CRISEI
Centro di Ricerca Interdipartimentale in Sviluppo Economico e Istituzioni

Discussion Paper Series

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Discussion Paper
No. 03
Giugno 2012

ISSN: 2280-9767

CRISEI - Università di Napoli - Parthenope

Università degli Studi di Napoli- Parthenope

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Income Distribution and Growth: A Critical Survey

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Abstract

This paper reviews a large bulk of the theoretical literature on income distribution and growth with a fixed open window on individual poverty. Although there is yet no unambiguous consensus on how, whether and the extent to which income distribution does affect economic growth, and vice versa, we start from the classical and the neoclassical literature, following which inequality has positive or yet no effects on economic growth, while economic growth stimulates convergence of incomes to a unique invariant distribution. This framework is integrated with the insights of the new growth theories that conversely maintain a striking role for income distribution, by relaxing some of the important assumptions behind classical and neoclassical models; namely, representative agents and homogeneity in skills, endowments and preference. Finally, the unified growth theory approach is reviewed in the attempt to reconcile both the views on the linkages between economic growth and personal income distribution.

Despite the fact that capitalism is the more dynamic economic system, its initial emergence does depend on the existence of a population of dispossessed whose best choice is to work for a wage.
(Banerjee and Newman 1993)

1 Introduction

The relationship between growth, poverty and inequality has long history in the economic literature, perhaps longer than any other issues. The most striking question in this debate is likely to seem whether there exists a *systematic* relation between growth and distribution and whether this link can affect in some way the poverty reduction strategies; as Bourguignon (2003) points efficiently out *"the real challenge to establishing a development strategy for reducing poverty lies in the interactions between distribution and growth, and not in the relationship between poverty and growth on one hand, and poverty and inequality on the other, which are essentially arithmetic"*. The growth effects on poverty must be analysed joint to the distributional changes accompanying the same growth processes. Inequality could either dampen or foster poverty reduction in several ways. To the extent that inequality fosters economic growth, it could greatly contribute to poverty reduction, whether it is acknowledged the positive role of economic growth on poverty changes. On the other side, starting from the Bhagwati's "immiserizing growth"[1] (1958) idea, part of the literature have recognized the possibility that growth happenings could be not pro-poor, but cause of increasing poverty; this last eventuality has been more deeply formalised under the idea that growth could produce increasing inequality. Several other arguments are furnished, on the contrary, to maintain the non-distortionary role of economic growth in terms of income distribution. Yet, the links between the two phenomena have been analysed under the reverse causality of the inequality effects on economic growth; while part of the literature maintains the positive effect that greater inequality has on fostering economic growth, an other one strongly claims its negative role.

This paper surveys the broad literature on growth and inequality, with a fixed open window on poverty. As stated above, growth and income distribution jointly contribute in determining it as well as they simultaneously influence each other. Often the theoretical literature separately focuses on the effects of growth on inequality and, reversely, on the effects of the latter on the former to isolate the determinants of those processes. However, there is a broad consensus that growth and income distribution simultaneously influence

[1] For sake of honesty, long time after that research the same author expressed his disappointment for the interpretation of part the economic literature on his work; with that work he would not have established new reasons for why economic growth might be absolutely not beneficial for poverty, idea which he does not support. Otherwise, he has stressed that he would interpret that research as a mathematical experiment, to point out, more importantly, that everything can be said by using mathematics, but not everything has an economic ground.

each other. Albeit their connection, growth and inequality are different concepts, at least as much as the former and poverty. Growth happenings do refer to structural processes, and the transformations due to these; growth theory asks what happens, both absolutely and relatively, to factors of production, consumption, aggregate income, technology and so forth, during the development of economies. Income distribution and poverty do directly refer to persons. This difference will be show to be hugely relevant in the evolution of theoretical literature.

The subject of income distribution has in the past been long marginalised and, as Atkinson (1997) refers to, Dalton (1920) was already concerned of these difficulties when he stressed:

> *"While studying economics at Cambridge in 1909-10, I became specially interested in those [parts] which set out to discuss the distribution of income. I gradually noticed, however, that most "theories of distribution" were almost wholly concerned with distribution as between "factors of production". Distribution as between persons, a problem of more direct and obvious interest, was either left out of the textbooks altogether, or treated so briefly, as to suggest that it raised no question, which could not be answered either by generalisations about the factors of production, or by plodding statistical investigations, which professors of economic theory were content to leave to lesser men."* (Dalton, 1920 as reported in Atkinson, 1997)

Despite its prediction, the neoclassical growth theory opened the door to the possibility that endogenous factors not taken into account in previous formulations may help explain why higher growth happenings may be followed or may produce increasing inequality.
Investment indivisibilities, or more broadly non-convexities in the production function, have been introduced to explain the occurrence of poverty traps, due, for instance, to threshold effects. Further, relaxing the assumption of the representative agent as well as the competitive structure, while allowing heterogeneity in endowments or preference, yields interesting results in terms of both multiple equilibria and individual effects.

The first attempt to explicitly introduce income distribution analysis in the neoclassical setting, by integrating macroeconomic and growth theories of factors of production and consumption with microeconomic theories of income and wealth distribution and accumulation is due to Stiglitz (1969)[2]. It is shown that different assumptions about representative agent, saving functions, and agents homogeneity, in labour skills and assets, lead to different conclusions for convergence. Under particular hypothesis and exploiting old results, Stiglitz proved that in the absence of intrinsic differences between people, of imperfections in the capital market, and of stochastic elements, the distribution converges to equality. Convergence to long-run equality of wealth is guaranteed by the steady state condition that the rate of return is less than the rate of growth.

[2] See Appendix 1.A for a detailed sketch of the model.

In the case of linear saving function, constant reproduction rate, homogeneous labour, and equal division of wealth, if the balanced growth path is stable, it is shown that all wealth and income is asymptotically evenly distributed, with the possible exception in the case of negative savings at zero income.

If, instead, income and wealth are initially unequally distributed, some considerations need. Let consider two different income groups, a poor and rich one; two equilibria, an upper and lower one, are possible. If the economy asymptotically converges to the upper globally stable equilibrium in the long-run, there must be an equalitarian distribution of wealth, since the law of diminishing returns sets in, ensuring that the per capita wealth of the poorer groups grows faster than that of the richer groups. This is the standard case of economies on balanced growth path. On the other side, at the lower unstable equilibrium, those groups with initial per capita wealth less than the equilibrium will grow continually poorer, while those groups with initial per capita wealth greater than the equilibrium will grow continually richer. In this latter case, small perturbations on the poorer group do lead towards a unique steady state equilibrium, in which wealth and income are evenly distributed, when it is assumed that the perturbations go in the right direction[3].

So, "*…although the fact that each of the individual groups is in equilibrium implies that the aggregate is in equilibrium, the converse is not true. The aggregate can be in equilibrium while the distribution of wealth is changing*" (Stiglitz, 1969).

The basic conclusions of long-run convergence of wealth distribution toward a globally stable steady state are preserved in presence of non-linear, but concave saving function as well as in the case of savings as function of income and wealth and, finally, in the classical saving function case, where different proportion of profits and wage income are saved.

The determinants of inequality are then isolated in the framework of neoclassical theory; namely, heterogeneity in labour skills, class saving behaviour (i.e. convex saving function) or unequal inheritance, in the case consumption decisions are taken maximising over a dynastic utility setting, may tend to two-class equilibrium, leading to sustained inequality[4].

The next sections will proceed as follow: in section 2 the link between income distribution and growth are put forward, while the reverse causation from growth to inequality is taken into account in section 3, after a discussion on the unified growth theory approach. before concluding in section 4.

[3] Stiglitz points out that it would be useless to assume perturbations decreasing the absolute wealth of the poorer group, because out of interest.

[4] See also the more recent discussion in Hoff and Stiglitz (2001) on neoclassical theory of growth and development, in which the departure from the former through non-convexities in consumer behaviour, initial disparities in income and wealth, and market imperfections are analysed in light of poverty issues, exploiting the role the economics of information, the theory of coordination problems, and institutional economics.

2 Inequality to Growth

2.1 Classical and New Theories

Under the Kaldor's hypothesis that the marginal propensity to save of the rich is higher than that of the poor, increasing inequality fosters economic growth, by increasing investments if these are positively related to both saving rate and national GDP.

In a reply to Stiglitz (1969), Bourguignon (1981) shows how non-convex saving functions lead to a two-class equilibrium with persistent inequality despite people being intrinsically identical. When they exist, locally stable unegalitarian stationary distributions are *Pareto superior* to the egalitarian ones. On this ground, inequality in the neoclassical settings is not only the source of higher aggregate income and consumption per capita, but also conducive for higher income and consumption for all the individuals. However, as Bourguignon points out, this result is only consistent when all individuals have a positive wealth, which does set a bound on the likelihood of such arguments in most of the areas or regions of the world.

More insights on both the positive and negative role of concentrated income and wealth distribution on economic growth and development are gained, once the assumption of representative agent, present in the classical and neoclassical literature, is relaxed.

Incentives arguments (Mirless, 1971) have been offered for claiming the benefits of higher inequality, emphasizing hence a potential trade-off between efficiency and equality.

In moral hazard environments, when output depends on an unobservable effort, rewarding (i.e. in terms of wage) agents with a constant return independent from the (observable) output performance will obviously discourage them from investing any effort. Making that return too elastic to the output performance may also generate inefficiency, from an insurance point of view, in case of high uncertainty of the output realization and high degree of risk aversion of agents. This point appears relevant since a large part of the literature considers redistribution to have negative effects on economic growth, through incentives mechanisms. In the case of moral hazard, reverse positions maintain that higher the amount that is needed to borrow, lower the effort provided by the borrower because of its less incentives. Redistribution from the lender to the borrower would then results in positive effects on the effort, stimulating in turn economic growth if that positive effect is much higher than the likely negative effect on the lender incentives. *"Redistribution may sometimes be growth-enhancing as a result of incentive effects only!"* (Aghion and Howitt, 1998, p. 287).

In a model where moral hazard with binding wealth constraints for the borrower is the source of capital market imperfections, Aghion and Bolton (1997) develop a trickle-down mechanism with endogenous interest rate that may explain the emergence of persistent income inequalities. More capital is accumulated in the economy more funds may be available to the poor for investment purposes, that in turn enables them to grow richer. Persistent wealth inequalities arise because imperfections in the capital market do not allow perfect insurance against the risk of such investments. Due to the stochastic nature of their setting (i.e. random returns on investment) and to the endogeneity of the interest rate, the wealth of a single individual does depend on the evolution of the state of the whole economy. Even though the Markov process produced shows non-linear dynamics, they are able to find convergence to a unique invariant distribution. Despite the fact that wealth does trickle-down from the rich to the poor and leads to a unique steady-state distribution of wealth, that mechanism is not sufficient to ensure efficiency in the distribution of resources. They stress the positive effects of redistribution policies, that contribute to accelerates the trickle-down process. One-shot redistributions have only temporary effects, while permanent redistribution policies must be set up in order to permanently improve economic efficiency.

Even in case redistribution is assumed to have negative effect on economic growth, political economy arguments, mainly based on the median voter mechanism[5], have been furnished by the literature (Alesina and Rodrik, 1994; Persson and Tabellini, 1994) to support the negative effect of high inequality. In democratic systems, the extent of inequality can affect taxation through the political mechanism; higher the inequality, greater the amount of voters that would prefer strong redistribution policies, greater the bulk of redistributions. If, as assumed by a body of literature, redistribution is negatively correlated with economic growth more equal societies should grow faster than the more unequal.

Alesina and Rodrik (1994) develop a model with individual heterogeneity in relative endowments of labour and capital as well as in tax preferences. Long run endogenous growth is generated by capital stock expansion, which depends on individuals' saving decisions. The lower the capital income is in relation to labour income for an individual, the higher tax rate he will prefer. Lower inequality in an economy means higher capital for the median voter, and this will result in a lower tax on capital through the electoral system. So the model implies an inverse relationship between income inequality and growth.

In a median voter model, where economic growth is determined by human and physical capital accumulation, incentives to acquire these factors depend on private agents ability to appropriate economic benefits (Persson and Tabellini, 1994). In societies with distributive conflicts it is more likely that the political process leads to the use of transfers as a redistributive mechanism, reducing economic incentives. Even this model implies that greater income inequality is negatively correlated to future economic growth, because it leads to the adoption of policies that do not protect property rights and it does not allow private appropriation of returns to investment.

A different view in this literature is stressed by Saint Paul and Verdier (1993). In a model where public education is provided in a egalitarian way and financed by non-distortionary proportional taxation on income, they highlight that redistribution and democratisation of a society do not necessarily have adverse effects on growth, when public education is

[5] The original median voter theorem was proposed by Meltzer and Richard (1981). In their model, the economy is composed by individuals with different income levels and a government that imposes a proportional tax and redistributes tax revenues between people. Asymmetric income distribution implies that median income is below mean income. As income distribution becomes more unequal, median gets far away from mean income, so the ration median/mean decreases. If agents vote on the redistributive tax system, the theory predicts that results will correspond to the tax rate preferred by the median voter. Preferences for redistributive taxes are inversely related to the voter's income, so higher inequality implies lower median/mean relation and higher preferred tax rate.

the main redistribution channel. Agents are altruistic in that they care about their children's human capital levels, so that each individual's human capital has an inherited component and a component that is due to public education. They find that, for a given structure of political rights, starting from a high inequality position the economy converges towards a steady state growth path, and during this convergence process income distribution becomes more equal and tax rates decline as well as the growth rate. As the distribution of human capital gets more equal through the public system, the median voter gets richer so his children will benefit less from public education relative to inherited human capital and the level of public education tends to decline. With the median voter poorer than the mean, more inequality is associated with a lower initial human capital stock and with higher spending on public education; hence, the more unequal countries initially are, the faster they will grow. Further, democratisation does foster growth and equalization of income, by stimulating more redistribution and larger spending on public education. Their main idea is that in democratic societies, increased inequality may be good for growth, provided it implies more support for public education. Their conclusion doesn't hold if poverty is correlated with non participation in the electoral process.

As shown above, either individual heterogeneities in skills (i.e. human capital), preference and endowments – income and wealth –, or market imperfections or both have been introduced in the attempt to make individual distributions of income and wealth matter for growth and vice versa.

Based on capital market imperfections, another argument supporting the positive effect of inequality on economic growth is based on investment indivisibilities: if there large setup costs, higher inequality fosters economic growth. If there are large costs of setting up new economic projects and capital markets do not completely supply, through lending and borrowing, the necessary financial resources, higher wealth inequality could be beneficial for growth (Barro, 2000).

On another ground, a great bulk of theories has supplied a contrasting view.

With imperfect capital markets, people cannot freely borrow and lend and then cannot perfectly exploit all the investment opportunities; the marginal rates of return on investments are, in other words, not equated at margin, producing not optimizing behaviours and sub-optimal outcomes. In presence of limited access to credit, individual's wealth and income become discriminatory factors in the optimal choices undertaken by the people and undermine the potential economic growth; *"...greater inequality in the distribution of wealth results in lower rate of growth. Redistributing wealth from rich (whose marginal productivity is relatively low) to poor (whose marginal productivity of investment is relatively high, but who cannot invest more than their limited endowments), would enhance aggregate productivity and therefore growth"* (Aghion et al. 1999).

Following this line, Banerjee and Newman (1993)[6] build a model based on the implications of binding wealth constraints for the interplay between occupational choice

[6] See Appendix 1.B for a detailed sketch of the model.

and economic development[7]. Capital market imperfections due to contracts enforceability problems, which require high collateral requirements, induce a strong segmentation in the occupational choice. There exist four potential activities to be entered depending on initial wealth: 1) subsistence, where individual choose to not work and only investing, if any, their small amount of wealth; 2) working as employed for a wage; 3) self-employment, if the amount of initial wealth is high enough to begin the activity and it is worthwhile to invest; 4) entrepreneurship, when people are not wealth constrained, so to implement a productive activity, employing people. Initial wealth is a necessary collateral for borrowing on the financial market, due to contracts enforceability difficulties, modelled as the likelihood that each borrower may take into account the chance of reneging on the loans received.

The static equilibrium is reached under the assumption that labour markets must clear; initial distribution determines the occupational choice, since, depending on the degree of initial inequality, there will be more or less people disposed to work for a wage. Similarly, depending on the extent to which a large fraction of individuals in the economy are rich enough to set up a "capitalist" activity, there will be a higher or lower demand for employees. The initially wealth distribution across agents as well as the relative size of rich and poor fractions of population determines the wage level of equilibrium. If the number of rich people is much larger than the number of poor, that is if the distribution is highly skewed to the right, the labour market will clear for a high wage; otherwise, in equilibrium a low wage will prevail. Even if all people do have the same abilities and preferences, occupational structure is determined by initial wealth distribution and it determines people's savings and the risks they face. Further, given that the occupational structure does shape the wealth distribution, dynamics are studied to evaluate the implications of this interplay between occupational structure and income distribution for long-run economic development.

These dynamics are quite complex; due to the fact that the prevailing wage shapes the intergenerational transmission of wealth, that at each point in time the wage is function of wealth distribution, and that, finally, as distribution changes over time, so does wage, the process follows a non-stationary Markov process, for which no close solution can be found. Several examples are furnished to show how and whether the economy ends up on prosperity or stagnation, depending on initial distribution. For relatively reasonable parameterizations, it is shown that

> "*If the economy initially has a high ratio of very poor people to very rich people, then the process of development runs out of steam and ends up in a situation of low employment and low wages (this may happen even when the initial per capita income is quite high, as long as the distribution is sufficiently skewed). By contrast, if the economy initially has few very poor people the per capita income can still be quite low), it will "take off" and converge to a high-wage, high-employment steady state*" (Banerjee and Newman, 1993).

[7] Other relevant pieces of research on this topic are Ghatak and Jiang (2002), who simplify the Banerjee and Newman (1993) model, and Mookherjee and Ray (2003). Further applications of occupational choices model have been applied in migration analysis (Mesnard, 2001; Rapaport, 2002).

Nevertheless, it is added that even if an economy initially has a high ratio of poor to wealthy, it is not necessarily doomed to stagnate, particularly if the middle class is sufficiently large.

2.2 The Role of Human Capital

Education is a clearly common example; in presence of limited endowments, poor households sacrifice investments in human-capital that have both high rate of returns and affect positively growth rate. In this case, a reduction in inequality by redistributing wealth may foster economic growth by allowing poor households to invest in new and profitable opportunities. A striking caveat of this example is that not every market imperfections must pass on through incentive arguments. Indeed, "...*Note that this "opportunity creation effect" of redistribution does not fundamentally rely on incentive considerations: even if one could force the poor to invest* ***all*** *their initial wealth endowments rather than maximize intertemporal utility..., redistributing wealth from the richest to the poorest individuals would still have an overall positive effect on aggregate productivity and growth, again because of decreasing returns to individual investments.*"(Aghion and Howitt, 1998, p. 286).

This is exactly the structure on which Galor and Zeira (1993) based their so popular model[8]. They show that in presence of capital market imperfections and indivisibilities in human capital, the initial conditions do crucially matter for the development of the economy, generating multiple steady states[9]; initial distribution of wealth affects aggregate output and investment both in the short and in the long run. The authors consider a general equilibrium model for a small open economy, where a single good can be produced by either a skill-intensive or an unskilled-intensive production function. They model an overlapping generations economy in which individuals live for two periods and each of them has the option in the second period of leaving a bequest to his child. In the first period each person receives the bequest and has to decide either to invest in human capital and to acquire qualifications or to work as unskilled workers. In the second period he can work as skilled or unskilled, depending on their education level. If he chooses to acquire education in the first period, he will work, in the second one, as skilled for a wage higher than the unskilled one; otherwise, he works in both periods for the unskilled wage. The source of heterogeneity comes from the fact that individuals are different only in their initial wealth, coming from inheritance, while identical in preference and potential skills.

The two basic assumptions of the model are capital market imperfections and indivisibilities in human capital. The former derives from asymmetric information on the credit market due to the high costs of monitoring the borrowers and enforcing the contracts; borrowers and lenders will face different interest rates, higher for the former than for the latter. In the fashion of the new growth theories, the existence of individual non-convexities in the production is assumed, which are driven in the model by the indivisibility of individual investment in human capital; increasing returns to human

[8] See Appendix 1.C for a detailed sketch of the model.

[9] See also Krugman (1991) for the way and the conditions under which initial conditions and history do matter.

capital investment set in as this investment must cross a minimum threshold level in order yield any benefits[10]. These two assumptions drive the main conclusions of the model; namely, multiple steady states arise in both the short and the long run. Credit markets imperfections imply that wealth distribution affects economic activity in the short run. If borrowing is difficult and costly, only those who inherit a large initial wealth and do not need to borrow may have access to investment in human capital. Hence the distribution of wealth affects the aggregate investment in human capital and the per capita GDP. This short-run effect carries over in the long-run as well, due to the second assumption of non-convexities in the production function. The intergenerational transfers of wealth, through inheritance, generate non-convergence of the income distribution to a unique equilibrium in the long-run as well; multiple long-run equilibria arise and the dynamics are no longer ergodic[11] (see also Durlauf, 1993). This model offers further insights on the interplay between income distribution and subsequent growth, and vice versa.

Countries with an initially more equal distribution of wealth grow more rapidly and have a higher income level in the long run as well as countries with greater income per capita have a more equal distribution of income and smaller wage differentials. Let define g, $\bar{x}_n$ and $\bar{x}_s$ the points at which, in a two-dimensional graph, the curve representing the bequests dynamics intersects the 45° degree line, with $\bar{x}_n < g < \bar{x}_s$; $\bar{x}_n$ and $\bar{x}_s$ correspond respectively to the stable lower and upper equilibria, while g to the unstable intermediate one (see figures 1.C.1 in Appendix). Let be L_t^g the number of people who inherit less than g, that is the cumulative distribution function of the wealth at g. Two case are possible: economies in which *per capita* wealth is greater than g and others in which it is lower than g. In the former case, it is shown that if wealth is unevenly distributed, that is L_t^g quite large, the economy ends up quite poor. Otherwise, for $L_t^g = 0$, that is in the extreme case of perfect equality, the society will end up rich. In the second case, economies with per capita wealth less than g, "*for maximizing long-run per capita wealth the ideal redistribution policy is equivalent to minimizing the head-count measure of poverty, where the poverty line is given by g*" (Basu, 2003, p. 60).

Basu (1998, p. 61) maintains that it may be worthwhile subsidizing education. However, nothing more can be added to this discussion without taking fully into account the

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[10] Threshold models have been introduced in Azariadis and Drazen (1990); further development of poverty trap theories can be firstly found in Azariadis (1996).

[11] The relevance of these assumptions is evident when one analyses the different results obtained in the long-run by Loury (1981); in his models, under credit market imperfection the effect of wealth distribution disappears in the long-run, as all initial wealth distributions in his model converge to a unique ergodic distribution. In this model the dynamics of earnings across generations are modelled as stochastic process, due to the fact individuals are randomly assigned different abilities by nature. Despite the presence of capital market imperfections, the convergence to a unique distribution is obtained by assuming that: 1) the parental utility function, which depends on family consumption and offspring expected utility – through intergenerational altruism –, is *strictly increasing, strictly concave, and twice differentiable*; 2) the human capital production function, linking ability and training, is *continuously differentiable, strictly increasing and strictly concave in the training element*; 3) finally, that innate abilities are *i.i.d. distributed.* What does generate the convergence result in this case is the assumption 2, which ensures decreasing returns to human capital training, that is a convex human capital production function.

process of human capital formation[12]. Remarkable insights on the effects of redistribution and distribution of income on economic growth through human capital heterogeneity are furnished by Glomm and Ravikumar (1992). They figure out a general equilibrium model, without market imperfections, but perfectly competitive structure, and heterogeneous agents, in order to examine the implications of public versus private educational funding on inequality and economic growth. Under the assumption that incomes are lognormally distributed, they offer an overlapping generation model in which individuals live for two periods. Each agent's stock of human capital depends on the parent's stock of human capital, time spent in school, and the quality of schools. Differently from Galor and Zeira (1993) and following Lucas (1988), they endogeneize the process of human capital as function of two components, individual and collective. The bequest motive is modelled as the parent leaving to the offspring a certain amount of quality of education. Although setting the structure of the bequest in the form of quality of school, instead of assuming people bequeathing wealth, may not methodologically and essentially change the structure of a model, at least after Lucas (1988) this has been quite common, since it allows to shed new lights on the interplay between inequality and growth. Human capital is not only an individual ability or property, but its formation is function of individual – or local – components as well as aggregate – societal or community, as more recently Durlauf (1996, 2004) and Benabou (1996a) stress. Human capital of each person is function of the time spent in school, of the individual specific human capital, and of the quality of school, inherited from the parent. Formally, human capital production function is:

$$h_{t+1} = \theta\left(1 - n_t\right)^{\beta} e_t^{\gamma} h_t^{\delta} \tag{1}$$

with $0 < \delta < 1$, and $\beta > 0$, so that all factor exhibits diminishing returns; h is the individual specific human capital, e the quality of school, and n the leisure time, so that (1-n) is the time left for education.

Under the public regime the quality of school is homogeneous for all individuals, so that it is given by:

$$h_{t+1} = \theta\left(1 - n_t\right)^{\beta} E_t^{\gamma} h_t^{\delta} \tag{2}$$

where E_t^{γ} is the common level of quality of school, determined by tax revenues levied from a government on the income of the old, so that the quality of public education is an increasing function of the tax revenues, and out of the control of the individuals; these may only contribute in determining the tax rate through majority voting. That is,

$$E_{t+1} = \tau_{t+1} H_{t+1} \tag{3}$$

where

$$H_{t+1} \equiv \int h_{t+1} dG\left(h_{t+1}\right) \tag{4}$$

H_{t+1} is the distribution of human capital over its entire support, and τ_{t+1} is the tax rate.

Otherwise, in the private system individuals maximize their utility on the quality of education to be passed on to the offspring and on their own consumption, without taking into account the aggregate effect, so that the human capital production function is given as in (1).

[12] The role of human capital formation has long history in economic literature; the more prominent pieces of research which considerably inspired the literature are Becker and Tomes (1979) and years later Lucas (1988).

The intergenerational transmission is, then, due to two channels:
Firstly, on individual specific ground of each household, the stock of human capital of parents affects their children's learning; secondly, the linkage between generations occurs through bequests, which is the quality of education received by the children.
In the public education regime, the latter linkage does not differ across agents of the same generation since school quality under the public education system is common to all agents.
Different results for the two regimes obtain if the initial distribution of income is either homogeneous or heterogeneous. It is proved that if the representative agent hypothesis may be maintained, since the initial distribution degenerate toward a unique equilibrium, in both regimes a necessary condition for persistent growth is that, as usually, the human capital production function must be concave into the quality of schools and the parental stock of human capital. In each period, per capita income under private education is higher than per capita income under public education, while inequality is lower in the latter than in the former. This happens since the time devoted to human capital accumulation is higher in the private situation than it is under the public education system.
Further, if the population is sufficiently heterogeneous and inequality sufficiently high, the public education economy may yield higher mean incomes for some future periods than a private education economy. When allowing for enough heterogeneity, in the public education economy, income inequality declines over time. In the private education economy, income inequality either declines or increases or remains constant over time depending on whether increasing returns set in or not; even in case income distribution should convergence towards a unique equilibrium, income inequality in the private education economy does not decline as fast as in the public education economy. Finally, private education yields greater per capita incomes unless the initial income inequality is sufficiently high for all future periods.

On the implications of community – or neighbourhood[13] – effects for the linkage between human capital formation, inequality and growth, more recently two major works (Benabou, 1996a; Durlauf, 1996) shed relevant lights.
Benabou (1996a) develops a general equilibrium model to explore the implications of socioeconomic segregation on inequality and growth and on the likelihood of the trade-off between equity and efficiency, under the idea that "*…The accumulation of human capital underlies the evolution of both income inequality and productivity growth. Certain essential inputs in this process are of a local nature. They are determined neither at the level of individual families nor that of the whole economy, but at the intermediate level of communities, neighbourhoods, firms or social networks*" (Benabou, 1996a).
Each individual chooses its own location where to live, depending on the one which ensures its utility is maximized. Heterogeneous individuals live for two periods; initially, they are assigned different human capital endowments, with $h_A > h_B$. Each parent, with type $\{h_A, h_B\}$, chooses a community j, where to live, such to maximize its utility, over

[13] See Durlauf (2004) for a surveys of the theoretical and empirical literature on the neighbourhood formation.

the present and future income stream d (i.e. d represents the debt, to which the parents may have access):

$$U^j(h) \equiv \max_d U(c, c', h') \tag{5}$$

$$s.t.$$

$$c + \rho^j + t^j(h) = \omega(h) + d \tag{6}$$

$$c' + P(h, d) = y(h) \tag{7}$$

$$h' = F(h, L^j, E^j) \tag{8}$$

Each person maximizes utility in (5) choosing a sequence of present consumption c, second period consumption or bequest c', and its own child human capital h'. It is worthwhile to notice the difference with the above specification (Glomm and Ravikumar, 1992). Here, the community effect on human capital formation is modelled as the parent choosing *in the first period* the human capital for its child, where human capital production in (8) is function of: parent human capital h, quality of social interactions in the chosen community L^j, and resources devoted to its schools, measured by the per student budget E^j. The other two constraints – (6) and (7) – are respectively the present and future budget constraints, function of: rent paid for housing in community j, ρ^j, taxes $t^j(h)$ out of his initial wealth $w(h)$, increased with his chosen level of debt d, and function of current income $y(h)$ minus debt repayments, $P(h, d)=d(1 + r(h, d))$, in the second period. It is shown that small degrees of heterogeneity in education technologies, preferences, or wealth can lead to a high degree of stratification; imperfect capital markets assumption is not necessary for this result, but, if present, does amplify the effect in the same direction. This stratification causes inequality in education and income to strongly persist across generations. This effect does not mechanically carry over inequality in total wealth, which depends on the ability of the rich to appropriate the rents. Indeed, segregation in heterogeneous communities occurs if families with higher human capital are more sensitive to neighbourhood quality than those with lower human wealth. Such families, in order to exploit the more desirable communities, can be induced in dissipating more of their savings on housing (relatively to poorer ones). The determining factor becomes the cost paid by the rich to separate themselves from the poor, or conversely the extent to which they are able to appropriate the rents generated in the process of segregation. This mechanism is amplified when that difference in "willingness" to pay is accompanied by differences in "ability" to pay; namely, in case of either capital market imperfections or heterogeneity – even small – in wealth endowments, or both. Applying this setting to the city-suburbs case (see also Baumol, 1967), the author proves that, in equilibrium, aggregate surplus in excessively stratified and heterogeneous communities is lower than it would be under homogeneous clustering; the potential trade-off between equity and efficiency, emphasized in part of the literature, appears to vanish. *Pareto efficiency* improvements (i.e. increases in aggregate surplus) may be reached by redistributing resources across communities, such to induce better reallocations of families. This is obtained either through direct taxation if the two type (i.e. A's and B's) are observable, or by using local public goods – for instance education – if they are not; in this latter case, the mechanism works efficiently, if this local public good is attached different values from the two types. Finally, the author stresses that it is likely to be much harder to cancel out the stratification process and its effects on inequality in the long-run than when it is in its early stages.

On the implications for poverty and inequality of human capital investment and endogenous neighbourhood formation, Durlauf (1996) figures out a stochastic model of income inequality dynamics, positing the general conditions for the persistence of inequality and poverty, even in growing economies. As the models above, also this model is based on an overlapping generation economy, with incomplete markets for human capital investment, where each generation within a family lives two periods. In the first period, the young receives education or human capital investment which will shape his own earnings in the second period, when old. In the second period a continuous set of occupations is offered to each old person, depending on the amount of human capital he is invested in the previous period; the level of human capital invested places an upper bound on the set of occupations which can be successively entered. In the second period, each individuals chooses how much to consume and how much to bequest to its child, in the form of human capital investment. Inequality and poverty do persist across generations due to the correlation between human capital and job earnings. The model does exploit the role of community income and the process of endogenous stratification to evaluate this persistence; this stratification is due to the clustering of individuals with similar features, who decide to isolate themselves. This is modelled by assuming that each family chooses the neighbourhood where to live, and this choice is subject to income constraints, so that rich can always separate themselves from the poor[14].
The level of human capital is primarily function of the total income of a neighbourhood, with different communities choosing different levels of human capital investment. Due to its local public good nature, that investment is financed through neighbourhood-specific taxes on income, so that the level of human capital ends up as function of the total amount of taxes collected inside the community and of its number of children. In particular, it is supposed that:

$$\frac{\partial g\left(H_{i,t},\#\left(\Re_{d,t}\right)\right)}{\partial H_{i,t}} > 0, \quad \frac{\partial^2 g\left(H_{i,t},\#\left(\Re_{d,t}\right)\right)}{\partial H_{i,t}^2} \geq 0$$

$$\text{and} \qquad \frac{\partial g\left(H_{i,t},\#\left(\Re_{d,t}\right)\right)}{\partial \#\left(\Re_{d,t}\right)} < 0$$

where $H_{i,t}$ is the human capital invested in the young, $\#(\Re_{d,t})$ is the number of families in each neighbourhood, whose size is then unspecified, and $g()$ the human capital expenditure function. Together these three conditions respectively say that, per capita expenditures are increasing, and not concave, function of the desired level of human

[14] Durlauf does establish a specific algorithm, a set of rules, for the formation of such neighbourhoods, to avoid the possibility that an equilibrium may not exist. In particular, some cost of switching community is introduced to avoid the rich may move to a poor neighbourhood, the poor then move out, the rich then follow, creating an unending cycle; this cost is represented by income barriers, for instance due to housing prices – as above in Benabou (1996a), and this cost is so high that the family has no incentive in doing it.

capital, and, for a fixed level of human capital, decreasing in the neighbourhood population, which establishes the likely incentive for aggregation. In addition to this community-wide effect, within each neighbourhood there exist individual-specific characteristics, which determine the individual-specific productivity and are affected by the income distribution of the community. As in Glomm and Ravikumar (1992), different results arise whether considering that human capital depends on either only individual-specific features, or only community-wide effects, or finally on a combination of the first two. In the first case, equilibrium with individual-specific characteristics only, human capital formation becomes a private good under the control of each family; the conditional distribution of income depends only on the information of each individual families, so that:

$$\text{Prob}\left(Y_{i,t+1} \mid \Im_t\right) = \text{Prob}\left(Y_{i,t+1} \mid Y_{i,t}\right) \tag{9}$$

This says that the for family i the probability of obtaining an income $Y_{i,t+1}$ in the period t+1 is conditional to all the information available (i.e. $\Im_t$), where all the information available is, in this case, family specific; income probability in period t+1 is conditional only on income of the previous period.

It is proved (i.e. author's theorem 2) that it is likely that one family may always have greater income than another, but only if both family incomes are becoming infinite with probability 1 as well as permanent poverty may therefore be a feature of permanent inequality; this latter possibility may occur when poverty requires that some families get stuck within a certain income range which other families can avoid. For instance, when agents are too poor, because of binding liquidity constraints, they cannot form sufficient human capital in their offspring to allow them to attain high income occupations, so that also each successive generation is trapped in low income absorbing states.

Otherwise, when human capital is a complete public good, that is in the equilibrium with only community-wide effects, the conditional probability of family income does depends on the empirical distribution of income,

$$\text{Prob}\left(Y_{i,t+1} \mid \Im_t\right) = \text{Prob}\left(Y_{i,t+1} \mid \hat{f}_Y\left(\Re_{0,t}\right), I\right) \tag{10}$$

where $\hat{f}_Y\left(\Re_{0,t}\right)$ is the empirical probability measure of income, and I the total number of families. In this case, there is no room for income inequality both to be generated and to persist.

Finally, in the case of endogenous neighbourhood formation, human capital production function does depend on a combination of the two above channels and on the income probability measure, which it turns to be

$$\text{Prob}\left(Y_{i,t+1} \mid \Im_t\right) = \text{Prob}\left(Y_{i,t+1} \mid \hat{f}_Y\left(\Re_{d,t}\right), \#\left(\Re_{d,t}\right)\right) \tag{11}$$

Sufficient conditions, ensuring that regimes of persistent poverty and inequality can arise even in growing economies, are put forward.

As in Benabou (1996a), in this model "*...wealthy families have an incentive to isolate themselves from the rest of the economy in order to provide the highest level of education of their children at the lowest cost. Decreasing average costs in human capital formation function and mobility costs, on the other hand, create incentives for communities to*

emerge with heterogeneity in income across agents. When the forces leading to homogeneity are strong enough, endogenous stratification of the economy can occur, causing poor families to be isolated from the rest of the population. This isolation can induce persistent or permanent poverty among some families as they are unable to jointly generate sufficient human capital investment in their children to escape from low paying occupations" (Durlauf, 1996).
There exists a linkage between individual-specific and community choices; each family's decision is affected by the aggregate choices at neighbourhood level (i.e. distribution of income), and vice versa the former contributes to determine the latter. So, poverty may persist across generations, likely self-perpetuating.

3 The Unified Approach and the Kuznets hypothesis

As shown in the sections above, several pieces of theory have been offered to maintain how and whether inequality might have either positive or negative or yet no role in the determination of growth output.

More recently, an effort has been accomplished in the attempt to find a justification for a possible reconciliation of both the views. Galor and Moav (2004, 2006) offer a reasonable explanation for why it is likely that inequality may firstly have a positive effect in stimulating economic growth, as the classical tradition sustains, as well as negative impacts on it in the very long-run, as the new theories on imperfect capital markets point out.
The crux of the argument is that inequality does change its role on the determination of growth output, when and whether the process of development, along its long-run path, switches its main determinant from physical towards human capital accumulation; in this case, inequality would fuel economic growth in the first stages of industrialization, when physical capital accumulation is the main channel through which it happens, while more equality would ensure this process to keep on in the later stages, when due to diminishing returns, physical capital is replaced by human capital accumulation. The key hypothesis is that there does exist a fundamental asymmetry between physical and human capital. Contrary to the former, the latter is inherently embodied in humans which implies that its accumulation at the individual level is constrained by significant diminishing returns. While the aggregate stock of human capital significantly depends on the distribution of investment in human capital across individuals, the marginal returns to physical capital is largely independent on the distribution of physical capital across individuals and ownership.
Inequality stimulates economic growth in the initial stages of development, when physical capital accumulation does fuel it, as the classical theory suggests, while equality does it in later stages, when human capital accumulation becomes the prime engine of economic growth and credit constraints, due to capital market imperfections, are strictly binding for a large part of the population. These constraints do bind in the later stages, since the increase in inequality in the first period does not allow a great part of the population to exploit the benefits of human capital accumulation, in the second period. The authors

develop this idea in an overlapping generation economy, where individuals live for two periods. In the first of them they spend their entire time for the acquisition of human capital; due to capital-skill complementarity, the level of human capital will be higher whether the time invested is supplemented with capital investment in education. In the second period of their lives, when old, individuals supply their efficiency units of labour and allocate the resulting wage income, along with their inheritance, between consumption and transfers to their children; these transfers may take the form of both an immediate investment in their offspring's expenditure on education and saving for their future wealth. In order to generate the described pattern across stages of development two specific and relevant assumptions are made with regard to the human capital production and utility functions. Human capital develops as following:

$$h_{t+1} = h(e_t) \tag{12}$$

where human capital in period $t+1$ is a strictly increasing, strictly concave function of the government real per capita expenditures on education e_t, which in turns is given by taxing, at rate τ_t, the aggregate level of intergenerational transfers of period t, B_t; that is: $e_t = \tau_t B_t$. In order to obtained the desired path for human capital accumulation being determinant in later stages of development important assumptions are required on the features of the function in (12); $h(0) = 1$, $h'(0) = \gamma < \infty$, and $\lim_{e_t \to \infty} h'(e_t) = 0$. These conditions state that the slope of the production function of human capital is finite at the origin (i.e. Inada condition not verified) and that individuals are assigned by nature a minimum level of it; jointly these two assumption are necessary to ensure that in early stages of development only physical capital matter for economic growth and that, even without any investment in human capital, productive activities can be realized. Secondly, utility functions are assumed non-homothetic to ensure that workers can switch investments from physical to human capital only after some minimum wealth level is reached, as savings are function of wealth.

On these ideas and under those hypotheses, the authors show that the economy will pass through two principal regimes. In the first one, since physical capital is scarce, the returns to it are higher than those on human capital accumulation, and hence physical capital accumulation is the only engine of economic growth; at this stage the classical idea that inequality does foster economic growth might be maintained. In this phase, the wage rate is low enough that the poor, who cannot bequeath through intergenerational transfers, do consume their entire current income, and do not are active in capital accumulation. Also their descendants will be unable to start accumulating physical capital and will be stuck in low wage equilibrium. On the other side, individuals rich enough do start accumulating physical capital, due to its high returns, and will bequeath to their child that wealth, starting an increasing accumulation path. The physical capital accumulation put pressure on wages, inducing these to start rising towards the end of the regime. Inequality increases the wealth of individuals whose marginal propensity to save is higher and consequently increases aggregate savings and capital accumulation and it is conducive for economic growth.

When returns to human capital reach the physical capital ones the economy enters the second regime, which passes through three stages. In the first stage, although wage

increases induce to start investing in human capital, the capital-labour ratio is not yet high enough to induce all the population to invest in it. In this stage, the human capital investment is selective and only performed by the rich; as in the first regime, the poor consume the whole current income without any saving and investment. This implies again that their descendants will be not able to afford saving and investments in future periods, being trapped in temporary low steady states equilibrium. Conversely, income of the rich is high enough to allow for both intergenerational transfers and physical and human capital accumulation. In this phase, even though wages continue raising, the economy does experience increasing inequality. When the capital-labour ratio reaches a threshold level such that even for the poor becomes profitable to start investing in human capital, the economy enters the stage two of the second regime. At this point, even the poor begin investing in human capital; however, differently from the rich they are constrained by parental wealth. Equality, instead of inequality, will boost economic growth, by spreading human capital across the population. Towards the end of this stage, the constraints begin being much relaxed such to allow more people to invest in human capital, until when in the final stage – stage three – every one is wealth unconstrained, returns to human capital are equalized across groups, and inequality therefore has no effect on economic growth. The two authors use this framework to stress two long-run structural processes. Firstly, Galor and Moav (2006) maintain that the above mechanism does explain the demise of the capitalist-workers class structure. Secondly, Galor and Moav (2004) apply that for sustaining a new way of thinking about the Kuznets hypothesis.
The main theoretical approach used to analyse, on the reverse side, the effect of economic growth on inequality, is due to the Kuznets (1955) seminal work; the inverted-U curve hypothesis characterizes the relationship between growth and inequality, with inequality increasing in the first stages of development and then decreasing as the economy develops[15]. This formalisation was based on the mobility between less and more advanced sectors of the economy; the Kuznets starting idea takes into account the mobility of workers from an agricultural to an industrial and urban sector. Initially, agriculture is the main sector of the economy, with the larger share of population, low inequality and low per capita income; the industrial and urban sectors, instead, starts small, with higher per capita incomes and possibly an higher degree of inequality within the sector. As urbanization proceeds and the economy develops, the shift of workers from the first to the second sector is initially followed by increasing inequality; when a large part of the rural population moves to the industrial centres and the agricultural sector diminishes, inequality fall as more poor workers are enable to join the relatively rich sector. Further, the same pattern is experienced by the workers within the industrial sector; many of them, starting at the bottom steps of the industrial sector tend to move up in relation to the richer workers. Finally, the decreasing size of the agricultural labour force, tending to

[15] Since then, a great bulk of studies has been offered to actually test the empirical and theoretical relevance of the hypothesis. For instance, in a famous note, Robinson (1976) shows how the inverted-U path may be obtained with a minimum of economic assumptions. In particular, he demonstrates that if the difference between mean incomes in the rural and urban sectors is constant, then the inverted-U hypothesis does not depend on which sector has the higher income nor it does matter which sector has the more unequal distribution of within sector income. So, in order to observe inequality – as measured by the variance of the log-incomes – firstly increasing, reaching a maximum for a share between zero and one, and then decreasing, it is not necessary to assume that urban incomes are more unevenly distributed than rural ones nor it might be assumed that inequality declines in the urban centres as its share of population increases.

drive up the relative wages within that sector, produces the narrowing in the gap of incomes between the two sectors and within them; that is, the reduction in the inequality indexes.

This basic idea has been applied in several frameworks. Some of the theories above reviewed on the effects of inequality on growth bring about interesting insights also on the reverse causation – from growth to income distribution. Galor and Zeira (1993) maintain that their model is consistent with the observed difference in the degree of inequality among developed and less-developed countries; ultimately, this path should be accounted for by a quadratic relationship between inequality and economic growth. Yet, Banerjee and Newman (1993) do find that the Kuznets hypothesis is indeed an actual possibility in the very long-run for particular parameterizations of the dynamics of their model.

The unified approach allows analysing the implications of the linkage between human capital and technological progress as the channel through which the Kuznets relationship may be observed. Galor and Tsiddon (1996, 1997) study this channel in an endogenous growth model where individual human capital is an increasing function of parental level of human capital – which they call local home environment externality – and technological progress is positively correlated to the average level of human capital in the society – which they call global technological externality. Similarly to Benabou (1996a) and Durlauf (1996), parents have a double effect on their children level of human capital. On a side, they affects it directly through the local externality, which ensures better schooling for a given level of human capital investment; on the other side, they contribute indirectly to the global externality as well, by increasing the average level of human capital in the society. They study a small open overlapping generation economy, with perfectly competitive structure, in which individuals live for three periods, produce a single homogeneous good, and are identical in preference and production technology of human capital; the only source of heterogeneity is due to differences in parental level of human capital, which is modelled by assuming that at time t=0, there exist two dynasties H and L, with the former having higher level of human capital than the latter. Due to the labour-augmenting character of the production, the average level of human capital affect the magnitude of the technological progress in successive periods; that is, the a neoclassical production function takes the form

$$Y_t = F\left(K_t, \lambda_t H_t\right) \equiv \lambda_t H_t f\left(k_t\right); \text{ with } k_t \equiv K_t / \left(\lambda_t H_t\right)$$

where K_t and H_t are the quantities of capital and efficiency-labour employed at time t, while λ_t is the coefficient of the endogenous labour-augmenting technological change at time t. The level of technological progress in period t+1 – λ_{t+1} – depends on the average level of human capital of the society, such that

$$\lambda_{t+1} = \lambda\left(h_t\right) = \begin{cases} \lambda^1 & \text{if } h_t < \hat{h} \\ \lambda^2 & \text{if } h_t > \hat{h} \end{cases} \quad \text{with } \lambda^1 < \lambda^2 \tag{13}$$

where if the average level of human capital is below a threshold level $\hat{h}$ technological progress is stationary at a lower level, λ^1, than if it is above that threshold. The individual human capital production function is given by:

$$h_{t+1}^i = \mu + g\left(h_t^i\right)\phi\left(x_t^i,1\right); \quad \mu > 0 \tag{14}$$

with

$$\phi\left(x_t^i,1\right) = \left(x_t^i\right)^{\alpha} 1^{1-\alpha}; \quad \alpha \in (0,1) \tag{15}$$

and

$$g\left(h_t^i\right) = \begin{cases} \left(h_t^i\right)^{\beta} & \forall h_t^i \le \tilde{h}, \\ \tilde{h}^{\beta} & \forall h_t^i > \tilde{h}, \end{cases} \quad \beta \in (0,1) \tag{16}$$

The human capital accumulation requires both capital investment and labour time. Since there are no imperfections in the capital market, every individual who would need can borrow the necessary capital at the market interest rate. The individual i human capital, at time $t+1$, born in time t, from a parent with h^i_t units of human capital, and who invests, at time t, x^i_t units of capital and one unit of labour is given by h^i_{t+1} in (14). By nature, every individual is assigned a minimum level μ of human capital, even whether he does invest any amount, while the number of efficiency units is augmented by the physical capital, x^i_t, invested in human capital formation and by the parent's level of human capital, which is upper bounded, (15) and (16). In this environment, multiple locally stable steady states arise, when in the early stages of development, low levels of the aggregate technology makes only the local externality matter for economic growth; in this phase inequality widens stimulating more technological progress. An uneven distribution is indeed a necessary condition for allowing people to start investing in human capital. As the investment in human capital of the highly educated segments of society increases and income inequality has reached its maximum, the accumulated knowledge spreads across the less-educated part of the population through the technological progress, inducing a reduction in inequality; at this point the global externality drives the process of development towards an equalitarian distribution and a unique globally stable steady state.

Other approaches consider the poor sector the one using old technologies, while the rich or "industrialised" sector the one implementing more advanced technologies. Mobility from the old to new is slow and with frictions, due to the requirements of the new technology in terms of familiarization and knowledge; in this framework, many technological innovations imply an initial increase and then decrease in inequality. As in the original Kuznets idea, few persons initially take advantage of the relatively high incomes of the more advanced technological sector; as more people shift in this sector inequality tends initially to rise. When a large part of the population can exploit the advantages of the new technologies, inequality fall (Barro, 2000; Galor and Tsiddon 1997a). Similar arguments have been used to prove, on the contrary, why and whether the Kuznets process may not be observed, while inequality, in fact, increasing along the process of development.

If the technological change is endogenously biased toward certain skills, the Kuznets idea must be reversed; in this case, economic growth, enhanced by technological progress, increases inequality even in mature stages of development.
In endogenous growth theory frameworks, based on Schumpeterian technological forces, Aghion et al. (1999) and Aghion (2002) show that the Kuznets hypothesis can be partly rejected even in advanced countries, because increase in earnings dispersion is observed, when technological change is biased towards certain skills or specialisations. In their model, the advent of a new General Purpose Technology[16] (GPT) erodes the stock of specific human capital, inducing mobility across different sectors. There could be cyclical movements tending to initially increase and then decreasing inequality, in the Kuznets fashion; the point is that the nature of the transition process from the old to the new GPT can produce final higher inequality. If the technological progress is, indeed, biased towards certain skills, in the first phase of the adoption of the new GPT, when the number of sectors using it is too small to absorb the entire skilled labour force, an important fraction of skilled workers must be employed by the sectors with the old technologies at the same wage as the unskilled ones; hence the real wage is almost the same for skilled and unskilled workers. When, subsequently, the new sectors grow sufficiently to absorb the entire skilled labour, "*the labour market will become segmented, with skilled workers being exclusively employed (at a higher wage) by new sectors whilst unskilled workers remain in old sectors*" (Aghion et al. 1999). Further, this conclusion appears to solve a striking puzzle present in these theories. Human capital accumulation (in the form of increased education or knowledge) should ideally lead to narrow the gap between skilled and unskilled workers, reducing inequality in the final phase of the development process; the cyclical nature of the innovation process and the inability of the labour market in absorbing all the skilled workers can generate increasing inequality, also in mature stages of development (Galor, 2000).

4 Conclusion

In this paper we have surveyed a large bulk of the theoretical literature on income distribution and growth, with a particular orientation towards the implications of their interplay for poverty analysis at individual level. Although economic growth, inequality and poverty are interrelated phenomena, which do affect each other, at the same time they are very different for their intrinsic features; economic growth stems from macroeconomic attitudes and does refer to aggregate processes, such as structural processes of economic transformations, with reference to countries, regions or areas at aggregate level. On the other side, inequality and poverty are micro concepts referring to "heads", such as individuals, families or households. This paper does review the macro issues of economic growth and the micro ones of income distribution, connecting them to their potential effects for the individual well-being.
The old but still relevant issue of a potential trade-off between equity and efficiency is analysed starting from the classical and the neoclassical growth settings, following which inequality has either a positive or little role to play in shaping the paths of economic

[16] A GPT is a technological innovation (or breakthrough) that affects the *whole* economic system.

growth; ultimately, this conclusion is based upon the assumptions, among others, that a representative agent might actually represent, *at margin*, the economy as a whole, or yet that market information is complete enough to ensure that capital markets works quite well such to entail perfect competition. In this framework growth is very likely to be egalitarian, with incomes converging to unique invariant distribution through the convergence properties of the factors of production.

On the other side, the new growth theories highlight the role of market imperfections and heterogeneity in either skills, endowments, preference or both to evaluate the impact of initial inequality on economic growth and development at individual level. In this case, the personal income distribution appears to strikingly matter for the economic development of societies; initially strongly inequalities, in endowments as well as in skills or preferences are likely causes of trap phenomena, following which initially disadvantaged individuals have little chances to rise above their initial conditions, as they are trapped in low equilibria states.

Finally, we review the more recent attempt of the unified growth theories to find a justification for a possible reconciliation of both the views. Under the key hypothesis that there does exist a fundamental asymmetry between physical and human capital, this approach offers rationalities for why it is likely that inequality may firstly have a positive effect in stimulating economic growth, as the classical tradition sustains, as well as negative impacts on it in the very long-run, as the new theories on imperfect capital markets point out. The crux of the argument is that inequality does change its role on the determination of growth output, when and whether the process of development, along its long-run path, switches its main determinant from physical towards human capital accumulation; in this case, inequality would fuel economic growth in the first stages of industrialization, when physical capital accumulation is the main channel through which it happens, while more equality would ensure this process to keep on in the later stages, when due to diminishing returns, physical capital is replaced by human capital accumulation.

Appendix

1.A Stiglitz, 1969

The basic case involves linear saving function, constant reproduction rate, homogeneous labour, and equal division of wealth.

Let consider a society divided in a number of homogeneous groups, with all members within any group holding the same wealth, while let be the case that this wealth may differ across groups. Homogeneous labour and competitive structure guarantee that each factor is paid its marginal returns and, the, workers receive same wage.

Let the production function respect all the neoclassical property, then if y is the per capita output, and k the aggregate capital-labour ratio

$$y = f(k), \quad f'(k) > 0, \quad f'' < 0 \qquad \text{[A.1]}$$

with factors rewards

$$r = f'(k), \quad w = f(k) - kf'(k) \qquad \text{[A.2]}$$

Let y_i be the per-capita income of group i and c_i the per-capita wealth,

$$y_i = w + rc_i \qquad \text{[A.3]}$$

and

$$s_i = my_i + b \qquad \text{[A.4]}$$

where the saving function s_i is linear in per capita income, with constant marginal propensity m, and with per capita level b at zero income.

Given a constant rate of population growth n and constant population share a_i in each group i, the dynamic of per-capita wealth for each group is given by

$$\frac{\dot{c}_i}{c} = \frac{s_i}{c_i} - n = \frac{b + mw}{c_i} + mr - n \qquad \text{[A.5]}$$

Let K_i be the total wealth of group i so that

$$k_i = K_i / L = a_i c_i \qquad \text{[A.6]}$$

and

$$k = \sum k_i = \sum a_i c_i \qquad \text{[A.7]}$$

The law of capital accumulation is then

$$\dot{k} = \sum \dot{k}_i = \sum a_i \dot{c}_i = b + mw + rk - nk \qquad \text{[A.8]}$$

such that the aggregate capital accumulation is independent of the distribution of wealth.

If the economy is on the balanced growth path, i.e. $\dot{k}_i = 0$, we have

$$my = nk - b \qquad \text{[A.9]}$$

Several results apply. If b=0, the Solow model equilibrium is obtained; if b>0 there is a unique aggregate balanced growth path for which my=nk; finally if b<0, in general there will be two balanced growth path. In this latter case, the lower path is locally unstable, while the upper locally stable; in turn this will depend on whether

$$\left.\frac{\partial \dot{k}}{\partial k}\right|_{\dot{k}=0} = mr - n \begin{cases} < 0 & \text{stable path} \\ > 0 & \text{unstable path} \end{cases}$$

So, for values of k less than that at the lower equilibrium k^*, the capital-labour ratio falls continuously, for value of k higher than that at upper equilibrium k^{**}, the capital-labour ratio declines; between k^* and k^{**}, it the capital-labour ratio increases.

In order to establish the equilibrium condition for each group, it must noticed that for each aggregate capital-labour ratio k, there exist only one group, with per-capita wealth c^*, which is in equilibrium, that is

$$c^* = \frac{b + mw(k)}{n - mr(k)} \qquad \text{[A.10]}$$

Let, finally, define two values for k: $\hat{k}$ and $\tilde{k}$, with this latter being the golden rule level, so that

$$w(\hat{k}) = f(\hat{k}) - \hat{k}f'(\hat{k}) = -b/m; \text{ so that } k: \ mw = -b$$

$$r(\tilde{k}) = f'(\tilde{k}) = n/m; \quad \text{so that } k: \ mr = n$$

with $k^* < \hat{k} < \tilde{k} < k^{**}$, from concavity assumption.
Stiglitz shows that

$$\begin{array}{llll}
k < k^*, & my + b - nk < 0, & mr - n > 0, & mw + b < 0; \\
k^* < k < \hat{k}, & my + b - nk > 0, & mr - n > 0, & mw + b < 0; \\
\hat{k} < k < \tilde{k}, & my + b - nk > 0, & mr - n > 0, & mw + b > 0; \\
\hat{k} < k < k^{**}, & my + b - nk > 0, & mr - n < 0, & mw + b > 0; \\
k^{**} < k, & my + b - nk < 0, & mr - n < 0, & mw + b > 0.
\end{array} \qquad \text{[A.11]}$$

For any given k, there is a unique wealth income group in equilibrium; moreover, in equilibrium the wealth of this group increases or decreases depending on

$$\begin{cases} c^* > 0, & \text{if } k < \hat{k} \\ c^* > 0, & \text{if } k > \tilde{k} \\ c^* < 0, & \text{if } \hat{k} < k < \tilde{k} \end{cases}$$

In the first case, $k < \hat{k}$, groups with per-capita wealth less than c^* will experience decreasing per-capita wealth, while in the second case, if $k > \tilde{k}$, these groups will have increasing per-capita wealth; in the intermediate case, the third one, all groups with positive wealth, will observe increasing wealth.
In order to assess the implications for the distribution of wealth, let suppose there exist two groups, i=1, 2, with $c_1 < c_2$; if c_1 grows faster than c_2, this implies that the distribution is becoming equal, otherwise if the former grows slower than the latter. Then,

$$\frac{\dot{c}_1}{c_1} - \frac{\dot{c}_2}{c_2} = (b + mw)\left(\frac{1}{c_1} - \frac{1}{c_2}\right) \qquad \text{[A.12]}$$

$$\begin{cases} b + mw > 0 \Rightarrow \text{the distribution becomes more equalitarian} \\ b + mw < 0 \Rightarrow \text{" \quad " \quad " \quad " inequalitarian} \\ b = -mw \quad \Rightarrow \quad \text{" \quad " \quad does not change.} \end{cases} \qquad \text{[A.13]}$$

From [A.11] and [A.13], *"it derives that if the economy is at a stable* [, upper,] *equilibrium, the distribution of wealth must eventually be equalitarian"* (Stiglitz, p. 387).
At the low equilibrium level of aggregate capital, k*, from A.5 may be rewritten as

$$\dot{c}_i = mw + b + mrk^* + m(c_i - k^*)r - nk^* - n(c_i - k^*)$$
$$= (c_i - k^*)(mr - n)\begin{cases} > 0 \text{ if } c_i > k^* \\ < 0 \text{ otherwise} \end{cases} \qquad [A.14]$$

such that group with equilibrium wealth less than the equilibrium one will grow poorer, while the others will grow richer.
These results carry over into the analysis of income distribution. The conclusions are dependent on the elasticity of substitution of the production function; in case it is equal to one, from A.11 it results that

$$\begin{cases} \hat{k} < k < k^{**} \Rightarrow \text{income distribution becomes more equalitarian} \\ k > k^{**} \Rightarrow \quad " \quad " \quad " \quad " \\ k < k^* \Rightarrow \quad \text{unequal} \end{cases}$$

The above results are consistent also in the cases of non-linear, but concave saving function, of savings as function of wealth and income, and of variable rates of population growth.

Relaxing some of the assumptions behind this structure, it is finally shown how growth can be distributionally non-neutral, increasing inequality. For instance, this is the case of heterogeneous labour, if it is hypothesised that exists a productivity gap between labours and/or worker groups; let p_i be the number of efficiency units of each member of group i and $g(p)$ the density function of p, hence the equilibrium per-capita wealth of group i is now given by

$$c_i = \frac{b + mp_i w}{n - rm} \qquad [A.15]$$

and the density function of c by

$$F(c) = \frac{n - rm}{mw} g\left(\frac{c(n - rm) - b}{mw}\right) \qquad [A.16]$$

Applying results in A.11 and following a similar structure, it is indeed proved what stated.

1.B Banerjee and Newman, 1993

The model is based on the overlapping generation structure, with a continuum of individuals, ordered by a distribution function $G_t(w)$, which gives the measure of population that at time t holds a wealth less than w, with identical preferences of the form

$$u = c^{\gamma} b^{1-\gamma} - z \qquad \text{[B.1]}$$

which implies an indirect utility function

$$u^{*} = \delta y - z, \qquad \text{[B.2]}$$

where $\delta \equiv \gamma^{\gamma}\left(1-\gamma\right)^{1-\gamma}$, y is the income realization, and z the labour effort (z=0,1).

Four possible occupations may be entered: (1) subsistence, (2) working for a wage, (3) self-employment, and (4) entrepreneurship. The different occupations entail different degrees of risk and returns. Depending on its amount, initial wealth can be invested either in a divisible safe asset that requires no labour and whose fixed return is $\hat{r} < 1/\left(1-\gamma\right)$, or in a two different risky projects. The first – the self-employment or individual activity – does require neither the employment of workers nor specific skills, but it does require an initially indivisible investment of I units of capital and one unit of labour, as start-up cost for beginning the activity; if lower level of inputs are otherwise employed, this investment does not generate any returns. It can generate a random return rI, with

$$r = \begin{cases} r_o & \text{with probability} \quad q \\ r_1 & \text{with probability} \quad 1-q \end{cases} \qquad \text{[B.3]}$$

and $0 < r_0 < r_1$, with mean $\bar{r}$. Such a project will be held from the agent if its returns is high enough to cover at least the costs; agents will start a self-employment activity if and only if

$$I\left(\bar{r}-\hat{r}\right)-\left(1/\delta\right) \geq \max\left\{0, I\left(r_0-\hat{r}\right)\right\} \qquad \text{[B.4]}$$

where $1/\delta$ is the lowest possible wage rate, since at lower wage workers will prefer to not work and to remain in the subsistence sector, eventually investing the little amount of wealth they would hold.

The other risky project involves the start-up of a capitalist industry, with the employment of $\mu>1$ individuals, hired at the competitive wage v. By investing I' units of capital and one unit of labour, this activity entails a random return $r'I'$ such as

$$r' = \begin{cases} r_0' & \text{with probability} \quad q' \\ r_1' & \text{with probability} \quad 1-q' \end{cases}, \qquad \text{[B.5]}$$

and with $I = I'$, r and r' having the same mean $\bar{\text{r}}$, but $q \neq q'$.

If feasible, this activity is assumed to be more profitable than the self-employment one

$$\mu\left[I\left(\bar{r}-\hat{r}\right)-\left(1/\delta\right)\right]-\left(1/\delta\right) \geq \max\left\{I\left(\bar{r}-\hat{r}\right)-\left(1/\delta\right), \mu\left[I\left(r_0'-\hat{r}\right)-\left(1/\delta\right)\right]\right\} \qquad \text{[B.6]}$$

While labour and goods markets are assumed perfectly competitive, capital markets are imperfect due to contract enforceability problems, which arise from the chance the borrowers renege on debt. Although projects returns are high enough to allow the repayment of debt, borrowers have attached a probability 1-π of escaping and fleeing upon its obligations; conversely, if caught, with probability π, he is punished with the loss of the collateral $w\hat{r}$ and with a non-monetary sanction (i.e. prison) F, so that reneging on debt yields to the borrower a pay-off

$$V(L) - \pi F \qquad \text{[B.7]}$$

while if the contract is satisfied by paying the debt, the pay-off is

$$V(L) + w\hat{r} - L\hat{r} \qquad \text{[B.8]}$$

where L is the amount borrowed.
The incentive compatible constraint is hence given

$$V(L) + w\hat{r} - L\hat{r} \geq V(L) - \pi F \qquad \text{[B.9]}$$

The lenders will make loans only if the amount asked for is

$$L \leq w + \left(\frac{\pi F}{\hat{r}}\right) \qquad \text{[B.10]}$$

from which a minimum initial wealth level, to be furnished as collateral, required for qualifying for a loan can be derived, depending on the activity for which the loans is asked for; for a self-employment activity the minimum initial wealth level required is

$$w^* = I - \frac{\pi}{\hat{r}} F \qquad \text{[B.11]}$$

while for starting a capitalist activity, this amounts to

$$w^{**} = \mu I - \frac{\pi}{\hat{r}} F \qquad \text{[B.12]}$$

with $w^{**} > w^*$, as $\mu > 1$.
A static equilibrium is obtained when each agent finds out his optimal occupation on perfectly competitive labour markets, depending on his initial wealth level. So in order to find this equilibrium, only the wage that clears labour market is needed. Each occupations yield the following payoffs:

1) Subsistence: $\delta w\hat{r}$;
2) Worker: $\delta(w\hat{r} + v) - 1$;
3) Self-Employed: $\delta\left[w\hat{r} + I(\bar{r} - \hat{r})\right] - 1$;
4) Entrepreneur: $\delta\left[w\hat{r} + \mu I(\bar{r} - \hat{r}) - \mu v\right] - 1$.

Since only entrepreneurs demand labour, and since only agents with wealth $w > w^{**}$ can be entrepreneurs, the labour demand correspondence is given by

$$L^D = \begin{cases} 0 & \text{if } v > \bar{v} \\ \left[0, \mu\left[1 - G_t\left(w^{**}\right)\right]\right] & \text{if } v = \bar{v} \\ \mu\left[1 - G_t\left(w^{**}\right)\right] & \text{if } v < \bar{v} \end{cases} \qquad \text{[B.13]}$$

where $\bar{v} \equiv \left[(\mu - 1)/\mu\right] I(\bar{r} - \hat{r})$ is the maximum wage level that ensures entrepreneurship activity is profitable. On the other side of the market, labour supply is given by

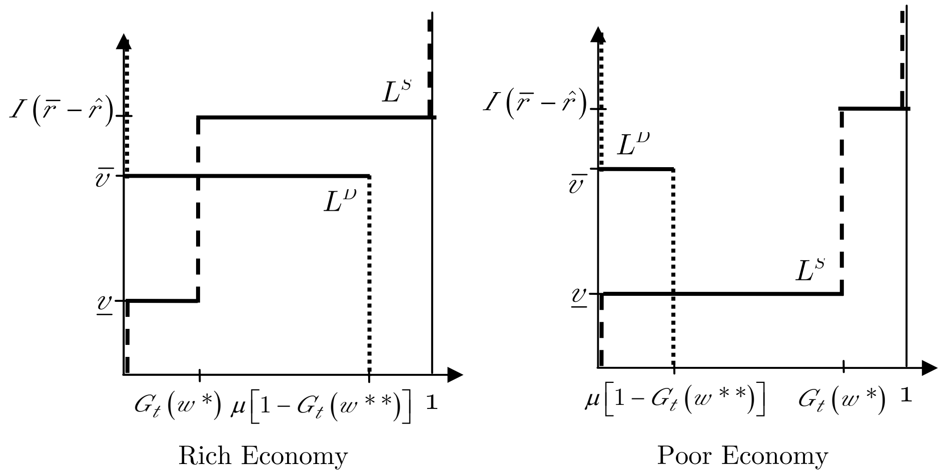
$$L^S = \begin{cases} 0 & \text{if } v < \underline{v} \\ \left[0, G_t\left(w^*\right)\right] & \text{if } v = \underline{v} \\ G_t\left(w^*\right) & \text{if } \underline{v} < v < I\left(\bar{r} - \hat{r}\right) \\ \left[G_t\left(w^*\right), 1\right] & \text{if } v = I\left(\bar{r} - \hat{r}\right) \\ 1 & \text{if } v > I\left(\bar{r} - \hat{r}\right) \end{cases} \quad \text{[B.14]}$$

The equilibrium wage will be then,

$$v^* = \begin{cases} \underline{v} & \text{if } G_t\left(w^*\right) > \mu\left[1 - G_t\left(w^{**}\right)\right] \\ v \in \left[\underline{v}, \bar{v}\right] & \text{if } G_t\left(w^*\right) = \mu\left[1 - G_t\left(w^{**}\right)\right] \\ \bar{v} & \text{if } G_t\left(w^*\right) < \mu\left[1 - G_t\left(w^{**}\right)\right] \end{cases} \quad \text{[B.15]}$$

Graphically, it is possible to better figure out the role of the initial distribution or better the importance of initially having either high or low number of poor in the society. In the first case, the "poor economy" for which $G_t(w^*)>\mu[1- G_t(w^*)]$ is verified, the equilibrium wage is very low. Otherwise, in a "rich economy" for which $G_t(w^*)<\mu[1- G_t(w^*)]$, the equilibrium wage will be very high. Finally it can take any values between the two bounds when the society is perfectly equilibrates, that is when the number of poor is exactly equal to number of rich, i.e. $G_t(w^*)=\mu[1- G_t(w^*)]$.

Figure 1.B.1 – Labor Market Equilibrium



Despite the fact that agents have identical preferences and are characterised by homogeneous skills, differences in initial wealth will determine their occupational choice. Given that the occupational choice and hence the equilibrium wage does affect the wealth distribution in successive periods, the model entails very significant and complex dynamics. As the utility function is Cobb-Douglas, every agent will bequeath a fraction 1-γ of his realized income, so that for each occupational class, we have that the intergenerational transmission of wealth is determined as follow:

1) subsistence: $b_t = \left(1 - \gamma\right) w_t \hat{r}$;

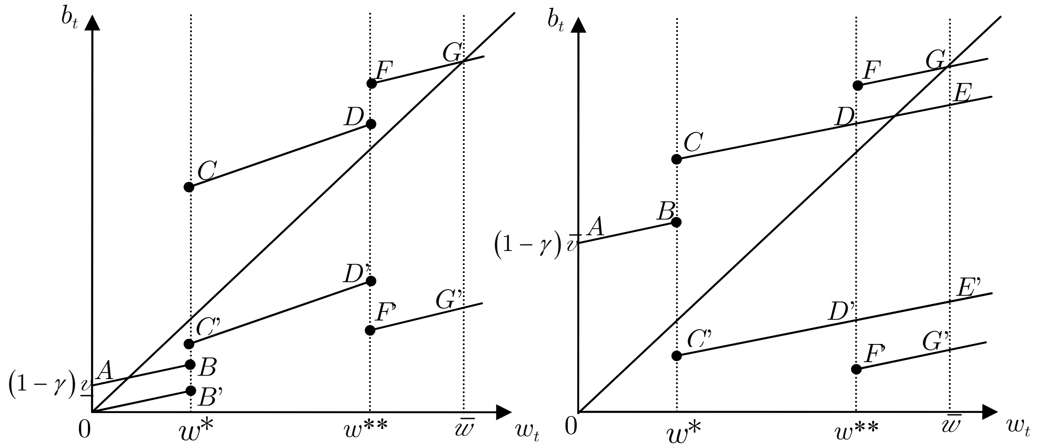
2) working: $b_t = (1-\gamma)(w_t\hat{r} + v)$

3) self-employment: $b_t = (1-\gamma)\left[w_t\hat{r} + I(r-\hat{r})\right]$, which is random;

4) entrepreneurship: $b_t = (1-\gamma)\left\{w_t\hat{r} + \mu\left[I(r'-\hat{r}) - v\right]\right\}$, also random .

The dynamical equilibrium is very sensitive to different parameterisations, such as high or low wage level, high or low altruism degree of parents, and yet high or low riskiness of production. For instance let consider here one of the cases analysed in the paper (i.e. case D), in which initially different wealth may determine the prosperity or stagnation of an economy. Since the dynamics of the bequest will depend on the wage realization of the parents, two extreme case are studied, when wages are low and when they are high. Graphically, the law of motion of the bequest can be characterised as follow.

Figure 1.B.2 – Wealth Dynamics



a) Poor Economy; Low wage: b) Rich Economy; High Wage:

The figure (1.B.2) represents the intergenerational transmission of wealth through the bequests parents are able to assign to their children, depending on their initial wealth level, which in turns determines the level of the wage of equilibrium. In the case of a poor economy (panel a), which ends up in equilibrium with a low wage, agents with wealth between zero and w^* follow one of the path AB or OB', depending on whether they choose either to work for a wage (i.e. AB) or to not work at all and remain in the subsistence sector (i.e. OB'); in both the cases they cannot aspire to let their children an amount of wealth high enough to jump in a higher class of income, while in fact they are trapped in converging toward a low equilibrium wealth (i.e. between 0 and w^*). For individuals holding an initial wealth level between w^* and w^{**}, the bequest dynamics are represented by the lines CD and C'D'; these agents will choose to be self-employed and the final outcome will depend on whether they are successful (i.e. CD) or not (i.e. C'D') in their activity. In the former case, agents who succeed in their activity will let their lineage to shift on an higher wealth accumulation path, as the next generation will born with a wealth level between w^{**} and $\bar{w}$; otherwise, individuals who fails or are unlucky may end up producing a deterioration of their whole lineage wealth level, as they may fall shortly on a lower range of wealth, [0, w^*].

Let $\bar{w}$ be the fixed point of the intergenerational transition map of wealth, related to the best possible case for the capitalists, in which the salary is at its lowest possible level; that is, $\bar{w}$ represents the highest wealth attainable in the most favourable case. Then, the law of motion of the bequests of people with wealth between w^{**} and $\bar{w}$ follows one of the paths FG and F'G', depending on whether these agents will succeed in their entrepreneurial activity or not. For agents holding an initial wealth level higher than $\bar{w}$, their path will be the same as in the latter case, as the presence of an upper bound on wealth accumulation given by that fixed point ensures that in this case in the long-run wealth of these agents will eventually fall in the range $[w^{**}, \bar{w}]$. So, similarly, the offspring of an agent holding an initial level between w^{**} and $\bar{w}$, may remain on that range if his parent is successful or otherwise badly falling on a lower income class, $[w^{*}, w^{**}]$. Similar reasoning may explain the case of the high wage economy (panel b).
Since the transition rule of any lineage depends on the prevailing wage, since this depends in turn on the current distribution of wealth across all agents in the economy wealth dynamics follow a non-stationary Markov process; indeed, the distribution changes over time, so does the wage,. This implies that the state space of these dynamics is not simply the wealth interval, but the set of all the possible distributions on that interval. Indeed, given a distribution shaping at time t=0 the equilibrium wage, at time t=1, this wage will shape the occupational choice, which generate the path of wealth accumulation across a dynasty. Then, in time t=2, the next dynasty will start again the same process, but with a changed distribution of wealth. It is this mechanism that generates the non-stationarity. The dynamics are complicated furthermore as the interaction between the composition of each class implies that the process is non-linear. In particular, since the equilibrium wage and the occupational structure of the economy are determined only by the ratio of the number of people in $[0, w^{*})$ and the number of people in $[w^{**}, \bar{w}]$ and not by any other properties of the distribution, it is possible to formally define the three wealth classes, as L, M and U (for lower, middle, and upper), depending on whether their members are respectively in the intervals [0, w*), [w*, w**), and $[w^{**}, \bar{w}]$. So the wealth distributions defined as the fraction of population in each of the three classes are shaped by the probability that each agent in the economy is within those classes at each time; this means that the three classes may be defined as three probability vectors p_L, p_M, and p_U, each of them corresponding to a different wealth class; that is, $p_L=G(w^{*})$, $p_M=G(w^{**})-G(w^{*})$ and $p_U=1-G(w^{**})$. The final step for resolving the very long-run dynamics of an economy starting with this composition is to track the whole evolution wealth distribution; this results to be described by a transition matrix of the form

$$\frac{dp}{dt} = A\big(p(t)\big)\,p(t) \qquad \text{[B.16]}$$

where $A(p(t))$ is 3x3 matrix of probabilities which depends on the vector of probability $p(t)$ describing the current distribution, as this latter shapes the dynamical process depending on whether p_L is greater or less than μp_U (i.e. whether respectively $v = \underline{v}$ or $v = \bar{v}$) , with p_M defined as 1-p_L-p_U. Given the parameterisation leading to the case depicted in figure 1.B.2 above, for the low wage economy case, i.e. for $v = \underline{v}$ and $p_L > \mu p_U$, the dynamics can be described then as

$$\begin{bmatrix} \dot{p}_L \\ \dot{p}_M \\ \dot{p}_U \end{bmatrix} = \begin{bmatrix} 0 & (1-q) & (1-q') \\ 0 & -1 & 0 \\ 0 & q & -(1-q') \end{bmatrix} \begin{bmatrix} p_L \\ p_M \\ p_U \end{bmatrix} \qquad [B.17]$$

where q' is the fraction of people of the upper class, whose parents have been lucky and successful in their activity so that they remain in the upper class, while a proportion of 1-q' agents of the upper class will eventually descend toward the lower class. Similarly, a fraction q of middle-class individuals achieves succeeds in their project so that their descendants will ascend toward the upper class of income; otherwise, a proportion 1-q of them will fail so that their offspring will be relegated to the lower class. So the dynamics of exit and entrance within each class, which describe the system above in B.17, can formally represented by

$$\dot{p}_L = (1-q)\, p_M + (1-q')\, p_U \qquad [B.18]$$

$$\dot{p}_M = -p_M \qquad [B.19]$$

$$\dot{p}_U = qp_M - (1-q')\, p_U \qquad [B.20]$$

Applying the condition p_M=1-p_L-p_U yields the following dynamics for the above system in the case of an economy with low wages; that is in the case of $p_L > \mu p_U$, with $v = \underline{v}$:

$$\begin{cases} \dot{p}_L = 1 - q - (1-q)\, p_L + (q - q')\, p_U \\ \dot{p}_U = q - qp_L + (q' - q - 1)\, p_U \end{cases} \qquad [B.21]$$

Similar reasoning yields the dynamics for the case of a rich economy, with $p_L < \mu p_U$ and then $v = \overline{v}$; that is

$$\begin{cases} \dot{p}_L = 1 - q - \left(2 - q + \dfrac{q'}{\mu} - \dfrac{q}{\mu}\right) p_L \\ \dot{p}_U = q - \left(q + \dfrac{q}{\mu} - \dfrac{q'}{\mu}\right) p_L - p_U \end{cases} \qquad [B.22]$$

As described in the section 2.1, the long-run behaviour of this economy depends on the initial conditions. If the initial ratio of poor to wealthy is high, the economy will be converge to the low-wage dynamics with persistent poverty; otherwise economies starting richer or better distribution of wealth are more likely to end up converging to higher states.

1.C Galor and Zeira, 1993

An overlapping generations economy is inhabited by a continuum individuals of size L who live for two periods and each of them has the option in the second period of leaving a bequest to his child. Any individual who holds an initial wealth y has to choose how much to consume and how much to bequest; under the hypothesis that utility function is Cobb-Douglas, the agents problem is

$$\max u = c^{\alpha} b^{1-\alpha} \quad s.t. \quad c + b = y \tag{C.1}$$

which yields the common indirect utility as

$$u^* = ey \tag{C.2}$$

with $e = \alpha^{\alpha}\left(1-\alpha\right)^{1-\alpha}$, and

$$c = \alpha y \tag{C.3}$$

$$b = \left(1-\alpha\right) y \tag{C.4}$$

A single good can be produced by either a skill-intensive or an unskilled-intensive production function; that is respectively given by either

$$Y_t^s = F\left(K_t, L_t^s\right) \tag{C.5}$$

or

$$Y_t^n = w_n \cdot L_t^n \tag{C.6}$$

The two basic assumptions of the model are capital market imperfections and indivisibilities in human capital. Capital markets imperfections are due to asymmetric information on the credit market. Due to the high costs of monitoring borrowers and enforcing contracts, borrowers and lenders will face different interest rates, higher for the former than for the latter; in particular the money must be borrowed at a rate i and lent at an interest r, with $i>r$.

In the first period each person receives the bequest and has to decide either to invest in human capital and to acquire qualifications or to work as unskilled workers. In the second period he can work as skilled or unskilled, depending on their education level. A person who inherits an amount x of wealth and decides to not invest in human capital, working both the periods as unskilled worker, will earn during his life a wealth

$$y = \left(x + w_n\right)\left(1+r\right) + w_n \tag{C.7}$$

such that its life-time utility and bequest will be

$$u_n\left(x\right) = e\left[\left(x + w_n\right)\left(1+r\right) + w_n\right] \tag{C.8}$$

$$b_n\left(x\right) = \left(1-\alpha\right)\left[\left(x + w_n\right)\left(1+r\right) + w_n\right] \tag{C.9}$$

The other important assumption of the model is the existence of individual non-convexities in the production, which are driven in the model by the indivisibility of individual investment in human capital; in particular, increasing returns to human capital investment set in as this investment must cross a minimum threshold level h in order yield any benefits.

Then, a person who inherits $x \geq h$ and decides to acquire education in the first period, while working for a skilled wage $w_s > w_n$ in the second will have an utility

$$u_s(x) = e\left[(x-h)(1+r)+w_s\right] \quad \text{[C.10]}$$

and a bequest of

$$b_s(x) = (1-\alpha)\left[(x-h)(1+r)+w_s\right] \quad \text{[C.11]}$$

as he is net lender on the capital market. Otherwise a person who inherits $x<h$ and decides to invest in human capital, by asking for a loan at rate i have an utility

$$u_s(x) = e\left[(x-h)(1+i)+w_s\right] \quad \text{[C.12]}$$

and a bequest of

$$b_s(x) = (1-\alpha)\left[(x-h)(1+i)+w_s\right] \quad \text{[C.13]}$$

Borrowers[17], then, will invest in human capital insofar as $U_s(x) \geq U_n(x)$; from C.8 and C.12 this implies that investment in human capital is done as long as the initial inherited wealth is

$$x \geq f \equiv \frac{1}{i-r}\left[w_n(2+r)+h(1+i)-w_s\right] \quad \text{[C.14]}$$

Individuals who inherit an amount smaller than f would prefer not to invest in human capital, but work as unskilled. Education is, therefore, limited to individuals with high enough initial wealth, due to a higher interest rate for borrowers. So, initial distribution of wealth will determine the number of people who work as skilled and who work as unskilled. Let ϕ_t be the density function of the inherited wealth at time t; that is

$$L = \int_0^\infty \phi_t(x)\,dx \quad \text{[C.15]}$$

Given that L is the population size, the mass of skilled workers is given by

$$L_t^s = \int_f^\infty \phi_t(x)\,dx \quad \text{[C.16]}$$

while the mass of unskilled, given that $L_t^n = L - L_t^s$ is

$$L_t^n = \int_0^f \phi_t(x)\,dx \quad \text{[C.17]}$$

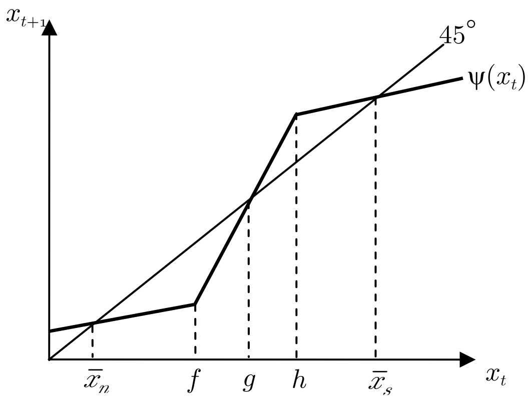
At the same time, initial distribution does shape the future distribution of inheritances; then, for each individual who inherits an amount x, the dynamics of the bequest is

$$x_{t+1} \equiv \psi(x_t) = \begin{cases} b_n(x) = (1-\alpha)\left[(x_t+w_n)(1+r)+w_n\right] & \text{if } x_t < f \\ b_s(x) = (1-\alpha)\left[(x_t-h)(1+i)+w_s\right] & \text{if } f \leq x_t < h \\ b_s(x) = (1-\alpha)\left[(x_t-h)(1+r)+w_s\right] & \text{if } h \leq x_t \end{cases} \quad \text{[C.18]}$$

[17] If borrowers find investment in human capital more profitable than working as unskilled in both periods, it will be verified for the net lenders as well, that is for who inherits a wealth $x \geq h$ as long as one condition is respected; that is, $w_s - h(1+r) \geq w_n(2+r)$. This last condition is assumed to be always verified.

Graphically, this is represented by

Figure 1.C.1 – Wealth dynamics



Individuals who inherit less than f work as unskilled and so are their descendants in all future generations. Their wealth converges to the long-run level

$$\bar{x}_n = \frac{(1-\alpha)}{1-(1-\alpha)(1+r)} w_n (2+r) \qquad \text{[C.19]}$$

Individuals who inherit more than f invest in human capital. However two situations may happen; if some of their descendant will not remain in the skilled labour sector in future generations, then the wealth of their dynasty converges to a critical point g

$$g = \frac{(1-\alpha)\left[h(1+i)-w_s\right]}{(1+i)(1-\alpha)-1} \qquad \text{[C.20]}$$

Even though individuals who inherit less than g in period t may invest in human capital, after some generations their descendants become unskilled workers and their inheritances converge to $\bar{x}_n$. Otherwise individuals who inherit more than g invest in human capital and are able to ensure that also their offspring do so; so their bequests converge to

$$\bar{x}_s = \frac{1-\alpha}{1-(1-\alpha)(1+r)}\left[w_s - h(1+r)\right] \qquad \text{[C.21]}$$

Finally, the last point to highlight is why societies may evolve richer or poorer, depending on their initial wealth level and on the distribution of this wealth. In particular, countries with a more equal initial distribution of wealth grow more rapidly and have a higher income level in the long run as well as countries with greater income per capita have a more equal distribution of income and smaller wage differentials. Indeed, let suppose that at particular point in time t, L_t^g represents the number of people who inherits less than g; it is possible to show that in the long-run the average wealth in the economy is

$$\frac{\left(L - L_t^g\right)\bar{x}_s + L_t^s \bar{x}_n}{L} = \bar{x}_s - \frac{L_t^g}{L}\left(\bar{x}_s - \bar{x}_n\right) \qquad \text{[C.22]}$$

Then as shown in section 2.2, if wealth is unevenly distributed L_t^g is high and the average wealth of the economy is low; otherwise if initial wealth is equally distributed, as $L^g{}_t$=0.

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