems posed by the failure of these two assumptions are almost unsurmountable. The absence of an effective vehicle of redistribution has certainly an important endogenous component: countries where the upper class has a dominant position or the middle class is close to the upper class will generally not want to redistribute income to a significant extent even if this were technically feasible. Moreover, it might be difficult to distinguish empirically this situation from one where redistribution of income is constrained by the inefficiency of the tax collection system. The second caveat is probably even more important. Although in principle one can treat limitations to the voting process as a shift in the position of the median voter, in practice it may be very difficult to determine in what direction the shift is.

With these two caveats in mind, how should one proceed to estimate the model of Chapter 1? There are essentially three sets of testable cross-sectional implications that one can derive from the model of Chapter 1:

1) the cross-section, steady-state relation between inequality variables and per-capita GDP (the Kuznets' curve);

2) the relation between the pattern of income distribution and the pattern of investment in education;

3) the relation between the shares of the different classes and the degree of redistribution in the economy.

As to the time-series results, the main implication of the model concerns the evolution of income distribution along the growth path, as detailed in Chapter 1. Since there is an extensive literature on both the time-series and the cross-section aspects of the Kuznets' curve[1] this chapter will concentrate on points 2) and 3) above.

Consider first the relation between the pattern of income distribution and the pattern of investment in education. The basic idea of the model is that there is an asymmetry in the way income distribution affects the dynamics of investment in human capital, depending on the average income of the economy.

To see how this occurs, one has to ask what characterizes a poor economy as opposed to a rich economy from the standpoint of the model developed in Chapter 1.

There are two possible definitions of a poor economy that can be derived from the model of Chapter 1. First, when $\bar{n} < e$, only the upper class can invest in human capital. For this to happen the share of the upper class must be sufficiently large. This is all is needed in an economy without redistribution. This suggests estimating an equation of the form:

$$Sec_{70} = c_1 + \gamma_1 \, GDP_{60} + \gamma_2 \, Top + \epsilon \qquad (2.1)$$

[1]See the brief discussion in Section 6 of Chapter 1 and the references cited therein.

where the variables are defined in the Appendix. The same system could be estimated with primary enrollment instead of secondary enrollment.[2] If the model is correct, the coefficients γ_2 should be positive. In an economy with redistribution, the basic message is that the upper class can be hurt by too much redistribution. This means that high enrollment will occur if the share of the upper class is sufficiently high and/or the middle class does not have enough incentives to expropriate the upper class. Thus, a condition favorable to high investment in human capital is one where the share of the upper class is high and the share of the low-income class is low. This suggests estimating an equation of the form:

$$Sec_{70} = c_3 + \gamma_1 \; GDP_{60} + \gamma_2 \; Top + \gamma_3 \; Midbot + \epsilon \qquad (2.2)$$

instead of equation (1). Under the null hypothesis, both coefficients γ_2 and γ_3 should be positive.

The second definition of a poor economy corresponds to an "intermediate income" economy in the terminology of Chapter 1 whith $\bar{n} > e$ but still small. Thus, the low-income class will not be able to invest in human capital for any reasonable value of its share. High investment in human capital will then result if the share of the middle class is sufficiently large. This suggests estimating the same equation (2), but now one should expect a negative value for the coefficient γ_2 of Top in equation (2).

The main characteristic of a rich economy is that high investment in human capital will occur when the low income class invests in human capital. This will happen under two conditions. First, the share of the high income class should be low enough; second, the income of the low-income class and of the middle-class should be reasonably close. This suggests estimating equation (2) where both γ_2 and γ_3 are negative under the null hypothesis.

Consider now the relation betwen the share of the various classes and the degree of redistribution in the economy. The model implies that redistribution should be

[2]There is some evidence in the recent empirical work on growth that primary enrollment as a proxy for human capital has a higher explanatory power in growth regression than secondary enrollment.

a negative function of the income of the median voter relative to average income. Other recent models of income distribution and growth, like Alesina-Rodrik[1991] and Persson-Tabellini [1991], imply some version of the same relation. This is also the prediction of the static models of "voting over linear tax schedules" like Roberts [1977] and Romer [1975].

In addition, the model of Chapter 1 suggests that the distance between the income of the median voter and the income of the typical agent of the low income class should matter. The rationale for this effect is that, when the distance is large, the costs to the median voter of enacting high redistribution offset the gains. This suggests that the ratio of the share of the third and fourth quintiles to the share of the first and second quintile should be negatively related to the level of redistribution.[3]

One problem in testing this relation is that it is rather difficult to locate exactly the empirical counterpart of the concept of redistribution used in the theoretical model. Ideally, one would want a measure of the redistribution achieved through both the tax *and* transfer systems. It is well known that this is a very difficult measure to obtain, and some (not uncontroversial) results are available only for a few developed countries. The cross-section of data currently available does not allow one to even get close to a reliable measure of the incidence of the tax-transfer system. I therefore had to rely on rather crude proxies for the redistribution process. From the Barro-Wolf data set I utilized two variables, government transfers as a fraction of GDP (TR) and social insurance and welfare payments as a fraction of GDP (SS). Both variables are averages between 1970 and 1985. The equations estimated are:

$$RD = c_3 + \mu_1 GDP_{60} + \mu_2 Mid + \epsilon \tag{2.3}$$

and

$$RD = c_4 + \pi_1 GDP_{60} + \pi_2 Mid + \pi_3 Midbot + \epsilon \tag{2.4}$$

where RD is one of the two proxies for the degree of redistribution in the economy

[3]It is assumed here that the country is not "poor" in the definition of Chapter 1.

indicated above.

2.3 The basic tests.

There are two strategies that can be followed at this point. One can test the model only for democracies. With enough data, this is probably the best course of action. The obvious problem is that there are very few poor countries where meaningful and regular votes took place during the sample period.[4] Consequently, if one uses this criterion the model cannot be tested on poor countries. Thus, the test cannot address the most important implication of the model, namely that there is an asymmetry in the way income distribution affects growth in poor and rich countries.

The second strategy consists in testing the model with the available data under the heroic asssumption that something close to the position of the median voter emerges. It is important to note that this might not be completely misleading if the poor countries are also those countries where there is no redistribution because an effective tax system is simply not technically available. As illustrated in Section 2, in this case the initial income distribution still affects the dynamics of investment in human capital according to the same pattern analyzed there (see equation (2)).

In this section, I will follow both strategies leaving it to the reader to decide what conclusions can plausibly be drawn from the tests. In Section 6, I will expand on the issue of the relative importance of the "democracy/non democracy" classification as opposed to the "rich/poor" classification in determining the effects of income distribution on the rate of growth of an economy.

Finally, one word should be spent on the estimation procedure adopted. It is well known that income distribution data are likely to be subject to substantial measurement errors. In addition, in cross-section estimation one should certainly worry about the different definitions adopted in different countries to measure the same variable. It is therefore clear that an instrumental variable approach is called for. Unfortu-

[4]A classification of countries in democracies and non-democracies is obviously often a matter of judgment. The Barro-Wolf [1990] data set has a "political rights" variable that was used to split the sample in democracies and non-democracies.

nately, I am not aware of any good instrument for the income distribution variables used here. If the test used only some crude measure of inequality, e.g. the share of the top quintile, it would probably be possible to find a plausible instrument. But a crucial element of the theory tested is that other income distribution variables, like the ratio of the share of the middle class to the share of the low-income class, play an important role. It is clear that finding a good instrument for this variable is a prohibitive task.

It is important to note that the problem is compounded by the fact that there is really no ground for arguing in which direction the bias induced by measurement error operates. In particular, as far as I know there is no indication that the income distribution variables used in this chapter tend to be overestimated or underestimated. Moreover, it is not clear that, if there is indeed a systematic error, it should be larger in poor countries than in rich countries. For all these reasons, it seems wisest to use OLS in the estimations of this and the next sections.[5]

The first test consists in a rather crude estimation of the equations set up in the previous section for both poor and rich countries. To this end, the sample of 72 countries was split into two subsamples of poor and rich countries in two different ways. The first subdivision allocates the poorest 33 countries to the category of "poor" countries and the richest 39 to the category of "rich" countries. In the second subdivision the two categories comprise 46 and 26 countries respectively.[6] Results are reported here only for the second classification, since the first classification gave very similar results. Table 1 reports the estimation of equations (1) and (2) for poor and rich countries.

The coefficient of Top in equation (1) is negative and significant. The sign suggests that it might be more appropriate to estimate the specification (2) rather than (1), for the reasons presented in Section 2. The results of such estimation are also reported in Table 1. The signs of the coefficients for the income distribution variables are as predicted by the null hypothesis, but the coefficient of $Midbot$ is insignificant in both

[5] Exactly the same argument applies to the estimation of the bivariate system in Section 4.

[6] The cut-off points for the two classifications are a real GNP of 1,000 and 2,000 1980 dollars respectively in the Summers-Heston dataset.

Table 2.1: Income distribution and enrollment.

Eq.	Constant	GDP_{60}	*Top*	*Midbot*	$\bar{R}^2$
			Poor countries		
(1)	.661	.209	-.007		.484
	(4.956)	(6.679)	(-3.185)		
(2)	.661	.209	-.007	.002	.473
	(4.953)	(6.670)	(-3.918)	(.544)	
			Rich countries		
(2)	1.009	.217	-.014	-.004	.438
	(2.395)	(1.753)	(-2.366)	(-.080)	

Dependent variable in equations (1) and (2): Sec_{70}. t-statistics in parentheses. Sample sise: poor countries: 46; rich countries: 26. All the standard errors are corrected for heteroskedasticity using the White heteroskedasticity-robust variance-covariance matrix.

cases.

It is important to note, however, that in the case of rich countries insignificant estimates of the coefficients of the income distribution variables are not inconsistent with the model of Chapter 1. As shown formally there, the richer the country, the less important is income distribution in terms of investment in human capital. Indeed, in a very rich country even a poor agent will have enough income to invest in education. An agent in the same percentile of the income distribution of a poor country, instead, will not be able to invest in education.

Very similar results were obtained when the dependent variable was the primary enrollment ratio and when all the regressions were repeated with the (primary or secondary) enrollment ratio as measured in 1960 rather than 1970.

The next step consists in estimating the redistribution relations, equations (3) and (4). The results are reported in Table 2.

The point estimates do not support the null hypothesis: the crucial coefficient, that of *Mid*, has the wrong sign in all equations. This is particularly worrisome be-

Table 2.2: Income distribution and redistribution.

Eq.	Constant	GDP_{60}	*Mid*	*Midbot*	$\bar{R}^2$
		Poor countries, SS			
(3-SS)	-.017	.018	.001		.197
	(-.796)	(2.513)	(1.742)		
(4-SS)	-.015	.017	.001	-.001	.179
	(-.718)	(2.544)	(1.784)	(-2.167)	
		Rich countries, SS			
(3-SS)	-.122	.016	.005		.084
	(-1.404)	(.598)	(2.449)		
(4-SS)	-.094	.164	.005	-.006	.042
	(-.967)	(.639)	(2.503)	(-.318)	
		Poor countries, TR			
(3-TR)	-.108	.011	.005		.296
	(-2.321)	(1.066)	(3.351)		
(4-TR)	-.106	.011	.005	-.002	.275
	(-2.294)	(1.019)	(3.314)	(-1.572)	
		Rich countries, TR			
(3-TR)	-.232	.030	.009		.202
	(-2.037)	(1.055)	(3.222)		
(4-TR)	-.123	.025	.008	-.002	.218
	(-1.133)	(.894)	(3.169)	(-2.244)	

Dependent variable in equations (3-SS) and (4-SS): social security transfers. Sample size: poor countries: 30; rich countries: 24. Dependent variable in equations (3-TR) and (4-TR): government transfers. Sample size: poor countries: 28; rich countries: 25. t-statistics in parentheses. All the standard errors are corrected for heteroskedasticity sing the White heteroskedasticity-robust variance-covariance matrix.

cause the relation between the median voter's income relative to the average income and the degree of redistribution is at the heart of all models where endogenous redistribution, as determined by the political process, plays a crucial role.[7] The estimates for the case of rich countries are particularly puzzling. One can argue that the social security system (and in general the transfer system) in developing countries is not fully developed due to technical and institutional reasons, so that one should not attach too much weight to regressions (3) and (4) in Table 2 for these countries. But if there is any content in the politico-economic approach to fiscal policy, the same relation should hold for developed countries (under the maintained hypothesis that the variables used are good proxies for the right ones). As a further check, I run the same regressions only for those countries that can be characterized as democracies[8] among the group of the richest countries(Table 3).

Table 2.3: Income distribution and redistribution, democracies.

Eq.	Constant	GDP_{60}	Mid	$Midbot$	$\bar{R}^2$
(4-SS)	-.086	.014	.005	-.006	-.062
	(-.662)	(.321)	(1.825)	(-.257)	
(4-TR)	.046	-.027	.006	-.015	.015
	(.342)	(-.579)	(1.936)	(-.732)	

Dependent variable in equation (4-SS): social security transfers. Dependent variable in equation (4-TR): government transfers. Sample size in bothe regressions: 19. t-statistics in parentheses. All the standard errors are corrected for heteroskedasticity using the White heteroskedasticity-robust variance-covariance matrix.

If anything, the general fit of the equations worsens, while the sign of the coefficient of Mid remains positive. The sign of the coefficient of $Midbot$ is more comforting

[7]One might object that the share of the third and fourth quintile overstates the median voter's income relative to the average income, and is therefore not the right variable to use. Although I am skeptical on this argument, I am planning to explore this potential explanation of the finding in future research.

[8]A democracy was defined as a country whose value of the political rights variable in the Barro-Wolf data set was equal to or smaller than 2.

(although it is insignificant), but given the estimates of the coefficients of *Mid* it is not clear what importance one should attribute to this.

In summary, the results concerning human capital investment are mixed at best. While it is true that investment in human capital seems to be negatively related to the share of the top quintile, as predicted by the model, the other income distribution variables enter insignificantly in the regression. The estimates of the redistribution regressions are even less supportive of the theoretical model. The share of the middle class simply does not have the effects predicted by all the politico-economic models of endogenous redistribution. True, the measurement error problem is likely to be severe in the estimates presented above, and the specification used would provide a very crude measure of overall redistribution anyway. All things considered, however, it is difficult to avoid the conclusion that the income distribution channel described in the chapter is not likely to be at work in determining the level of redistribution and possibly of investment in human capital of an economy.

2.4 Growth vs. levels.

The human capital regressions of Section 3 tested the relation between the *level* of secondary school enrollmemt and the pattern of income distribution. Although this is the relation suggested by the model of Chapter 1, a somewhat looser interpretation of it provides a natural extension of the relation, one that links *growth* and the pattern of income distribution. [9] Testing such empirical relation is interesting because it might allow a comparison with other recent empirical evidence on the relation between income distribution and growth, based on different theoretical approaches (see in particular Alesina-Rodrik [1991] and Persson-Tabellini [1991].)

The model of Chapter 1 suggests two important elements that should be captured by the specification adopted. First, the model is recursive: income distribution affects

[9] It should be emphasized that this is correct even in the context of a literal interpretation of the model, under the assumption made throughout Chapter 1 that the countries being compared have the same average income but different patterns of income distribution. Of course, dividing the sample into two subsamples takes care only partially of the problem.

the dynamics of human capital accumulation and the latter determines the rate of growth of the economy. Second, as in the equations estimated in Section 3, there is an asymmetry in the way income distribution affects human capital accumulation, depending on the average income of the economy. For poor countries this suggests estimating a system like:

$$\Delta Sec_{6070} = c_1 + \gamma_1 Sec_{60} + \gamma_2 Top + \gamma_3 Midbot + \epsilon \tag{2.5}$$

$$\Delta GDP_{7085} = c_2 + \delta_1 GDP_{70} + \delta_2 \Delta Sec_{6070} + \eta \tag{2.6}$$

where under the null hypothesis both coefficients γ_2 and γ_3 should be positive. If the alternative definition of a poor country is adopted (see the discussion in Section 2), one should expect a negative value for γ_2 in equation (5). In the case of a rich economy, the model suggests estimating the same system (5)-(6), but now γ_3 should be negative under the null hypothesis. It should be noted that all this is a straightforward, although informal, extension of the discussion of Section 2 to a context where there is growth. Table 4 reports the results of the estimation of the system (5)-(6) for poor countries.

Both coefficients of the income distribution variable have the right sign, and one of them (the coefficient of *Midbot*) is strongly significant. However, the coefficient of ΔSec_{6070} in equation (6) are both negative, although insignificant. But things are even worse because the results do not seem to be robust to small modifications of the sample. The earliest available observations for the income distribution variables in some country refers to years after 1965. Therefore, they can hardly be regarded as exogenous for the purpose of estimating the first equation of the system. Since no good instruments are available, the wisest strategy is probably to drop them from the sample. One then obtains equations (5') and (6') in Table 4, where the coefficient of *Midbot* is now insignificant (with the wrong sign) *and* the coefficient of ΔSec_{6070} is still negative and strongly significant.

The corresponding results for rich countries are reported in Table 5.

Contrary to the case of poor countries, the estimates seem to be quite robust

Table 2.4: Recursive system, poor countries.

Eq.	Constant	Sec_{60}	Top	$Midbot$	GDP_{75}	ΔSec_{6070}	$\bar{R}^2$
				Full sample			
(5)	2.950	-8.244	-1.174	.349	.264		
	(2.948)	(-3.802)	(-1.174)	(6.348)			
(6)	.353				.289	-.034	.190
	(4.430)			(2.293)	(-.980)		
				Restricted sample†			
(5')	3.201	-7.670	.002	-.279	.115		
	(2.505)	(-2.844)	(.074)	(-.535)			
(6')	.321				.208	-.060	.185
	(3.977)			(2.446)	(-3.623)		

Dependent variable in equations (1) and (1'): ΔSec_{6070}. Dependent variable in equations (2) and (2'): ΔGNP_{7585}. Sample size: full sample: 46; restricted sample:30. In the restricted sample, all countries whose income distribution variables refer to the years after 1965 have been dropped. All the standard errors are corrected for heteroskedasticity using the White heteroskedasticity-robust variance-covariance matrix.

Table 2.5: Recursive system, rich countries.

Eq.	Constant	Sec_{60}	Top	$Midbot$	GDP_{75}	ΔSec_{6070}	$\bar{R}^2$
			Full sample				
(5)	1.550	-1.340	-.005	-.091			.282
	(1.547)	(-2.820)	(-.289)	(-.853)			
(6)	-.630				.468	.141	.271
	(-2.896)				(4.343)	(1.287)	
			Restricted sample†				
(5')	1.070	-1.066	.002	-.091			.206
	(1.014)	(-2.057)	(.094)	(-.866)			
(6')	-.648				.494	.071	.206
	(-2.009)				(3.003)	(.550)	

Dependent variable in equations (1) and (1'): ΔSec_{6070}. Dependent variable in equations (2) and (2'): ΔGNP_{7585}. Sample size: full sample: 26; restricted sample: 21. In the restricted sample, all countries whose income distribution variables refer to the years after 1965 have been dropped. All the standard errors are corrected for heteroskedasticity using the White heteroskedasticity-robust variance-covariance matrix.

to changes in the sample that exclude late observations. Moreover, all the income distribution variables enter equations (5) and (5') with the signs predicted by the null hypothesis and the coefficient of ΔSec_{6070} in equations (6) and (6') is positive. But all these coefficient are insignificant at the 10% level.

Very similar results were obtained when the dependent variable in equation (6) was the rate of growth of GNP between 1970 and 1985 rather than between 1975 and 1985, when the subsample of poor countries comprised the poorest 33 countries rather than the poorest 46 countries, when primary enrollment was used rather than secondary enrollment, and when countries with implausibly high rates of growth of primary and secondary enrollment were left out. I also regressed the average of government expenditure on education between 1970 and 1985 (as a fraction of GDP) on the income distribution variables and initial GDP on the ground that enrollment ratios might be observed with substantial measurement error. The pattern of the coefficients of the income distribution variables was very similar to that of the regressions presented in this section. In particular, the same lack of robustness to changes in the sample was present in these regressions.

In summary, the main message of the estimate of the system (5)-(6) is similar to that of the static regressions of Section 3. Now there are two elements that worsen the overall picture, however. First, the coefficients of the income distribution variable seem to be highly unstable. Second, the effect of human capital accumulation on growth is negative in developing countries - an obviously puzzling result - while it is positive but insignificant in developed countries.

2.5 Further tests.

One can think of several drawbacks in the estimation procedure adopted in Section 4. Since the model makes essentially long-run predictions, the decade between 1960 and 1970 might be too a short period to detect the effects of income distribution in 1960 on the evolution of human capital accumulation. The same considerations might apply to the GDP growth equation. Furthermore, the rate of growth of GDP between 1970 (or 1975) and 1985 contains a lot of cyclical components and is notoriously affected by supply shocks.[10]

It is clear that with the available data it is not possible to correct both problems at the same time. One can estimate the effects of income distribution in 1960 on the rate of growth of secondary enrollment between 1960 and 1985, i.e. an equation like:

$$\Delta Sec_{6085} = c_4 + \lambda_1 GDP_{60} + \lambda_2\, Sec_{60} + \lambda_3\, Top + \lambda_4 Midbot + \epsilon \qquad (2.7)$$

Having done this, however, one cannot use ΔSec_{6085} as an independent variable in a growth equation, because of simultaneity problems. Alternatively, one can estimate directly the effects of income distribution in 1960 on the rate of growth of GDP between 1960 and 1985, i.e. an equation like:

$$\Delta GDP_{6085} = c_5 + \theta_1\, GDP_{60} + \theta_2 Sec_{60} + \theta_3\, Top + \theta_4 Midbot + \eta \qquad (2.8)$$

Table 6 reports the results of the human capital accumulation regression for secondary enrollment (equation (7)), while Table 7 reports the results of the corresponding growth regressions (equation (8)).

As usual, all regressions for poor countries are highly unstable. Also, the coefficient of *Midbot* has generally the wrong sign in all regressions, although it is insignificant. Overall, the problems with these regressions are essentially the same as in the previous section.

2.6 Political regime vs. average income.

The model of Chapter 1 implies that two factors are important in the relation between income distribution and growth: the initial income and how the political process reditributes the available resources. For the reasons analyzed in Section 2, the first

[10]This might also explain the negative effect of the accumulation of human capital on subsequent growth, if the countries that invested the most in human capital were the most affected by the oil shock. However, there are no obvious rationalizations of this effect.

Table 2.6: Effects of income distribution on secondary enrollment, 1960 to 1985.

Eq.	Constant	GDP_{60}	Sec_{60}	Top	$Midbot$	$\bar{R}^2$
			Poor countries, full sample			
(7)	16.114	.913	-35.586	-.195	1.565	.501
	(3.432)	(.657)	(-5.090)	(-2.702)	(8.753)	
			Poor countries, restricted sample†			
(7')	14.077	-1.475	-25.762	-.040	-1.589	.353
	(3.220)	(-.772)	(-3.500)	(.374)	(-.882)	
			Rich countries, full sample			
(7)	3.408	-.609	-3.199	-.008	.144	.657
	(3.090)	(-1.977)	(-4.723)	(-.348)	(.529)	
			Rich countries, restricted sample†			
(7')	3.708	-.705	-3.488	-.0189	.350	.638
	(2.380)	(-1.781)	(3.659)	(-.637)	(.914)	

Dependent variable: ΔSec_{6085}. Sample size: see Tables 4 and 5. In the restricted sample, all countries whose income distribution variables refer to the years after 1965 have been dropped. All the standard errors are corrected for heteroskedasticity using the White heteroskedasticity-robust variance-covariance matrix.

Table 2.7: Effects of income distribution on growth, 1960 to 1985.

Eq.	Constant	GDP_{60}	Sec_{60}	Top	$Midbot$	$\bar{R}^2$
			Poor countries, full sample			
(8)	.006	-.002	.085	-.0003	.002	.147
	(.248)	(-.400)	(1.975)	(-.072)	(2.574)	
			Poor countries, restricted sample†			
(8')	.011	.002	.077	.0002	-.006	.054
	(.334)	(.345)	(1.897)	(.336)	(-.773)	
			Rich countries, full sample			
(8)	.071	-.020	-.032	-.008	.002	.387
	(4.020)	(-2.470)	(2.132)	(-2.967)	(1.079)	
			Rich countries, restricted sample†			
(8')	.083	-.022	-.030	-.0009	.001	.504
	(3.600)	(-2.880)	(2.321)	(-2.552)	(.635)	

Dependent variable: ΔGDP_{6085}. Sample size: see Table 4 and 5. In the restricted sample, all countries whose income distribution variables refer to the years after 1965 have been dropped. All the standard errors are corrected for heteroskedasticity using the White heteroskedasticity-robust variance-covariance matrix.

factor is the more important and the more easily testable. In fact, the tests presented in Sections 3 to 5 relied on the classification of countries in poor and rich rather than democracies and non-democracies.

Alesina-Rodrik [1991] have developed a model of income distribution and growth in which the crucial empirical implications hinge on the "democracy/non-democracy" dicotomy. The basic idea is the following: in an economy where the individuals vote over the level of capital taxation for redistribution purposes, the lower the wealth of the median voter relative to the average, the higher the tax rate that will prevail through majority voting. In turn, a higher tax rate on capital will depress capital accumulation and therefore growth. Consequently, the growth rate of a democracy should be positively correlated to the share of the two middle quintiles and negatively related to the share of the upper quintile.

The model of Chapter 1 and the Alesina-Rodrik model differ in two important respects. First, in the latter the mechanism by which income distribution affects growth is independent of the level of income of the economy. Therefore, the relation between the shares of the various quintiles and growth should hold for any democracy, irrespective of its average income. The second difference is that in the model of Chapter 1 the *qualitative* relation between income distribution and growth *for a given level of income* is independent of whether a country is a democracy.

It is then clear that potentially the two models can be tested against each other along several dimensions. In practice, however, the current availability of data poses serious limitations. For instance, one would like to divide poor and rich countries into democracies and non-democracies, and then test whether, within each category, there is an asymmetry in the behavior of democracies and non-democracies. Analogously, one would like to test whether there is an asymmetry in the behavior of poor and rich democracies, and the same for non-democracies. The problem is that there are very few poor countries that might be labeled democracies under any reasonable definition of the term.

Only a much weaker test of the two models is available. One can take the subsample of the richest 39 countries,[11] separate them into democracies and non-democracies, and then look for asymmetries in their behavior.[12] Two growth equations were estimated for democracies and non-democracies for the period 1960-1985: equation (8) and a slight variant (eq. (8a)). Results are reported in Table 8.[13]

The results are inconclusive. If anything, the coefficients are more significant for non-democracies than for democracies. If the relevant dividing line is average income, this would not be too surprising in view of the discussion of Section 2 and the fact that political rights are highly correlated with income even in this sample. However, the results of a Chow test for structural break do not reject the null hypothesis that the coefficients of the income distribution variables are the same at the 20% significance level.[14]

2.7 Conclusions.

The main purpose of this chapter was to analyze the available evidence on income distribution and growth in light of the theoretical model developed in Chapter 1. The results are little supportive of that approach.

Schematically, three different components were tested: the effect of income distribution on human capital accumulation, the effects of human capital accumulation on growth, and the effect of income distribution on redistribution. Although the estimates of all three components were rather disappointing, in these conclusions I will concentrate on the last one, because its implications extend beyond the specific model of Chapter 1.

As is well known, in recent years there has been a resurgence of interest in models

[11] The richest 39 countries are those countries with a GNP per capita in 1960 above 1,000 1980 dollars.

[12] One should be aware that even this test is subject to the same problem analyzed above. In fact, in the Barro-Wolf data set there is a very high correlation between the index of political rights that was used here to define a democracy and the per capita income of a country.

[13] Only results for equation (8) and its variant are reported because they are directly comparable with the specification used by Alesina-Rodrik [1991].

[14] In both regressions (8a) and (8) the coefficients of all the variables other than the income distribution variables were constarined to be the same in both subsamples. The significance level of the Chow test in regression (8a) was .494, while for regression (8) it was .604.

Table 2.8: Effects of income distribution on growth, 1960 to 1985.

Eq.	Constant	GDP_{60}	Sec_{60}	Top	$Midbot$	$\bar{R}^2$
			Rich countries, democracies			
(5a)	.053	-.010	.028	-.0006		.220
	(3.101)	(-1.272)	(1.496)	(-1.596)		
			Rich countries, non-democracies			
(5a)	.124	-.024	-.019	-.001		.533
	(4.935)	(-3.381)	(-.634)	(-3.604)		
			Rich countries, democracies			
(5)	.046	-.011	.354	-.0001	-.007	.215
	(2.594)	(-1.523)	(1.759)	(-.301)	(-.899)	
			Rich countries, non-democracies			
(5)	.129	-.026	-.200	-.002	.004	.542
	(5.010)	(-4.180)	(-.797)	(-3.668)	(1.520)	

Dependent variable: ΔGDP_{6085}. Sample sise: democracies: 22; non-democracies: 16. All the standard errors are corrected for heteroskedasticity using the White heteroskedasticity-robust variance-covariance matrix.

where policy (in particular fiscal policy) is the outcome of the political process, which in turn is often described in terms of the median voter result.[15] Although it is obviously based on a very stylized model, the median voter theorem delivers a very clear and strong message, whose qualitative implications are testable and *should* be tested.

In most models where policy is endogenously determined, the relevant differences between the agents of the economy are not in their preferences but in their budget constarints, so that there is a precise mappping between income distribution and indirect preferences. Thus, income distribution, as captured by the position of the median voter in the income distribution spectrum relative to the average voter, is a major determinant of the political outcome in these models.

It is clear that the regressions performed in this chapter can be considered preliminary at best. As argued in section 2, ideally one would want to measure the incidence of the whole tax-transfers system. Besides being a difficult exercise in any case, it can be done at most in a few developed countries. But for purposes of testing cross-sectional results such as those usually predicted positive models of political determination of fiscal policy and/or growth, it is unlikely that one will be able to use much more comprehensive data than those utilized here. Consequently, it will be unlikely that the empirical results of Section 3 will be easily reversed. Whether this can undermine the whole positive approach to fiscal policy, as formalized in the recent literature, remains an open question.

[15]Recent important examples are Tabellini-Alesina [1990], Persson-Svensson [1989] and Tabellini [1991].

Chapter 3

Increasing returns to scale, politics, and the timing of stabilizations.

3.1 Introduction.

In the last two decades the economic policy of several Latin American countries has been repeatedly characterized by perverse cycles of "unsustainable policies" and attempts at stabilization. The pattern is generally some variant of a very simple one. First a reckless expansion of government expenditure is financed by money printing beyond any level that could reasonably be sustained for more than few months. Then, when the time for fiscal consolidation and stabilization comes, everyone realizes how pervasive the costs and how persistent the damages are. Why then do government engage in such unsustainable policies, when everyone can foresee their perverse effects? More generally, why do governments often wait so long to stabilize an economy when some crucial policy variables are obviously at unsustainable levels?

To an economist, these have always been uneasy questions, because the observed behavior of the policymakers seems to clash with any hypothesis of rationality on the part of the agents of an economy. Indeed, why should anyone that recognizes the long-run costs of postponing a needed adjustment not act immediately to spread such costs evenly over time?

Delays in stabilizations are not necessarily inconsistent with rationality, provided one is willing to drop the representative agent assumption. Once the existence of different groups is recognized, a delay in stabilizing an economy can be optimal for some if by so doing they can impose a higher share of the burden of the adjustment on others.

The most successful formal model along these lines is probably Alesina-Drazen [1989]: there, asymmetric information about the distribution of the costs of adjustment generates a game of chicken in which each group tries to wear out the opponent.

This chapter is based on a different approach, one that emphasizes the political process that may lead to the adoption of unsustainable policies. In particular, the main object of the model developed in this chapter is to determine which groups are more likely to support such policies and under what conditions. The basic story is conceptually very simple. Essentially, a country must decide, through majority voting, how much of a given external debt to repay in each of two periods. Under normal circumstances, the view of the "middle class" prevails and exactly half of the debt is repaid each period. Thus, the standard textbook result of perfect consumption smoothing obtains. When a sufficiently large adverse terms of trade shock hits the economy, however, both the "capitalists" and the low income class have an incentive to postpone the adjustment: the former because they own a mobile factor in the long-run, and can therefore avoid paying the costs of stabilization by waiting, the latter because by keeping activity relatively high in the first period they can achieve some redistribution, which is precluded anyway in the second period due to the political process.

The following sections develop this idea formally. In particular, Section 2 discusses those aspects of the "macroeconomics of populism" that have an important political component. Section 3 presents the essential structure of the model. Section 4 solves the model under "normal" circumstances and shows that the adjustment will be spread evenly across the two periods. Section 5 shows the effects of a large terms of trade shock, i.e. the complete postponment of the stabilization process to the second period. Section 6 presents an assessment of the logical structure of the model. Section 7 illustrates how the model fits several important aspects of a typical populist experience, that of Peru 1985-1988. Section 8 concludes briefly.

3.2 Politics, redistribution and populism.

In recent years, a growing body of historical research on "populist experiences" has tried to sort out the systematic factors behind delays in stabilizations.[1] Probably the single most important contribution of this literature has been the investigation of the crucial role played by political factors and redistribution issues. To highlight these factors, consider the following oversimplified story. Suppose an adverse shock (for instance, a terms of trade shock) hits an economy, decreasing its growth prospects in the future. As a result, the previous path of external borrowing is now unsustainable, and the country has to adjust consequently by reducing domestic absorption. To the extent that government dissavings contribute to the need for external borrowing, an important component of the adjustment process is the reduction in government spending. It is also important to recognize that any model with a forward-looking, utility-maximizing representative agent will prescribe to spread the burden of the adjustment evenly over time, essentially by scaling consumption down in every period.[2]

However, when one analyzes a more realistic economy composed of different groups, the question arises of how the burden of the adjustment should be distributed across them. It is here that political aspects become important. Indeed, one fairly systematic element identified by the literature on "populist experiences" seems to be the following: when the political system cannot generate the consensus needed to distribute the burden of the adjustment across different groups, aggregate demand is kept at unsustainably high levels as an easy way out of the political deadlock. Of

[1] See especially Dornbusch-Edwards [1989] and Sachs [1989].

[2] See Blanchard-Fischer [1989] for the infinite horizon case and Frenkel-Razin [1987] for the two period case. In this second case, which allows for the presence of non-tradables, importables and exportables goods, some additional effects might enter the picture depending on the changes in the consumption-based interest rate.

course, this is achieved essentially by postponing fiscal consolidation. Thus, the interaction of different groups in the context of a fragmented political system seems to be a major factor behind delays in stabilizations.

Although this explanation seems to be roughly consistent with the facts, its underlying assumptions about the rationality of the agents involved need to be spelled out more precisely. Once it is recognized that it is efficient to spread the costs of the adjustment evenly in a representative agent economy, what makes it rational for some (presumably the majority) of agents to postpone the adjustment in an economy with different groups? Two new elements seem to be relevant in this respect.

First, to the extent that the costs of adjustment have to be borne by *someone* at *some* point, postponing the adjustment can be the rational outcome of the political process if enough groups can escape some or all costs of adjustment by delaying it. In particular, the owners of those factors that are more mobile in the long-run are probably one such group. Thus, it seems plausible that owners of capital might benefit from an unsustainable level of aggregate demand initially, simply because they can move at least part of the capital abroad when the costs of the adjustment have to be incurred.

The obvious question now is under what conditions other groups in the economy will find it optimal to postpone stabilization, thus effectively creating a coalition with the owners of the mobile factors. If some sectors of the economy are so poor that it is unrealistic or simply unfeasible to impose on them a proportional cost of the adjustment, essentially they will not care about when the stabilization takes place. As a consequence, they will have an incentive to delay any stabilization if by so doing they reap the benefits of high demand. What are these benefits? When there is scope for redistribution, a high level of economic activity can be beneficial to low-income agents through the high level of redistribution it allows.[3] To take advantage of this, it is optimal for an agent that is otherwise almost indifferent to the timing of stabilization to postpone the adjustment for as long as possible.

[3]Redistribution is one of the possible factors linking a high level of economic activity to the welfare of low-income agents. More generally, any positive externality will generate the mechanism considered in this model.

Thus, when different groups interact through the political process, delays in stabilizations can arise as rational outcomes of majority voting. The next section presents a model that tries to incorporate the essential ingredients of the analysis of delays in stabilizations developed above.

3.3 The model.

The basic elements of the model of this section are the presence of an increasing returns to scale (IRTS) sector with product differentiation, like in the work of Murphy-Shleifer-Vishny [1989], with the addition of a traded goods sector, a non degenerate income distribution and the possibility of redistribution through the tax-transfer system. This framework provides the basis for a non trivial political equilibrium, which is analyzed in the following sections.

The distribution of income.

Consider an economy that lasts for two periods and can produce two types of goods: one traded (T) good and a continuum of non traded (NT) goods belonging to the interval $[0, J_{NT}]$.

As emphasized in the previous section, the possibility of sudden shifts in the membership of the dominant "coalitions" (in a sense made precise below) seems to be an crucial in understanding the observed experiences of delays in stabilizations. It is obvious that a meaningful analysis of the formation of coalitions requires a set up in which more than two groups can be identified. Accordingly, I assume that individuals can belong to one of three groups: A, B and C, with sizes p^A, p^B and p^C respectively.

The distinguishing features of each class are as follows.In each period, A and B have labor endowment n^A and n^B respectively, $n^A < n^B$. Each member of group C owns $\frac{J_{NT}}{p^C}$ different IRTS technologies for the production of as many NT goods. As an innocuous and very convenient normalization, assume that $J_{NT} = p^C$, so that every C agent owns one IRTS technology.

The sizes of the different classes satisfy the following relations:

- $p^S < .5$, $S = A, B, C$;
- $p^B > p^A$.

The first requirement guarantees that no group can impose its proposal through the electoral process without the support of other groups, in the sense that it must prevail in pairwise comparison against all other proposals. The second condition implies that the "middle" class is larger than the low income class.

Production.

The T good can be produced with a CRTS technology that converts one unit of labor into one T good:

$$y_T = n_T \tag{3.1}$$

There are two technologies for the production of each type of NT good:
- a CRTS technology, available to every agent of the economy, such that

$$y_{NT}(j) = n_{NT}(j), \quad j \in [0, p^C] \tag{3.2}$$

- an IRTS technology, such that an initial fixed investment of F units of labor is required each period, after which production is:

$$y_{NT}(j) = \alpha n_{NT}(j), \quad \alpha > 1 \quad j \in [0, p^C] \tag{3.3}$$

The purpose of assuming the presence of IRTS (and of this particular type) is to have a simple framework in which demand "matters". Indeed, in this model profits and therefore redistribution of profits income are a positivefunction of aggregate demand. Of course, this is not the only setup which can be used to study the issues analyzed here. As in Sachs [1989] or Dornbusch [1989], one can construct a model with constant returns to scale in both the tradeables and the nontradeables sectors, in which a higher government spending increases the real wage. The framework utilized here is however more tractable once a formal model of the political process is superimposed on the model of the economy. In particular, it will be clear that the element that greatly simplifies the analysis is that all relative prices are constant in equilibrium.

The assumption that the increasing returns to scale are in the NT goods sector needs some further justification, however. Indeed, all the new literature on trade has emphasized the importance of increasing returns to scale in the T goods sector. In this case, however, it would be impossible to make the "small country assumption, so that a two-period model with income distribution and repeated voting would become quickly intractable.[4]

It must also be stressed that the assumption of IRTS in the NT goods sector is probably appropriate for the group of countries to which this model applies, since in many developing countries manufactured goods are often highly protected. For instance, Sachs [1989b] develops a model of a typical populist experience with an economy composed of a T goods sector - primary commodities - for which the assumption of CRTS is certainly realistic, and a NT goods sector of services and manufactures, which are heavily protected.

Preferences.

Each individual has a utility function of the form:

$$\frac{1}{2}\, ln\, \left[\int_0^{p^C} c^{\lambda}_{NT,1}(j)dj\right]^{\frac{1}{\lambda}} + \frac{1}{2}\, ln\; c_{T,1} + \beta\, \frac{1}{2}\, ln\, \left[\int_0^{p^C} c^{\lambda}_{NT,2}(j)dj\right]^{\frac{1}{\lambda}} + \beta\frac{1}{2}\, ln\; c_{T,2} \quad (3.4)$$

where $0 < \lambda < 1$ and the second subscript indicates the time period. Thus, every individual spends exactly a half of each period's expenditure on NT goods and the remaining half on the T good. It is easy to verify that the one-period subutility functions are homothetic, so that the problem of the consumer can be separated into two distinct problems: first, find total expenditure in each period; second, allocate the given expenditure in each period to each good.

Prices.

Given the utility function (4), it is relatively easy to show that each producer of a

[4] In particular, relative prices would tend to vary with the amount of the initial debt repaid in the first period and several more difficulties would arise when the issue of the mobility of the IRTS technology is considered.

NT good faces a demand function of the form:

$$D_{NT}(j) = \frac{E_{NT} P_{NT}^{-\sigma}(j)}{\int_0^{p^C} P_{NT}^{1-\sigma}(j) dj} \tag{3.5}$$

where $\sigma = 1/(1-\lambda)$ is the elasticity of substitution between NT goods and E_{NT} is the expenditure on NT goods by the whole economy.

Therefore, the profit maximizing price for each producer of a variety of NT goods is:

$$P_{NT}^{*}(j) = \frac{\sigma w}{(\sigma - 1)\alpha} \tag{3.6}$$

For simplicity, assume that the elasticity σ is sufficiently low relative to α that the profit maximizing price $P_{NT}^{*}(j)$ exceeds w, i.e. the price charged by an agent who uses the CRTS technology to produce the same good. Since the CRTS technology for the production of NT goods is available to all agents, this guarantees that the price charged by a monopolist is $P_{NT}(j) = w$.[5] Therefore

$$P_{NT}(j) = w = 1, \quad j \in [0, p^C] \tag{3.7}$$

assuming $P_T = 1$ by normalization. Also, since in equilibrium all NT goods have the same price and are consumed in the same proportions by each agent, it is possible to define a composite NT good, whose price is obviously $P_{NT} = 1$.

Initial debt and debt repayment.

In the first period, the country inherits an amount D of foreign debt, denominated in units of the T good. The debt must be repaid by the end of the second period, by collecting taxes from the various agents of the economy. The interest rate per period is ρ, which is assumed equal to the invers of the discount rate for simplicity. In order to further simplify the analysis, and without any loss of generality, both are assumed to be equal to 1.

[5]This very convenient setup was first introduced in the literature by Murphy-Shleifer-Vishny [1989].

The country is shut off from further borrowing in the world capital market. Also, private individuals cannot operate in the world capital market.[6] Thus, effectively the agents have to decide how much of the outstanding debt to repay in each period. Let R_i be the amount of debt repaid in period i, $i = 1,2$. Obviously, $R_2 = \rho(D - R_1)$. The debt is repaid by collecting taxes from the various agents of the economy.

Taxes.

There are two types of taxes: on labor and on profits. Taxes are proportional to income, with the rates being τ for the labor tax and θ for the profit tax. There is an exemption level such that the labor tax applies only to the part of income exceeding n_{min}.

There are convex costs in collecting taxes: the process of collecting $\tau(p^B(n^B - n_{min}) + p^A(n^A - n_{min}))$ in labor taxes requires the expenditure of a total of $\gamma\tau^2(p^B n^B + p^A n^A)$. Like in the model of Chapter 1, this assumption ensures that the tax rate proposed by any agent will be between 0 and $\frac{1}{2\gamma}$, the exact value being a continuous, negative function of the income of the agent relative to the average income. Thus, the assumption is quite useful in order to avoid corner solutions for the tax rate in a model where the elasticity of the supply of factors to the tax rate is 0 (except for the owners of the IRTS technology, who can move it abroad in the second period.

Moreover, the technology of collecting taxes is such that half of this latter sum is spent on NT goods, half is spent on the T good.[7] The same holds for the tax on

[6]This assumption is rather strong, and is made mainly to simplify the analysis. If individuals could borrow and lend freely at the given interest rate ρ, they could essentially undo the effects of delays in stabilization by lending abroad in the first period. If capital controls are in place, and if they have *some* effectiveness, then an agent will no longer be able to undo perfectly the effects of different timings of the stabilization. The assumption made in the text can be interpreted as the extreme case of a situation where some capital controls are in place in the first period.

[7]The assumption on collection costs is quite useful in simplifying the computational aspects of the model. One can interpret $\gamma\tau^2(p^B(n^B - n_{min}) + p^A(n^A - n_{min}))$ as the net demand for goods by the "government", i.e. the entity that collects and redistributes taxes in this economy. Then the assumption guarantees that the government has the same propensity to spend on the different goods as all the other agents of the economy. It is then intuitive how this assumption helps simplify computations.

profits. All this means that the revenues raised by each tax are

$$(\tau - \gamma\tau^2)(p^B(n^B - n_{min}) + p^A(n^A - n_{min})) \tag{3.8}$$

and

$$(\theta - \gamma\theta^2)\pi p^C \tag{3.9}$$

respectively.

Taxes are first used to pay the amount R_i of foreign debt, as decided through the voting process spelled out below. The remaining taxes are redistributed lump-sum to the members of groups A and B, net of the tax collection costs. Thus, the subsidy received by each member of groups A and B is:

$$\frac{(\tau - \gamma\tau^2)(p^B(n^B - n_{min}) + p^A(n^A - n_{min})) + (\theta - \gamma\theta^2 p^C)\pi - R}{p^A + p^B} \tag{3.10}$$

Note that under these assumptions no agent will ever propose a tax rate larger than $1/2\gamma$, because beyond this value the per capita subsidy is decreasing in the tax rate.

Demands.

Consider first the equilibrium demands for the T good by each class of agents of the economy (for simplicity, time indices are omitted). Demand by each C agent is:

$$D^C_{NT} = \frac{\pi(1-\theta)}{2} \tag{3.11}$$

Demand for the T good by each A and B agent is:

$$\frac{n^S(1-\tau) + \left[\frac{(\tau-\gamma\tau^2)(p^B(n^B-n_{min})+p^A(n^A-n_{min}))+(\theta-\gamma\theta^2 p^C)\pi-R}{p^A+p^B}\right]}{2} \tag{3.12}$$

with $S = A, B$. Finally, net demand for the T good by the government is:[8]

$$\frac{\gamma\tau^2(p^B(n^B - n_{min}) + p^A(n^A - n_{min})) + \gamma\theta^2 p^C\pi}{2} + R \qquad (3.13)$$

The same expressions represent total demands for the NT goods, except that the net demand by the government is:

$$\frac{\gamma\tau^2(p^B(n^B - n_{min}) + p^A(n^A - n_{min})) + \gamma\theta^2 p^C\pi}{2} \qquad (3.14)$$

Summing these demands, one obtains that total demand for the T good by the whole economy is:

$$D_T(j) = \frac{\bar{n} + p^C\pi + R}{2p^C} \qquad (3.15)$$

while demand for the NT goods is:

$$D_{NT}(j) = \frac{\bar{n} + p^C\pi - R}{2p^C} \qquad (3.16)$$

Profits.

Given the assumptions on the elasticity of substitution σ, in equilibrium each member of group C earns profits π from the use of the IRTS technology:

$$\pi = \left(1 - \frac{1}{\alpha}\right) D_{NT}(j) - F \qquad (3.17)$$

Using expression (16) for $D_{NT}(j)$, one obtains:

$$\pi = \frac{(\bar{n} - R)(\alpha - 1)}{p^C(\alpha + 1)} - \frac{2\alpha F}{\alpha + 1} \qquad (3.18)$$

[8]This expression includes the payment of foreign debt R_i

Mobility of the IRTS technology.

The IRTS technology cannot be moved in the first period. Therefore, as long as profits are positive, it will be used. In the second period, however, it can earn a reservation level of profits π^R, inclusive of any possible cost of transferring the technology. It is then obvious that the IRTS technology will not be available in the economy in the second period if $(1-\theta_2)\pi_2 < \pi^R$.

As emphasized by Murphy-Shleifer-Vishny [1990], in this economy there is a pecuniary externality from the profits of a C agent onto the demand and therefore profits of another C agent. Thus, the level of profits in the second period depends on the number μ of C agents that remain in the country. For future reference, it is useful to give an expression for profits in the second period as a function of μ. Indeed, now the demand facing a monopolist *in equilibrium* is:

$$D_{NT}(j) = \frac{\bar{n} + \mu\pi - R}{2p^C} \tag{3.19}$$

and therefore

$$\pi(\mu) = \frac{(\bar{n} - R)(\alpha - 1)}{2\alpha p^C - \mu(\alpha - 1)} - \frac{2\alpha F p^C}{2\alpha p^C - \mu(\alpha - 1)} \tag{3.20}$$

where $0 < \mu < p^C$. Thus, as expected, in the second period profits are a decreasing function of the number of C agents who remain in the country, μ.

Market equilibrium.

Given the assumptions made so far, in each period the allocation of resources between the T and NT goods sectors is determined as follows:

$$y^d_{NT} = \frac{p^C\pi + \bar{n} - R}{2} \tag{3.21}$$

$$y^s_{NT} = \alpha n_{NT} \tag{3.22}$$

$$y^d_T = \frac{p^C\pi + \bar{n} + R}{2} \tag{3.23}$$

$$y^s_T = n_T \tag{3.24}$$

$$\bar{n} = n_T + n_{NT} + p^C F \tag{3.25}$$

$$y^d_{NT} = y^s_{NT} \tag{3.26}$$

$$y^d_T = y^s_T \tag{3.27}$$

Expressions (21) and (22) represent total demands and supply of NT goods, while expressions (23) and (24) represent total domestic demand and domestic supply for the T good. Equations (24), (25) and (26) give the equilibrium conditions in the markets for labor, NT goods and the T good respectively. Since no private borrowing and lending is allowed, and the amount to be repaid R has been included in the net demand of T goods by the government (equation (13)), the last expression is obviously the same as the balance of payment equilibrium condition. Together with the labor market equilibrium condition, it yields:

$$n_T - \alpha n_{NT} = R \tag{3.28}$$

i.e., as expected, production of the T good must exceed production of NT goods by R, the amount transfered abroad.

<u>The political process.</u>

Given the assumption that profits are redistributed only to members of groups A and B, it is natural to fix θ at its maximum level $\theta^{max} = 1/2\gamma$. Note that, although this assumption is natural, it is not without problems, since it would obviously be more appealing to endogenize taxes on profits. An original version of this model allowed for the agents to vote over the value of θ too. However, this leads to severe problems of existence of a non-cycling majority when a shock occurs. One way out of this difficulty would be to assume that the index of costs of redistribution γ is higher for taxes on labor than for taxes on profits.

In the first period, all agents vote by majority rule over two issues: the amount of debt to be repaid R_1 and the tax rate on labor income τ_1. In the second period, R_2 is endogenous so that the agents vote only over the tax rate τ_2. Voting in the second period takes place before owners of the IRTS technology decide whether to move it abroad or not.

Once a tax rate is decided by majority rule in one period, it is binding for that period. However, commitments across periods are not possible. This means that the optimal proposals in the first period must be computed through a backward induction procedure, starting from the political equilibrium in the second period for any given R_2.

3.4 Solution when no shock occurs.

In this section, I will consider the determination of the timing of repayments when no economy-wide shock occurs. The main result is that in this situation the agents of this economy will decide by majority rule to repay exactly $D/2$ in each period.

For expository clarity, consider first a situation where $n^A = n_{min}$, so that A agents cannot be asked to bear any share of the burden of repayment cost.

In addition, suppose the initial amount of debt is sufficiently low that

$$\left[\frac{(\bar{n}-D)(\alpha-1)}{p^C(\alpha+1)} - \frac{2\alpha F}{\alpha+1}\right]\left(1-\frac{1}{2\gamma}\right) > \pi^R \tag{3.29}$$

According to this inequality, C agents will never move out in the second period since even in the worst possible scenario profits are still larger than the reservation profits.

It is straightforward to determine the equilibrium prevailing in period 2. Indeed, it is clear that group A will propose $\tau_2^A = 1/2\gamma$ and group B will propose $\tau_2^B = 0$, while C agents are indifferent between τ^A and τ^B. Since $p^B > p^A$, group B's proposal will prevail. Therefore, $\tau_2 = 0$.

Consider now the optimal proposals in period 1.

By virtue of inequality (29), it is clear that group B can achieve perfect consumption smoothing between the two period by proposing $\tau_1^B = 0$ and $R_1^B = D/2$.

As to A agents, they know that in period 2 there will not be any redistribution of labor income. On the other hand, since $n^A = n_{min}$, group A does not have any share in debt repayment in any period. It is clear that A agents will propose $\tau_1^A = 1/2\gamma$. The value of R_1^A is determined by the condition that the marginal rate of substitution between consumption in period 1 and consumption in period 2 must be equal to the marginal rate of transformation. In general, this implies $R_1^A \neq D/2$. Thus, members of group A will propose $\tau_1^A = \tau^{max} = 1/2\gamma$ and $R_1^A \neq D/2$.

Finally, because of inequality (29) C agents can clearly achieve perfect consumption smoothing by proposing $R_1^C = D/2$, while they are indifferent between τ^A and τ^B.

In the end, it is obvious that group B's proposal will prevail under majority voting in the first period.

The main conclusion is that, under normal conditions, the economy will repay exactly half of its debt in each period. Note that the economy as a whole and indeed every agent achieve perfect consumption smoothing in equilibrium. Given that $\rho = 1/\beta = 1$, this is what an outside observer who abstracts from income distribution issues would prescribe.

3.5 The effects of an economy-wide shock.

In this section, I will show that when a sufficiently large *permanent* shock hits the economy, the outcome of the political process will be to postpone the whole adjustment to the second period, i.e. $R_1 = 0$. Moreover, this occurs because there is a shift in the group where the decisive voter lies.

Note that, because the shock is permanent, a textbook expositing the standard CRTS economy with a representative agent would prescribe to spread the burden of the adjustment evenly across the two periods.

The natural shock to consider would be a terms of trade shock. However, there is only one traded good in this model, so that strictly speaking a terms of trade shock cannot be defined. However, in this model any type of shock that reduces the profits of a producer of a NT good will proxy the type of shock that is needed. For the purposes of this model, the main point can be made by considering a proportional decrease in n^A, n^B (and n_{min}), so that $\bar{n}$ decreases proportionally, say to $\bar{n}'$.

Specifically, assume that the shock is so large that the following inequality is verified:

$$\left[\frac{\bar{n}'(\alpha-1)}{p^C(\alpha+1)} - \frac{2\alpha F}{\alpha+1}\right]\left(1-\frac{1}{2\gamma}\right) < \pi^R \tag{3.30}$$

Then, even if in period 2 no debt has to be repaid, profits expressed in terms of T goods are so low that all members of group C will certainly move the IRTS technology abroad.

It is again obvious that in the second period $\tau_2 = 0$ since $p^B > p^A$.

Given this, in period 1 group A will now propose $\tau_1^A = \tau^{max} = 1/2\gamma$ *and* $R_1^A = 0$. The reason why now group A finds it optimal to postpone *all* the adjustment to the second period is that in the second period there will be no redistribution of either labor income or profits. In the former case, because it is politically infeasible, in the latter, because of the mobility of capital. Thus, even if the labor income of group B is drastically reduced in period 2 by completely postponing the adjustment, no loss of subsidies is incurred in that period because redistribution would be infeasible anyway. Moreover, group A does not lose any labor income directly in period 2 because A agents are not going to bear any burden of the large adjustment needed anyway. By not repaying any debt in period 1, however, group A maximizes redistribution in the only period in which it can be achieved. Note also that redistribution of *both* labor (under group A's proposal) *and* profit income is maximized by completely postponing the adjustment.

Given that taxes on profits cannot be redistributed in period 2, it can be shown that group B will want to repay slightly more or less than $D/2$ in the first period, but in any case not at a corner. Thus, in period 1 B will propose $\tau_1^B = 0$ and $R_1^B \neq 0$.

As to C agents, since they will not be around in period 2 in any case, they maximize utility by maximizing first period consumption. Thus, $R_1^C = 0$, while as usual C agents are indifferent as to the value of τ_1.

It is then clear that group C's proposal will now prevail.

Therefore, when a large, permanent economy-wide shock occurs, the interplay between mobility of capital and the politics of profit and labor taxation induces a drastic shift in the political equilibrium, resulting in a complete postponment of the stabilization process. Note that this is at odds with the standard textbook prescription that a permanent terms of trade shock should induce an immediate revision of the consumption patterns in both periods.

3.6 An assessment.

It is time to summarize the basic logical structure of the model developed so far. There are three starting points:

a) redistribution of labor income is politically unfeasible in the second period;

b) a sector of the economy is so poor that it cannot be asked to bear any *direct* cost of the adjustment;

c) because of the existence of IRTS technologies, there are profits in the economy that are an increasing function of demand. Also, profits can be a source of income for the other classes through redistribution.

The combination of a), b) and c) means that the only reason for the low income sector of the economy not to postpone adjustment is that by so doing activity and therefore profits in the second period would be drastically reduced. This would cause a decrease in the resources redistributed through the tax system in the second period.

Symmetrically, in normal circumstances the owners of the IRTS technology have an incentive to achieve consumption smoothing by spreading the repayments of the external debt equally between periods.

However, the incentives of both groups change drastically when a large terms of trade shock hits the economy. This is where a fourth feature of the economy becomes important:

d) since "capital is mobile", the IRTS technology will leaves the country because the profits it generates are now lower than those tha can be earned abroad.

This has drastic consequences on the political equilibrium. In fact, both the owners of the IRTS technology and the low income sector have all the incentives to postpone *all* the repayment of the external debt to the second period. Since they will not be around to bear any cost, the owners of the IRTS technology just want to maximize activity, and therefore profits, in the first period. Since the only source of redistribution in the second period is now unavailable, the only interest of the low income sector is to maximize redistribution in the only period when it can be attained.

3.7 An illustration: Peru 1985-1988.

The political outcome in Section 5 has the characteristics of a typical "populist" policy, in the sense that it incorporates elements of the preferred policy of groups at the opposite ends of the income distribution spectrum. In particular, since group A prefers group C's proposal to group B's proposal, and group C prefers group A's proposal to group B's proposal, there is a sense in which the political outcome represents a coalition of the "capitalist" sector and the low income class. Indeed, as emphasized by Dornbusch-Edwards [1989] (p. 249), (drawing in turn on Drake [1982]) populist policies tend to appeal to "a heterogeneous coalition aimed primarily at the working class, but including and led by significant sectors from the middle and upper strata".

It is also important to realize that redistributive issues are at the heart of the mechanism described above. Again, this seems to be consistent with the findings of the recent literature on populist experiences, according to which "redistributive objectives are a central part of the [populist] paradigm" (Dornbusch-Edwards [1989] p. 249) and "in all these [populist] experiments, governments have explicitly argued that the policies are necessary to correct glaring inequities in th eincome distribution, and to raise the living standard of the poor" (Sachs [1989a]).

These redistributive goals are often coupled with arguments referring to the existence of excess capacity in an economy with decreasing average costs, like the one described in the model. In such an economy, *in the short run* by increasing demand it is possible to achieve both an increase in profitability and an increase in the living standards of the low income class, thus avoiding social conflict. It is exactly this outcome that the political equilibrium of the previous section tries to capture.

The populist experience of Peru in 1985-1988 provides a typical illustration of the political process described above. Thus, the *Plan Nacional de Desarrollo 1986-1990* states: "[it is necessary] to redistribute income as a means for sustained growth and [it is possible] to bring together with the redistribution process the necessary capacity to save and invest.....The generalized and open-ended restraint on wages reduces profitability because it reduces workers' purchasing power, bringing about recessive effects that reduce demand and thus the benefits of dynamic economy." (quoted in Dornbusch-Edwards [1989], p. 35). Similarly, in *El Peru Heterodoxo: Un Modelo Economico*, the blueprint for the populist policy of Alan Garcia, the authors of the program write: "It is necessary to spend, even at the cost of a fiscal deficit, because, if this deficit transfers public resources to increased consumption of the poorest they demand more goods and this will bring about a reduction in unit costs." (quoted in Dornbusch-Edwards [1989], p. 41).

Thanks to this complementarity between profitability and real wages, the initial phases of a populist experiment enjoy, not surprisingly, a high degree of support: in 1986 (one year after the start of the populist experiment) the approval rating of Alan Garcia reached 90 % (Sachs [1989a] p. 23). It must be emphasized that this high popularity was due to exactly the mechanism analyzed before: in fact "...the success [was] broadly based because the recovery of demand can raise firms' profitability by raising capacity utilization. A year after the program started Garcia was celebrated by the business class for the success of his recovery strategy." (Dornbusch-Edwards [1989] p. 38).

As in the model of this Chapter, the NT goods sector benefitted the most in these experiments. As emphasized by Sachs [1989] (p.16) "...the expansionary policy is attractive only when the interests of the nontradeables sector politically dominate the interests of th etradeables sector..". Although the interests of the T goods sector are not explicitly represented in this model, the political outcome of Section 5 captures the basic point in the quotation from Sachs.

But how is the expansion in domestic demand generally brought about? Fiscal expansion is the typical way. The other side of the coin is, of course, a quick accumulation of external debt or, equivalently, a delay in repaying an existing debt.[9] Once again, Peru provides a stark illustration of the point. Soon after taking office, Alan Garcia limited external debt service to 10 % of exports. According to Dornbusch-Edwards [1989] (p. 37) this was "the most widely noted measure of the Garcia government... The policy of limiting debt service was not only an essential step on the political front. It effectively suspended the external constraint. With the foreign exchange savings resulting from limited debt service, a widening of the trade deficit became possible. Thus external constraints on growth...were suspended." This is another typical element of a populist experience that seems to be captured, albeit in a stylized way, in the model of this Chapter.

Of course, this type of expansion cannot last for long. As described forcefully in the literature on populism, after a certain point the external constraint can no longer be overcome and a drastic reduction in demand becomes unavoidable. This model has provided a possible explanation for the timing of the process, based on the high mobility of capital. Although empirical evidence is obviously harder to find on this point, it is worth noting that high capital mobility has long been recognized as a crucial ingredient of the story: "..when everything is said and done, the real wage will have declined massively, to a level significantly loer than when the whole episode began...The extremity of the real wage decline is due to a simple fact: capital is mobile across borders, but labor is not." (Dornbusch-Edwards [1989] p. 7).

3.8 Conclusion.

As emphasized forcefully by Dornbusch-Sturzenegger-Wolf [1990] in their survey of historical experiences of unsustainable policies, incorporating an explicit treatment

[9] Berg-Sachs [1988] analyze the relation between debt rescheduling and structural characteristics of the economy, and in particular income distribution.

of the political process seems to be a necessary step towards a better understanding of delays in stabilizing an economy. This chapter has presented a framework for such an analysis.

From a more technical point of view, this model is based on a two-period model where agents vote repeatedly over *two* issues. It is well known that a non-cycling majority will exist under these assumptions only under very restrictive conditions. When agents belong to a discrete (and small) number of classes as here, however, the model can be handled quite easily. Furthermore, in this framework with more then one issue the interesting possibility exists that the decisive voter and the coalition behind the winning proposal changes drastically as a result of a sufficiently large shock.

One should also be clear about what the approach adopted in this model cannot achieve. Two shortcomings, among many, are particularly apparent.

First, whenever the policy implemented is the result of majority voting, the outcome is necessarily Pareto optimal, in the sense that it is the preferred outcome of one group of agents. It is frequently maintained that the result of unsustainable policies is that, in the end, everybody is worse off than in the case of a prompt stabilization. This points toward the direction of a model featuring multiple, Pareto-ranked equilibria. It is clear that the approach taken in this model cannot formalize this idea.

The second drawback of the model presented here is that it is an exclusively real model. To the extent that inflation is thought to be possibly *the* crucial factor in practically all the observed experiences with unsustainable stabilizations, a very important element is missing in the explanation offered here. However, unlike the previous one, this shortcoming of the model is amendable, at least in principle.

Appendix A

Proof of Result 1.

This Appendix proves Result 1. To this end, I will first prove some preliminary results.

Result A.1: Consider the case $e < \bar{n} < 4e$. Let t_{min} be defined by $\tilde{n}_{min}(1 - t_{min}) + (t_{min} - t_{min}^2)\bar{n} - e = 0$, i.e. t_{min} is the tax rate at which $\frac{d\tilde{n}}{dt} = 0$ in Figure 1(b). Then, $t_i^* > t_{min}$ if and only if $n_i < \tilde{n}_{min}$.

Proof: The proof is immediate upon manipulation of the expressions for t_i^* and t_{min}. □

Essentially, Result A.1 says that t_i^* is on the upward sloping part of the $\tilde{n}(t)$ curve if and only if $n_i < \tilde{n}_{min}$.

Result A.2: $t_2^* \leq \hat{t}_3$, for $\bar{n} > e$.

Proof: Result A.1 ensures that n_3 might be liquidity constrained at t_2^* only when $n_2 < \tilde{n}_{min}$ (which implies necessarily $e < \bar{n} < 4e$). To show that this will never occur, consider the smallest possible value of n_3 corresponding to each value of n_2. Clearly, given n_2, n_3 will be smallest when $n_1 = n_2$, so that n_{3min} is defined by:

$$p_3 n_{3min} = \bar{n} - (1 - p_3)n_2 \tag{A.1}$$

Clearly:

$$ {}_1c_{n_{3min}}(t_2^*) \geq n_{3min}(1-t_2^*) - e = n_{3min}\frac{1}{2}\left(1+\frac{n_2}{\bar{n}}\right) - e \qquad \text{(A.2)} $$

Define $H(n_2) = n_{3min}\frac{1}{2}\left(1+\frac{n_2}{\bar{n}}\right) - e$. Since H is quadratic in n_2 it is sufficient to show that:

- $\frac{dH(n_2)}{dn_2} > 0$ when evaluated at $n_2 = 0$;
- $H(0) > 0$, $H(\bar{n}_{min}) > 0$.

Now:

$$ \frac{dH}{dn_2} = \frac{1}{2} - \frac{n_2}{\bar{n}}\left(\frac{1-p_3}{p_3}\right) \qquad \text{(A.3)} $$

Thus, at $n_2 = 0$, $\frac{dH(n_2)}{dn_2} = \frac{1}{2}$. It is also easy to show that $H(0) = \frac{\bar{n}}{2p_3} \geq e$ for $\bar{n} \geq e$. By computing $H(\bar{n}_{min})$, one finds after some manipulations that $H(\bar{n}_{min}) \geq e \Leftrightarrow \sqrt{e\bar{n}} \geq e$, where the second inequality is always verified for $\bar{n} \geq e$. □

Result A.2 ensures that, when $\bar{n} > e$, the tax rate that maximizes the post tax income of the median voter can never be so high as to prevent n_3 agents from investing in education.

A similar argument can be used to show that, under certain sufficient conditions, n_3 agents cannot be liquidity constrained at t_1^*. In fact, given n_1, n_{3min} is now defined by:

$$ p_3 n_{3min} = \bar{n}(1-p_2) - p_1 n_1 \qquad \text{(A.4)} $$

One can now apply to $H(n_1)$ the same procedure used above and show that $t_1^* < \hat{t}_3$ if the sufficient condition $p_1 > p_3$ holds[1].

Note however that this condition is not necessary for proving Result 1, only it simplifies the analysis a little. Indeed, it is possible to prove Result 2 without any assumption on p_1 and p_2 by adopting the following strategy: *assume* that $t_1^* > \hat{t}_3$ is possible (which might not be true). Then it is easy to show that either certain triples in which n_1 proposes $\hat{t}_3$ cannot occur, or preferences are Order Restricted on these

[1]This condition seems to be rather plausible, and in fact it is almost invariably assumed in applied work, where p_1 typically represents the two bottom quintiles of the distribution of income and p_3 represents the top quintile or more often the top five percentiles.

triples, so that the proposal of the median voter is the winner and n_1's proposal is irrelevant.

Before proving that preferences are Order Restricted on all triples $T_s \in \mathcal{T}$, one must be able to rule out a particularly degenerate situation in which a non-cycling majority might not exist. Suppose that $\bar{n} \geq e$ and $\tilde{n}_{min} \leq n_2 < e$. Also, suppose that n_2 agents propose t_2^* in period 1, while n_3 agents propose $t_3^* = 0$. If n_1 agents cannot invest in education at t_2^*, when t_2^* is voted pairwise against t_3^*, it might be the case that *both* n_3 agents *and* n_1 agents prefer the latter to the former. The reason why n_1 agents might prefer $t = 0$ to a positive value of t in period 1 is that, at $t = 0$, the middle income class cannot invest in education; consequently, the tax rate in the next period will be higher relative to the case when n_2 agents invest in education, when $t_2^* = 0$ (in fact, it will be even higher than the tax rate preferred by the median voter in period 1). Moreover, the marginal benefit to n_1 agents from a given tax rate in period 2 is higher than in period 1 because average income is higher in period 2.

Thus, n_1 agents might be willing to trade no redistribution today for more redistribution tomorrow; to achieve this, they might support t_3^* against t_2^*. It is easy to show that there will not be a non-cycling majority in this case.

However, note that for exactly symmetrical reasons n_3 agents might have a preference for n_2 agents investing in education in period 1, i.e. the high income group might be willing to trade more redistribution today for less redistribution tomorrow, when a high tax rate would be more costly to n_3 agents because their pre-tax income has increased. In other words, the high income group might propose $\tilde{t}_2$ instead of $t_3^* = 0$. If this happens, then preferences will be Order Restricted (as shown below) and a non cycling majority with the median voter as the decisive voter will exist in all possible states.

I will now find sufficient conditions under which n_3 agents prefer $\tilde{t}_2$ to $t_3^* = 0$ when $\tilde{n}_{min} \leq n_2 < e$; then, I will show that these conditions are not particularly demading.

Define ${}_2\bar{n}^*$ and ${}_2\bar{n}^{**}$ as the average income in period 2 if n_3 agents only or n_2 and n_3 agents invested in education, respectively. Correspondingly, define ${}_2t_2^*$ and ${}_2t_2^{**}$ as the tax rates preferred by the median voter in period 2 in the same situations. If n_3 agents prefer $t = \tilde{t}_2$ to $t = 0$, it must be true that

$$\begin{aligned} Q(n_2, \tilde{t}_2) &= n_3(1-\tilde{t}_2) + (\tilde{t}_2 - \tilde{t}_2^2)\bar{n} + (n_3 + Re)(1 - {}_2t_2^{**}) + ({}_2t_2^{**} - {}_2t_2^{**^2})\bar{n}^{**} \\ &\quad - n_3 - (n_3 + Re)(1 - {}_2t_2^{*}) - ({}_2t_2^{*} - {}_2t_2^{*^2})\bar{n}^{*} \\ &\geq 0 \end{aligned} \quad \text{(A.5)}$$

It is possible to prove the following

Result A.3: For R and/or p_1 sufficiently high, n_3 agents will propose $\tilde{t}_2$ instead of $t_3^* = 0$.

Proof: Note that, since $t_2^* \geq \tilde{t}_2$, a sufficient condition for $Q(n_2, \tilde{t}_2) \geq 0$ is $Q(n_2, t_2^*) \geq 0$. Since t_2^* is a linear function of n_2, while $\tilde{t}_2$ is not, it is much simpler to work with the former. I will therefore find conditions under which the latter inequality is true.

It is easy to show that $Q(n_2, t_2^*)$ is an increasing and concave function of n_2. Also, it can be shown that $Q(\bar{n}, t_2^*) > 0$. Therefore, if $Q(\tilde{n}_{min}, t_2^*) \geq 0$, $Q \geq 0$ everywhere. Next, notice that $Q(\tilde{n}_{min}, t_2^*)$ reaches a minimum at $n_2 = 0$. Finally, it is possible to show that

$$\frac{dQ}{dR} > 0; \qquad \frac{dQ}{d_2t_2^{**}} < 0; \qquad \frac{d_2t_2^{**}}{dR} < 0; \qquad \frac{d\,[d_2t_2^{**}/dR]}{dp_1} < 0; \quad \text{(A.6)}$$

Result A.3 follows from the above inequalities and from the fact that $Q(0, t_2^*) > 0$ for $t_2^{**} = 0$. □

I will therefore make the following

Assumption A.1: R and/or p_1 are sufficiently high that n_3 agents will propose $\tilde{t}_2$ instead of $t_3^* = 0$ whenever $\tilde{n}_{min} \leq n_2 < e$ and n_1 agents cannot invest at t_2^*.

Assumption A.1 does not appear to be particularly strong. There are two sources of slack in the proof of Result A.3. First, the proof was conducted using $Q(n_2, t_2^*)$ instead of $Q(n_2, \tilde{t}_2)$. Second, when $n_2 = 0$ or close to 0, necessarily n_1 is close to n_2 and therefore either $z > 0$ (in which case no problem will arise) or n_2 agents cannot invest in education, in which cases the problem will not arise in the first place. This amounts to say that it would be enough to have $Q(n_2, \tilde{t}_2) = 0$ for some $n_2 > 0$. Finally, note that for $t_2^{**} = 0$ Assumption A.1 is always satisfied. In addition, when n_2 is very low, n_1 agents might not prefer $t = 0$ to t_2^*.

It is now relatively easy to prove

Result 1: Preferences are Order Restricted on all triples $T_s \in \mathcal{T}$.

Proof: An exhaustive proof of Result 1 would require an analysis of all relevant states of the economy. In what follows, I will provide the proof for one case. The other cases can be treated similarly.

Consider therefore the case $e < \tilde{n} < 4e$, and $\tilde{n}_{min} \leq n_2 < e$. By Assumption A.1, the following are the conceivable proposals by each type of agent:

$n_1 : t_1^*$ or t_2^* or $t_2^\dagger$

$n_2 : t_2^*$ or $\tilde{t}_1$

$n_3 : \tilde{t}_2$

where $t_2^\dagger$ is defined as a tax rate infinitesimally larger than $\hat{t}_2$, such that n_2 agents cannot invest in education. This implies that there are 6 possible triples of proposals:

$T_1 = \left\{t_1^*, t_2^*, \tilde{t}_2\right\}$; $T_2 = \left\{t_1^*, \tilde{t}_1, \tilde{t}_2\right\}$; $T_3 = \left\{t_2^*, t_2^*, \tilde{t}_2\right\}$;

$T_4 = \left\{t_2^*, \tilde{t}_1, \tilde{t}_2\right\}$; $T_5 = \left\{t_2^\dagger, t_2^*, \tilde{t}_2\right\}$; $T_6 = \left\{t_2^\dagger, \tilde{t}_1, \tilde{t}_2\right\}$.

Of these, T_4 and T_6 cannot occur, while it is easy to show that the other satisfy the Order Restriction Condition. Consider for instance T_1 and plot preferences by the three types of agents as follows:

$$\begin{vmatrix} n_1 & n_2 & n_3 \\ t_1^* & t_2^* & \bar{t}_2 \\ t_2^* & t_1^* & t_2^* \\ \bar{t}_2 & \bar{t}_2 & t_1^* \end{vmatrix}$$

It is easy to check that, for *any* pair of proposals, all the agents that prefer the first proposal to the second come first, and then come all those who prefer the second proposal [2] (where of course it is irrelevant which proposal is termed the "first"). The same procedure can be applied to the other triples and to the other states. □

[2]Note that it is irrelevant whether n_2 prefers t_1^* to $\bar{t}_2$ or the opposite.

Appendix B

Proof of Result 3.

this Appendix proves Results 2 and 3 in Section 4.

Result 2: For an economy with $\bar{n} \geq 4e$:

- the $x = 0$ locus is upward sloping and is defined for $n_1 \in [\bar{n}_{min}, e]$ and $n_2 \in [n_2^a, \bar{n}]$, where n_2^a is a function of $\bar{n}$;

- the $z = 0$ locus is upward sloping and is everywhere below the $x = 0$ locus;

- $z < 0$ in the region comprised between the locus $z = 0$ and $n_1 = \bar{n}_{min}$.

Proof: The proof consists of several steps:

- The locus of points n_1, n_2 such that $t_2^* = \bar{t}_1$is also the locus of points such that $x = 0$. In fact, since $t_2^* = argmax\{c_1\}$ and t_2^* is unique, ${}_1c(t_2^*) >_1 c(\bar{t}_1)\ \forall\, t_2^* \neq \bar{t}_1$. Thus, $x(t_2^*, \bar{t}_1) > 0 \quad \forall\, t_2^* \neq \bar{t}_1$. This means that only for $\bar{t}_1 = t_2^*$ is $x = 0$;

- Using the implicit function theorem, it is easy to verify that along the $x = 0$ curve $\frac{dn_1}{dn_2} > 0$ and $\frac{d^2n_1}{dn_2^2} > 0$. It is also easy to show that $x(n_2 = \bar{n}, n_1 = e) = 0$, while $x(n_2 = \sqrt{\bar{n}^2 - 4\bar{n}e}, n_1 = 0) = 0$ (in the case $\bar{n} \geq 4e$) and $x(n_2 = \bar{n}_{min}, n_1 = \bar{n}_{min}) = 0$ (in the case $e < \bar{n} < 4e$).

- Along the $z = 0$ locus, $\frac{dn_1}{dn_2} > 0$. This follows immediately from the implicit function theorem and the envelope theorem, since when $z = 0$: :

$$\frac{dn_1}{dn_2} = -\frac{[{}_2t_2^*(t_2^*) - {}_2t_2^*(\bar{t}_1)] + [{}_1t_2^* - \bar{t}_1]}{[-n_2 + (1 - 2\bar{t}_1)\bar{n}]\frac{d_1\bar{t}}{dn_1}} > 0 \tag{B.1}$$

- To show that the $z=0$ locus lies everywhere below the $x=0$ locus, notice first that y is independent of n_1. Also, $y \geq 0 \; \forall n_2$, and $y=0$ only for $n_2=\bar{n}$. Now note that, since $y(\bar{n},n_1)=0 \quad \forall \; n_1$, the $z=0$ locus and the $x=0$ locus coincide at $n_2=\bar{n}$. Consider a point $(n_1', n_1'$ such that $x(n_2', n_1')=0$. Then $z(n_2', n_1')>0 \quad \forall \; n_2' \neq \bar{n}$. To obtain $z=0$ one must decrease (increase) n_1 to $n_1=n_1''$ (n_1'''), where n_1'' (n_1''') $<$ $(>)$ n_1', since $x(n_2', n_1) > x(n_2', n_1') = 0 \quad \forall \; n_1 \neq n_1'$. □

I will now prove

Result 3: For an economy with $\bar{n} < e$:
- the $x=0$ locus is downward sloping;
- $z>0$ always at $n_2=\bar{n}$;
- $z>0$ everywhere for $\bar{n} < 2p_3 e$;
- for $\bar{n} > 2p_3 e$, if $z>0$ for admissible values of n_2 and n_3, this will occur in a region comprised between the n_{3min} curve and the $x=0$ locus;
- for p_3 sufficiently small, there exists a region where $z<0$ and $x<0$;
- for p_3 sufficiently large, there is no region where $z<0$ and $x<0$.

Proof: The proof is composed of several steps:
- By the implicit function theorem it is easy to show that the $x(n_2,n_3)=0$ locus is downward sloping and convex; also, $x(0, 2e-\frac{1}{2}\bar{n})=0$ and $x(\bar{n},e)=0$;
- Now consider the $z(n_2,n_3)=0$ locus. By the implicit function theorem and the envelope theorem, along the $z=0$ locus:

$$\frac{dn_3}{dn_2} = -\frac{{}_2t_2^*(t_2^*) - {}_2t_2^*(\hat{t}_3) + t_2^* - {}_1\hat{t}_3}{\left[-n_2+\bar{n}(1-2\hat{t}_3)\right]\frac{d\hat{t}_3}{dn_3}} \tag{B.2}$$

While the denominator is always positive, the sign of the numerator is ambiguous.

However, one can still obtain some information about the region where $z<0$. Observe first that, for $p_3 \to 0$, the $z=0$ locus tends to coincide with the $x=0$ locus. Thus, for very small values of p_3, the region in which the median voter has an incentive to let n_3 agents invest when $t_2^* > \hat{t}_3$ tends to be of measure zero.

The next step in gathering information about the shape of the $z = 0$ locus consists in investigating the sign of $z(n_2, n_3)$ along the line $n_3 = e$. The reason why this is useful is the following. The second period gain to the median voter , $y(.)$, depends only on $n_2, \bar{n}$ and p_3 but not on n_3; in addition, the first period loss x is such that $x(n_2, n_3') < x(n_2, n_3'')$ for $n_3' > n_3''$. Thus, if $z(n_2, e) > 0$, then $z(n_2, n_3) > 0 \ \forall n_3 > e$. On the other hand, if $z(n_2, e) > 0$, then $z(n_2, n_3''') = 0$ for some n_3''', $e < n_3''' < n_3''''$, where n_3'''' is defined by $x(n_2, n_3'''') = 0$.

Next, notice that $z(\bar{n}, e) = 0$ since in this case $t_2^* = \hat{t}_3$. However, as a function of n_2 $z(n_2, e)$ is discontinuos in $n_2 = \bar{n}$. This is so because, when $n_2 = \bar{n}$ and $n_3 = e$, an infinitesimal decrease in n_2 makes y jump to a positive value (which is larger the larger p_3).

Now consider $z(0, e)$. Since $\hat{t}_3 = 0$ when $n_3 = e$ and ${}_1t_2^* = {}_2t_2^*(\hat{t}_3) = \frac{1}{2}$ when $n_2 = 0$, it is easy to show that

$$z(0, e) = \frac{2p_3 e - \bar{n}}{4} \tag{B.3}$$

which can be negative or positive depending on the value of p_3 and $\frac{\bar{n}}{e}$. Finally, consider the derivative of $z(n_2, e)$ at $n_2 = 0$ and $n_2 = \bar{n}$. By applying the envelope theorem, one obtains after some algebraic manipulation:

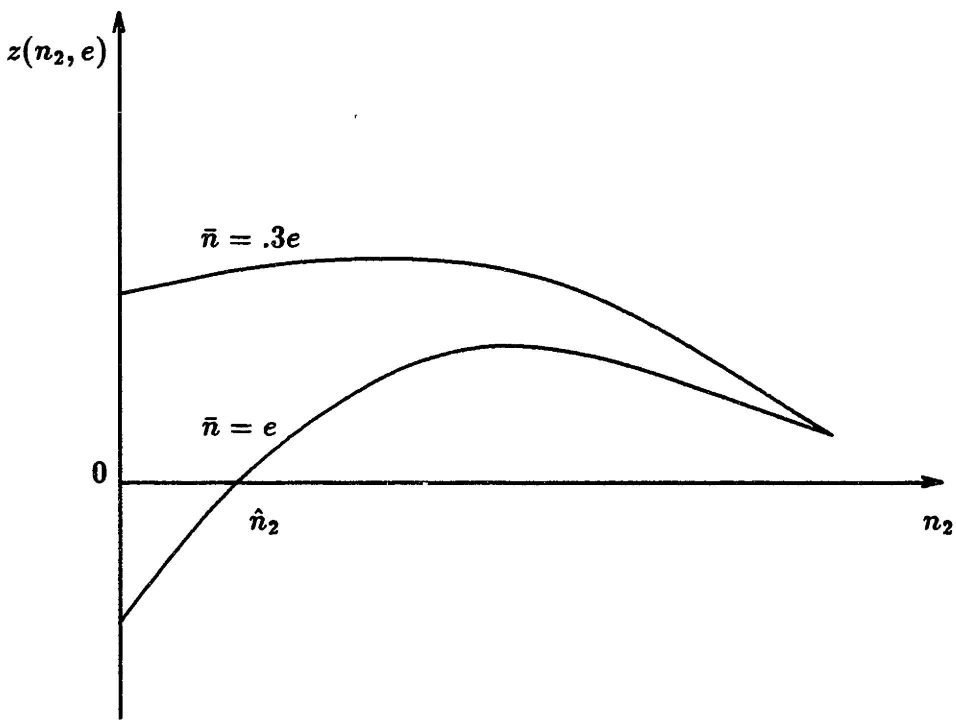
$$\frac{dz}{dn_2}(n_2, e) = \frac{1}{2} + \frac{1}{2} \frac{n_2}{\bar{n} + 2p_3 e} - \frac{n_2}{\bar{n}} \tag{B.4}$$

Thus, for $n_2 \to \bar{n}^-$, $\frac{dz}{dn_2} \geq 0$, with equality only for $p_3 = 0$. When $n_2 = 0$, $\frac{dz}{dn_2} > 0$. Since $\frac{dz}{dn_2}$ can change sign only once, the shape of $z(n_2, e)$ as a function of n_2 is like in Figure 1, which assumes $p_3 = .2$.

Thus, when $z(0, e) > 0$, necessarily $z > 0$ always in the region comprised between the $x = 0$ locus and $n_3 = e$. If $z(0, e) < 0$, then there exists some $\hat{n}_2$ such that $z(n_2, e) < 0$ for $n_2 < \hat{n}_2$, and $z(n_2, e) > 0$ for $n_2 > \hat{n}_2$. Notice however that, by equation (23), $z(n_2, n_3) > 0$ everywhere for $\bar{n} < 2p_3 e$.

So far, no mention has been made of the fact that not all points in the region of the (n_2, n_3) space with $n_2 \leq \bar{n}$, $n_3 \geq \bar{n}$ are admissible. This asymmetry with respect to

Figure B-1: $z(n_2, e)$.



the case $\bar{n} \geq e$ is due to the fact that n_1 is constrained to be non-negative, while there is no upper bound on n_3. Given n_2 and $\bar{n}$, n_3 must lie necessarily between n_{3min} and n_{3max}, which occur when $n_1 = n_2$ and $n_1 = 0$ respectively. Let n_2^p be the projection of the intersection of the $x = 0$ locus with the curve $n_{3min}(n_2)$ on the n_2 axis. Since the $z(n_2, n_3) = 0$ locus lies below the $x = 0$ locus for $n_2 < n_2^p$, all one needs to know is the behavior of $z = 0$ for $n_2 > n_2^p$. Recall that when $z(0, e) > 0$, $z(n_2, n_3) > 0$ $\forall n_2$. In this case, the median voter will always have an incentive to let n_3 agents invest when $t_2^* > \hat{t}_3$. More information is needed when $z(0, e) < 0$. In this case, if $\hat{n}_2 < n_2^p$, then clearly $z(n_2, n_3) > 0$ in the admissible region. However, if $\hat{n}_2 > n_2^p$, then $z(n_2, n_3)$ *might* be negative (but need not) in some part of the admissible region comprised between n_2^p and $\hat{n}_2$ and of course the $x = 0$ locus. Notice that, for very small values of p_3, necessarily a region where $z(n_2, n_3) < 0$ will exist by a simple continuity argument. In fact, for $p_3 = 0$, the $z = 0$ locus coincides with the $x = 0$ locus; the position of the latter is independent of p_3, while the position of the former is continuous in p_3. On the other hand, notice that for $p_3 = .5$ $z(0, e) \geq 0$, so that $z(n_2, n_3) \geq 0$ in the admissible region. Thus, one can conclude that, for non negligible values of p_3, $z(n_2, n_3) > 0$ always. □

Appendix C

The overlapping generations model.

This Appendix provides a formal treatment of the overlapping generations model. As in the two period model, I will first derive a sufficient condition which ensures that a parent will always want to invest in the education of her offspring, if possible.

Result C.1: Assume that in all periods $j+k$, $k = 1, 2, \ldots$, all parents will behave according to the following strategies: if ${}_{j+k}n_i \geq e$ at time $j+k$ a parent of class i invests in the education of her offspring. Then, if $R\delta \geq 2$, a parent at time j will always want to invest in the education of her offspring.

Proof: Since $R\delta \geq 2$ and $\delta < 1$, $R > 2$. This means that the pre-tax income of an agent who obtained education is no smaller than $2e$, and therefore that agent cannot be liquidity constrained since in equilibrium the tax rate is no larger than $\frac{1}{2}$. Given the assumed Markov strategies, this means that if agent n_i decides to invest in the education of her offspring her utility is

$$\begin{aligned} {}_jU_i &= {}_jn_i(1 - {}_jt) + ({}_jt - {}_jt^2)_j\bar{n} - e + \\ &\sum_{k=1}^{\infty} \delta^k \left[(n_i + Re)(1 - {}_{j+k}t) + ({}_{j+k}t - {}_{j+k}t^2)_{j+k}\bar{n} - e\right] \end{aligned} \tag{C.1}$$

If agent n_i does not invest in the education of her offspring, her utility can at most be:

$$
\begin{aligned}
{}_jU_i &= {}_jn_i(1-{}_jt)+({}_jt-{}_jt^2)_j\bar{n}+\delta\left[n_i(1-{}_{j+1}t)+({}_{j+1}t-{}_{j+1}t^2)_{j+1}\bar{n}-e\right] \\
&\quad+\sum_{k=2}^{\infty}\delta^k\left[(n_i+Re)(1-{}_{j+k}t)+({}_{j+k}t-{}_{j+k}t^2)_{j+k}\bar{n}-e\right] \qquad \text{(C.2)}
\end{aligned}
$$

Subtracting (23) from (24), one obtains that a parent prefers to invest in education if

$$
R\delta(1-{}_{j+1}t)e \geq e \qquad \text{(C.3)}
$$

Since ${}_{j+1}t \leq \frac{1}{2}$ in equilibrium, a sufficient condition for inequality (25) to hold is $R\delta \geq 2$. □

I will now determine the dynamic path of the overlapping generation economy as a function of the initial state (i.e. the initial pattern of income distribution). This will be done in steps. First, I will consider all possible states that can arise once the economy has left the initial state (i.e. after the upper class has invested in education). For each state, I will postulate strategies (i.e. tax proposals) followed by agents finding themselves in that state in future periods. These strategies are restricted to depend only on the state of the economy in that period. Then, I will show that given these future strategies and assuming that in the future periods the median voter is the decisive voter, agents finding themselves in a given state in the *current* period will indeed optimally choose the strategy assumed to be followed by future agents facing the same state; also, the median voter is indeed the decisive voter in the current period. Finally, the same procedure will be applied to the decision problem faced by agents in the first period. □

Thus, let $V_i({}_jn_1, {}_jn_2, {}_jn_3)$ be the value function of agent n_i when the state of the economy is ${}_j\vartheta = ({}_jn_1, {}_jn_2, {}_jn_3)$. Let $t_i({}_{j+k}\vartheta)$ be the tax rate proposed by agent i when the state of the economy is ${}_{j+k}\vartheta = ({}_{j+k}n_1, {}_{j+k}n_2, {}_{j+k}n_3)$. Then one must show that:

$$\begin{aligned} V_i({}_j\vartheta) &= Max_{t_i}\{U_i({}_j\vartheta, t_i) + \delta V_i({}_{j+1}\vartheta(t_i), t_2(t_i)\} \\ &= U_i({}_j\vartheta, t_i({}_j\vartheta)) + \delta V_i\left[{}_{j+1}\vartheta(t_i({}_j\vartheta)), t_2({}_{j+1}\vartheta(t_i({}_j\vartheta)))\right] \end{aligned} \tag{C.4}$$

For future reference, it will prove useful to define the following tax rates:

$t_2^{\circ} = \frac{1}{2}\left(1 - \frac{n_2}{\bar{n}}\right)$

$t_2^{\bullet} = \frac{1}{2}\left(1 - \frac{n_2}{\bar{n}+p_3 Re}\right)$

$t_2^{\bullet\bullet} = Max\left\{0, \quad \frac{1}{2}\left(1 - \frac{n_2+Re}{\bar{n}+(p_2+p_3)Re}\right)\right\}$

$t_2^{\bullet\bullet\bullet} = \frac{1}{2}\left(1 - \frac{n_2+Re}{\bar{n}+Re}\right)$

$\tilde{t}_1^{\bullet} = \tilde{t}(n_1, \bar{n} + p_3 Re)$

$\tilde{t}_1^{\bullet\bullet} = \tilde{t}(n_1, \bar{n} + (p_2 + p_3)Re)$

The first four tax rates are the tax rates that maximize the current period's post-tax income of the median voter when no class has invested in education, one class has invested, and so on. The last two tax rates are the tax rates that enable the low income group to invest in education when one class has invested and two classes have invested respectively.

The strategies which are initially assumed to be followed by future agents in a given state are derived as natural extensions of the strategies followed in the same states in the two period case. These strategies are made explicit below.[1]

Assumption C.1: In each period $j + k$, $k = 1, 2, \ldots$ the median voter proposes the following Markov tax rates as functions of the state of the economy.

State 1: If ${}_{j+k}\vartheta$=$(n_1 + Re,\ n_2 + Re,\ n_3 + Re)$: $t_2({}_{j+k}\vartheta) = t_2^{\bullet\bullet\bullet}({}_{j+k}\vartheta)$;

State 2: If ${}_{j+k}\vartheta$=$(n_1 < n_1^c,\ n_2 + Re,\ n_3 + Re)$: $t_2({}_{j+k}\vartheta) = t_2^{\bullet\bullet}({}_{j+k}\vartheta)$;

State 3: If ${}_{j+k}\vartheta$=$(n_1^c \leq n_1 < n_1^d,\ n_2 + Re,\ n_3 + Re)$: $t_2({}_{j+k}\vartheta) = \tilde{t}_1^{\bullet\bullet}({}_{j+k}\vartheta)$;

[1] For the sake of brevity, I will present only the proposals of the median voter. The proposals of the other agents can be derived as the optimal proposals in the current period, given that in the future periods the median voter is the decisive voter (which will be proved to be true in equilibrium).

State 4: If ${}_{j+k}\vartheta$=($n_1 \geq n_1^d$, $n_2 + Re$, $n_3 + Re$): $t_2({}_{j+k}\vartheta) = t_2^{\bullet\bullet}({}_{j+k}\vartheta)$;

State 5: If ${}_{j+k}\vartheta$=(n_1, $n_2 < \tilde{n}_{min}$, $n_3 + Re$): $t_2({}_{j+k}\vartheta) = t_2^{\bullet}({}_{j+k}\vartheta)$;

State 6: If ${}_{j+k}\vartheta$=($n_1 < n_1^e$, $n_2 \geq \tilde{n}_{min}$, $n_3 + Re$): $t_2({}_{j+k}\vartheta) = t_2^{\bullet}({}_{j+k}\vartheta)$;

State 7: If ${}_{j+k}\vartheta$=($n_1^e \leq n_1 < n_1^f$, $n_2 \geq \tilde{n}_{min}$, $n_3 + Re$): $t_2({}_{j+k}\vartheta) = \tilde{t}_1^{\bullet}({}_{j+k}\vartheta)$;

State 8: If ${}_{j+k}\vartheta$=($n_1 \geq n_1^f$, $n_2 \geq \tilde{n}_{min}$, $n_3 + Re$): $t_2({}_{j+k}\vartheta) = t_2^{\bullet}({}_{j+k}\vartheta)$;

where n_1^d and n_1^f are the values of n_1 at which $t_2^{\bullet\bullet} = \tilde{t}_1^{\bullet\bullet}$ and $t_2^{\bullet} = \tilde{t}_1^{\bullet}$ respectively. The symbols n_1^c and n_1^e are defined in the proof of Result C.2. Notice that the optimal proposals of the median voter in each state can be easily understood by referring to the two period case. It is also important to note that the problems that maight arise in the two period model with the existence of a non-cycling majority (see discussion in Appendix A) do not arise in the overlapping generation model. In fact, it can be shown that n_1 agents will never prefer $t_3^* = 0$ to t_2^*.

In order to determine how the initial pattern of income distribution affects growth and the steady-state pattern of income distribution, I will first determine the possible steady-states of an economy that has left the initial state and then proceed backward to analyze its dynamic path.

Result C.2: a) States 1, 2, 5 are all the possible states of an economy that has moved out of the initial state; b) the Markov proposals postulated in assumption C.2 are indeed optimal; c) the median voter is the decisive voter in all states.

Proof: I will prove that states 1, 2, 5 are steady-states. That they are all possible steady-states that an economy can reach after leaving the initial state follows from the fact the other states are not steady-states. In particular, I will prove that states 1 and 2 are steady-states. The proof for state 5 follows immediately.

Consider first State 1, i.e. assume that the economy in period j has the following pattern of income distribution: ${}_jn_i = n_i + Re$, $i = 1, 2, 3$. Assume also that the tax rate in all periods $j + k$, $k = 1, 2..$ is no larger than $\frac{1}{2}$; by Result C.1 and Assumption C.1, if ${}_{j+1}n_i = n_i + Re$ $\forall n_i$, then all agents will invest in education in all future periods $j + k$, $k = 1, 2...$ Now assume the in all future periods the median voter is the decisive voter. It is then easy to show that the optimal proposal of each type of agent n_i in period j is $t_i^*({}_j\vartheta)$, i.e. the tax rate that maximizes her current period's post-tax income. It is then immediate to prove parts b) and c) for State 1.

Now assume that the economy is in state 2, 3 or 4. I will consider the problem of the median voter; the problem of a voter belonging to the other classes can be solved similarly. Again, assume that the median voter is the decisive voter in all states that can be reached from states 2, 3 and 4 (in equilibrium, this will be shown to be correct). I will first prove that, given the median voter's proposals in the future periods, it is indeed optimal for an n_2 agent in period j to propose to make the proposals postulated in Assumption C.1.

Note first that, in State 4, n_1 agents can invest at the median voter preferred tax rate $t_2^* = t_2^{**}$ because, by definition of n_1^d, $t_2^{**} \geq \tilde{t}_1^{**}$ for $n_1 \geq n_1^d$; thus, at $t = t_2^{**}$, the economy reaches State 1. This proves parts b) and c) for State 4. In what follows, I will therefore assume that the economy being analyzed is either in State 2 or State 3. In these two states, $t_2^{**} \leq \tilde{t}_1^{**}$ but the median voter will have an incentive to set $t = \tilde{t}_1^{**}$ if $n_1 \geq n_1^c$. In turn, n_1^c is found as follows.

Consider the median voter in period $j+1$. If ${}_{j+1}\vartheta = (n_1 < n_1^c, n_2 + Re, n_3 + Re)$, the median voter will propose ${}_{j+1}t = t_2^{**}$ and n_1 agents will not be able to invest in education. The median voter's overall utility will then be:

$$
{}_jU_{n2} = \sum_{s=1}^{\infty} \delta^s \left[(n_2 + Re)(1 - t_2^{**}) + (t_2^{**} - t_2^{**^2})(\bar{n} + (p_2 + p_3)Re) - e\right] \qquad \text{(C.5)}
$$

If ${}_{j+1}\vartheta = (n_1 \geq n_1^c, n_2 + Re, n_3 + Re)$, the median voter will set ${}_{j+1}t = \tilde{t}_1^{**}$ and from period $j+2$ on ${}_{j+k}\vartheta = (n_1 + Re, n_2 + Re, n_3 + Re)$. Thus, the overall utility of the median voter will be in this case:

$$
\begin{aligned}
{}_jU_{n_2} \; = \; & \left[(n_2 + Re)(1 - \tilde{t}_1^{**}) + (\tilde{t}_1^{**} - \tilde{t}_1^{**^2})(\bar{n} + (p_2 + p_3)Re) - e\right] \\
& + \sum_{s=1}^{\infty} \delta^s \left[(n_2 + Re)(1 - t_2^{***}) + (t_2^{***} - t_2^{***^2})(\bar{n} + Re) - e\right] \qquad \text{(C.6)}
\end{aligned}
$$

Denote by $L(n_1)$ the expression obtained by subtracting (27) from (28). n_1^c is defined by $L(n_1^c) = 0$. The reason why such a value of n_1 exists is exactly analogous to the two period case. Indeed, if $p_1 = 0$, $L(n_1) < 0 \; \forall n_1$ such that $\tilde{t}_1^{\bullet\bullet} > t_2^{\bullet\bullet}$. However, if $p_1 > 0$, necessarily there is a value of n_1 such that $L(n_1) = 0$ and $\tilde{t}_1^{\bullet\bullet} > t_2^{\bullet\bullet}$. Moreover, n_1^c is the only value of n_1 with these properties. This follows from the fact that $\frac{dL}{dn_1} > 0 \; \forall n_1$ such that $\tilde{t}_1^{\bullet\bullet^2} > t_2^{\bullet\bullet}$. It is also immediate to verify that, at n_1^c, $z^{\bullet\bullet}(n_1) = 0$, where $z^{\bullet\bullet}(n_1)$ is defined as:

$$
\begin{aligned}
z^{\bullet\bullet}(n_1) \;=\;& (n_2 + Re)(1 - \tilde{t}_1^{\bullet\bullet}) + (\tilde{t}_1^{\bullet\bullet} - \tilde{t}_1^{\bullet\bullet^2})(\bar{n} + (p_2 + p_3)Re) - e \\
& + \sum_{s=1}^{\infty} \delta^s \left[(n_2 + Re)(1 - t_2^{\bullet\bullet\bullet}) + (t_2^{\bullet\bullet\bullet} - t_2^{\bullet\bullet\bullet^2})(\bar{n} + Re) - e\right] \\
& -(n_2 + Re)(1 - t_2^{\bullet\bullet}) - (t_2^{\bullet\bullet} - t_2^{\bullet\bullet^2})(\bar{n} + (p_2 + p_3)Re) + e \\
& -H(n_1) \qquad\qquad (C.7)
\end{aligned}
$$

and $H(n_1)$ is defined as

$$
\begin{aligned}
H(n_1) \;=\;& \sum_{s=1}^{\infty} \delta^s \left[(n_2 + Re)(1 - t_2^{\bullet\bullet}) + (t_2^{\bullet\bullet} - t_2^{\bullet\bullet^2})(\bar{n} + (p_2 + p_3)Re) - e\right], \quad n_1 < n_1^c \\
=\;& \delta \left[(n_2 + Re)(1 - \tilde{t}_1^{\bullet\bullet}) + (\tilde{t}_1^{\bullet\bullet} - \tilde{t}^{\bullet\bullet 2}_1)(\bar{n} + (p_2 + p_3)Re) - e\right] \\
& + \sum_{s=2}^{\infty} \delta^s \left[(n_2 + Re)(1 - t_2^{\bullet\bullet\bullet}) + (t_2^{\bullet\bullet\bullet} - t_2^{\bullet\bullet\bullet^2})(\bar{n} + Re) - e\right], \quad n_1 \geq n_1^c \text{(C.8)}
\end{aligned}
$$

Again, $z^{\bullet\bullet}(n_1) = 0$ only at $n_1 = n_1^c$, since it is always increasing in n_1. Thus, one can identify a $z^{\bullet\bullet}(n_1) = 0$ locus in the $(n_1, n_2 + Re)$ space by implicitly differentiating $L(n_1) = 0$, obtaining:

$$
\frac{dn_1}{d(n_2 + Re)} = \frac{\sum_{s=1}^{\infty} \delta^s \left[(1 - t_2^{\bullet\bullet}) - (1 - t_2^{\bullet\bullet\bullet})\right] - \left[(1 - \tilde{t}_1) - (1 - t_2^{\bullet\bullet})\right]}{\left[-(n_2 + Re) + (1 - \tilde{t}_1^{\bullet\bullet})(\bar{n} + (p_1 + p_2)Re)\right] \frac{d\tilde{t}_1^{\bullet\bullet}}{dn_1}} > 0 \qquad (C.9)
$$

Finally, note that in the $(n_1, n_2 + Re)$ space the $x = 0$ locus is exactly as in the two period model. Thus, one can analyze the overlapping generation model with essentially the same tools developed for the two period model.

The calculations above indicate that, when ${}_jn_1 = n_1 < n_1^c$, it is indeed optimal for the median voter to propose $t_2^{\bullet\bullet}$, while it is optimal to propose $\tilde{t}_1^{\bullet\bullet}$ when ${}_jn_1 = n_1 \geq n_1^c$. But these are exactly the strategies *assumed* to be followed by the median voter in each state. Thus, relation (26) is verified for the median voter.

The best Markov proposals for the other agents can be derived in a similar way. It is then easy to show that the median voter is the decisive voter in each of the States 2 and 3. This proves parts b) and c) for these states. Also, the same procedure can be applied to the other states. In the end, part a) is proved. □

Result C.2 allows one to determine the dynamic path of an economy that has left the initial level of average income $\bar{n} < e$. By working backward, it is possible to establish the following

Result C.3: Consider an economy with $\bar{n} < e$. a) If ${}_j\vartheta = (n_1, n_2 \geq \tilde{n}_{min}(\bar{n} + p_3Re), n_3 \geq e)$, the median voter will always propose $t = \hat{t}_3$ whenever $t_2^\circ > \hat{t}_3$ if δ is sufficiently large. b) Moreover, the median voter is the decisive voter in period j.

Proof: Suppose the Markov strategies for the future median voters prescribe $t_2({}_{j+k}\vartheta) = \hat{t}_3$ if $n_3 \in \mathcal{A}$ and ${}_{j+k}\vartheta = (n_1, n_2 \geq \tilde{n}_{min}(\bar{n} + p_3Re), n_3 \geq e)$ where $\mathcal{A}$ is some range of values of n_3, and $t_2({}_{j+k}\vartheta) = t_2^\circ$ if $n_3 \in \mathcal{A}$. Assume $n_3 \in \mathcal{A}$ in period j. By deviating and proposing ${}_jt_2 = \hat{t}_3$, the median voter can obtain at least:

$$\begin{aligned} B(n_2, n_3) &= n_2(1 - \hat{t}_3) + (\hat{t}_3 - \hat{t}_3^2)\bar{n} \\ &\quad + \delta\left[n_2(1 - t_2^\bullet) + (t_2^\bullet - t_2^{\bullet^2})(\bar{n} + p_3Re) - e\right] \\ &\quad + \sum_{s=2}^{\infty} \delta^s \left[(n_2 + Re)(1 - t_2^{\bullet\bullet}) + (t_2^{\bullet\bullet} - t_2^{\bullet\bullet^2})(\bar{n} + (p_2 + p_3)Re - e)\right] \end{aligned}$$

while by proposing t_2° she obtains:

$$A(n_2, n_3) = \sum_{s=0}^{\infty} \delta^s \left[n_2(1 - t_2^\circ) + (t_2^\circ - t_2^{\circ^2})\bar{n}\right] \tag{C.10}$$

Then:

$$B - A = n_2(1 - \hat{t}_3) + (\hat{t}_3 - \hat{t}_3^2)\bar{n}$$

$$
\begin{aligned}
&+\delta\left[n_2(1-t_2^{\bullet})+(t_2^{\bullet}-t_2^{\bullet^2})(\bar{n}+p_3Re)-e\right] \\
&+\sum_{s=2}^{\infty}\delta^s\left[(n_2+Re)(1-t_2^{\bullet\bullet})\right] \\
&+\sum_{s=2}^{\infty}\delta^s\left[(t_2^{\bullet\bullet}-t_2^{\bullet\bullet^2})(\bar{n}+(p_2+p_3)Re-e)\right] \\
&-\sum_{s=0}^{\infty}\delta^s\left[n_2(1-t_2^{\circ})+(t_2^{\circ}-t_2^{\circ^2})\bar{n}\right] \qquad \text{(C.11)}
\end{aligned}
$$

After some computations, it is possible to give a lower bound for the expression $B-A$:

$$
\begin{aligned}
B-A &\geq V(n_2) \\
&= \frac{1}{1-\delta}\left[(1-\delta)n_2-[n_2(1-t_2^{\circ})+(t_2^{\circ}-t_2^{\circ^2})\bar{n}]+\delta^2(n_2+Re-e)\right] \qquad \text{(C.12)}
\end{aligned}
$$

The second derivative of $V(n_2)$ is always negative, so $V(n_2)$ achieves its minimum at one of the extreme values for n_2, $\bar{n}$ or $\tilde{n}_{min}(\bar{n}+p_3Re)$. Next, note that

$$
\frac{dV}{dn_2}=\frac{1}{1-\delta}\left[\frac{1}{2}-\delta+\delta^2-\frac{n_2}{2\bar{n}}\right] \qquad \text{(C.13)}
$$

is always positive at $n_2=0$. Thus, the lowest value of $V(\tilde{n}_{min}(\bar{n}+p_3Re))$ is achieved for $\tilde{n}_{min}(\bar{n}+p_3Re)=0$. It is easy to show that $V(0)\geq 0$ for $\delta\geq 1-\frac{\sqrt{3}}{2}$. Also, $V(\bar{n})>0$ always since

$$
V(\bar{n})\geq\frac{e\delta}{1-\delta}\left[R\delta-1\right] \qquad \text{(C.14)}
$$

which is positive since $R\delta>2$. Thus, a sufficient condition for $B-A\geq 0$ is $\delta\geq 1-\frac{\sqrt{3}}{2}\approx .134$.[2]

Following a similar procedure, it is easy to show that, when the region $\mathcal{A}$ for all future median voters includes all values of $n_3\geq e$ below the $x=0$ locus, it is optimal for the median voter in period j to follow the same strategy and propose $\hat{t}_3$ whenever

[2] Note that for reasonable values of R this condition is necessarily satisfied, since it was assumed at the beginning (Result C.1) that $R\delta\geq 2$. Also, note that this is a sufficient condition, and rather weak.

$t_2^\circ > \hat{t}_3$, provided as usual that δ is sufficiently large.

Therefore, the region $\mathcal{A}$ includes all values of $n_3 \geq e$ below the $x = 0$ locus. This proves part a). By repeating the same procedure for the other voters, it is easy to show that the median voter is the decisive voter in period j. □

Appendix D

The inverted U-curve.

This Appendix generalizes to a certain extent the result of an inverted-U curve in the $(G, \bar{n})$ space obtained in Section 6. Since trying to prove it for all admissible values of p_1, p_2, p_3 and R would imply solving an extremely complicated linear programming problem, in what follows I will limit myself to the case $p_1 = .4, p_2 = .4, p_3 = .2$ and $R = 4$ considered in Section 6. Also, in order for the problem to be meaningful, I will consider economies that have a chance to reach the highest value of income where all classes invest, i.e. economies with $\bar{n} \geq \tilde{n}_{min}(\bar{n} + p_3 Re)$. Given the value of the parameters, this implies $\bar{n} \geq .88$.

Consider the expression for the Gini coefficient of the class of economies under consideration:

$$_jG = 1 - \frac{1}{_j\bar{n}}\left[(p_1^2 + 2p_1p_2 + 2p_1p_3)_jn_1 + (p_2^2 + 2p_2p_3)_jn_2 + (p_3^2)_jn_3\right] \qquad \text{(D.1)}$$

For the values of the parameters assumed above, this means

$$_jG = 1 - \frac{1}{_j\bar{n}}\left[.64_jn_1 + .32_jn_2 + .04_jn_3\right] \qquad \text{(D.2)}$$

It was shown in Appendix C that, whenever $n_3 \geq e$, the median voter sets $t = \hat{t}_3$ if $t_2^o > \hat{t}_3$. In other words, the median voter always lets the high income group invest in education whenever the latter is liquidity constrained at t_2^o. This means that for a country never to leave the initial state with $\bar{n} < e$, it must be the case that $n_3 < e$. Given this, it is easy to verify that the maximum level of the Gini coefficient of an economy with $\bar{n} < e$ in steady state can be found by letting $n_1 = 0$ and $n_3 = e$, while n_2 is obviously determined residually. In fact, let ${}_{ss}G^{(k)}$ denote the value of the Gini coefficient of an economy where k classes have invested in steady-state. Thus:

$$\begin{aligned} {}_{ss}G^{(0)} &\leq 1 - \frac{1}{\bar{n}}\left[.32\frac{\bar{n} - .2e}{.4} + .04e\right] \\ &= \left[.2 + .12\frac{e}{\bar{n}}\right] \end{aligned} \tag{D.3}$$

The next step consists in showing that the lowest Gini coefficient for an economy where only the high income class has invested in steady-state is higher than the highest Gini coefficient of an economy where no class has invested in steady state. To this end, I will first find a lower bound for ${}_{ss}G^{(1)}$. It is easy to show that this is obtained when n_3 is at its lowest possible value, e , and n_1 at its highest possible value, n_2. Thus

$$\begin{aligned} {}_{ss}G^{(1)} &\geq 1 - \frac{1}{\bar{n} + p_3 Re}\left[.96\frac{\bar{n} - .2e}{.8} + .04(e + Re)\right] \\ &= 1 - \frac{1}{\bar{n} + .8e}\left[1.2\bar{n} - .04e\right] \end{aligned} \tag{D.4}$$

It is then easy to show that

$${}_{ss}G^{(0)} <_{ss} G^{(1)} \tag{D.5}$$

always. An analogous procedure allows one to establish that

$${}_{ss}G^{(3)} <_{ss} G^{(2)} \tag{D.6}$$

Thus, necessarily the Gini coefficient increases when a country moves away from the initial state and decreases when a country reaches the highest level of income. This proves that the inverted-U curve is indeed a general result for the given values of the parameters.

It remains only to show that $t = \hat{t}_3$ whenever $t_2^{\circ} > \hat{t}_3$ in the initial state with $\bar{n} < e$.

Therefore, assume from now on that $t^\circ > \hat{t}_3$. It was shown in Appendix C that, for $n_2 > \tilde{n}_{min}(\bar{n} + .8e)$, the median voter has always an incentive to set $t = \hat{t}_3$. Thus, one has only to consider the case $n_2^p < n_2 < \tilde{n}_{min}(\bar{n} + .8e)$[1], where n_2^p was defined in Appendix B as the projection on the n_2 axis of the intersection of the $x = 0$ locus with the $n_{3min}(n_2)$ curve. For $n_2 < n_2^p$, there is no trade-off because $t_2^\circ < \hat{t}_3$. I will show that, for $n_2^p < n_2 < \tilde{n}_{min}(\bar{n} + .8e)$, $z > 0$, so that the median voter will always let the high income group invest.

By finding the intersection of the $x = 0$ locus with the $n_{3min}(n_2)$ curve, one can show that $n_2^p \approx .85e$. Consider the expression for $z(n_2, n_3)$:

$$
\begin{aligned}
z(n_2, n_3) &= n_2(1 - \hat{t}_3) + (\hat{t}_3 - \hat{t}_3^2)\bar{n} \\
&\quad + \sum_{s=1}^{\infty} \delta^s \left[n_2(1 - t_2^\bullet) + (t_2^\bullet - t_2^{\bullet 2})(\bar{n} + .8e)\right] \\
&\quad - \sum_{s=0}^{\infty} \delta^s \left[n_2(1 - t_2^\circ) + (t_2^\circ - t_2^{\circ 2})\bar{n}\right]
\end{aligned}
\tag{D.7}
$$

i.e.

$$
\begin{aligned}
z(n_2, n_3) &= n_2(1 - \hat{t}_3) + (\hat{t}_3 - \hat{t}_3^2)\bar{n} \\
&\quad - \left[n_2(1 - t_2^\circ) + (t_2^\circ - t_2^{\circ 2})(\bar{n} + .8e)\right] \\
&\quad + \frac{\delta}{1-\delta} \left[n_2(1 - t_2^\bullet) + (t_2^\bullet - t_2^{\bullet 2})(\bar{n} + .8e)\right] \\
&\quad - \frac{\delta}{1-\delta} \left[n_2(1 - t_2^\circ) + (t_2^\circ - t_2^{\circ 2})\bar{n}\right]
\end{aligned}
\tag{D.8}
$$

This expression is smallest when n_3 is lowest, i.e. $\tilde{t}_3 = 0$ and n_2 is lowest, i.e. $n_2 = n_2^p$. Also, observe that if n_3 agents invest, in the future the median voter can obtain at least $(t_2^\circ - t_2^{\circ 2})(.8e)$ more than when n_3 agents do not invest. Thus,

$$
\begin{aligned}
z(n_2, n_3) &\geq n_2 t_2^\circ - (t_2^\circ - t_2^{\circ 2})\bar{n} + \frac{\delta}{1-\delta}(t_2^\circ - t_2^{\circ 2})(.8e) \\
&\geq n_2 t_2^\circ - (t_2^\circ - t_2^{\circ 2})\bar{n} + (t_2^\circ - t_2^{\circ 2})(.8e) \\
&= n_2 t_2^\circ - (t_2^\circ - t_2^{\circ 2})(.2e)
\end{aligned}
\tag{D.9}
$$

[1]It is shown below that indeed $n_2^p < \tilde{n}_{min}(\bar{n} + .8e)$.

Since $n_2 \geq n_2^p \approx .85e$, necessarily $z_(n_2, n_3) > 0 \ \forall n_2$ whenever $t_2^\circ > \hat{t}_3$.

Appendix E

Data Appendix for Chapter 2.

This Appendix describes the data used in the regressions. All the data are from the Barro-Wolf [1990] data set, except the income distribution data, which are from a variety of source detailed below.

GDP_{xx}: log of GDP in year xx in thousands of 1980 dollars, from the Summers-Heston data set.
ΔGDP_{xxyy}: rate of growth of GDP between years xx and yy.
Sec_{xx}: secondary school enrollment rate in year xx.
ΔSec_{xxyy}: rate of change of secondary school enrollmennt rate between years xx and yy.
Pr_{xx}: primarv school enrollment rate in year xx.
ΔPr_{xxyy}: rate of change of primary school enrollmennt rate between years xx and yy.
Top: the share in pre-tax income of the top quintile of the population in 1960.
Mid: the share in pre-tax income of the third and fourth quintiles of the population in 1960.
$Midbot$: the ratio of the share of the third and fourth quintile to the share of the first and second quintile in 1960.
TR: expenditure on transfers as percentage of GDP, average between 1970 and 1985;
SS: expenditure on social security as percentage of GDP, average between 1970 and

1985.

Legend for Table E.1:

lec: Lecaillon et al. [1984];

j: Jain [1975];

wdr89; World Development Report [1989];

pau: Paukert [1973];

pryorb: Pryor [1989b];

pryora: Pryor [1989a];

zar: Zartman [1983];

vgp: Van Ginneken and Bak [1984];

adb15: Asian Development Bank [1983];

wb240: World Bank [1976];

un81: United Nations [1981];

wdr79: World Development Report [1979];

flo: Flora et al. [1987];

schn: Schnitzer [1974];

kuz: Kuznets [1963];

fw: Figueroa and Weisskoff [1980].

Table E.1: Income Distribution Data.

Country	year	source	Country	year	source
benin	59	lec	botswana	71/72	j
chad	58	lec	congo	58	lec
egypt	74	wdr89	gabon	60	j
ivory coast	59	j	kenya	69	lec
madagascar	62	pryorb	malawi	68/68	pryora
morocco	65	pau	niger	60	pau
nigeria	63	zar	senegal	60	pau
sierra leone	68	vg	sudan	67/68	vg
tanzania	67	j	togo	57	lec
tunisia	61	j	zambia	59	j
zimbabwe	69	lec	bangladesh	63/64	j
burma	58	j	hongkong	71	lec
india	60	j	iran	59	j
iraq	56	pau	korea	66	adb15
malaysia	60	j	pakistan	63/64	adb15
philippines	61	j	sri lanka	63	j
taiwan	64	adb15	thailand	62	wb240
greece	57	j	turkey	63	un81
costarica	61	j	dominican republic	69	j
el salvador	61	lec	honduras	67	wdr79
jamaica	58	j	panama	70	vg
bolivia	68	pau	brazil	60	j
colombia	62	j	ecuador	70	lec
peru	61	lec	southafrica	65	lec
israel	56/57	j	japan	62	j
austria	57	flo	denmark	63	j
finland	62	j	france	62	j
germany	60	schn	ireland	73	wdr89
italy	48	kuz	netherlands	67	wdr79
norway	63	j	spain	65	j
sweden	63	j	switzerland	59	flo
united kingdom	59	schn	canada	61	j
mexico	63	j	united states	60	j
argentina	59	fw	chile	68	wdr79
uruguay	67	lec	venezuela	62	lec
australia	54/55	kuz	new zealand	66	j

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