The effects of inequality on growth:

perspectives from the theoretical literature

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Abstract

The economic literature on the effects of inequality on growth reveals a complex set of interactions between inequality and economic growth, where alternative arguments imply that inequality may have a beneficial or detrimental influence on the growth process. This paper argues that the key to derive more general conclusions from this vast literature is to organize it according to the assumptions that underlie its micro foundations. The paper first suggests a simple analytical framework to identify the main types of effect of inequality on the macroeconomy and relate different and seemingly opposite arguments expressed in the literature. Based on this framework, the rest of the study reviews an extensive set of mechanisms that have been suggested in the literature.

No society can surely be flourishing and happy, of which the far greater part of the members are poor and miserable. Adam Smith (Wealth of Nations, Book 1, Chapter 8)

1 Introduction

Although the study of inequality had lost popular appeal for most the 20th century (Atkinson 1997), the recent rise in economic disparities observed in many countries (OECD report 2008, World Development Report 2006) has prompted renewed interest in understanding the causes of inequality and associated implications for the macro-economy. Nevertheless, a reader of the contemporary literature may be forgiven for coming to the conclusion that it provides little guidance for economic decision making of any kind: empirical findings often appear to be contradictory, and the theoretical literature has explored a bewildering array of hypothesized mechanisms that bear upon the relationship between inequality and growth. Although the diversity of arguments expressed in this field can make it difficult to see the forest for the trees, I suggest that the key to unraveling the implications of this literature is to organize it according to its micro foundations. Using this approach, it becomes possible to relate different and seemingly contradictory arguments, and to identify conditions that may determine the relationship between inequality and growth.

A major obstacle to a better understanding of the relationship between inequality and growth has been the scarcity of reliable and comparable data on inequality. The seminal study by Kuznets (1955) that frames much of the subsequent literature on the relationship between inequality and growth provides a striking example of the data constraints that have limited empirical analysis in this field. This study considers the evolution of inequality during the process of development, suggesting that inequality first rises and then falls as a country industrializes (represented by the Kuznets' curve). It is startling to note that Kuznets based his findings on just two to five data points for three developed countries (the United States, England and Germany, split between Prussia and Saxony), and cited a further three data points for each of three developing countries (India, Ceylon and Puerto Rico). This paucity of data led Kuznets to warn that his findings "came perilously close to pure guesswork", p.6.

The release of several new data sources since the mid 1990s, has spurred much work to close the empirical gap. These studies have focused on testing both hypothesized mechanisms that characterize the inequality/growth

relationship, as well as attempting to identify the aggregate influence that inequality has on growth. Up until the late 1990s, empirical analyses commonly concurred that inequality hinders growth prospects[1]. The initial consensus, however, has been over-turned by more recent research that makes use of improved data sources and advances in empirical methods; see recent reviews by de Dominicis, Florax and de Groot (2008), and Voitchovsky (2009). The empirical relationship between inequality and growth has since been shown to be sensitive to different aspects of the analysis, including the econometric method employed (Forbes 2000, etc.), the sample of countries considered (Barro 2000, Bleaney 2004), measurement error in inequality statistics or definition of inequality (Knowles 2001, etc.), as well as the model specification (Banerjee and Duflo 2003, Voitchovsky 2005, etc.) The general picture that is emerging from this more recent empirical literature is a rejection of the hypothesis of a simple (positive or negative) effect of inequality on growth in favor of a more complex and non-linear influence of inequality (Banerjee and Duflo 2003, add refs).

The lack of an empirical consensus has fostered a vigorous theoretical literature, which has considered a wide-range of alternative mechanisms through which inequality may affect growth. Some of the channels that have been suggested imply a trade-off between equality and economic performance: higher inequality, for example, may translate into higher growth rates if it encourages increased productive effort from individuals (e.g. Hassler and Mora 2000, add refs), or implies higher levels of savings and investments in the economy (e.g. Bourguignon 1981, add refs). Other models show how inequality may be linked adverse economic influences, such as depressed average educational levels (e.g. Galor and Zeira 1993), increased levels of corruption (add ref), social unrest (add ref), or macro economic volatility (Woo 2005).

In this study, I attempt to take stock of the theoretical literature that considers the effects of inequality on growth. The presentational approach that is commonly adopted makes it tempting to categorize the literature in terms of whether the implied effect of inequality is good or bad for growth. I argue, however, that this approach may be counter-productive, as it is likely to understate important nuances in the assumed economic context, while overemphasizing the effects of specific channels as they have been considered in the literature. Moreover,

[1] See e.g. the influential papers by Alesina and Rodrik (1994), Persson and Tabellini (1994) and Perotti (1996). A negative effect of inequality was usually obtained from a cross-sectional estimation of growth rates, measured over a single long interval of 20 to 30 years, as a function of several variables including a measure of inequality; a review of this empirical literature can be found in Benabou (1996).

providing that different mechanisms implying different effects of inequality on growth are not mutually exclusive, there is no reason to believe that they may not operate simultaneously in the economy. It may be more helpful, therefore, to identify 'when' rather than 'whether' inequality is beneficial or detrimental to the growth process. The main objective of this study is to draw out defining aspects of the complexity of this relationship and provide a more nuanced picture on the effects of inequality on growth. In doing so, the paper also seeks to establish what we now know about the effects of inequality on growth and how we should expect inequality to matter for growth.

The paper begins by identifying the key assumptions that underlie the different parts of the theoretical literature, which are central to the debate on the effects of inequality on growth (Part I). This discussion starts by placing studies where inequality affects a country's growth prospects in context of the wider growth literature. Indeed, most of the growth literature is based upon the simplifying assumption of a representative agent and has limited implications for the inequality growth relationship. Moreover, some of the literature argues that the correlation that is observed between inequality and growth may not reflect any causal links between these variables, but may be attributable to the joint influence of external factors like shocks or government interventions (add refs). It is therefore useful to begin by setting out the assumptions on which a representative model depends, and then proceed to explore the implications of relaxing the assumptions. Based on the framework developed in Part I, the second part of the paper reviews an extensive set of mechanisms that have been suggested in the literature.

Other reviews are related to and complement the survey undertaken here. For a more detailed discussion of certain mechanisms see, for example, Aghion, Caroli and Garcia-Penalosa (1999), Thorbecke and Charumilind (2002), and the World Development Report (2006) for a focus on developing countries. The reader is also referred to Bertola (2000), Mookherjee and Ray (2002, 2005), and Bertola, Foellmi and Zweimüller (2006) for more technical discussions and detailed coverage of endogeneity issues associated with the evolution of the income distribution and economic growth.

Part I

Important assumptions underlying the theoretical literature

A defining aspect of the studies that investigate the relationship between inequality and growth concerns the anticipated direction of causality between variables: to what extent does economic growth shape the distribution of income or wealth in a country; and how far does the distribution of economic resources affect a country's growth prospects? Although strong views often underlie the considered direction of causality, the absence of compelling empirical evidence one way or the other focuses attention in the current context on the common assumptions that underlie the theoretical literature.

Using a simple growth model as the point of departure, I first discuss the assumptions required for the distribution of economic resources in the economy to affect the growth process. In doing so, this section starts by placing studies where inequality has an effect on growth in the context of the wider growth literature. Several variations of the basic model are then suggested to portray the main types of distributional effects on growth that have been suggested in the literature.

2 A simple representative agent model

Our starting point is a simple neoclassical growth model, inspired by Stiglitz (1969), where the economy produces a single homogenous good. The good, which can be used for investment or consumption, is produced using physical capital and technology augmented human capital. The initial set of assumptions regarding production and behavior implies that the distribution of wealth has no effect on macroeconomic aggregates. Although the discussion is framed in terms of a neoclassical growth model (with transitional dynamics), endogenous growth models (see for example the review by Aghion, Caroli and Garcia-Penalosa 1999), or those that do not include transitional dynamics, have also been considered by the literature and are referred to throughout the survey.

2.1 Production and prices

Suppose that production at time t, $Y(t)$, is:

$$Y(t) = F(K(t), A(t)H(t)) = A(t)H(t)f(\widetilde{k}(t)) = A(t)H(t)\widetilde{k}(t)^{\alpha} \; ; \quad \widetilde{k}(t) = K(t)/(A(t)H(t)); \quad \alpha \in (0,1) \qquad (1)$$

where $K(t)$ and $H(t)$ represent the stocks of physical and human capital employed in the economy, and $\widetilde{k}(t)$ is the level of physical capital per efficiency unit of human capital. $A(t) = A\exp(gt)$ captures the human capital augmenting technology, which grows at a constant rate g. Given competitive factor markets, factor prices are set equal to marginal products:

$$\begin{aligned} \widehat{r}(t) &= \alpha\widetilde{k}(t)^{\alpha-1} = f'(\widetilde{k}(t)) \\ \widehat{w}(t) &= (1-\alpha)\widetilde{k}(t)^{\alpha} = f(\widetilde{k}(t)) - f'(\widetilde{k}(t))\widetilde{k}(t) = (1-\alpha)f(\widetilde{k}(t)) \end{aligned}$$

where $\widehat{r}(t)$ denotes the return to capital, and $\widehat{w}(t)$ is the wage rate per efficiency unit of human capital. Every individual is endowed with one unit of human capital $h_i = 1$, which they supply inelastically to the labour market. The stock of human capital in the economy,$H(t)$, therefore corresponds to the sum of workers, $N(t)$, as $H(t) = \sum_{i=1}^{N(t)} h_i = N(t)$, and the wage rate per worker (or unit of human capital) is $w(t) = A(t)\widehat{w}(\widetilde{k}(t))$.

To keep the model as simple as possible, a small open economy assumption is made: physical capital can flow freely between international boundaries, whereas the amount of labour supplied in the economy is constrained by the size of the domestic population. Consequently, the return to capital is fixed at the world rental-rate $\widehat{r}(t) - \delta = \overline{r}$ (where δ is the rate of capital depreciation), and the capital that is employed domestically adjusts so that $\widetilde{k}\,(t) = \overline{k}$. This also fixes the wage rate per efficiency unit of human capital, $\widehat{w}(t) = \widehat{w}(\overline{k}) = \overline{w}$. The wage rate that each worker receives consequently varies with advances in technological progress $w(t) = A(t)\overline{w}$. The small open economy assumption also implies that domestic production (GDP) evolves with $A\,(t)$ and $H\,(t)$ only, whereas National Income (GNP) depends crucially upon domestically owned wealth. Given this context, the remainder of the study focuses upon the intertemporal evolution of domestically owned capital and income.

2.2 Preferences and dynastic behavior

Consider a domestic population that is divided into G dynasties. The number of individuals in each dynasty, $N_i(t)$, is assumed to grow at a constant exponential rate $N_i(t) = N\exp(nt)$, so that the weight of each dynasty in the population, a_i, $\sum_{i=1}^{G} a_i = 1$, is time invariant. The total wealth held by each dynasty is assumed to be shared equally among the members of the dynasty. Preferences and abilities are identical throughout the population, but dynasties differ in the amount of per capita wealth that constituent members hold, $k_i(t) \geq 0$. Each individual must choose how to allocate their total net worth between consumption, $c_i(t)$, and savings, $s_i(t)$. These decisions are made to maximize their instantaneous utility $U_i(t) = c_i(t)^{1-\gamma}s_i(t)^{\gamma}$ subject to the budget constraint $c_i(t) + s_i(t) \leq A(t)\overline{w} + (1+\overline{r})k_i(t)$, which excludes the possibility of negative net worth at any point in time. The homothetic utility function that is assumed implies that all individuals choose to save a fixed share of their total budget:

$$s_i(t) = \gamma(A(t)\overline{w} + (1+\overline{r})k_i(t)) \tag{2}$$

The per capita wealth of each dynasty evolves according to[2]

$$\dot{k}_i(t) = \gamma(A(t)\overline{w} + (1+\overline{r})k_i(t)) - (1+n)k_i(t) \tag{3}$$

The evolution of the individual law of motion described by Equation (3) is represented in Figure 1. It can be shown that regardless of the initial wealth distribution, individual wealth holdings converge to equality in steady-state, where $k_i^*(t) = k^*(t) = \frac{\gamma A(t)\overline{w}}{1+n-\gamma(1+\overline{r})}$; see e.g. Stiglitz (1969) for similar distributional outcomes in a closed economy model[3]. Once in steady-state, individual wealth grows at the exogenous rate of technological progress, g. As new technologies are introduced in the economy, wages rise, which shifts the individuals' savings function from $s_i(t)$ to $s_i(t')$, $t < t'$.

[2] to see this, note that $k_i(t) = \int_0^t \widehat{s}_i(z)N\exp(nz)dz / N\exp(nt)$, where $\widehat{s}_i = s_i - k_i$

[3] Convergence to equality is not a necessary outcome of representative agent models. Different assumptions regarding utility maximizing behaviour, for example, may imply history dependence and persistent inequality in equilibrium (e.g. Caselli and Ventura 2000). Chatterjee (1994) demonstrates that, if agents save according to a utility function that is maximised over an infinite horizon, inequality may persist at the steady state. Although the distribution of wealth has no impact on the accumulation dynamics redistribution may have a social welfare impact.

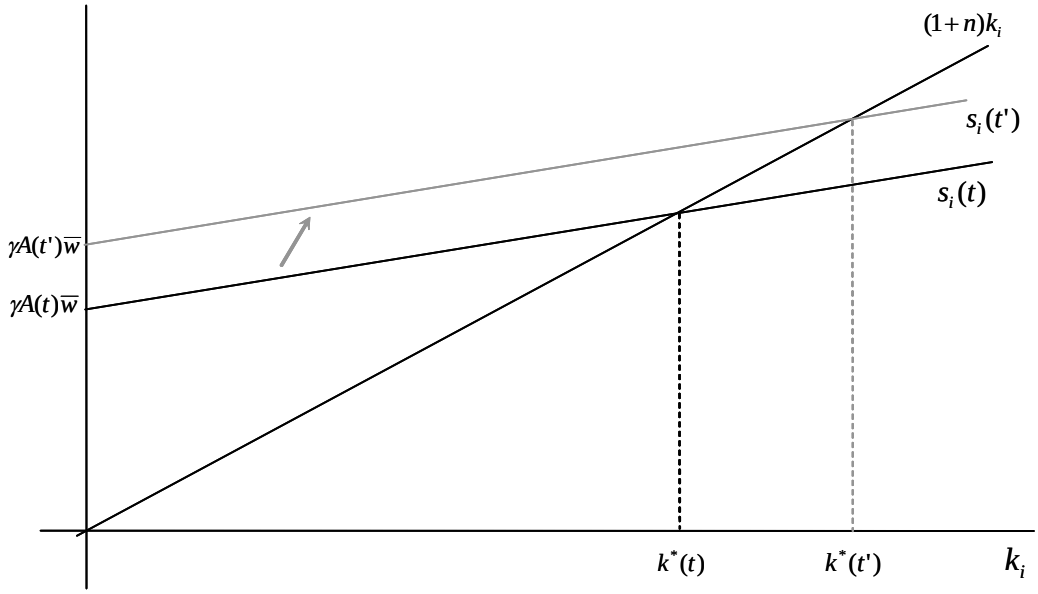

Figure 1: Individual laws of motion of capital

2.3 Aggregates

Each Individual in the population is distinguished only by their wealth holding $k_i(t)$, which differs between but not within dynasties. We can therefore rewrite the per capita level of physical capital owned by the population as $k(t) = \sum_{i=1}^{G} a_i k_i(t)$, and the (average) accumulation of capital per capita $\dot{k}(t) = \sum_{i=1}^{G} a_i \dot{k}_i(t)$. The rate of capital accumulation per capita in the economy becomes

$$\dot{k}(t) = \gamma(A(t)\overline{w} + (1+\overline{r})k(t)) - (1+n)k(t) \tag{4}$$

and the national income per capita, $y(t) = A(t)\overline{w} + \overline{r}k(t)$, grows according to $\dot{y}(t) = gA(t)\overline{w} + \overline{r}\dot{k}(t)$.

Equation (4) reveals that the accumulation rate of capital (and of income) is independent of the distribution of wealth in the economy, both during convergence and at the steady-state. This important implication of the model arises from the assumption that the individual accumulation function (3) is a linear function of individuals' absolute wealth level, which is a result of the linearity of both the income and savings functions. More generally, as discussed in Caselli and Ventura (2000), the aggregate accumulation behaviour of a population may be summarized by a representative agent only when the individual law of motion is linear in the source of heterogeneity. Linearity

here stems from the assumptions that preferences are homogenous throughout the population and homothetic[4], the decision set is convex, and all agents face the same prices. The representative agent assumption furthermore rules out the possibility that common variables or aggregates – e.g. policy variables – be influenced by the degree of heterogeneity within the population.

To illustrate this last point, consider the individual accumulation function (3) extended to include a proportional income tax

$$\dot{k}_i(t) = \gamma\left[(1-\tau)y_i(t) + k_i(t)\right] - (1+n)k_i(t) \tag{5}$$

where τ is the uniform tax rate. The funds raised through taxation are assumed to be consumed. As long as the tax function is linear in individual heterogeneity, the conclusions reported above will apply, and aggregate accumulation behaviour can be summarized by a representative agent function. However, consider the situation where the tax rate is set by a median voter mechanism (see e.g. Persson and Tabellini 1994, Alesina and Rodrik 1994) and therefore depends on the level of inequality in the economy $\tau = \tau(\xi)$, where ξ is the mean to median income ratio. In this case, the level of inequality will also affect capital accumulation, so that a representative agent framework will no longer be sufficient to derive growth dynamics; see Caselli and Ventura (2000) for more discussion.

3 Inequality affects the growth process

The representative agent model just described incorporates several simplifying assumptions regarding individual behavior. In particular, preferences and the economic context are such that optimal decisions are a linear function of individual specific circumstances, and independent of the circumstances of others. By construction, modelling assumptions reflect an imperfect balance between perceptions of the economy and the practical constraints of analytical tractability. Although the simplifications entailed in the representative agent model may help to characterize the economy at the macro level, they appear unduly restrictive when focus is switched to the individual. Specifically, there is growing evidence to suggest that households' allocations of resources and their expected

[4] More specifically, to ensure the existence of a representative agent at the aggregate level, and without imposing restrictions on the wealth distribution, a sufficient condition imposed on preferences is that they take the Gorman form. See e.g. Acemoglu (2009) for details.

returns vary with their economic circumstances. For example, several empirical papers report how saving rates are increasing with income (Dynan, Skinner and Zeldes, 2004; Villanueva 2005), that individuals do take into account other people's circumstances when deciding how to allocate their own resources (add refs), or document rising returns to education (add refs). The question then is how far a representative agent context limits our understanding of the way in which individual decisions link in with the macroeconomy. In my view, there is a lot to be gained by augmenting growth models to allow for a more plausible description of the individuals' economic environment and their decision making process.

By exploring different ways to relax the representative agent assumption, theoretical studies have suggested a wide array of mechanisms through which inequality and the macroeconomy may influence one another. These studies have considered, for example, the implications of non-convexities in the use of physical or human capital, departures from the assumption of homothetic preferences, and alternative formulations that bear upon the prices that individual face. More indirectly, analyses have explored the influence of inequality on the stability of financial and political systems, or on the type of policies that a country implements. These and other mechanisms are reviewed in more detail in the second part of the paper.

Before moving on discuss detailed mechanisms that have been the subject of analysis, this part of the paper focuses upon the implications of stylized assumptions that underlie aspects of the theoretical literature. The objective is to tease out the main elements of the debate in order to draw more nuanced and informed conclusions. To do so, I consider several variations of the representative agent model that capture what I see as the main lines of distinction in this literature.

3.1 Introducing non-linearities

This section discusses several ways in which inequality may affect the growth process by considering examples where different types of non-linearities work through human capital. The choice of human capital as the principal channel of interest also reflects its importance in the recent literature. Following the influential paper by Galor and Zeira (1993), the first variation introduced here implies non-convexities in the production of human capital.

Most models consider non-linearities in the presence of imperfect credit markets, where individuals have no or

limited access to borrowing[5]. With perfect capital markets, individuals would have access to sufficient liquidity to bypass investment indivisibilities or other non-linearities in the individual law of motion, and everyone would face the same returns to investment. Initial financial disparities would then have no impact on the average rate of capital accumulation or steady-state properties of the model. Nevertheless, credit contraints alone are not sufficient to imply an effect of inequality on growth. Some degree of non-linearity in the individual accumulation function is also required[6]; see e.g. Galor and Zeira (1993).

Suppose that individuals' basic level of human capital, h_i, can be augmented by investment in education, which increases labour productivity. Human capital is determined by current expenditure on education, and is independent of past expenditures. This is designed to reflect, in continuous time, the fact that investment by parents in the education of their children does not have a bearing upon the education of their grand-children other than through the impact that such investment has on the financial circumstances of their children.

In this economy, people can have three distinct levels of human capital, $h_i = (\lambda_1,\ \lambda_2,\ \lambda_3)$. The lower level of human capital, λ_1, is the default level of human capital, which requires no further investment in education. In an advanced economy, this could be interpreted as high school qualifications. For a fixed investment of $e_2(t)$, individuals can acquire human capital $\lambda_2 = \lambda_1 + \mu_2$, $\mu_2 > 0$. This additional level of education could be interpreted as a first degree or equivalent. A high investment in education, $e_3(t) > e_2(t)$, endows individuals with the highest level of education in the economy, $\lambda_3 = \lambda_2 + \mu_3$, $\mu_3 > 0$, which here could be interpreted as an advanced university degree.[7] The costs of education are each assumed to grow at a fixed rate of ϵ. This categorization of human capital is meant to reflect important aspects of the role of human capital in the macroeconomy, as suggested by the recent literature. Namely, the composition and not only the average level of human capital may influence the rate of economic growth; see e.g. Galor and Tsiddon (1997b), Mokyr (2005), Vandenbussche et al (2006).

As earlier, individuals supply their human capital inelastically. Hence, there are three distinct stocks of human

[5] See Aghion, Banerjee and Piketty (1999) for a situation where the borrowing ceiling depends on individuals' income.

[6] In some models, non-linearities are related to (heterogeneity defined by) individuals' social background rather than to their wealth levels, and can therefore not be compensated by access to credit. In Galor and Tsiddon (1996) e.g., all individuals have access to capital markets but the return to their (human capital) investment depends on parental characteristics (i.e. on their parents' level of human capital).

[7] In a developing economy, the gradation in education could instead be translated as individuals with no formal education, workers with on the job training or appenticeships, and people with some degree of formal education.

capital in this economy, the lower educated workers, $H_1(t) = \sum_{i=1}^{N_1(t)} \lambda_1$, the middle educated workers, $H_2(t) = \sum_{i=1}^{N_2(t)} \lambda_2$, and the highly educated workers, $H_3(t) = \sum_{i=1}^{N_3(t)} \lambda_3$, where $N_1(t)$, $N_2(t)$ and $N_3(t)$ denote the number of workers in each educational group, respectively, and $N_1(t) + N_2(t) + N_3(t) = N(t)$. Different skills can be used as substitutes in production, and together form a composite level of human capital $N(t)$ defined as

$$H(t) = (\lambda_1 N_1(t) + \lambda_2 N_2(t) + \lambda_3 N_3(t)) \tag{6}$$

(see e.g. Galor and Moav 2000 for a similar a approach). Individuals can expect different wages, depending on their level of human capital. Low skill workers receive the lowest wage $w_1(t) = A(t)\lambda_1\overline{w}$, middle educated workers get, $w_2(t) = A(t)\lambda_2\overline{w}$ and highly educated workers receive the highest wage rate, $w_3(t) = A(t)\lambda_3\overline{w}$.

Savings can therefore be allocated between cash transfers and investment in education. The decision is set to maximize the overall financial return to the individual, subject to the constraint that $k_j(t) \geq e_j(t)$,where $j = 1, 2, 3$ and $e_1(t) = 0$. It is furter assumed that the return to education is sufficiently high to ensure that individuals invest in the highest level of education that they can afford, so that $e_2(t) < \frac{A(t)\overline{w}\mu_2}{1+\overline{r}}$ and $e_3(t) < \frac{A(t)\overline{w}(\mu_3+\mu_2)}{1+\overline{r}}$. Note that the upper thresholds imposed on the costs of education $e_2(t)$ and $e_3(t)$ are also increasing with the level of technology. This human capital production function effectively implies that the return to savings is increasing in the amount of individual net worth. Heterogeneity in human capital translates in different laws of motion, depending on individual net worth:

$$\begin{aligned} \dot{k_i}(t, e_j(t)) &= \gamma(A(t)\lambda_j\overline{w} + (1+\overline{r})(k_i(t) - e_j(t)) - (1+n)k_i(t) \\ \text{where } j &= \begin{cases} 1 & \text{if } k_i(t) < e_2(t) \\ 2 & \text{if } e_2(t) \leq k_i(t) < e_3(t) \\ 3 & \text{otherwise} \end{cases} \end{aligned} \tag{7}$$

To explore the implications of the model further, I denote $a_1 = N_1(t)/N(t)$ the proportion of the population that does not acquire additional units of human capital. Similarly a_2 and a_3 are the fractions of workers in total population who have middle and high levels of human capital. The average accumulation of capital per capita in

the economy then becomes $\dot{k}(t) = \sum a_j \dot{k}_j(t)$ and can be written as:

$$\dot{k}_t = [\gamma(A(t)\lambda_1 \overline{w} + (1+\overline{r})k(t)) - (1+n)k(t)] + a_2\psi_2 + a_3\psi_3 \tag{8}$$

where $\psi_2 = \gamma(A(t)\overline{w}\mu_2 - (1+\overline{r})e_2(t))$ and $\psi_3 = \gamma(A(t)\overline{w}(\mu_2+\mu_3) - (1+\overline{r})e_3(t))$. The constraints imposed on education costs imply that $\psi_2, \psi_3 > 0$. Due to the presence of non-linearities in the individual law of motion (equation 7), equation 8 reveals that the average accumulation of capital is now influenced by the distribution of wealth in the economy. The first term of equation 8 (in square brackets) represents the average accumulation of capital in the absence of additional investment in education; in the special case when $\lambda_1 = 1$ this term corresponds to the rate of accumulation in the earlier representative agent version of this model (equation 3). The last two terms of equation 8, $a_2\psi_2$ and $a_3\psi_3$ capture the additional contributions to capital accumulation made by the middle and higher wealth groups resulting from their access to more profitable investment opportunities. Overall, poor dynasties, or those who hold low levels of per capita wealth, end up contributing less to production than individuals with better economic circumstances – a common implication of non-convexitites in this literature.

Whether the distribution widens or contract as the economy grows will determine whether the effect of inequality persists or disappears in equilibrium. Different predictions regarding the evolution of the income or wealth distribution, however, represent an important aspect of the debate on the effects of inequality on growth. In the presence of credit market imperfections, and given initial conditions, transitional dynamics are determined by the type of non-linearity that is assumed.

3.2 Inequality has a short term effect on output

Models that imply a short term effect of inequality on growth consider economic environments where the initial distribution eventually converges to equality[8]. These studies represent a distinct category of non-linear accumulation functions that allow for a temporary effect of inequality on output while on the path to convergence, but where inequality does not affect its long-term properties[9]; see e.g. Loury (1981), Scheinkman and Weiss (1986),

[8] The distribution could also converge to a pre-defined range of income or ergodic distribution, for example.
[9] This implies that the individual law of motion is non-linear but with only one root, at least in the long-term.

Tamura (1991), Galor and Tsiddon (1996), Aghion and Bolton (1997), Zilcha (2003). See also Albuquerque (2004), in particular, for an example in the context of an AK model.

An equalizing mechanism that has been considered at length is commonly referred to as trickle down. The central premise is that, in the presence of credit constraints, a country might rely on the most wealthy segment of its population to initiate or stimulate the growth process. The rise in wealth generated by the entrepreneurial activities of the better-offs may subsequently feed back to rest of the distribution, thereby allowing the poorer segments of society to catch up. (e.g. Perotti 1993; Galor and Tsiddon 1996, 1997b; Aghion and Bolton 1997; Maoz and Moav 1999; Fishman and Simhon 2002; Galor, Moav and Vollrath 2006). Other mechanisms may also see convergence to equality in steady-state if, for example, the savings fucntion is concave (Stiglitz, 1969), or with concave returns to individual investment (e.g. Zilcha, 2003; Tamura, 1991; Loury, 1981; Aghion and Caroli and Garcia-Penalosa, 1999)[10].

Here, I consider the case where convergence to equality is induced by trickle down from human capital accumulated by the better-offs. I assume that investment in education not only increases individuals' own labour productivity but also benefits the rest of the economy through advances in technological progress[11]; see e.g. Galor and Tsiddon (1996,1997b), Vandenbussche at al. (2006). Part of the working time of individuals in this economy is spent on R&D activities to improve the productivity of their current job or firm. Nevertheless, only the innovations put forward by highly educated workers, have the potential to benefit the rest of economy, thereby raising the productivity of all workers. (see also Mokyr 2005). Technological advances suggested by highly educated workers are therefore considered to drive the economy's rate of technological progress, $\widehat{A}_t$. In this simple set-up, technological progress is a by-product of the stock of advanced human capital, and is therefore also constrained by the availability of highly educated workers. The rate of technological progress is now defined as

$$\widehat{g}(t) = \int_0^t \left((\beta a_3(z))^\eta + b\right) dz \tag{9}$$

where $a_3(t)$ is the proportion of the population with the highest level of education at time t, and $\beta a_3(z))^\eta + b$

[10] As well, in the absence of a perfect insurance market, poor agents may have to work harder and accumulate faster than richer people as a precautionary measure; Scheinkman and Weiss (1986).

[11] Skill levels or human capital have indeed been widely linked to the adoption and development of new technologies, especially in the endogenous growth literature, with a positive externality effect on the rest of the economy. (add refs).

represents the instantaneous rate of technological progress. Futhermore, $0 \leq \eta < 1$ implies that the size of the highly educated pool of workers has a decreasing positive effect on the rate of technological progress. The rate of technological progress can then vary from a minimum of b in the absence of educated workers, up to a maximum rate of $(\beta^{\eta} + b)$ when the entire population is highly educated. The lower threshold b could be interpreted as the rate of a country's adoption of new technologies through imitation. Furthermore, it is assumed that the cost of education increases at a lower rate than the maximum rate of technological progress, that is $\epsilon < (\beta^{\eta} + b)$.

From equation 7, it can be shown that within the basin of attraction of each education group, low, middle and highly educated workers will tend to converge to levels of capital holdings defined as $k_j^*(t) = \frac{\gamma(\widehat{A}(t)\lambda_j\overline{w} - (1+\overline{r})e_j(t))}{1+n-\gamma(1+\overline{r})}$. Moreover, technological progress benefits all workers by raising their productivity and wages. Steady-state wealth holding of the three groups will grow with technological progress, but at different rates depending on indiviudal the human capital:

$$\frac{\dot{k_j^*}(t)}{k_j^*(t)} = \widehat{g}(t) + (\widehat{g}(t) - \epsilon)\phi_j(t) \tag{10}$$

where $\phi_j(t) = \frac{(1+\overline{r})e_j(t)}{\widehat{A}(t)\lambda_j\overline{w} - (1+\overline{r})e_j(t)} > 0$ if $e_j(t) > 0$. If the rate of technological progress is sufficiently high to ensure that wages grow faster than the cost of education, $\widehat{g}(t) > \epsilon$, then all members of the society will eventually be able to afford high education levels, and the economy converges to equality at the high wealth point, $k_3^*(t)$. This scenario is represented graphically in Figure 2.

The high education equilibrium entails the fastest rate of growth in steady state, where $g(t) = (\beta^{\eta} + b)$. During transition, however, average capital accumulation of educated workers will initially grow at a faster rate and inequality increase, as $(\widehat{g}(t) - \epsilon)\phi_j(t) > 0$. By acquiring additional units of human capital, rich individuals are better able to take advantage of the benefits of technological progress, and accumulate capital faster as a result.

Given the concavity of technological progress in the size of the highly educated workforce, convergence to wealth equality in steady state requires sufficient initial wealth concentration $a_3(0) > \frac{(\epsilon - b)^{1/\eta}}{\beta}$ to ensure $\widehat{g}(0) > \epsilon$ and that convergence occurs. This feature of the model reflects a common argument in the literature: some degree of initial inequality may be required to stimulate the growth process or initiate industrialization, especially when access to credit is limited (e.g. Lewis 1954, Galor and Tsiddon 1996, add refs).

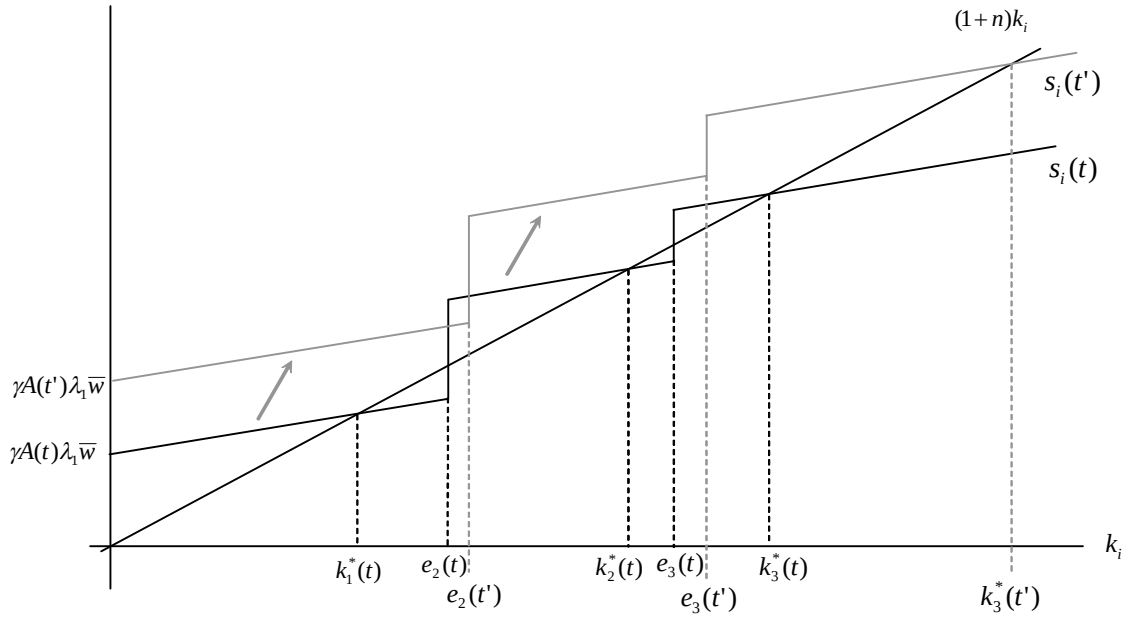

Figure 2: Individual law of motion with short term effect of inequality

Another common distributional implication is the widening inequality in the initial stages of growth, as the rich get richer. The distribution then contracts as wealth trickles down, which allows poorer individuals to take advantage of higher returns to investment and avoid the creation of a low equilibrium point in the wealth distribution[12]. Trickle down may take place through many different channels, including the average wage rate (e.g. Galor and Tsiddon 1996, Banerjee and Newman 1993, Maoz and Moav 1999; Fishman and Simhon 2002), the market return to capital (e.g. Aghion and Bolton 1997; Matsuyama 2000), redistributive policies (e.g. Perotti 1993, Aghion and Bolton 1997, Galor, Moav and Vollrath 2006), via the average rate of return to education (e.g. Tamura 1991), or changing levels of technology in a country (Galor and Tsiddon 1997b)[13]. Many studies however, consider trickle down in the context of a closed economy, where the change in supply of the different factors of production affects their relative prices. As the country develops, the rich (capitalists) get richer owing to their growing capital investments, which sees wages rise and inequality decline.

This literature suggests that some degree of inequality may be required for the country to take off and develop, after which the evolution of the distribution is endogenous to the growth process. Under certain conditions, once

[12] For example, in Galor and Tsiddon (1996), the accumulation function is convex at low values of human capital up to a certain threshold and constant there after. As the rich get richer and the economy grows, this function is shifted upwards, eliminating the possibility of a lower convergence point.

[13] Note that trickle down can also occur in the absence of an effect of inequality on growth.

the economy is growing, the entire population can then converge to a single high (or ergodic) wealth equilibrium in the long-term, which is independent of the initial level of inequality. The level of initial inequality (together with trickle down effect) will, however, influence the speed of convergence to the steady-state.

3.3 Inequality has a long-term effect on output

In other models, inequality characterizes the path as well as the attributes of the macroeconomy in equilibrium. The conditions required for history dependence and the consequences of persistent inequality for growth have been the focus of the more recent literature: see e.g. Bourguignon (1981), Galor and Zeira (1993), Alesina and Rodrik (1994), Piketty (1997), Kremer and Chen (2002), Moav (2002), Chakraborty and Das (2005), Woo (2005); see also Mookerjee et al. (2005) for more discussion.

Persistent inequality in equilibrium may be due to adverse initial conditions. Initial equality in poverty may imply that only a small fraction of people can successfully become productive entrepreneurs or invest in human capital, (see e.g. Galor and Tsiddon 1996, Romer and Lee 1998, etc.). Without sufficient initial impetus, not enough wealth is created to trickle down the distribution and enable the rest of the distribution to participate in production. Some studies also suggest that the trickle down process may run out of steam during the development process, or as inequality increases, preventing full convergence to equality and prosperity. One example of this concerns the evolution of trickle down through redistribution. In spite of rising average wealth levels, redistribution could decline if, as the median voter gets richer, they opt for lower levels of redistribution (Perotti, 1993), or if the wealthy use their growing influence through lobbying (Galor, Moav and Vollrath 2006; add refs). As a result, part of the population remains trapped in poverty – below the diverging threshold – as the economy grows, leading to a sub-optimal and unequal equilibrium[14].

Although many recent studies have considered the case where the term 'higher inequality' refers to widespread poverty, persistent disparities and lower output in the long-run, this is not necessarily the case. Lasting or even growing inequality may be associated with faster growth if it is the outcome of higher savings by the

[14]These models imply that the individual accumulation function has at least two roots in equilibrium – i.e. two stable roots, or a stable and unstable root, in which case the rich grow continuously richer or the poor are pushed against the liquidity constraint.

rich (Bourguignon 1981)[15], an ability rewarding wage structure (add refs), or due to faster, but skill-baised, technological progress (Galor and Moav 2000). Furthermore, in the literature that considers relative rather than absolute income as a determinant of individuals' savings, the evolution of aggregate variables may become highly non-linear; these latter models usually imply an optimal level of inequality at which production and capital productivity are maximized; see also Schlicht (1975).[16]

Consider, for example, a variation of the model developed above to accommodate differential rates of wage growth by education level, in response to skill-biased technological progress. This reflects the growing consensus that skill-biased technological progress has been a major driving force behind the widening wage gap of educated and non-educated workers in advanced economies (Autor et al. 2008, Acemoglu 2002). Several reasons have been suggested to account for this trend. One explanation states that human capital facilitates the adoption of new technologies and thus protects, to some extent, skilled workers from productivity erosion, increasing the gap between skilled and unskilled wages (Nelson and Phelps 1967, Galor and Moav 2000). Another interpretation considers capital-skill complementarities, and implies that technological progress is more biased in capital rich economies (e.g. Griliches 1969, Maoz and Moav 2004). In this section, I assume that skill bias arises from directed technological change (Acemoglu 2002, Acemoglu 2009). This argument states that innovations are developed to be used in conjunction with a specific factor (skilled or unskilled labour) and are motivated by profit maximizing objectives. As market size, rather than prices, determines profit opportunities, new technologies are developed to take advantage of the largest skill pool. As an economy develops, and more people acquire human capital, new technologies will switch from being skill-replacing to becoming skill-enhancing.

For example, suppose that new technologies are developed to be used in conjunction with workers from the largest skill group.To develop this idea, I extend the model of the preceeding sub-section so that each of the three education sub-groups in the economy are organized into one of two skill groups: low educated individuals work

[15] Bourguignon (1981), for example, shows that when all agents have positive wealth holdings and the savings function is convex, equilibria in which inequality remains are Pareto superior to the equal one, in that they imply a higher level of average as well as individual income.

[16] Models without transitional dynamics – where inequality is time-invariant – have also been considered in this context. Based on the endogenous growth framework in particular, this approach has been used to examine the effect of inequality via policy variables; e.g. Alesina and Rodrik (1994), Woo (2005). Similarly, some models assume that a new and unrelated generation of individuals is born each period, with a given randomly distributed level of wealth endowment; see e.g. Persson and Tabellini (1994), Banerjee and Duflo (2003), Foellmi and Oechslin (2005).

as unskilled, and people with medium or high levels of education form the skilled workforce. As previously, the instantaneous rate of technological progress, $\widehat{g}$, depends on the size of the highly educated workforce.

Define technology enhanced human capital as:

$$A(t) H(t) = (A_u(t) H_1(t) + A_s(t) H_2(t) + A_s(t) H_3(t)) \tag{11}$$

where the stock human capital of each education sub-group, $H_i(t) = \lambda_i N_i(t), i \in (1,2,3)$, combines with the technology of the associated skill class: $A_u(t)$ for unskilled and $A_s(t)$ for skilled workers. Low skill workers receive the lowest wage $w_1(t) = A_u(t)\lambda_1\overline{w}$. People with middle and high investment in education get $w_2(t) = A_s(t)\lambda_2\overline{w}$ and $w_3(t) = A_s(t)\lambda_3\overline{w}$.[17] Technology is assumed to evolve as:

$$A_f(t) = A\exp(g_f(t)) : g_f(t) = \int_0^t ((\beta a_3(z))^\eta + b)\Phi_f(z)\,dz;\ f \in (u,s) \tag{12}$$

where $\Phi_u(t)$ and $\Phi_s(t)$ captures the different adjustments in productivity of the unskilled and skilled groups following introduction of new technologies. Suppose that new technologies can either be developed for the skilled or unskilled group. When used in conjunction with the targeted group, f, the productivity gain of this group is adjusted by $\Phi_f(t) = \nu^+$, whereas the other group benefits to a much lower extent $\Phi_g(t) = \nu^-$, $g \neq f$, with $0 < \nu^- \ll \nu^+$. With the aim of maximizing the overall instantaneous productivity gains from the introduction of new technologies, innovators will target the largest skill pool of workers. Consequently, the larger is the share of the highly educated group, a_3, the faster the is rate of innovation in the economy. By affecting the values of $\Phi_u(t)$ and $\Phi_s(t)$, the relative distribution of workers between skill groups will determine who ultimately benefits from the development of these new technologies.

Assuming that the cost of education is still sufficiently low[18] to ensure that people choose the highest level of education that they can afford (given the constraint that $k_j(t) - e_j(t) \geq 0$), the rate of capital accumulation

[17] Remember that λ_1 was defined as the lower level of human capital, which required no further investment in education. For a fixed investment of $e_2(t)$, individuals could acquire the middle level of human capital $\lambda_2 = \lambda_1 + \mu_2$, $\mu_2 > 0$. A high investment in education, $e_3(t) > e_2(t)$, endowed individuals with the highest level of education in the economy, $\lambda_3 = \lambda_2 + \mu_3$, $\mu_3 > 0$.

[18] So that $e_2(t) < \frac{A(t)\overline{w}}{1+\overline{r}}(\widehat{\lambda}_2(t) - \widehat{\lambda}_1(t))$ and $e_3(t) < \frac{A(t)\overline{w}}{1+\overline{r}}(\widehat{\lambda}_3(t) - \widehat{\lambda}_2(t)) + e_2(t)$.

becomes:

$$\dot{k_j}(t) = \gamma(A_f(t)\lambda_j\overline{w} + (1+\overline{r})(k_j(t) - e_j(t))) - (1+n)k_j(t) \tag{13}$$

where $j \in (1,2,3)$, $f = u$ when $j = 1$,and $f = s$ otherwise. From equation 13, it can be shown that, within the basin of attraction of each group, the low, middle and highly educated workers will converge to levels of capital holdings defined by $k_j^*(t) = \frac{\gamma(A_f(t)\lambda_j\overline{w} - (1+\overline{r})e_j(t))}{1+n-\gamma(1+\overline{r})}$. Differences in the rate of growth of individual wealth in steady-state now also depends on the relative size of each groups:

$$\frac{\dot{k_1^*}(t)}{k_1^*(t)} = g_u(t) = \widehat{g}(t)\Phi_u(t) \tag{14}$$

$$\frac{\dot{k_{2,3}^*}(t)}{k_{2,3}^*(t)} = g_s(t) = \widehat{g}(t)\Phi_s(t) + \widehat{g}(t)\Phi_s(t)\phi_{2,3}(t) \tag{15}$$

where $\phi_j(t) = \frac{(1+\overline{r})e_j(t)}{\widehat{A}(t)\lambda_j\overline{w} - (1+\overline{r})e_j(t)} > 0$.

Suppose that a in poor economy a large proportion of the population holds very little wealth, $k_i(t) < k_1^*(t)$, but there is a sufficient fraction of highly educated workers so that initially $k_1^*(t) > e_2(t)$. As new technologies are developed to be used in conjunction with unskilled workers, their wages rise rapidly and $k_1^*(t)$ is growing relative to $e_2(t)$. Provided that ν^- is not too small so that people still find it profitable to invest in education, a higher share of the population becomes skilled, and technological progress eventually shifts towards skilled workers. As a result, $\dot{k_1^*}(t)$ stagnates relative to $\dot{e_2}(t)$ up to a point where $k_1^*(t) < e_2(t)$ and all individuals with wealth below $e_2(t)$ remain trapped in poverty. Meanwhile, skilled workers' wages continue to rise, and the economy converges to a two- (or three) point distribution in equilibrium. This scenario is is represented in figure 3

Depending on their initial level of wealth, therefore some dynasties may stagnate in poverty while others converge to a steady-state with high income. By defining the proportion of the population in each of these categories, the initial income distribution can determine both the transition path of per capita income and its long-term equilibrium. Countries with historically different levels of inequality may consequently converge to very different equilibria. See also Moav (2002) and Mookherjee and Ray (2005) for a related discussion. These models support a significant role for government policy, as a one-shot intervention, even in equilibrium, can shift the economy

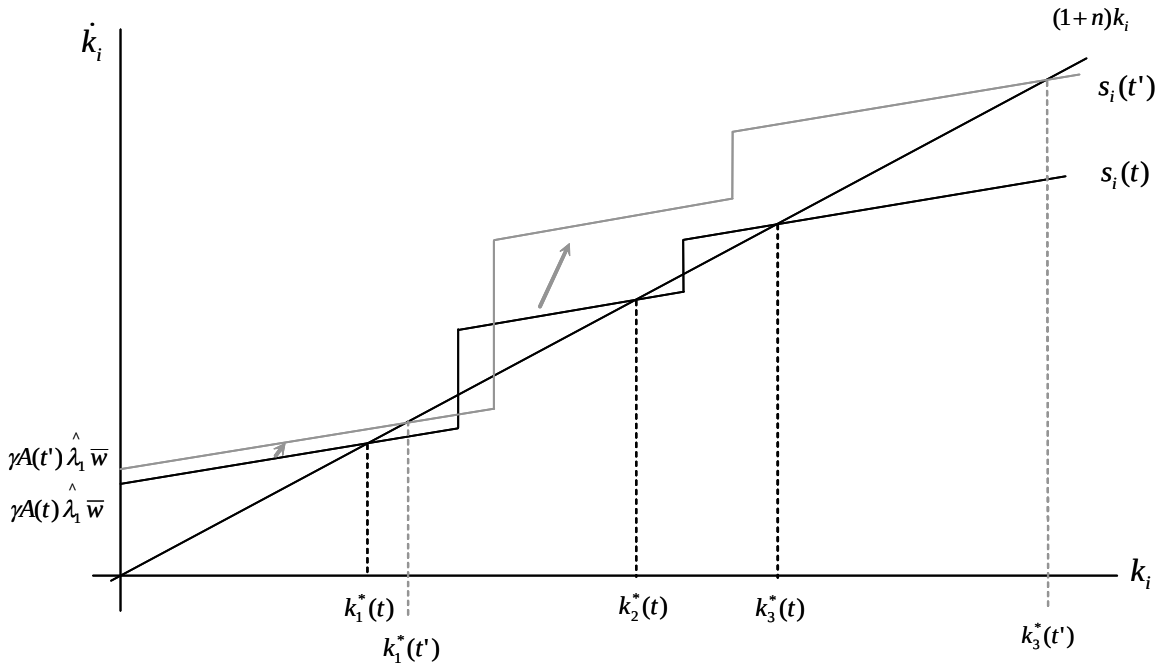

Figure 3: Evolution of the individual law of motion with long-term inequality

onto a permanently higher production path.

3.4 The role of initial conditions and level of development

Several models demonstrate how different combinations of initial inequality and levels or growth rates[19] of average capital may determine the type of relationship that holds between output and inequality, and how this relationship evolves over time. Initial conditions may not only determine the number of roots that hold in the long-term but also their levels, in terms of average individual income. In some cases, however, initial conditions may imply that the system does not converge to a steady-state but cycles around it; see e.g. Aghion, Banerjee and Piketty (1999).

In models consistent with the Kuznets literature, for example, a poor country may suffer from too much equality (in poverty) which hampers take-off and traps the economy in long-term poverty. At later stages of development, however, high inequality may hinder growth prospects, especially in the presence of capital market imperfections. See e.g. Perotti (1993), Galor and Tsiddon (1997b), Galor (2000); and also Galor (1996) for a discussion on the role of initial conditions in the neoclassical growth model. In this literature, the distributional feedback from

[19] See e.g. Hassler and Mora (2000), Maoz and Moav (1999). In these models, at higher growth rates, the world changes faster, return to ability becomes more important than return to social background.

aggregate capital accumulation plays an essential role in the development process, allowing the poor to catch up and eventually converge with the rich (add refs).

Other models show how high inequality may prevent rather than promote economic growth in the early stages of development. In the demand-side literature, for example, the poor as a group must reach a critical average income level or represent a minimum level of demand, before investments from rich agents can be successful and the economy take-off; see e.g. Murphy, Shleifer and Vishny (1989). Poor countries may also be more susceptible to instability, resulting from high inequality, than richer countries; see Benhabib and Rustichini (1996). Additionally, initial distributional conditions may imply that output growth oscillates between periods of boom and periods of depression, rather than converge to a high and stable equilibrium point; Aghion, Banerjee and Piketty (1999).

Another common feature of this literature is the assumption of an 'initial' income distribution, which is exogenously given or inherited by history at the start of the analysis. A few papers, however, have tried to explicitly take into account possible sources of the 'initial' inequality level. Labour market characteristics, in particular, have been considered in this context. When different coexisting professions (providing unequal returns) are not perfect substitutes in production, they must be filled in equilibrium for the market to clear. As a result, even if agents are initially identical – in endowments, abilities and tastes – by sorting themselves (maybe using lotteries) between the different occupations, income disparity is created. These different earning groups subsequently define the individuals' social background and opportunities. Because of incomplete credit markets and indivisibilities in human capital investments, this initial inequality will persist with certain dynasties stuck in poverty; see e.g. Bandyopadhyay and Basu (2005), Mookherjee and Ray (2003), (2005), Freeman (1996). Steady-state properties are therefore determined by a mix of capital market imperfections and labour market characteristics, which are sometimes also combined with a given initial level of inequality.

4 Distinguishing between the influence of abilities and parental background

The discussion so far has considered situations where the set of economic contributions that individuals can make to society is constrained by their family background. In practice, indivdual circumstances are likely to reflect the influences of social background as well as of other factors like abilities, effort, rents, government policies or random shocks. At the aggregate level, however, different disequalizing sources may imply different relationships between inequality and growth. An economic system that encourages individual effort and rewards ability should see faster growth associated with higher inequality. In contrast, in a country where individuals' productivity is mostly determined by social background, higher inequality will be associated with a higher proportion of poor but able individuals whose economic potential is lost to society. Several studies take into account the combined effects of abilities or shocks and private endowments as determinants of individuals opportunities and economic growth; see e.g. Loury (1981), Scheinkman and Weiss (1986), or Zilcha (2003). Other papers focus specifically on the allocation of talents in production to explain the evolution of economic growth (see e.g. Fershtman, Murphy and Weiss 1996; Jiang, Wang, Wu 2010)

Consider the model described in section 3.3 extended to include two levels of individual abilities, $\theta_h = 0, 1$. A random constant share of the population is endowed with high ability, $\theta_h = 1$, the rest of the population is born without any specific ability advantage, $\theta_h = 0$. People with high abilities are uniformly spread across the wealth distribution. Abilities affect workers' productivity in two different ways. First, high ability individuals find it easier to acquire human capital, which effectively reduces their financial cost of education, $e_{j,h}(t) = e_j(t) - \pi\theta_h$, where $h = 0, 1$. Another interpretation of this effect could be that high ability is a form of human capital. Second, abilities are considered to increase the innovative potential of highly educated workers. This potential can only be realized at the cost of increased individual effort, $C(d_i)$, where $C(d_i)$ represents the utility cost of effort and $d_i = 0, 1$ the effort supplied. The productivity of highly educated workers is now defined as $\lambda_{3,h} = \lambda_3 + \omega\theta_h d_i$, where $\omega > 0$. Provided their effort is sufficiently rewarded on the labour market, highly educated able individuals will find it beneficial to work harder. Their indirect impact on the rate of technological progress $\widehat{g}_f(t)$ is considered below.

The stock of technology enhanced human capital is defined as:

$$A\left(t\right)H\left(t\right)=\left(A_{u}\left(t\right)H_{1}\left(t\right)+A_{s}\left(t\right)H_{2}\left(t\right)+A_{s}\left(t\right)H_{3}\left(t\right)\right) \tag{16}$$

where the stock human capital of each education sub-group, $H_i\left(t\right)=\lambda_i N_i\left(t\right), i\in\left(1,2,3\right)$, combines with the technology of the associated skill class: $A_u\left(t\right)$ for unskilled and $A_s\left(t\right)$ for skilled workers. Low and middle educated workers receive wages defined as $w_1(t)=A_u(t)\lambda_1\overline{w}$ and $w_2(t)=A_s(t)\lambda_2\overline{w}$. People who can afford the highest level of investment in education get $w_{3,h}(t)=A_s(t)\lambda_{3,h}\overline{w}$, which varies with individual ability level, h.

Assuming that the cost of education is sufficiently low to ensure that people choose the highest level of investment that they can afford, and subject to the constraint $k_{j,h}(t)-e_{j,h}(t)\geq 0$, the rate of capital accumulation becomes:

$$\dot{k_{j,h}}(t)=\gamma(A_f(t)\lambda_{j,h}\overline{w}+(1+\overline{r})(k_j(t)-e_{j,h}(t))-(1+n)k_j(t) \tag{17}$$

where $j\in(1,2,3)$ captures the 3 levels of education, f represents the un/skilled groups ($f=u$ when $j=1$,and $f=s$ otherwise), and h distinguishes between low ($h=0$) and high ($h=1$) ability individuals. From equation 17, it can be shown that, within the basin of attraction of each group, the low, middle and highly educated workers will converge to levels of capital holdings defined by $k^*_{j,h}(t)=\frac{\gamma(A_f(t)\lambda_{j,h}\overline{w}-(1+\overline{r})e_{j,h}(t))}{1+n-\gamma(1+\overline{r})}$. This convergence scenario is represented in Figure 4.

Given the effect of abilities on the individual cost of education, there will be a higher/lower concentration of able workers in the high/low educational groups, at least in the short term. Wealth and income inequalities are also higher due to the higher reward to abilities at the top end of the distribution. Additionally, (hard working) talented individuals are now assumed to be the most productive innovators in the economy. Let's define the rate of technological progress as

$$\widehat{g}_f\left(t\right)=\int_0^t\left(\left(\beta a_3\left(z\right)\left(1+a_H\left(z\right)\right)\right)^{\eta}+b\right)\Phi_f\left(z\right)dz;\ f\in\left(u,s\right)$$

where $a_H(t)$ is the share of talented workers in the top education group. A concentration of able individuals in

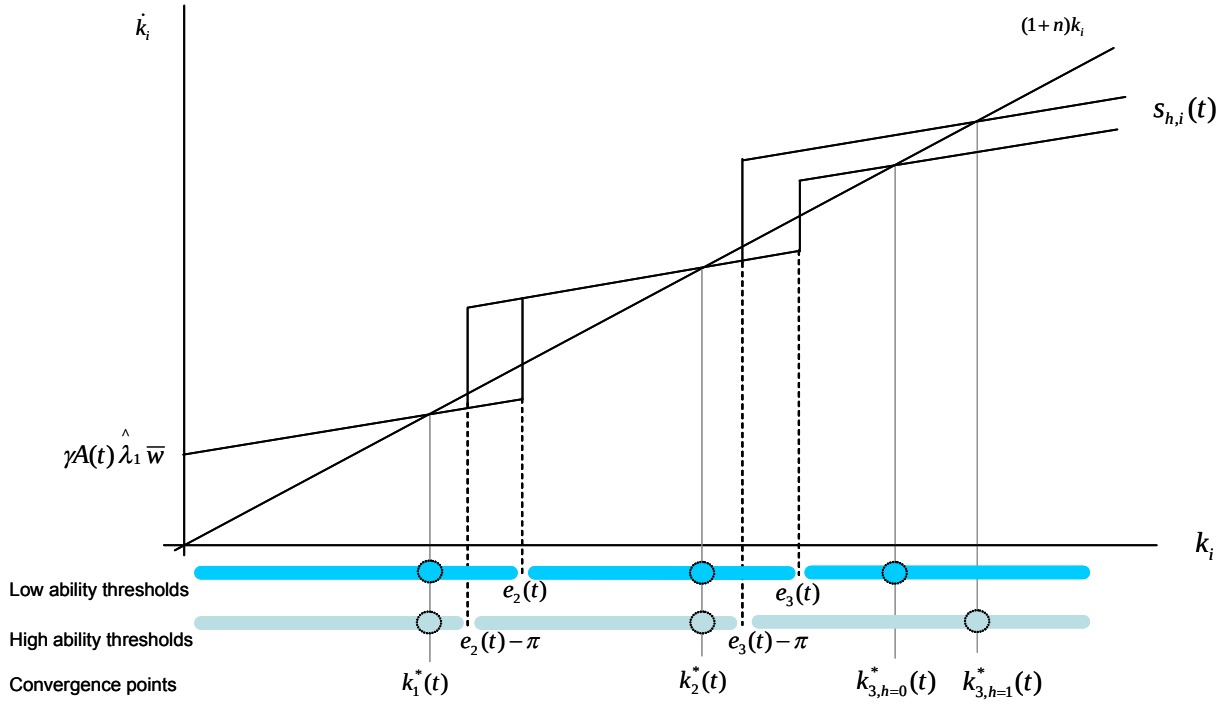

Figure 4: Convergence and divergence points with abilities

the top education group will therefore be conducive to faster technological progress[20]. In the extreme case where the highly educated sub-group is only conmposed of low ability indiviudals, the rate of technological progress will be similar to $g_f(t)$ in section 3.3.

This last variation of the model has illustrated a situation where inequality may simultaneouly be associated with higher and lower growth, during transition and in steady-state. On the one hand, (income) inequality fosters growth by ensuring a higher reward to effort and abilities, and thereby encouraging technological progress. On the other hand, (wealth) inequality has an adverse effect on output by preventing the able poor individuals, and the poor more generally to fully contribute to economic growth. Overall, the distribution of abilities together with the distribution of individual wealth will determine the evolution and convergence properties of the income and wealth distributions as well as the effect of inequality on growth.

[20] see e.g. Galor and Tsiddon (1997), Hassler and Mora (2000) for papers that look at innovation in the context of abilities.

5 Implications for the effect of inequality

The non-linearities introduced in growth models to study the inter-relationships between inequality and growth fall in three main categories:

- Non-convexities in production, with or without the influence of abilities. These assumptions usually imply that the wealthy are more productive than the poor.
- Non-homothetic preferences, where individuals' decisions are based on their relative economic circumstances or on the behavior of others in the distribution. The effect of inequality in this case depends on whether the pursuit of status encourages or reduces individual savings, investment in education, (conspicuous) consumption or the amount of labour supplied. These mechanisms are reviewed in Part II.
- Externality effects via socio-economic instability and policy variables. These mechanisms usually imply a negative effect of inequality on growth. Perceptions of inequality regarding its source and level play in important role in these mechanisms

Nevertheless, regardless of the specific channel considered, studies that imply a positive effect of inequality are also based on a combination of the following premises: individuals make their decisions in an economic system that rewards effort and abilities; in the presence of credit constraints, the rich may be more productive; even though wealth people may drive economic growth in the short term (especially in the presence of credit constraints) their activities are essential for the prosperity of rest of the economy. Mechanisms commonly considered in this context include: wealth accumulation and entrepreneurship, higher effort to escape poverty, higher incentives to acquire education or innovate, and trickle down through various channels. These studies usually imply an adverse effect of government intervention through distorted incentives.

In contrast, studies that report a negative effect of inequality on growth argue that social background at the bottom of the distribution and rents at the top of the distribution are important determinants of individual income. Also suggested is how the stability of economic and political system may be weakened in the presence of large economic disparities, which in turn increases uncertainty over macroeconomic policies (Woo 2005) or

property rights (Sonin 2002, etc.), generally reduces the efficiency of government allocation of funding (lobbying groups) and distorts incentives. Redistribution is seen as a way to help restore efficiency in the economic system.

At a more fundamental level, therefore, the debate on the effect of inequality on growth concerns several aspects of the economic environment. First, what is the nature of inequality that is observed in the economy, that is whether to what extent does inequality reflect a functioning incentive system. Second, different sides of the argument have different views regarding the extent to which higher inequality in the short term eventually lifts all boats. Third, the question arises as to how far the distance between rich and poor creates social tensions, which contribute to an inefficient and unstable socio-economic or policy environment. The importance of the latter set of mechanisms also depends on other factors, like the strength of a country's institutions, the level of financial development or economic development of a country and are discussed in Part (II)

Part II

Common mechanisms through which inequality affects growth

- Sections 6 to 8 survey mechanisms largely based on non-convexities in production and return to abilities
- Section 9 looks at channels where inequality affects growth in the presence of non-homothetic preferences. These first sections, up to section 9, generally report mechanisms that concern the individual (or firms) contributions to aggregate production.
- Section 10 looks at channels where inequality influences the stability and efficiency of the economic, social and political environment.

6 Wealth, entrepreneurship, abilities and rent-seeking

Mechanisms that have been explored, include:

- wealthier individuals have a higher savings rate, which is beneficial for economic growth
- higher individual wealth reflects (return to) higher effort, ability and risk taking
- In the presence of non-convexities and imperfect capital markets, private wealth helps entrepreneurship and growth, and entrepreneurship contributes to raising private wealth and growth
- An advantage of private wealth over individual abilities in becoming entrepreneur/ innovator might be counter-productive in terms of growth
- the economy at large (and growth) may benefit from rising wealth concentration associated with entrepreneurship through trickle down
- private wealth gives access to rent-seeking opportunities which, when more lucrative than productive activities, lead to lower growth - impact on the entire economy

7 Poverty and the role of social-background in production

People located at the lower end of the income distribution may be too poor to contribute to the accumulation process efficiently. If these households and their descendants are unable to escape from poverty as the economy grows, the country may end up stuck at a sub-optimal production level with persistent inequality. Several factors have been explored to explain the lower productivity associated with poverty, and its persistence. Different mechanisms may interact and reinforce each other (empirically and theoretically), within and between generations – e.g. high fertility rates and low human capital (e.g. de la Croix and Doepke, 2003; Docquier 2004, Moav, 2005), low health and a low educational attainments (e.g. Galor and Mayer (2002), Chakraborty and Das, 2005), or low education and high crime rates.

7.1 Indivisibilities in investment

In the presence of imperfect credit (or insurance) markets and non-convexities in production, households with a low initial wealth do not have access to higher (riskier) return investments and remain trapped in poverty. Studies in this literature have looked in particular at the role of forgone opportunities of investment in human capital. By

raising labour productivity, education could ensure a wage premium in later life. Instead, poverty implies that individuals remain unskilled at the minimum subsistence wage. With intergenerational-transfers like bequests, initial conditions also determine the convergence properties of the model, i.e. the size of each class, the average income and education level in the economy, and possibly the social organization or occupational structure of the society in equilibrium. See e.g. Scheinkman and Weiss (1986), Galor and Zeira (1993), Banerjee and Newman (1993), Torvik 1993; Freeman (1996); de Gregorio (1996); Fishman and Simhon (2002), Ghatak and Jiang (2002), Moav (2002), de Gregorio and Kim 2000, Mookherjee and Ray (2002; 2003), Chakraborty and Das (2005), Reiss and Weinert (2005), Mejia and St-Pierre (2007).

While some empirical analyses report an adverse relation between average educational levels and inequality (e.g. Hwang and Jung 2005), evidence in support of this argument could also come from a different angle. According to this mechanism, market imperfections make it difficult for the poor to escape poverty. An easing of credit constraints should therefore reduce the impact of inequality on investment and on growth. Beck, Dermirgüç-Kunt and Levine (2007) find that financial development disproportionately favours the poor and therefore contributes to reducing inequality. A finding echoed in the study of Clarke, Xu and Zou (2006). Several studies also find negative correlation between school enrolment rates and imperfect capital markets or borrowing constraints (e.g. De Gregorio 1996 Flug, Spilimbergo and Wachtenheim 1998). Nevertheless, based on micro-data, some analyses indicate a positive correlation between parental income or educational level and the child's education (e.g. Acemoglu and Pischke 2001, Johnson 2002), pointing to the enduring role of poverty in human capital acquisition, even in the presence of developed financial markets. This correlation, however, could also reflect some degree of correlation of abilities between generations; Shea (2000), for example, finds a positive effect of parental income on children's human capital only in families where the father has less than 12 years of schooling.

7.2 Return to effort and labor supply

The expected rate of return to effort or labor supply will in turn determine how much time and effort individuals allocate on the labor market. Several papers have shown that individuals at the bottom end of the distribution are likely to receive a lower rate of return to their effort, and end up being less productive as a result.

Suppose that indivisibilities in investment mean that for small wealth holdings borrowing is required. Furthermore, the gross return to individuals' investment depends on their unobservable level of effort. Poor people (who need to borrow in order to invest) see a share of the return to their effort appropriated by the lender, as debt repayment. The charge levied by the lender reduces the incentives to supply effort, resulting in a lower probability of success of poor individuals. Lenders anticipate this outcome and thus prefer not lend, or lend at the higher interest rate, to poor agents – a situation of credit rationing due to moral hazard; (e.g. Aghion and Howitt 1998; Aghion and Bolton 1997, Piketty 1997). . Nevertheless, if owing to hard work, poor individuals are able to bypass the non-linearity associated credit market imperfections and get a high rate of return to their investment, poverty could be linked to higher effort; see e.g. Ghatak, Morelli and Sjöström (2001). The debate at the core of this literature therefore concerns the return to effort function, and whether, as a result, hard work would allow poor people to escape the poverty trap.

Similar concerns regarding poverty and productivity arise in the labor literature. Agents retain control over their labor supply by adjusting their effort level. Several papers explain how shirking from low paid workers can then be prevented by a wage premium. A higher wage may reduce workers' feelings of frustration and unfairness, (Akerlof and Yellen, 1990), or increase the cost of being caught and fired (Shapiro and Stiglitz, 1984) and increase labor productivity. The empirical analysis in Goldsmith, Veum and Darity (2000), with data from the US National Longitudinal Survey of Youth, suggests that receiving an efficiency wage premium encourages effort, and that a higher effort supplied increases the wage received.

7.3 Crime

For poor people, low wages or high unemployment may imply that the net gain from illegal activities may be higher than an income from the legal sector[21]. Additionally, as the rich get richer, the expected return to crimes like burglary increase; Chiu and Madden (1998). A higher crime rate is likely to reduce the return to legal activities and provides further incentives for individuals to seek illegal income, with an adverse effect on investment and individual human capital accumulation; (e.g. Josten 2003; Burdett, Lagos and Wright 2003). These studies suggest a mix of policing, labour reforms and other poverty reduction policies to tackle crime rates.

[21] Note that the crime commited by the rich, usually refered to as rent-seeking in this literature, is included in section ...

With data for US metropolitan counties, Kelly (2000) reports that property crime is strongly correlated with poverty, but not with inequality. In contrast, inequality explains violent crime, which has no financial return. The interpretation of these findings is that property crime is consistent with the low opportunity cost of the poor, while violent crime is probably more related to frustration theories. With data for England and Wales, Machin and Meghir (2004) also report a strong negative relation between changes in wages at the bottom end of the distribution and property crime. Further evidence of a significant positive effect of inequality on property crime (and violent victimization) is reported from studies using data at the individual, regional or county level; e.g. Fajnzylber, Lederman and Loayza (2002, 2002b), Van Wilsem, de Graaf and Wittebrood (2003). Another common finding in these empirical studies is the (regional) inertia of crime.

7.4 Health

Individuals' health is shown to depend on their income level, and/or may be affected by the level of inequality in the region in which they live. A low income may imply poor health due to the limited access to health resources it provides.[22] Better nutrition in early age also implies better cognitive abilities; see Chakraborty and Das (2005) for more discussion. The other factors mentioned are usually associated with poverty directly, or with living in a poor area: e.g. reduced access to education, higher crime rates and unemployment. Moreover, relative disparities may damage social cohesion at the societal or neighborhood level with an adverse impact on health prospects. Although it is usually agreed that inequality has a detrimental influence on social capital (see section 4.2.1), the role of social capital on health remains controversial; see Kunitz (2004). Another pathway from inequality to health works through social comparisons with peers or to a target set by social norms. The psychological stress caused by social comparison has an adverse effect on health and self-rated health; (e.g. Singh-Manoux, Adler and Marmot 2003; Yngwe et al. 2003).

7.5 Fertility rates

Poor households (with low wages and low education) not only tend to have a higher fertility rate, but also provide a lower level of education to each child. Assuming the wage rate is increasing with the level of education, higher

[22] The reader is referred to Deaton (2003) for a detailed review of this literature.

fertility rates reinforces the poverty trap situation of poor households. The fertility mechanism, which has mostly been discussed in the context of poor countries , suggests that high fertility may result from the low opportunity cost of children, the child's prospective labor earnings, and the lack of old-age insurance to a poor household in the country.

At the macro level, high fertility rates tend to dilute the average level of human capital and increase the relative supply of unskilled to skilled workers, or of labour to capital. Uneducated workers' wages are pressured downwards and high inequality with poverty and high fertility rates are perpetuated; (e.g. Morand 1999; Fernandez and Rogerson 2001; Kremer and Chen 2002; de la Croix and Doepke 2003; Moav 2005). Education subsidies can provide a way out of this poverty trap by raising poor households' incomes as well as the opportunity cost of children. Another option may be to raise the cost of children for poor households directly, e.g. by regulating the child labour market; Fan (2004), Moav (2005). The strong negative relation between inequality and growth via fertility rates appears in many empirical studies; (e.g. Barro 2000; De la Croix and Doepke 2003; Kremer and Chen 2002).

8 Innovation

9 Social comparison and demand for status

By considering non-homothetic preferences, a number of studies have also explored how individuals' behavior might be influenced by their (perceived) relative income or ranking in a population, or linked to the behavior of other people in the same or different parts of the distribution[23]. These studies suggest that relative financial situations may affect economic behaviors, either through the pursuit of a rank as means of attaining status or respect of peers and the greater utility it provides, or through the access that a higher status confers to non-market goods, such as invitations to exclusive clubs and improved mating prospects (e.g. Cole, Mailath and Postlewaite 1992; Corneo and Jeanne 1998, 1999).

[23]Not all papers mentioned in this section look at the role of inequality in the growth process. Some papers look at the role of inequality in the pursuit of status, and how the pursuit of status in turn affects individuals' decisions like the labour supply, savings or investment in education.

Status is commonly proxied by one's wealth, income, or consumption relative to a target[24] (e.g. Harbaugh 1996; Futagami and Shibata 1998; Knell 1999; Stark 2006); one's rank in the wealth distribution (e.g. Cole, Mailath and Postlewaite, 1992; Corneo and Jeanne, 1999, 2001); or by belonging to a certain occupational group (Fershtman, Murphy and Weiss 1996; Mani and Mullin 2004; Ferrer 2005).[25] When income (or wealth) is not observable, however, individuals need to signal their type by purchasing a luxury consumption bundle, for example (e.g. Bagwell and Bernheim 1996; Rauscher 1997; Corneo and Jeanne 1998; Ireland 1998).

Status-seeking alters a whole range of behaviors including savings, labour supply, consumption, and investment in education.[26] The resulting impact on growth depends on the direction of the distortions, i.e. whether status-seeking implies increased savings or increased consumption. In the lower part of the distribution, distortions stem from the fact that poorer individuals attempt to mimic the rich, while at the top end the rich strive to distance themselves from the lower classes. In this context inequality not only affects the relative location of the individual within the distribution, but also their relative distance to any comparison target.

Behavioral response to status-seeking

Many studies have looked at the impact of social comparison on increased consumption, with a negative implication for growth through reduced savings (e.g. Duesenberry 1962; Ireland 1998; Knell 1999). Duesenberry (1962), for example, argues that when consumption preferences are inter-related, the consumption habits of the poor are influenced by the behaviour of the wealthy, and therefore what defines the economy's acceptable standard of living is continually driven up by exposition to the expensive and superior goods consumed by the rich.[27] This theory of consumption could also explain why, even in rich countries, poor people do not save substantially. A sufficient level of savings – to initiate the growth process – might then be more difficult to secure in poor countries where its population is exposed to consumption patterns of rich countries, and highlights the role of international inequality as a factor influencing growth at the national level (Nurkse, 1953).

[24] The target could be an absolute, relative (e.g. to the population mean, or to the situation of individuals in another part of the distribution), or perceived standard.

[25] In models where status is demanded for its intrinsic value, status enters the utility function as a ratio or difference of the actual to desired wealth or consumption level. Another approach is to include the individuals' rank directly into the utility function.

[26] Fertility decisions are another aspect considered to be influenced by social comparison (see Macunovich 1998) as well as unsustainable resources depletion or pollution (e.g. Ng and Wang 1993; Howarth 1996; Mainwaring 2001).

[27] Note that when 'status' is defined as a minimum standard of living to be reached, only the behaviour of poor agents is distorted, which is the reverse of the conspicuous consumption argument where it is the rich who engage in wasteful consumption to signal their type

In other studies, the pursuit of a higher rank in the wealth distribution or of status (defined in terms of relative wealth or consumption [28]) induces people to save more than they would have chosen otherwise (e.g. Cole, Mailath and Postlewaite 1992; Harbaugh 1996; Cole, Mailath and Postlewaite 1998; Corneo and Jeanne 1999, 2001; Van Long and Shimomura 2004; Stark 2006) and boosts the growth rate up to a potentially sub-optimal welfare level. Social comparison is also found to influence labour decisions, by inducing people to work harder in order to get a higher income (Ireland 1998), or because they do not want to be seen working less than their neighbors (Pingle and Mitchell 2002). As well, the pursuit of status can encourage people to invest in education if it implies a higher status in later life (e.g. Fershtman, Murphy and Weiss 1996; Ferrer 2005). The ensuing impact on growth will depend on the ability agents undertaking education and crowding out effects.

The consequences of a change in the income distribution

Since most studies have looked at the effect of status on savings or consumption, inequality usually affects growth through the quantity and quality of investments that are undertaken. The distribution of economic resources, however, may enter the social comparison-growth picture in two ways. First, financial disparities can reinforce or weaken the demand for status. Second, disparities may increase or decrease the distortions caused by status-seeking.

While many papers report a detrimental effect of inequality on growth in the presence of social comparison, the mechanisms considered differ considerably between studies. For example, inequality could discourage the demand for status but status-seeking normally boosts investment (Corneo and Jeanne 2001), or inequality can encourage the demand for status but status-seeking decreases growth by an inefficient allocation of talents in society (Fershtman, Murphy and Weiss 1996). In both cases inequality is detrimental to growth via its effect on the demand for status, but for different reasons.

Similarly, when an increase in inequality raises the distance to the income target, the outcome for growth depends on the model's assumption. In Knell (1999) or Duesenberry (1962), where status seeking has an adverse effect on investment, inequality worsens this effect by inducing more consumption in the population. On the other

[28] When patient or risk averse individuals may save more than they otherwise would in the current period, to prevent a fall in their relative consumption in future periods; see e.g. Harbaugh (1996).

hand, in Futagami and Shibata (1998), as people try to meet a wealth target, an increase in the distance to the target means poor individuals save more than they would have otherwise. Nevertheless, the distortions caused by status-seeking may disappear altogether as inequality increases further. That is, at high levels of inequality the rat-race may lose its potential benefit for everybody. People at the bottom end of the distribution give up trying to catch up with the rich, and at the top end the need to signal one's status is reduced (Cole, Mailath and Postlewaite 1992; Corneo and Jeanne 1999, 2001; Hopkins and Kornienko 2006); see Stark (2006) for a reverse argument.

These considerations also imply a welfare-enhancing role for government regulations. Taxation may be a useful instrument to limit the negative externalities associated with status-seeking (e.g. Ireland 1998). Taxation, however, may also increase the attractiveness of certain good by raising their prices. Furthermore, status goods might follow fashion and change quickly, making it difficult to keep up to date with fiscal policy, Ireland (1998). Ireland, for example, argues for an income or expenditure tax and redistribution that would not only decrease consumption but induce a reduction in the otherwise over-supply of labour.

10 Stability and efficiency of the economic, social and political environment

Inequality affects how people collaborate and cooperate to share economic resources in the economy. This is turn affects the degree of uncertainty in the economy, the level of social tensions, how economic resources are allocated between productive and non-productive uses, and therefore economic growth. This literature also emphasizes the role people's perceptions of inequality.

10.1 Trust and social capital

10.2 Taxation and redistribution

10.3 Good governance and the quality of institutions

10.4 Polarization and social conflict

When disparities are high, the cost of cooperation between classes might outweigh the benefits of a deviation to appropriate a larger share of the economic pie. Both ends of the distribution might be tempted to expropriate the opposing end. The resulting political instability, social unrest and reduced protection of property rights increase production costs – e.g. transportation costs, spending on security for staff and factories. As argued by Collier and Hoe- er (2002), if wages are constrained at the bottom, the full cost of insecurity will be borne by capital, with direct implications for aggregate accumulation.

In certain cases, the rich may agree to a certain degree of redistribution – e.g. by funding public education – to ease the expropriation pressures off their wealth, and indirectly pave the way to democracy and prosperity, (e.g. Bourguignon and Verdier 2000; Acemoglu and Pischke 2001 Robinson 2000, Galor, Moav and Vollrath 2006). In other cases, social tension may degenerate into revolt, violence and civil war; see Bénabou (1996), Benhabib and Rustichini (1996), Esteban and Ray (1999).

Empirical evidence for the complete link between inequality, political instability and growth, appears in numerous studies (e.g. Alesina and Perotti 1996, Easterly 2001). However, looking at a sample of 161 countries over eight 5-year periods between 1960 and 1999, Collier and Hoe- er (2002) find that inequality and social divisions are not significantly related the probability of a large-scale civil conflict outbreak. They argue that "this is consistent with the view that groups with grievances are sufficiently common that differences in the supply of such groups between societies are not an important influence on the risk of conflict initiation", p. 17. Instead, other factors like growth and initial average income as well as geographic and historical factors (peace duration) appeared to play a significant role in their study.

10.5 Policy volatility, macroeconomic volatility, and shock management

Social polarization can lead to a policy environment where shifts in policies like property protection policies, become more likely, increasing economic uncertainty, Keefer and Knack (2002). Woo (2003, 2005) explores the situation when social polarization (due to ethnic division or income inequality) leads to policy coordination failure. Coordination failure happens when different ministers have very different objective functions (e.g. left and right wing). In that case, each policymaker pursues an individually rather than collectively rational policy, leading to an overspending of current government resources, increased deficit and procyclicality of fiscal policies. This volatile fiscal path is found to reduce growth in the short-term as well as at the steady state.

Many studies also show how higher income or wealth inequality levels may be associated with greater inflation, even in democratic countries. Two lines of arguments have been suggested. First, a greater demand for redistribution, associated with higher inequality in democratic countries, may induce governments to rely more heavily on the inflation tax to finance it. How inequality then translates into inflation also depends on the strength of the country's institutions, like the independence of the central bank. In non-democratic countries, instead, higher inflation may result from the elite's benefit from seigniorage. See e.g. Dolmas et al. (2000), Desai et al. (2003). The second argument states that countries with a greater distance between their rich and poor populations are more likely to implement inflation tax as a redistributive policy than rely on other non-inflationary policies – although the relation may be non-monotonic. See e.g. Bhattacharya et al. (2005), Albanesi (2006).

Credit constraints and inequality may generate short-run macroeconomic fluctuations by inducing a mismatch between individuals who save and those who invest in a high-yield return asset (e.g. by starting a firm or setting a factory); Aghion, Banerjee and Piketty (1999). In their model, as long as demand for funds from borrowers-investors exceeds the savings capacity of the economy, the interest rate and debt burden are low, the debt capacity of investors and the economy is growing, up to the point where planned investments exceed savings available. Then the interest rate rises, the debt burden increases, investment collapses and the cycle starts again. Policies that improve access to credit, or reduce the separation between savers and investor, can pull the economy out of the cycle and onto a superior growth path, and in permanent boom.

An unequal distribution of resources is also found to amplify external economic shocks, by weakening the 'insti-

tutions of conflict management' and therefore the ability of a country to deal with economic shocks, like the oil shocks in the 1970s; Rodrik (1999). Anbarci et al. (2005) develop a similar argument in the context of natural disasters, by investigating the death toll of large earthquakes worldwide between 1960-2002. The paper suggests that inequality undermines the collective action required to mitigate the impact of earthquakes, by failing to enforce construction norms for example. Instead, the wealthy self-insure and the poor are left more vulnerable.

10.6 Sustainable use of resources and cost on the environment

The correlation between inequality and the level of pollution produced within a country may result from an aggregation or externality effect . Assuming the level of pollution produced at the individual level is a concave or inverted-U shape function with income – i.e. rich agents have access to (or consume) cleaner technologies (goods) – the rate of pollution of a country will be lower at higher levels of inequality. Equality may instead trap the country in poverty and environmental degradation. This argument has also been used to explain the varying levels of environmental damage between rich and poor countries and gives an important role to the growth process as a result; (e.g. Ravallion et al. 2000; Heerink et al. 2001; Ikefuji and Hori 2007) The externality effect works through a median voter mechanism, which determines the level of environmental protection. High inequality usually implies a lower level of protection chosen (for different reasons in different models), and more pollution; e.g. Magnani (2000); Eriksson and Persson (2003); McAusland (2003). The impact of inequality on growth via this mechanism is likely to be ambiguous. Most studies, however, seem to agree that the aggregation effect reflects the situation in poor countries and that the externality story fits the data from rich (democratic) countries better.

11 Mitigating factors

Several factors have been suggested to influence the relative importance of alternative mechanisms, in different economic contexts. These include:

- the strength and quality of the country's institutions
- the country's political system
- the level of development of the country and its distance to the technological frontier

- the level of inequality in the country
- the level of development of the financial sector and ease of access to credit

12 Conclusion

13 References

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