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Structural Change and Economic Dynamics

Time to build and out-of-equilibrium growth process

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ABSTRACT

This paper proposes an analytical approach to growth modelling that focuses on the temporal and hence the organizational dimension of real production processes, rather than making use of a production function, which is a pure technical relationship. This approach takes advantage of the breakthroughs in economic theory by Georgescu-Roegen and Hicks. The step-by-step analysis of production in time proposed by Georgescu-Roegen has brought into light the idleness of capital equipment and of human resources as the main obstacle to growth, and given a robust basis to Smith's growth theory according to which the articulation between the division of labor and the extent of market is the main engine of growth. The analysis of the time dimension of production processes proposed by Hicks that focuses on the distinction between construction and utilization phases has opened the way for a comprehensive analysis of the type of disturbances – unemployment and productivity slowdown – which arise along an out-of-equilibrium growth path. These contributions provide the basis for the analysis of qualitative change as a learning process, whose evolution is not predetermined but depends on what happens along the way, that is, on the recurrent distortions in the structure of productive capacity due to co-ordination failures.

1. Introduction

We maintain that identifying the real nature of production processes, rather than focusing on consumers' preferences and the properties of technology as the only determinants of a long-run equilibrium, is essential for understanding the out-of-equilibrium process in which consists the dynamics of the economy.

The way we look at production – we shall see in particular in what follows – is the watershed between analytical approaches suited to deal with equilibrium or out-of-equilibrium phenomena.

The distinction made by Schumpeter between growth, explicitly defined as a quantitative phenomenon, and development, a "...discontinuous change that comes from

within the economic process because of the very nature of that process" (Georgescu-Roegen, 1974, 1976, p. 245) helps to grasp the point. That is, that qualitative change – a change that implies a structural modification, which can only be brought about through a process in real, irreversible time – is involved whenever a thorough dynamic problem is contemplated. Innovation, which implies creation of new resources and construction of different productive options, is the foremost example of qualitative change: but also a speeding up of the growth rate or a simple change of the technique in use partake of the same nature.

In all these cases, the previously existing productive structure is disturbed, its way of functioning is affected and as a result a problem of intertemporal complementarity arises which calls for co-ordination over time of production processes to render the process of change undertaken viable. The focus must therefore be in the first place on the time structure of production processes.

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The coordination problems involved are far more reaching, though. As a matter of fact new aggregates of elements that exhibit different complementarity relations among them have to be shaped up for a different productive structure with its distinctive way of functioning to emerge: it is the nature of these relations, and the processes through which they are created and established, what really matters. Viability is the main problem associated with these processes, and interaction, complementarity and co-ordination over time, which determine how the processes themselves are actually shaped up, are the relevant issues for viability.

The remainder of the paper is structured as follows. Section 2 proposes a physiological analysis of production, which makes use of the flow-fund model elaborated by Georgescu-Roegen, in the perspective of bringing into light the idleness of capital equipment and of human resources as the main obstacle to growth, and giving a robust basis to Smith's growth theory according to which the articulation between the division of labor and the extent of market is the main engine of growth.

Section 3, makes use of the production analysis elaborated by Hicks focusing on the distinction between the construction and the utilization phase of any production process, to throw light on the main aspect of any qualitative change, that is, the distortion in the structure of productive capacity that generates a dissociation between costs and proceeds. Section 4 opens the way for a comprehensive analysis of the disturbances –unemployment and productivity slowdown – that arise along an out-of-equilibrium growth path. Section 5 stresses qualitative change as a learning process, whose evolution is not predetermined but depends on what happens along the way, that is, on the recurrent distortions in the structure of productive capacity due to co-ordination failures.

2. Complements and substitutes in the economics of production: towards a physiological analysis of economic change

"It is because time is such an elusive notion that it has been possible to treat it lightly, especially in economics. For most of the economic processes the time now is clock-time... Yet in economics time enters also in a role that cannot be associated with a clock. Whatever belongs to strictly human manifestation, expectations and innovations, is not tied to the clock" (Georgescu-Roegen, 1994, p. 242).

The most relevant aspect of the economic process is that 'production takes time'. The essence of the problem of the time dimension of production is that complementarity rather than substitution characterizes the production process. This is a point that, although in different analytical contexts and with different accents, both Georgescu-Roegen (1970, 1971, 1976, 1994) and Hicks (1970, 1973) hint at.

Georgescu-Roegen (1971) refers to the catalogue of feasible recipes that describe production processes and that "consists of a set of points in an abstract space, as opposed to the Euclidian space" (p. 236). This set may be represented by a relation of the form:

$$Q(t) = F\left[E_i(t),\, S_j(t)\right] \quad 0 < t < T$$

where $Q(t)$ is the coordinate for the final output, $E_i(t)$ the coordinate for the *flow* factors (that enter the production process but do not come out of it, or come out without having entered) and $S_j(t)$ the coordinate for the *fund* factors (which "represent the material base of the process" (Georgescu-Roegen, 1965, p. 86) as they "enter and come out of the process in an economically, if not physically, identical form, and in the same amount" (ibid. p. 84), and hence can serve in any process over and over again, although needing maintenance); all defined over the time interval $(0 - T)$ which corresponds to only one process. As a consequence the factors included in any of the functionals (or of the point functions when there are complete synchronization) representing the catalogue of recipes, cannot be substituted for. They are *complementary* factors. In the functional F, S represents generically funds (equipment, labor skills, and the like) of various qualities, S_j meaning a certain amount of the fund of quality j. There may be no change corresponding to, for example, the substitution of more capital K (in the sense of machines or equipment) for less labor L. Substitution means rather than K_a and L_a are used instead of K_b and L_b.

In other words substitution concerns processes and not the coordinate (capital and labor) of one particular process. However, the substitution of a process b for a process a cannot be realized instantaneously. The reason is that the fund factors are specific to each process and that their accumulation and decumulation differ from accumulation and decumulation of a stock of commodities in that it cannot take place at any speed. It is in fact characterized by intertemporal complementarities.

Dissociating commodities from processes is a step with important analytical implications. It makes it possible to stress that "commodities are *not* produced by commodities, but by processes" (Georgescu-Roegen, 1974, 1976, p. 251). And that, whereas in a stationary state the attention can be confined to the production of commodities (the 'utilization' moment of a production process), this is no longer the case "in any non-stationary economic system" where "the production activity is aimed at two distinct objectives – to produce *goods* and to produce *processes*" (ibid.) and where the latter activity may come before the former.

The elementary process is the process by which a unit or a batch of product is produced from specific materials by some specific agents (funds). *Idleness* of funds characterizes any elementary production process. It is the main source of inefficiency of any productive system. And then, it prevents firms from investing in these factors, thus limiting the division of labor, which is the real source of the growth process as underlined by Smith (1776). How to reduce the idleness of funds is the real challenge. The degree of idleness is not a technical problem but an *organizational* one. Elementary processes may be "arranged *in series*, one following the other, as in a small artisan shop, or in the production of bridges (...). (They) may be also arranged *in parallel*, as in most bakeries or in ordinary farming (...) Finally,