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Growth and Accumulation as Coordination Failures

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ERRATA CORRIGE

The following footnote substitutes for the footnote (1) of the paper:

[1] The idea that growth can be fed by negative externalities was originarily formulated in an evolutionary context in Antoci and Bartolini (1997). In order to show its logical robustness, the idea has subsequently been studied in the context of three very different neoclassical growth models. In Bartolini and Bonatti (1997) a non-storable output is a perfect substitute for the resource. The dynamics of the economy under different laws of motion of the resource is analized. It is shown what kind of law of motion give rise to multiple equilibria. An interpretation is provided of this law of motion, in terms of the role played in growth by different social values and mass-psychology. In Bartolini and Bonatti (1998), a non-storable output can be used as a perfect substitute for the resource or to satisfy needs different from those satisfied by the environmental good. Also analysed is the impact of technical progress on labour input in the economy. In Bartolini and Bonatti (1999) it is shown that negative externalities can generate endogenous growth. We show that in an AK growth model if working time is a control variable, the model is no longer able to generate endogenous growth, unless negative externalities are introduced. In this fourth neoclassical model contained in the present paper the growth mechanism based on negative externalities is introduced in a model *à la* Solow-Ramsey. The inclusion of accumulation of physical capital in the scheme makes it possible to examine the inter-temporal dimension of individual decision-making. Contrary to the standard results in the presence of a renewable resource, the model shows that the steady-state welfare of the representative individual improves if individuals discount the future more heavily.

The following articles should be included in the bibliogragraphy

Bartolini S. and Bonatti L. (1998), *Growth as a coordination failure*, Discussion Papers n. 5, Università di Trento, Dipartimento di Economia

Bartolini S. and Bonatti L. (1999), *Endogenous Growth and Negative Externalities*, Quaderni del Dipartimento di Economia Politica, Università degli Studi di Siena, n.270.

INTRODUCTION *

In this paper we present a neoclassical growth model in which accumulation and growth are caused by negative externalities. This idea, evidently different from the emphasis placed on positive externalities by current endogeous growth models, is at the basis of a research program originarily formulated in an evolutionary context and then brought into a neoclassical world.[1]

According to the explanation offered by the theory of endogenous growth, in a market system individuals unintentionally generate increasing returns through positive externalities. This feeds a self-reinforcing mechanism whereby growth generates externalities and externalities generate growth. If a complete set of markets allowed the agents to internalize these externalities growth would be enhanced. In fact, markets are incomplete (given that there are positive externalities) and growth is sub-optimal (if there existed markets for externalities, steady state growth rates would be higher): the formation of markets generates growth.[2]

We offer an alternative explanation (not necessarily incompatible), this too based on a self-reinforcing mechanism between externalities and growth, and in which the individual actions most relevant to growth are non-intentional. But with the difference that in this case the externalities are negative. This difference amounts to claiming that a market system may generate growth due to the fact that it is incomplete, Indeed, the completeness of markets would weaken growth rather than enhance it.

Here is a brief desciption of the growth mechanism on which this model is based. Welfare depends on three goods: leisure, a free environmental renewable resource, and a good that can be produced by combining physical capital and labor. The latter can be used in three ways: as a substitute for the free resource[3], to satisfy needs different from those satisfied by the free resource, and for investment in physical capital. The stock of the resource is negatively affected by an increase in the level of activity, because of the

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[1] These ideas were first formulated in Antoci and Bartolini (1997) and then studied in neoclassical growth models (Bartolini and Bonatti (1997 and 1998)). The fact that in the same structural circumstances identical results are obtained with both neoclassical and evolutionary choice mechanisms, gives robustness to the results themselves, highlighting that they do not depend on assumptions concerning the existence or otherwise of bounded rationality. All these papers do not consider capital accumulation, which is considered in the present one. Therefore our aim here is to study the intertemporal dimension of the decision problem that the economic structure described in the preceding papers, poses to individuals.

Bartolini and Bonatti (1997) and (1998) differ in certain of their structural features. The former model has been constructed to handle problems of industrial take-off in third world countries, while the latter allows to handle growth processes in the advanced countries. This point will be clarified later.

[2] This implication seems to have been fully grasped by North (North (1981), North and Thomas (1973)). Indeed, he uses it as the basis for a theory of growth which he employs to reconstruct around 10,000 years of human economic progress driven by the formation of rights (first communal and then private) on resources..

[3] Concept and interpretation of free resource and its substitute will be explored below. For the moment we provide an illustrative example: if the quality of freely-available water suitable to swim (e.g. the sea or the river close to home) deteriorates, agents may decide to buy substitutes as a holiday to some tropical resort. or a swimming pool.

negative externalities caused by the production process. Households react to the deterioration of the environmental resource by increasing labor supply and accumulation, so as to be able to consume (both in the present and in the future) an increased amount of the good that can substitute for the resource. In its turn, this brings about a further deterioration of the environmental resource, thus giving rise to a self-feeding growth process.

This model assumes that production activities cause negative externalities in a general equilibrium context. This allow to study the way in which changes in negative externalities give rise to changes in production decisions, accumulation, consumption and the labour supply. The result is that these changes produce growth; that is, a relation is constructed whereby negative externalities generate accumulation and growth. Economic growth is therefore treated as a self-reinforcing process whereby growth generates negative externalities and negative externalities generate growth.The former relation amounts to asserting that what matters for the welfare of agents is not only the goods they are able to purchase but also goods that they do not purchase, and whose endowment is negatively affected by growth.[4] The second relation derives from the incentives provided by the economy to individuals. In an economy in which those who maintain their purchasing power unchanged worsen their position, there will be strong individual incentives for a progressive increase in real income.

Hence, the core of this growth mechanism is that growth works as a substitution process based on the destruction of non-market goods, in the sense that growth is fuelled by a diminuition in free consumptions and by its substitution with costly ones.[5] In other words, growth and accumulation are driven by their own destructive power. Note that this is true in the full sense in the model. The predictions are, first, that dynamically stable steady states will exhibit a higher activity level and higher capital as the impact of production on environment becomes greater; and second that at any point along a growth path, a shock which reduces the endowment of the resource will generate a higher activity level.

Growth is described as a process of market expansion in the sense that along a growth path, welfare increasingly depends on what is transacted on the market. This signifies that free resources increasingly become costly ones. Hence the expansion of markets restricts the availability of free resources, forcing individuals to satisfy their needs by increasing their participation in the market sector of the economy. This applies both to the goods market and to the labour market, given that the labour supply expands.

We shall discuss later the sociological echoes of this argument, evoking the destruction of the communal bases of traditional societies. For the time being we would stress that it is well-known that growth is generally associated with the "creation of new needs" and with a "change in patterns of consumption". These terms, of sociological flavour, tend to be interpreted in terms of an endogenous change in preferences. Our model suggests that the creation of new needs and change in consumption patterns constitute the engine of growth, but in a context of invariant preferences. The interpretation is as follows: new needs are increases in demand for (present and future) substitute consumptions generated

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[4] Bartolini (1996) shows that that it is possible to reformulate the concept of externality into that of the rationing of demand for a free good. On the basis of this reformulation one can conclude that there is a systematic relation between negative externalities and growth, while conversely growth does not systematically generate positive externalities.

[5] Henceforth the term ‘free consumption’ will be used synonymously with environmental good (or resource), while ‘costly consumption’ will be used synonymously with substitute consumption.

by a diminution in free consumptions, while change in patterns of consumption concerns the passage from common (free) goods to private (costly) ones. Growth is thus described as a change, whereby agents increasingly derive welfare from private rather than from common goods.

To be noted are some structural features of this model: this is a three-goods general equilibrium model with incomplete markets. There exist, in fact, one market for time (labour market), and one market for output, but there does not exist a market for a scarce resource, the environmental good.[6] Given the context, it is worth pointing out that we use the term ”growth” in the usual sense: the increase of per-capita output. Here, this implies that growth is measured only with respect to one of the three arguments of the utility function of the representative agent: the ouput. Given the trade-off existing between the level of economic activity and the other two arguments, this leads to mismeasurement of the impact of growth on welfare, which is systematically overestimated, to the point that growth may generate net losses of welfare.

Section 1 of this paper discusses its motivations: namely to provide an analytical framework for an enormous body of literature and knowledge which extends well beyond the bounds of economics. Sections 2, 3 and 4, present the model. Section 5 provides an explanation of why an urban-industrial society generates growth, while Section 6 shows why a rural society can become urbanized and undertake an industrial transition. Section 7 provides some examples of how the model’s predictions can be used to explain the Industrial Revolution. Section 8 examines the relationship between labor productivity and labour supply in advanced economies. Section 9 is devoted to a comment on the relation among discount rate, accumulation and sustainable growth. Section 10 is devoted to discussion of the welfare implications of the model.

1. MOTIVATIONS

We have said that growth is described as a self-reinforcing mechanism whereby accumulation and growth generate negative externalities and negative externalities generate accumulation and growth. The main motivation behind the construction of a model based on this mechanism is to provide a formal structure for the enormous quantity of literature and knowledge (i) on the environmental, social and cultural fractures generated by growth, and (ii) on the fact that these cleavages are, paradoxically a necessary condition for growth, This knowledge has traversed two centuries of industrial history. Although it is deeply rooted in modern culture and spreads through numerous disciplines - becoming almost an archetype of contemporary culture - it has never penetrated the 'mainstream' of economic theory. The intention here, therefore, is to propose a point of view on growth theory which tends to bridge a profound cultural rift between economics and the other social sciences, while suggesting innovative policy prescriptions with regard to growth.

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[6] Bartolini and Bonatti (1998) differ from Bartolini and Bonatti (1997) in certain of its structural features which enable it to handle growth processes in the advanced countries:
(i) it admits that the good may be used to satisfy needs other than those satisfied by the resource; that is, the good may not be utilised solely as a substitute for the resource;
(ii) it does not consider the possibility of alternative laws of motion of the resource, some of them giving rise to multiple equilibrium paths
(iii) analysis is conducted of the impact of technical progress on steady state welfare.

Let us examine the first of these ideas in more detail. The notion that growth generates negative externalities is, of course, not new to environmental economics. However, there is no reason why it should be restricted to environmental resources alone. Expressed in general, the idea that growth generates negative externalities signifies that there are important resources that are not transacted on the market, and that they tend to be lost with growth.[7] Put in these general terms, the idea is a stylization in economic language of a huge body of literature and knowledge concerning the social, cultural, psychological and environmental breakdowns associated with growth (the reference is to economic geography, anthropology, sociology, psychology, philosophy, economic history, as well as to economics, and the economics of development in particular). Since an exhaustive survey would obviously be beyond the scope of this paper, we merely provide a number of significant examples.

We begin with the early onset of the market economy, the collateral effects of which were viewed as largely positive in the course of the eighteenth century.[8] However, this early optimism was dispelled by the impact of the Industrial revolution. Nineteenth-century commentators generally viewed the new economic order as having wrought devastation to social bonds. Market relationships were blamed for the decline of the traditional institutions and for the severing of social and affective ties. The romantic and conservative critics of the Industrial Revolution saw a world shaped by growth as a world impoverished both culturally and spiritually. The metaphors used to describe these effects on traditional societies ranged through 'erosion', 'corrosion', 'contamination', 'penetration', 'intrusion' to 'destruction' (Hirschmann 1982). [9]

This vision has deeply rooted in the culture of two centuries of industrial history and it has developed in a wide variety of languages and images. It has spread throughout the social sciences, although communication on the issue has followed to be difficult.[10]

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[7] The tendency of economists to regard welfare as depending solely on what is object of a market transaction has given rise to a profound cultural fracture between economics on the one hand, and the social sciences and humanist culture on the other. This divide has persisted despite the advent in economics of neo-institutionalism and its contention that many of the coordination mechanisms in a capitalist economy are not market-based, and of the theory of externalities and its argument that important interdependencies among individuals are not coordinated by the market.

[8] Montesquieu (1749, 1961) wrote: "Commerce refines …and softens (*adoucit*) barbarian manners." Similar views were propounded by Robertson (1769, 1972), Condorcet (1795) and Thomas Paine (1792, 1951). For a masterly survey of the topic see Hirschmann (1982). However, the theme of "*doux commerce*" was not exclusive to the eighteenth century, as attested by the fact that the main argument of the conservative reaction against the advance of market society concerned the destruction of social ties. See for example the polemic waged by the opponents of Walpole and the Whig government of England in the 1730s (Hirschmann 1977). Montesquieu was in any case already aware of the harmful effects of asserting calculation and instrumental rationality in all areas of life.

[9] The tendency to attribute this vision to Marx, whose Manifesto, for example, placed great emphasis on the way in which the market corroded values and the traditional institutions, is probably due to the fact that he was the critic of capitalism *par excellence*. However, he was not the first, nor the last, nor even the principal exponent of these ideas.

[10] For example, at the end of the last century sociology tended to describe the social impact of the market economy in gloomy terms, viewing at as atomistic and as corroding social cohesion. One thinks, for example, of Durkheim's *anomie* or of Georg Simmel's (1908) analysis of the alienating properties of money. A philosophical echo of this themes can be found in Heidegger (1927). For the philosophers of the Frankfurt school (for instance Horkheimer (1947)), there is a dialectic complementarity between the debasement of reason as a mere calculation and the reactionary exaltation of the mythical and originary communitarian forms of life and values ("boden und blut").

Important resources for welfare like the social climate, the quality of human relationships, sociability, solidarity, generosity, and also to some extent social discipline, the capacity for collective cooperation and action, the social virtues of “truth, trust, gratitude” (Hirsch 1976), seem negatively correlated with growth "Because the individual behaviour has been increasingly oriented towards individual interest, instincts and habits based on communal attitudes and values has been lost" (Hirsch 1976). Polanyi (1944) called it the tendency of the market “to reduce society to a desert”. "As more and more relationships (...) come to be understood, by analogy, in contractual terms (...) the individual also finds himself in a world where nothing is permanent but where all human relationships are subject to cost/benefit recalculation by either party at any time" (Leijonhufvud 1995).

Up to this point, we have discussed some cultural foundations of the idea that growth generates negative externalities, and in the light of the foregoing discussion one may view it as a realistic hypothesis. In the model set out in Sections 2, 3 and 4 we shall ask how individuals react to increasing negative externalities, and we shall conclude that they react in a way that generates growth. But this too is an idea with a long and interdisciplinary history behind it. Among economists, it has perhaps been expounded most lucidly by Fred Hirsh (1976).

According to Hirsh, growth in advanced economies is largely due to an increase in defensive consumption, that is, the consumption induced by the negative externalities produced by growth, which is similar to the concept used here of substitute consumption. The notion of defensive consumption was then taken up in the debate on the corrections of GNP in order to improve it as a index of welfare (Shafik (1994), Musu and Siniscalco (1993). The literature on defensive consumption contains a large number of interesting examples,[11] but the idea that seems to inspire all authors, and Hirsh in particular, is that reactions to a situation of general decay may be very general[12]. Individuals can

[11] For instance, medical expenses to treat illnesses due to environmental deterioration or tranquilizers and sleeping pills, the consumption of which is closely correlated with noise pollution, soundproofing (double glazing, etc.), anti-pollution expenses, land reclamation, defence against crime. The demand for package holidays may also be considered sensible to deterioration of the local environment, or swimming pools can be considered substitutes for water quality deterioration. Typically, agents are able to escape the deterioration of the environment by deciding, for example, to buy a weekend cottage in pleasant surroundings or more simply by moving to a more comfortable city house. In any event, the limits of the concept of substitute are largely contiguous on those of psychological inquiry. What the reactions to psychological malaise and stress may be in terms of consumption is an open question. After all, even a ‘tamagotchi’ can be considered a substitute for affection.

[12] The econometric literature on defensive consumption displays a number of conceptual difficulties - evidenced, for example, by the variety of definitions of defensive expenditure - which derive in part from a failure to understand that the concept of defensive expenditure is a sub-case of the concept of substituted good (which is clearly codified). In the set of substitutes it is the sub-set of substitutes for environmental goods (i.e. for the free goods subject to negative externalities). In the opinion of these authors, however, it is difficult to give plausible statistical substance to the concept, due to the difficulty of identifying spending for defensive reasons among the items in the GNP, constructed on other criteria. The strategy followed is generally highly restrictive, in that only classified as defensive is spending which is certainly and wholly such: spending on environmental purification, on land reclamation, on pollution-related diseases. The estimates obtained are not negligible, but on the admission of the authors themselves they are enormously under-estimated.

For a growth model including defensive expenditures see Beltratti (1996). In the model the utility function of the representative agent is defined over consumption and effective environmental quality, obtained by the product between the stock of environment and defensive expenditures. In this model,the presence of defensive expenditures cannot generate a self-propelled process of growth, since (i) a rise in defensive expenditures does not stimulate economic activity by increasing labour supply (on the contrary,

compensate for deterioration in everything that is public with the wealth and concern for everything that is private, giving rise to the contrast typical of “affluent societies” (Galbraith’s (1968) well-known observation).

But if we give a more sociological connotation to the concept of negative externalities, we find that the idea that these are a necessary condition for growth has a long history behind it, and that this idea too is profoundly rooted in contemporary culture. It derives logically from the contention that the solidity of traditional cultures is an obstacle against growth (a concept also expressed as the need for cultural modernization); a contention argued in debate on the role of traditional culture that has involved sociologists, anthropologists and economists of development since the 1950s.

Before summing up this debate, we should clarify its logical implications. If traditional cultures are an obstacle to growth, their destruction and substitution with a system favourable to growth is a necessary condition for it to come about. This implies that the penetrative capacity of the cultural system appropriate to growth should be sufficient for it to impose itself on the traditional system. In other words, a necessary condition for growth is that the destructive capacity of growth itself on traditional culture should be strong enough. Expressed in economic terms, this entails that the negative cultural externalities generated by growth should be strong enough. This is the same logical core of the self-propelling mechanism on which the model that follows is based: the force of the destructive capacity of growth determines the expansionary capacity of the economic system.

The essential aspects of the debate can by clarified by starting with Schumpeter (1961) and his idea of the central role played by the entrepreneur in growth. An entrepreneur is a social deviant who acts out of selfishness. It is therefore essential for the formation of the entrepreneurial labour supply that such activity should take place in the context of cultural systems which accept it and encourage it. The point was already clear to Weber (1983) and Tawney (1955), with their analyses of the importance of religious systems for the birth of capitalism. The thesis that has been advanced since the 1950s by anthropologists, sociologists and economists of development can be viewed as another aspect of Weber and Tawney's argument: where traditional cultures do not provide a milieu favourable to growth, they raise obstacles against it.[13] This is not to imply, of course, that in those countries with a ‘cultural endowment’ more favourable to growth, cultural modernization has not brought the enormous social costs associated with the destruction of existing culture and institutions. Indeed the reverse has been the case, as we have seen. The point is that certain ‘cultural endowments’ prove to be impenetrable to the seeds of capitalist culture sown in those societies. In other words, capitalist culture fails to be sufficiently penetrating to destroy traditional culture, so that destructive action by the government is invoked (Sievers 1974).[14]

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it depresses capital accumulation, thus reducing future production), and (ii) the flow of use of the environmental asset is fixed (it does not depend on the level of production).

[13] See for example Boeke 1953, Sievers 1974, Hagen 1962. Anthropologists who are not of the opinion that traditional cultures obstruct growth are Geertz, M. Mead, Erasmus. We are indebted to Higgins (1969) for this treatment. The question of the entrepreneurial labour supply has been addressed by these authors as one aspect of the more general issue of the social acceptability of selfishness. Other important aspects concern the condemnation of usury, grid, the discrimination against women in the labour market, the role of caste systems. Also considered important for growth is a changed attitude towards risk in highly cautious traditional peasant societies.

[14] In this period the opinion spreads among development economists, that the strategy of the "development by displacement" of the traditional sector may be successful. These economists are

These arguments bear many similarities to those that contemporary historians and political scientists have used to explain the different level of development achieved by certain countries. Already in the preface to *Capital*, Marx (1872, 1932) attributed Germany's economic backwardness to the insufficient ability of capitalist production relations to penetrate pre-capitalist forms "with their array of social and political relationships". Which was essentially a matter of a failure to accomplish a "bourgeois revolution". These arguments have more recently been employed by C. Anderson (1967) and a number of neo-Marxist analysts to explain the economic backwardness of Latin America.[15]

Let us examine the economics of development in more detail. This discipline operates largely within a dual conceptual structure based on the modern/traditional antimony. Development, industrialization, and the urbanization connected with it, are viewed as the transition of an economy from the traditional sector to the modern one. Analysis of the determinants of this transition has concentrated on *push* and *pull* factors. The arguments of economists in particular (but also of sociologists and anthropologists) that have centred on push factors (see Williamson (1995) for a survey), echo many of the points made here. In effect the arguments expounded above support the claim that push factors are both important and necessary determinants of the passage between the two sectors. We refer to the decline of the cultures permitting the reproduction of the traditional institutions.

We now present the model.

2. **THE MODEL**

We consider an economy in discrete time with an infinite horizon. An equal number of identical households and firms operate in this economy.

The households

Population is constant. There is a large number J of households who have finite lifetimes: they have a strictly positive and constant probability ω, $0<\omega<1$, of dying in each period. Thus, the probability of dying in a certain period is assumed to be independent of the age of the individual; and it is also assumed that the mortality rate of a large group of households does not fluctuate stochastically even though each individual's lifespan is uncertain. This implies that at the end of each period a constant number $(1-\omega)J$ of households dies and is replaced by an equal number of newly born individuals.

The discounted sequence of utilities that the representative household expects during his/her lifetime is given by

$$\sum_{i=0}^{\infty} \theta^{i} U_{t+i}, \ \theta \equiv \zeta(1-\omega), \ 0<\zeta\leq 1, \qquad (1)$$

where U_{t+i} is the period utility function, and ζ is a time-preference parameter. Expectations are rational, in the sense that they are consistent with the true processes

fascinated by the beneficial effects exerted on the modern sector by the decline of the traditional sector (see Grabowsky and Shields 1996 for a critical reconstruction of the development by displacement strategy).

[15] According to A. Mayer (1981), the slow development of many European countries until the the First World War stemmed from a situation similar to that of Latin America: namely the cultural hegemony of the *ancien régime*. Gramsci (1949) and Sereni (1947) argued along similar lines as regards the weak development of Italy, which was due to a lack of "Jacobin energy" by the Italian bourgeoisie (especially to the absence of pressure for agrarian reform which, however, brings this point beyond the topic of this paper). Henry-Levy (1981) ascribed French economic backwardness until the Second World War to the culturial backwardness of the French bourgeoisie dominated by a mix of racist and proto-fascist nonsense.

followed by the relevant variables. The period utility function of the representative household is the following:

$U_t=\beta\ln(X_t)+\gamma\ln(C_{2t})+(1-\beta-\gamma)\ln(L_t)$, $\beta>0$, $\gamma>0$, $\beta+\gamma<1$, (2)

where X_t is the amount of services generated by some consumption activity, C_{2t} is an amount of the single good produced in the economy that is consumed in t, and L_t is leisure. We assume that:

$X_t=R_t+\delta C_{1t}$, $\delta>0$, (3)

where R_t is the stock of a resource to which all households have access for free in every period, and C_{1t} is the amount of the produced good that is used in t as a substitute for the resource. Hence X_t is the amount of a good that results from the sum of the endowment of the resource and a perfect substitute of it which is a produced good. Note that also C_{1t} -- as it is the case for C_{2t} -- is used for consumption purposes[16]. The interpretation is the following: the output can be used as a substitute for the free resource (C_{1t}) or to satisfy needs different from those satisfied by the resource (C_{2t}) (as examples of free resource and its substitute recall footnote 3). The parameter δ may be interpreted as a measure of the efficiency of C_{1t} as a substitute in consumption for the resource of common property.[17]

There is non-rivalry in the consumers' use of the resource R_t, from which no consumer can be excluded: it has the nonexclusive nature typical of a resource of common property that is not produced.

The total amount of time available to each household in every period is normalized to be one. Thus,

$L_t=1-H_t$, $0\leq H_t\leq 1$, (4)

where H_t are the units of time spent working in period t by the representative household.

The period budget constraint of the representative household is the following:

$C_{1t}+C_{2t}+I_t\leq W_tH_t+\pi_t$, (5)

where the single produced good is the numeraire of the system, I_t is the (gross) investment in real assets (capital) ,W_t is the wage rate per unit of time, and π_t are the firms' profits that the representative household receives as owner of the firms' real assets.

The motion of the capital stock owned by the representative household is governed by

$K_{t+1}=I_t+(1-\sigma)K_t$, $0<\sigma\leq 1$, K_0 given. (6)

For simplicity, we assume that individuals born in t inherit K_t from the households that have just died.[18]

The firms

There is a large number J of perfectly competitive firms. Each of them produces the single good Y_t according to the technology

$Y_t=K_t^{1-\alpha}(H_tN_t)^{\alpha}$, $0<\alpha<1$, (7)

where N_t is the number of workers employed in t.

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[16]The sum of two goods entering the utility function is a standard representation of two perfect substitute.

[17] Alternatively we can interpret (3) as an assumption of linearity of the technology adopted by the households to produce the services positively entering their utility function. In this case C_{1t} is the amount of the produced good that is combined with R_t to produce X_t and the parameter δ may be interpreted as a strictly technological parameter prescribing the quantity of a privately appropriable good that is necessary -- given the stock R_t -- to produce the amount of X_t desired by the consumers

[18] All the results of this model can be obtained by assuming that accumulation decisons are made taking care of infinite lived dinasties.

In each period, the representative firm must choose the combination of H_t and N_t that maximizes its profits π_t, which are given by

$$\pi_t=Y_t-W_tH_tN_t. \quad (8)$$

The resource

The resource R_t is subject to a spontaneous flow of renewal but it is damaged by the volume of economic activity:

$$R_{t+1}=-\rho JY_t+\xi R_t+A,\ \rho>0,\ 0<\xi<1,\ A>0,\ R_0 \text{ given.} \quad (9)$$

By interpreting R_t as an indicator of the quality in t of some environmental resource to which all households have access for free in every period, we can think of firms as freely disposing of their polluting waste because of the lack of property rights on the natural resource. Although a single firm's productive activity has a negligible impact on the environmental quality, the aggregate effect of firms' production in period t on R_{t+1} is not negligible and depends on both the technological parameter ρ and the number of producers J. The waste accumulated during the productive process is disposed of at the end of the period and damages the environment in the next period. In other words, the negative externality caused by each single firm is only intertemporal: (9) captures a productive technology whose negative inpact on the environment is not immediate. According to this interpretation, the level of economic activity remaining equal, a larger R_t in the present entails better environmental quality in the future.

Alternatively, one could propose a sociological interpretation of the concepts of resource and negative externalities: the expansion of market activities undermines the institutional and immaterial bases of a communitarian organization of life on which depends the individual welfare.

Market equilibrium conditions

Equilibrium in the product market and in the capital market implies, respectively:

$$Y_t=C_{1t}+C_{2t}+I_t, \quad (10a)$$

$$K_t^d = K_t^s. \quad (10b)$$

For equilibrium in the labor market, one needs:

$$H_t^d = H_t^s, \quad (10c)$$

$$J\,N_t^d = J, \quad (10d)$$

since all the households actively participate in the labor market.

3. **THE EQUILIBRIUM PATH UNDER LAISSEZ-FAIRE**

Derivation of the equilibrium path and the steady state of the economy

Solving the maximization problem of the representative firm and using (10), we obtain that along an equilibrium path

$$H_t^d = K_t\left(\frac{\alpha}{W_t}\right)^{1/(1-\alpha)}. \quad (11)$$

The condition (11) implies that at equilibrium

$$\pi_t = \pi(K_t, W_t) = (1-\alpha)K_t\left(\frac{\alpha}{W_t}\right)^{\alpha/(1-\alpha)}. \quad (12)$$

Considering (1)-(6), (10) and (12), we can solve the decision problem of the representative household by maximizing the Hamiltonian

$$\sum_{t=0}^{\infty}\theta^t\Big\{\beta\ln\Big[R_t+\delta(W_tH_t^s+\pi(K_t,W_t)-I_t-C_{2t})\Big]+\gamma\ln(C_{2t})+(1-\beta-\gamma)\ln(1-H_t^s)-$$
$$-\lambda_t\big[K_{t+1}-(1-\sigma)K_t-I_t\big]\Big\}$$

with respect to I_t, C_{2t}, H_t^s and K_{t+1}, and then by eliminating the multipliers λ_t and λ_{t+1}. Hence, an equilibrium path must satisfy the transversality condition

$$\lim_{t\to\infty}\frac{\theta^i K_t\beta\delta}{R_i+\delta[W_tH_t^s+\pi(K_t,W_t)-I_t-C_{2t}]}=0, \qquad (13)$$

the optimality conditions

$$\frac{W_t\beta\delta}{R_t+\delta[W_tH_t^s+\pi(K_t,W_t)-I_t-C_{2t}]}=\frac{(1-\beta-\gamma)}{1-H_t^s}, \qquad (14)$$

$$\frac{\beta\delta}{R_t+\delta[W_tH_t^s+\pi(K_t,W_t)-I_t-C_{2t}]}=\frac{\gamma}{C_{2t}}, \qquad (15)$$

and the Euler equation

$$\frac{\theta\big[(1-\sigma)+(1-\alpha)K_{t+1}^{-\alpha}(H_{t+1}^s)^{\alpha}\big]}{R_{t+1}+\delta[W_{t+1}H_{t+1}^s+\pi(K_{t+1},W_{t+1})-I_{t+1}-C_{2t+1}]}=\frac{1}{R_t+\delta[W_tH_t^s+\pi(K_tW_t)-I_t-C_{2t}]}. \qquad (16)$$

Together with (6) and (9)-(12), (14)-(16) can be used to obtain the system of difference equations in the labor-capital ratio D_t, in K_t and in R_t governing the evolution of this market economy:

$$\Psi(D_{t+1},K_{t+1},D_t,K_t)=\frac{\theta\big[(1-\sigma)+(1-\alpha)D_{t+1}^{\alpha}\big]}{D_{t+1}^{\alpha-1}(1-D_{t+1}K_{t+1})}-\frac{1}{D_t^{\alpha-1}(1-D_tK_t)}=0,\ D_t\equiv\frac{H_t}{K_t}, \qquad (17)$$

$$\Phi(K_{t+1},D_t,K_t,R_t)=K_{t+1}-(1-\sigma)K_t-\frac{(R_t+\delta D_t^{\alpha}K_t)}{\delta}+\frac{\alpha(\beta+\gamma)D_t^{\alpha-1}(1-D_tK_t)}{1-\beta-\gamma}=0, \qquad (18)$$

$$\Omega(R_{t+1},D_t,K_t,R_t)=R_{t+1}-A-\xi R_t+\eta D_t^{\alpha}K_t=0,\ \eta\equiv\rho J, \qquad (19)$$

where the equilibrium values of H_t, C_{1t}, C_{2t} and I_t can be written as functions of D_t, K_t and R_t:

$$H_t=H(D_t,K_t)=D_tK_t, \qquad (20)$$

$$C_{1t}=C_1(D_t,K_t,R_t)=\frac{\delta\beta[D_t^{\alpha}K_t-I(D_t,R_t)]-\gamma R_t}{\delta(\beta+\gamma)}, \qquad (21)$$

$$C_{2t}=C_2(D_t,K_t,R_t)=\frac{\delta\gamma[D_t^{\alpha}K_t-I(D_t,R_t)]+\gamma R_t}{\delta(\beta+\gamma)}, \qquad (22)$$

$$I_t=I(D_t,K_t,R_t)=\frac{(R_t+\delta D_t^{\alpha}K_t)}{\delta}-\frac{\alpha(\beta+\gamma)D_t^{\alpha-1}(1-D_tK_t)}{1-\beta-\gamma}=0. \qquad (23)$$

Solving the system (17)-(19) for $D^*=D_{t+1}=D_t$, $K^*=K_{t+1}=K_t$ and $R^*=R_{t+1}=R_t$, we obtain the steady state (D^*, K^*, R^*), where

$$D^*=\left\{\frac{1-\theta(1-\sigma)}{\theta(1-\alpha)}\right\}^{1/\alpha}, \qquad (24)$$

$$K^*=\frac{(\beta+\gamma)\alpha\delta(D^*)^{\alpha-1}-(1-\beta-\gamma)\,A/(1-\xi)}{(1-\beta-\gamma)\left[\left(\delta-\eta/(1-\xi)\right)(D^*)^{\alpha}-\sigma\delta\right]+(\beta+\gamma)\alpha\delta(D^*)^{\alpha}}, \qquad (25)$$

and

$$R^*=\frac{A-\eta K^*(D^*)^{\alpha}}{1-\xi}. \qquad (26)$$

By linearizing the system (17)-(19) around the steady state, one may check that for reasonable parameters' values the linearized system exhibits saddle-path stability: for initial values of K_t and R_t in a neighborhood of the steady state, the linearized system characterizes a unique path converging to (D*, K*, R*)[19].

Steady-state effects of changes in the discount rate and in the magnitude of the negative externalities caused by the economic activity

It is easy to check that $\frac{\partial K^*}{\partial \theta}>0$: it is not surprising that capital accumulation is boosted as the future is discounted less heavily by the households. Consistently, we have that $\frac{\partial D^*}{\partial \theta}<0$: the increased capital accumulation lowers the steady-state labor-capital ratio. As a consequence, $\frac{\partial Y^*/H^*}{\partial \theta}>0$, since $\frac{Y^*}{H^*}=(D^*)^{\alpha-1}$: at steady state labor productivity is raised because of the lower labor-capital ratio. Note that labor productivity increases together with both steady-state output per head and labor. Indeed, one may easily check that $\frac{\partial Y^*}{\partial \theta}>0$, where $Y^*=K^*(D^*)^{\alpha}$. In addition, one can show that $\frac{\partial H^*}{\partial \theta}>0$[20]: on one hand, the larger capital stock leads the firms to increase their labor demand at any wage level; on the other hand, the deterioration of R* due to the higher level of activity induces the households to increase their labor supply at any wage level. The individual tendency to react to a deterioration of the free resource by increasing their defensive use of the produced good is reflected by the fact that $\frac{\partial C_1^*/C_2^*}{\partial \theta}>0$: as a higher steady-state level of economic activity is made possible by the increased capital accumulation, consumers devote a larger proportion of their total expenditure to offset the negative impact on X_t due to the deterioration of the free resource. In other words, the households' expenditure in C_1^* is a larger share of total consumers' expenditure within an economy whose steady-state output is larger.

It is often argued that the welfare of the future generations would be increased if the present generations gave less weight to their current well-being, so as to save more and to leave their descendants with more productive assets. Typically, this is not the case in the set-up proposed here, where the steady-state level of utility tends to decrease as the future is discounted less heavily by the households: for reasonable parameters values, one can

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[19] Let $\alpha=\beta+\gamma=2/3$, $A=\sigma=.25$, $\delta=1.2$, $\xi=.5$ and $\theta=.8$. With these parameters' values, the characteristic roots of the linearized system

$$D_{t+1} - D^* = \frac{(\Psi_{K_{t+1}}\Phi_{D_t} - \Psi_{D_t})(D_t - D^*) + (\Psi_{K_{t+1}}\Phi_{K_t} - \Psi_{K_t})(K_t - K^*) + \Psi_{K_{t+1}}\Phi_{R_t}}{\Psi_{D_{t+1}}}$$

$$K_{t+1} - K^* = -\Phi_{D_t}(D_t - D^*) - \Phi_{K_t}(K_t - K^*) - \Phi_{R_t}(R_t - R^*)$$

$$R_{t+1} - R^* = -\Omega_{D_t}(D_t - D^*) - \Omega_{K_t}(K_t - K^*) - \Omega_{R_t}(R_t - R^*),$$

are the following: $\rho_1=2.0749$, $\rho_2=.601067+.15216i$ and $\rho_3=.601067-.15216i$. These values imply that along the unique saddle path converging to ($D_t=D^*$,$K_t=K^*$,$R_t=R^*$) the linearized system exhibits damped stepped fluctuations.

[20] One can check that $\frac{\partial K^*}{\partial D}\frac{D^*}{K^*}<-1$ is satisfied, thus entailing $\frac{\partial H^*}{\partial \theta}>0$, since $H^*=K^*D^*$.

show that $\frac{\partial U^*}{\partial \theta}<0$[21]. It should be emphasized that the lowering of the steady-state level of utility goes together with a higher steady-state level of economic activity: the beneficial effect on individual welfare due to the availability of more output to be used in consumption is more than offset by the negative effect on individual well-being due to the increased work effort and to the deterioration of the free resource. Moreover, as the households care less of the present, their awareness that the individual efforts to improve the future well-being will result in a deterioration of the free resource reinforces their desire to accumulate more, so as to dispose of additional income in the future and to buy more of the good that can substitute for the deteriorated resource. Capital accumulation and economic growth is fed by the individuals' anticipation that the uncoordinated efforts on the part of all the households to guarantee a better future to themselves and their descendants will exacerbate the welfare problem due to the negative externalities caused by the production process.

As this welfare problem becomes more serious, either because individual production is more detrimental for the free resource (ρ is larger) or because the number J of households and producing firms is larger, steady-state output tends to increase while steady-state utility tends to decrease. Indeed, one can see by inspecting (25) and by considering (7), (20) and (24) that $\frac{\partial K^*}{\partial \eta}>0$ and $\frac{\partial H^*}{\partial \eta}>0$, entailing $\frac{\partial Y^*}{\partial \eta}>0$. Furthermore, one can check for reasonable parameters' values that $\frac{\partial U^*}{\partial \eta}<0$ holds[22]. Technologies that have a larger impact on the free resource generate more economic growth and a higher level of per-capita output by inducing the households to save more and to work harder in order to counterbalance the more accentuated deterioration of the free resource. The same is true as total population increases: the prediction that a larger population gives a positive contribution to the growth of per-capita output is obtained by the model, but without relying on economies of agglomeration or on the presence of a larger number of agents, each of them producing a negligible externality in favour of all the others.[23] As a result of

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[21] For having $\frac{\partial U^*}{\partial \theta}<0$ one needs $(\beta+\gamma)(1-D^*K^*)(\delta-\frac{\eta}{(1-\xi)})(1-\alpha)(D^*)^{\alpha-1}+$
$+(\beta+\gamma)(1-D^*K^*)\frac{\partial K^*}{\partial D^*}\frac{\delta\sigma}{K^*}<(\frac{\partial K^*}{\partial D^*}\frac{D^*}{K^*}+1)(\beta+\gamma)(1-D^*K^*)(\delta-\frac{\eta}{(1-\xi)})(D^*)^{\alpha-1}-$
$-(\frac{\partial K^*}{\partial D^*}\frac{D^*}{K^*}+1)(1-\beta-\gamma)[K^*(D^*)^{\alpha}(\delta-\frac{\eta}{(1-\xi)})-\delta\sigma K^*+\frac{A}{(1-\xi)}]$ Evaluating (14) at steady state and taking into account that $\frac{\partial K^*}{\partial D^*}\frac{D^*}{K^*}<-1$, one may check that
$\alpha\delta\geq(\delta-\frac{\eta}{(1-\xi)})$ and $\sigma\theta\delta\geq[1-\theta(1-\sigma)](\delta-\frac{\eta}{(1-\xi)})$ are sufficient conditions for $\frac{\partial U^*}{\partial \theta}<0$.

[22] Since $\frac{\partial U^*}{\partial \eta}=\frac{\partial K^*}{\partial \eta}\{(\beta+\gamma)[\frac{(D^*)^{\alpha}(\delta-\frac{\eta}{(1-\xi)})-\delta\sigma}{(D^*)^{\alpha}(\delta-\frac{\eta}{(1-\xi)})K^*+\frac{A}{(1-\xi)}-\delta\sigma K^*}]-\frac{(1-\beta-\gamma)D^*}{1-D^*K^*}\}$
$-\frac{(\beta+\gamma)K^*(D^*)^{\alpha}/(1-\xi)}{(D^*)^{\alpha}(\delta-\frac{\eta}{(1-\xi)})K^*+\frac{A}{(1-\xi)}-\delta\sigma K^*}$, one can evaluate (14) at steady state to conclude that
$\alpha\delta\geq(\beta+\gamma)(\delta-\frac{\eta}{(1-\xi)})$ is also sufficient for having $\frac{\partial U^*}{\partial \eta}<0$.

[23] In models of technological change (Grossman and Helpman 1991; Aghion and Howitt 1992), an increase in population spurs technological change and economic growth by increasing the size of the

the individual efforts to escape the negative effects of the deterioration of R_t by saving more and working harder, the resource will be even more harmed and the steady-state utility of the representative agent is lowered in spite of the increased consumption of the produced good.

4. **THE PARETO-OPTIMAL PATH**

Derivation of the steady state consistent with the Pareto-optimal path

To derive the path selected by a benevolent planner which takes into account the impact of the productive activities on the free resource, one can maximize the following Hamiltonian

$$\sum_{t=0}^{\infty} \theta^t \{\beta \ln[R_t + \delta(K_t^{1-\alpha} H_t^{\alpha} - I_t - C_{2t})] + \gamma \ln(C_{2t}) + (1-\beta-\gamma)\ln(1-H_t) -$$

$$-\lambda_t[K_{t+1} - (1-\sigma)K_t - I_t] - \mu_t[R_{t+1} + \eta K_t^{1-\alpha} H_t^{\alpha} - A - \xi R_t]\}$$

with respect to H_t, I_t, C_{2t}, K_{t+1} and R_{t+1}, and then one can eliminate the multipliers λ_t, λ_{t+1}, μ_t and μ_{t+1}. Hence, an optimal path must satisfy the transversality conditions

$$\lim_{t\to\infty} \theta^t K_t \frac{\beta\delta}{R_t + \delta(K_t D_t^{\alpha} - I_t - C_{2t})} = 0, \qquad (27)$$

$$\lim_{t\to\infty} \theta^t R_t \left[\frac{\alpha\beta\delta(1-D_tK_t) - D_t^{1-\alpha}(R_t + \delta(K_tD_t^{\alpha} - I_t - C_{2t}))(1-\beta-\gamma)}{\eta\alpha(1-D_tK_t)(R_t + \delta(K_tD_t^{\alpha} - I_t - C_{2t}))}\right] = 0; \qquad (28)$$

the optimality condition

$$\frac{\beta\delta}{R_t + \delta(K_tD_t^{\alpha} - I_t - C_{2t})} = \frac{\gamma}{C_{2t}}; \qquad (29)$$

and the Euler equations

$$\frac{\theta\beta\delta(1-\sigma)}{R_{t+1} + \delta(K_{t+1}D_{t+1}^{\alpha} - I_{t+1} - C_{2t+1})} + \frac{(1-\beta-\gamma)(1-\alpha)\theta D_{t+1}}{\alpha(1-D_{t+1}K_{t+1})} = \frac{\beta\delta}{R_t + \delta(K_tD_t^{\alpha} - I_t - C_{2t})}, \qquad (30)$$

$$\frac{\theta\beta(\eta + \xi\delta)}{\eta(R_{t+1} + \delta(K_{t+1}D_{t+1}^{\alpha} - I_{t+1} - C_{2t+1}))} - \frac{(1-\beta-\gamma)\theta\xi D_{t+1}^{1-\alpha}}{\alpha\eta(1-D_{t+1}K_{t+1})} = \frac{\beta\delta}{\eta(R_t + \delta(K_tD_t^{\alpha} - I_t - C_{2t}))} -$$

$$- \frac{(1-\beta-\gamma)D_t^{1-\alpha}}{\alpha\eta(1-D_tK_1)}. \qquad (31)$$

It is straightforward from (29) that along an optimal path

$$C_{2t} = \frac{\delta\gamma(D_t^{\alpha}K_t - I_t) + \gamma R_t}{\delta(\beta+\gamma)}, \qquad (32)$$

from which we can obtain that for optimality

$$C_{1t} = \frac{\delta\beta(D_t^{\alpha}K_t - I_t) - \gamma R_t}{\delta(\beta+\gamma)}. \qquad (33)$$

Solving the system (6), (9) and (29)-(32) for $D^\circ=D_{t+1}=D_t$, $K^\circ=K_{t+1}=K_t$, $R^\circ=R_{t+1}=R_t$ and $I^\circ=I_{t+1}=I_t$, we obtain the steady state (D°, K°, R°, I°), where

$$D^\circ = D * F^{1/\alpha},\ F \equiv \frac{\delta}{\left(\delta - \theta\eta/(1-\theta\xi)\right)}, \qquad (34)$$

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market, because the cost of inventing a new technology is independent of the number of people who use it. According to Kuznets (1960) an increase in population boosts technological progress by favouring intellectual contacts among people and labour specialization. In this way greater population density can explain the disproportionally larger number of innovation in cities.

$$K^\circ = \frac{(\beta+\gamma)\alpha(D^\circ)^{\alpha-1}\left(\delta - \theta\eta/(1-\theta\xi)\right) - (1-\beta-\gamma)A/(1-\xi)}{(1-\beta-\gamma)\left((D^\circ)^{\alpha}\left(\delta - \eta/(1-\xi)\right) - \sigma\delta\right) + (\beta+\gamma)\alpha\delta(D^*)^{\alpha}}, \qquad (35)$$

$$R^\circ = \frac{A - \eta K^\circ (D^\circ)^{\alpha}}{1-\xi}, \qquad (36)$$

$$I^\circ = \sigma K^\circ. \qquad (37)$$

Comparison between the "laissez-faire" and the Pareto-optimal solutions

By inspecting (34) and by comparing (25) and (35), one can see that $D^\circ > D^*$ and $K^\circ < K^*$: the steady-state consistent with the optimal plan exhibits a higher labor-capital ratio (hence, a lower labor productivity) and a smaller capital stock than the steady-state associated with "laissez-faire". Hence, labor productivity is lower in the presence of a benevolent planner. This notwithstanding, one can easily check that $H^\circ = D^\circ K^\circ < H^* = D^* K^*$: the planner would choose an allocation of resources such that the individuals work less than in a pure market economy. Obviously, the combination of a reduced capital accumulation and a shorter working time chosen by the planner entails $Y^\circ = K^\circ (D^\circ)^{\alpha} < Y^* = K^* (D^*)^{\alpha}$: steady-state output is larger under "laissez-faire". Capital accumulation and individual working time are reduced because the planner would endogenize the intertemporal externalities caused by the productive activities of the households: it would prefer to raise the lifetime well-being of the households by safeguarding the free resource, whose level sustainable in the long run (its steady-state level) is kept higher than under "laissez-faire". The pure market economy is characterized by undesirable growth: the Pareto-inefficient excess of capital accumulation and work effort leads the economy toward a steady state exhibiting a too high level of economic activity.

As individuals' preferences and life expectancies are such that the future is discounted less heavily (θ increases), the level of activity associated with the Pareto-efficient steady state tends to become a smaller fraction of the steady-state level of economic activity under "laissez-faire": for reasonable parameters' values, one may check that $\frac{\partial Y^*/Y^\circ}{\partial\theta} > 0$[24]. An increase of θ determines a tendency of the differential between Y^* and Y° to increase more than proportionally than Y^*. This is because, as individuals care more of the future, they can react in a "laissez-faire" regime only by accumulating more capital, thus boosting future production; while in the presence of a benevolent planner the increased concern for the future is also reflected in a more "conservationist" use of the free resource. Indeed, the fact that the benevolent planner can overcome the market failure due to the lack of coordination among the individual actions prevents the steady-state utility of the representative household from decreasing with the planner's degree of concern for the future. This can be seen by considering that

$$\lim_{\theta\to 1} U^\circ = U^{GR},$$

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[24] Sufficient condition for having $\frac{\partial Y^*/Y^\circ}{\partial\theta} > 0$ is that $[\frac{\eta(\beta+\gamma)\alpha\delta(D^*)^{\alpha-1}}{(1-\theta\xi)^2\left(\delta - \theta\eta/(1-\theta\xi)\right)} - \frac{\eta(1-\beta-\gamma)A/(1-\xi)}{(1-\theta\xi)^2\left(\delta - \theta\eta/(1-\theta\xi)\right)}][\frac{A(1-\beta-\gamma)}{1-\xi} + (1-\alpha)(\beta+\gamma)\delta(D^*)^{\alpha-1}F^{-1/\alpha}] > \frac{A(1-\beta-\gamma)(\beta+\gamma)\delta}{D^*(1-\xi)\theta^2}(1 - F^{-1/\alpha})$.

where U^{GR} is the "golden rule" level of steady-state utility, i.e. the utility level associated with the steady state in which the utility of the representative individual is maximized[25].

5. WHY IS THE CITY "THE ENGINE OF GROWTH"?

The model suggests an explanation of certain phenomena. In this section we shall offer an explanation of why an urban-industrial society generates growth, while in the next we shall explain why a rural society may urbanize itself and undertake an industrial transition.

What we want to explain is why "the city is the engine of growth". This well-known statement by the World Bank is supported by the evidence of a strong cross-country correlation between rate of urbanization and per-capita income.

The idea that urbanization is a central factor in development has an extremely long history. In the almost unanimous view of economists, sociologists, historians and demographers, urbanization has been central to all development. It was so in the British Industrial Revolution, and the European Industrial Revolutions that followed it, and likewise in the industrial revolutions of the LDCs since the Second World War. There exist many (and not mutually exclusive) explanations for the link between urbanization and development [26]. The most frequent of them are couched in terms of agglomeration economies and of the higher savings rates that cities exhibit. These explanations are flanked by sociological explanations of the changed attitude towards risk induced by the city, compared with the strong risk-aversion of peasant societies.

The model suggests a different interpretation based on the following predictions: (i) dynamically stable steady states will exhibit a higher activity level and capital stock as the population and the impact of production on environment become greater; (ii) at any point along a growth path, a shock which reduces the endowment of the resource will generate a higher activity level.

The point is that in an urban setting, the per-capita endowment of environmental goods tends to be relatively low, while the reverse holds for the impact of production on the resource, which is a technological parameter. This latter point mainly relates to the urban location of industry. But it also relates to the environmental impact of consumption as well as of production. The city is in fact the core of the diffusion of consumption technologies with high environmental impact (consider packaging, for example). Hence, from the point of view of the predictions of the model, cities function as large-scale generators of labour supply and accumulation. Therefore our point of view can explain why cities have higher saving rates (Williamson 1995 for another explanation and for a review of the explanations of this phenomenon).

Numerous examples can be cited to support the claim that the per-capita endowment of environmental goods is relatively low in urban environments. In fact, a key reference for substitute consumption is to the costs of exploiting leisure time, of which urban life is

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[25] $U^{GR}=U(H^{GR},K^{GR})$ can be obtained by solving $\max_{H,K} U(H,K)$, where

$$U(H,K) = (\beta+\gamma)\ln\left(\delta(K^{1-\alpha}H^{\alpha} - \sigma K) + A/(1-\xi) - \eta K^{1-\alpha}H^{\alpha}/(1-\xi)\right) + (1-\beta-\gamma)\ln(1-H) + V,$$

and V is a constant whose value depends on the parameters. The values of H and K solving this maximization problem are such that $K^{GR} = \lim_{\theta\to 1} K^{\circ}$ and $H^{GR} = K^{GR}D^{GR}$, where $D^{GR} = \lim_{\theta\to 1} D^{\circ}$.

[26] Looming over most explanations is the enormous implication that if you are looking for industry its address is the city. This implication also informs this work.

a paradigmatic example. Cities are places built for work, where low-cost opportunities are extremely rare, beginning with the scarcity of places where people can meet.[27] This is evidenced by the distress of the categories of the population with the most leisure: the elderly and children.[28] From the point of view of leisure, cities have the advantage of offering a wide variety of costly entertainment, and the symmetrical disadvantage that cheap entertainment is difficult to find. In any case, the prolonged enjoyment of leisure (weekends, holidays) takes place as much as possible outside the city. The city defined as a space in which it is extremely difficult to find free enjoyment, induces a separation between the places of work and leisure which creates costs.[29]

This argument, beside explaining why the city is the engine of growth, supports the view that problems of sustainability of growth from an environmental and a social perspective have primarily an urban source. This is true not only because the urban economic activities produce relevant negative externalities but also because they are associated with an inefficiently high rate of physical capital accumulation and environmental resources decumulation.

6. AN EXPLANATION OF DEVELOPMENT

In this section we illustrate how the model suggests an explanation for industrial revolutions. In other words, while in the previous section we explained why an urban-industrial society generates growth, in this one we explain why a rural society may urbanize itself and undertake the transition to an industrial society, i. e. development..

Development economics operates largely within a dual conceptual structure based on the modern/traditional antimony. This is reflected geographically in the antimony between the city and the countryside, and sectorally between industry and agriculture. Development, industrialization, and the urbanization connected with it, are viewed as the transition of an economy from the predominance of the traditional sector to that of the modern one.

It is possible to interpret the model so as to provide an explanation for such a transition. The resource is the natural, as well as institutional and non-material, basis of the communal organization of the economy on which every form of traditional society is

[27] Of relevance here is the fact that loneliness is largely an invention of advanced societies. Moreover, the massive growth of ''home entertainment''(TV, video recorders, stereos, PCs, CD-Roms, etc.) may be a reaction against the difficulty of finding low-cost places to meet.

[28] Also the costs of bringing up children in an urban environment can be considered to be substitute consumptions. Urban living has generated a radical change in patterns of child development, dramatically reducing opportunities for children to gain experience independently of their parents. The city is a dangerous environment, especially because of the traffic, and children cannot be left free, but must be constantly supervised by adults. In this respect, also the costs of child-minding can be regarded as engendered by growth, i.e. as substitute consumptions. These, however, are poor substitutes, because they also involve the psychological costs to the children of their dependence on adults, and the stress suffered by the parents in bringing up children in an adverse environment. Perhaps one of the factors responsible for the declining birth-rate in the advanced countries is this growth in costs, psychological as well. For similar reasons, the costs of caring for the elderly can be considered substitute consumptions. The city forces the elderly into dependence, and it drastically reduces their opportunities to establish autonomous social relationships.

[29] Public and private spending on derence against crime can also be regarded as consumption which substitutes for the ‘safety’ that tends to be scarce in cities.

founded. It furnishes individuals with welfare that does not derive from the markets. The expansion of market activities undermines this basis, compelling individuals to satisfy their needs by increasing their participation in the market sector of the economy. This in turn leads to a further enlargement of the sphere of market relationships. [30] Anthropologists, historians, sociologists and economists have often emphasized how the development of cities and industries is closely related to the decline of traditional institutions. [31]

An implication of the model is that—other things being equal—labor supply increases as negative externalities become more relevant. This can contribute to explain stylized facts. Indeed, the idea that a mobilization of human resources is an essential feature of the industrial revolutions has long been a central concern of development theory (Lewis 1954). The reason is obvious: the mobilization of human resources has been an empirical regularity in all industrial revolutions, from Britain's to that of the 'Asian Tigers'.[32] This factor is so important that there are cases in which industrial take-off has been due to a large extent to the mobilization of human resources towards market activities (Krugman (1995).

Lewis provided the main explanation of the expansion of the labour market. In Lewis' model, development is the absorption of a labour surplus in the rural sector, viewed as a vast area of under-employment. Hence, development of the modern sector can take place without draining productive labour from the rural sector, and growth implies an increase in the supply of labor to be employed in productive activities.

However it is equally evident that a high level of labour employment (either as time as well as effort) is a key factor in the economic success of the advanced countries, and we shall return to this point in the next section. Nevertheless human resources mobilization has been largely ignored by the neoclassical growth literature, which generally considers the labour supply to be exogenous[33]. The reason is that this literature concentrates on other determinants of growth, such as capital accumulation and technical progress. Indeed, although it is intuitive (as well as evident) that, besides patience (accumulation) and ingenuity (technical progress), the virtues that generate growth also comprise work, no neoclassical answer has been yet given to the question: what factors determine whether

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[30] This explanation of development and urbanization is not necessarily incompatible with the others, but viewed from this standpoint certain facts assume different guise. For example, the Dickensian phase of the urban slums, with which all industrial revolutions are associated, appears to be not an unfortunate side-effect but as a fundamental part of the industrial transitions.

[31] See for example Polanyi (1944). Among economists we can indicate Hardin G., (1994), Larson B. A. and Bromley D. W., (1990), Anderson T. L. (1982), Bromley D. W. and Chapagain D. P. (1984), Brown (1991).

[32] As regards the Industrial Revolution the reference is to studies on the formation of the industrial labour supply associated with the "enclosures". We shall return to this point below. As regards the "Asian Tigers", many of them belong to the large group of case-studies for which human resources mobilization plays a crucial role in growth. In these countries, economic take-off is associated - from the point of view of the labour market - with rates of activity and dependent employment that in many cases have doubled in the space of ten years.

[33] Note that even the models of Lucas (1988) and Romer (1986) admit endogenous growth only if leisure is not a choice variable. See Solow (1995) and M. Baldassarri, G. Moscarini, (1992).

or not such mobilization actually comes about?[34] Our answer is that the main factor is the level of negative externalities. Thus we provide an explanation alternative to the one offered by the main development models, where the 'pull' factors play a dominant role.

7. A SUGGESTION FOR INTERPRETING THE INDUSTRIAL REVOLUTION

To recapitulate, the model's predictions are that shocks which raise the level of negative externalities, of the population, or which reduce the endowment of the resource, may trigger accumulation and growth.[35] In this section we shall show how these predictions may suggest an interpretation of the English Industrial Revolution.

The Industrial Revolution exhibits a shock on all these three factors which engenders growth. Besides the population increase that preceded the Industrial Revolution, the effect of the technological shock should also be obvious: it determined an increase in the environmental impact of production. Moreover, an increase in the level of negative externalities may have been due to the slow expansion of the market system in the centuries preceding the Industrial Revolution which may have undermined the institutions of traditional agriculture.

As regards the endowment of environmental goods, the negative shock on their level can be linked to the 'enclosures', the process whereby the private property of land was enlarged. The enclosures broke up the communal institutions of land use and deprived vast numbers of the rural population of their means of subsistance, uprooting them from agricultural under-employment and forcing them into urbanization or vagabondage. In our terms, the enclosures constituted a collapse of free consumption, and it is widely recognized by historians that they were a precondition for the formation of an industrial workforce.

8. LABOUR SUPPLY AND ACCUMULATION IN THE ADVANCED COUNTRIES

We have said that an increase in negative externalities increases the labour supply. This prediction, which in the previous two sections was applied to the Industrial Revolutions, may also give some insights to explain certain phenomena in the advanced countries.

What evidence is there for a relation between labour supply and technical progress in these countries? An empirical regularity seems to be that high labor productivity is always associated with a highly developed labour market. It is evident, in fact, that the large-scale use of human resources has been a key factor in the economic success of the advanced countries, where work rhythms and effort are relatively high,

[34] Neoclassical growth theory was never very interested in explaining the the labour supply mobilization. This is probably one of the reasons of its slow penetration into development theory.

[35] Note that the prediction that population increase will raise per capita income is entirely consistent with the evidence provided by Kremer (1993), which confirms the positive correlation between population density and growth. However our explanation of this findings emphasises the increase in negative externalities due to a larger population, rather than the positive externalities stressed by models of endogenous technological change.

work experience generally absorbs much of individual energy, and life is generally hurried. It is also evident that employment remains high even in the presence of labor productivity increases. In two centuries of industrial history, the working day has been reduced by (approximately) half, but labor productivity (and income) have increased hundredsfold. In particular, in the last few decades in Europe and the USA, despite the prolonged expansion of productivity, there has only been a very weak tendency towards any reduction in working day, and productivity increases have almost exclusively given rise to increases in income. Moreover the very slight reduction in daily working hours has been more than compensated by the growing female participation to the labor market, which has generally led to an increase in the total worked hours normalized by the working age popolation. [36]

An explanation of this empirical regularity is one of the fundamental explanations that a theory of growth must provide. It is not obvious, in fact, that in a model in which time is a control variable there will be growth if there is accumulation. Individuals may use labor productivity gains to increase their leisure. Therefore, assuming an exogenous labour supply amounts to assuming exactly one of the elements that one must explain: the fact that the increases in labour productivity generated by accumulation (and by technical progress) are not used to augment leisure but to increase production, If the reverse happened, growth would evidently not occur. So how can this phenomenon at the basis of growth be explained? If we consider markets to be complete and well-functioning then obviously the explanation can only be that individuals have a very low preference for leisure. But this explanation fits badly with the convincing evidence that the scarcity of free time is one of contemporary man's crucial problems.

The explanation we suggest is the following: a coordination failure generates excessive use of labour (as well as of free resources) in the presence of labour productivity gains generated by capital accumulation. Furthermore, steady-state labour supply increases as the negative externalities caused by production become more important. Our suggestion is that the diffusion of industrialization and urbanization can be responsible for the high labour supply in the presence of high labour productivity.

9. DISCOUNT RATES, ACCUMULATION, SUSTAINABLE GROWTH.

In contrast with the standard results in the presence of a renewable resource, we have that the steady-state welfare of the representative household improves as individuals discount more heavily the future. This is because in this case individuals accumulate less physical capital, thus causing a smaller impact on the environmental resource and leaving a larger endowment of it to future generations.

We want to discuss the implications of this result for the problems of sustainable growth. The model predicts that under laissaz-faire a lower discount rate worsens the well-being of the future generations because the environmental asset, in contrast with physical capital, cannot be privately accumulated. Facing an anticipated deterioration of the environmental asset, each agent protect him/herself (or his/her descendents) by

[36] In any event, even at the level of the individual worker, doubts can be raised over the fact that the sign of the variation in the labour supply is negative, if the reduction in working hours is compared with the apparent tendency for effort to increase. Quantification of the role played in growth by increased effort is problematic. In fact, no quantitative data are available, given that these increases are included in productivity increases. In any case the labour supply in the model described above - expressed in terms of working time - can be substituted by effort without altering the results.

accumulating capital, thus contributing to keep high the level of production and to reduce the quality of the environment. The agents' attempt to safeguard their future welfare on an individual basis causes a reduction of all agents' long-term well-being as an unintended result of their individual strategies.

This result reverses the traditional environmentalist explanation of the problems of sustainability based on the selfishness of the present generation, that is on the too high level of the discount rate.[37] This explanation suffers of a logical inconsistency due to the fact that it is incompatible with the existence of accumulation. One cannot argue that economic growth depends on the accumulation of productive assets, which is boosted by a low rate of time preference, claiming in the same time that the problems of social and environmental sustainability, which are exacerbated by high growth rates, are made more serious by a high discount rate. According to this work, the problem is not the intergenerational conflict, but the coordination failure among individual belonging to the present generations. The main implication is that the more individuals are concerned for the future, the more they will worsen the prospects of future generations. The cause of the undesired long-term outcome emerging under laissez-faire in the absence of a market for the environmental asset is the lack of institutions allowing individuals to coordinate their conduct in the face of the (both present and anticipated) deterioration of the environment, and not the excessively high discount rate.

10. CONCLUSION: GROWTH AS A COORDINATION FAILURE

This section is devoted to discussion of the welfare implications of the model.

This model suggests that growth is associated to a change in consumption patterns. During the growth process, agents increasingly derive welfare from private rather than common consumptions. This conclusion may strike sociologists as familiar, but it is in sharp contrast with the traditional view that increasing quantities of goods become available as growth proceeds. The image is one of luxury goods which become standard goods for the next generation, and absolute needs for the one which follows thereafter. The model suggests that this tells only part of the story, since the other part concerns free goods which progressively become costly ones. The point is an obvious one in an environmental interpretation of the concept of free resource: meadows, woods, clean beaches, unpolluted air and water, silence, and so on, are all examples of free goods which have become scarce and costly as growth has proceeded. A feature shared by the advanced economies is that, in order to obtain what was a free good thirty or forty years ago, agents must purchase a house in an exclusive area in the countryside or at the seaside, or an expensive holiday in some tropical paradise, etc. However, the evidence also seems to support a sociological interpretation of free goods, given that many of them relate to social relations and seem to grow scarcer with growth. With this broader interpretation in mind, the concept of substitute may help to explain changes in lifestyles and in patterns of consumption.

The growth mechanism described above does not entail that growth is necessarily undesirable. Although it is based on a destructive process, the substitution that it implies of diminishing free goods may generate Pareto-improvements. In any event, growth is fed by coordination failures. This is shown by the fact that the optimal steady

[37] See Pearce D. and Markandya A.(may 1988), Barry B, 1977, Goodin R. 1982, Parfit D.,1983, Lind R. (1986), Page T. (1977),

state activity level is positive and lower than the market steady state level. This implies that in an economy of this kind the optimal activity level is not zero: up to a certain level, sacrifice in terms of the environmental good is more than off-set by the increase in production, and this is why growth is not necessarily undesirable. But it also implies that, beyond that level, welfare decreases monotonically with the higher steady state levels of activity that are generated by a laissez-faire economy. Hence, beyond the optimal activity level, growth is fed by Pareto-worsening coordination failure; that is, it is generated by an excessive employment of labour and environment. This coordination failure is obviously due to market incompleteness: a missing market for a scarce resource generates growth.

Hence, the existence of substitute consumption may worsen welfare, compared with the case in which there is no opportunity for substitution. In other words, the reaction of agents to a worsening in their living conditions may produce a further worsening in them. This is a coordination failure: the model describes a world of individuals who, by trying individually to improve their position, produce a general worsening of individual positions.

In short, starting from analysis of the impact of production on free consumption, the model is able to describe a world in which production inefficiently affects common consumption, or in other words the sphere of common consumption is overcome by that of private consumption.

This perspective may help to explain what have been termed the “broken promises of growth”: dissatisfaction with the world created by the advanced economies, which people perceive as stressful, fraught with economic difficulties, and characterized by the deterioration of the social and natural environment. Furthermore, it is widespread the expectation of a futher deterioration. In any event, the correlation between growth and well-being seems, in the most optimistic of evaluations "very slight".[38] Someone from the last century would probably be astonished that a hundredfold increase in per-capita income has created work stress (largely an invention of the advanced economies) and that it has not freed humankind from the fetters of need and economic worries (what the model explains as an increase in the need for private consumption associated with growth). The decline of free consumption and the consequent growth of the labour supply may be a factor responsible for dissatisfaction with growth-generated welfare.[39]

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[38] The expression is Oswald’s (1997), who makes the most optimistic evaluation of the data on individuals’ perceptions of their happiness. A more pessimistic assessment is provided by Easterlin (1974, 1995), for whom happiness is the same in rich and poor countries, and growth does not increase well-being.

[39] Urban living seems to be a paradigmatic example of this. People flee from neighbourhoods which grow increasingly unlivable, but their efforts to escape make other neighbourhoods unlivable as well.

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