

Endogenous and exogenous factors in growth theory

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Introduction

During the 1980's the issue of economic growth returned to be a central concern of economic research. While it would be interesting to compare and discuss in depth the reasons for the revamping interest on the issue, the fact is that a fundamental change seems to have occurred in the way economic theory approaches the problem. In particular, the recent debate and the numerous contributions on the topic have been spurred by a generation of models which share some fundamental similarities and have become known as New Growth Theory (NGT).

The characteristic element of this strand of theory consists in endogenizing the growth rate, overcoming a view of growth associated with exogenous factors, so that we speak now of a theory of endogenous growth. This perspective is developed in a great number of contributions¹ and is now an established new doctrine presented in several textbooks. Still there seems to be a problem of full comprehension of the theoretical question it poses.

It open to question the extent in which the new theory is a real break with the previous theory. In this respect the paper discusses two critical accounts which have an opposite view on the Classical or Neoclassical nature of the ultimate message of NGT. Nevertheless it opened up a new research agenda, most notably for the reference made to increasing returns and the new focus on the endogenous nature of the growth process.

Starting precisely from the stress laid by NGT on the endogenization of the growth rate, the paper discusses how this result is achieved and ask the question: if this is indeed the main objective of the theory, in which sense can we speak now of an endogenous growth theory ?

The difficulties posed by this question suggest a closer scrutiny of the notion of endogeneity put forward by NGT and the role it plays in its logical structure. Focusing on the issue of exogenous vs. endogenous factors highlights effectively the main aspects of the theoretical approach and helps to uncover new problems.

Of particular relevance in this respect is the argument put forward by F. Hahn (1998). He stresses the limits under which we can speak of endogenous growth and argues that in the analysis of growth it is a matter of necessity to maintain exogenous elements. F. Hahn's critical assessment of NGT leads into the discussion of the contribution of NGT to the understanding of the basic mechanism of growth and thus guide the analysis of long-term growth patterns.

From this point of view the more substantial contribution is the stress laid on production and accumulation of immaterial resources, such as knowledge, and the role played by certain pivotal activities (R&D) and the education system.

To pursue the research agenda implied in the contribution of NGT does imply to examine the relationship between exogenous and endogenous factors with respect to a general view of the growth process thus of dynamics. For this purpose Schumpeter's view in the Theory of Economic Development is quite illuminating. Similarly it seems appropriate to reconsider the question of the "production of knowledge", starting from the exogenous aspect contained in the development of science.

¹ "The idea underlying that theory took off in the mid-1980s and has experienced a remarkable boom since, reflected in a formidable industry of theoretical and empirical research on economic growth." (Kurz and Salvadori, 1999, p.1)

1. The purpose and structure of NGT

Classical and Neoclassical views on growth?

In this first section the paper considers two critical accounts of NGT that have two distinct, and actually opposite, judgments as to the theoretical perspective NGT contributes to enhance. The focus on the analytical structure of the theory clarifies quite well the purpose and meaning of endogenous growth as now defined by NGT .

Starting from the fact that “the conventional wisdom about growth [is] the idea that thrift is the main determinant of economic growth and, associated with this, that in the long run there is a positive rate of profits, equal in equilibrium to the marginal productivity of capital, regarded as the reward for parsimony.” (p.772) Cesaratto (1999) argues that the main purpose of NGT is to re-establish this aspect of neoclassical orthodoxy, which was weakened and somewhat obscured by the Solow-Swan growth model.

He points out that the main problem with that is the “reduced role assigned to the preferences of the community between saving and consumption”(ibid.) together with the reliance on exogenous factors. The latter implies that the long run growth rate depends on the growth rate of the labour force and on labour augmenting exogenous technical progress. Thus savings have no effect on the rate of capital accumulation.² “Indeed, the central theoretical purpose of EGT appears precisely to build a neoclassical model of economic growth in which (i) there are positive (marginal) returns to capital, and (ii) the rate of growth is dependent on the preference of the community between present and future consumption and is, therefore, ‘endogenous’.” (ibid.)

Kurz and Salvadori call into question primarily the novelty of NGT and the claim of a revolutionary breakthrough made by at least some of the New

² Cesaratto recalls that Arrow considered this result “hardly intellectually satisfactory” (p.772)

Growth theorists.³ “The NGT purports to provide, to use Hick’s term, a ‘theory of economic history’. With respect to these “bold claims” they “ask simpler questions, namely in what sense is the theory really ‘new’ and in what sense is growth explained ‘endogenously’.” (1998, p.64)⁴

Starting from the fact that: “The meaning of endogenous growth in the new growth literature is that output grows faster than the exogenous factors alone would make it grow. The innovation of these contributions relative to the Solovian model is that the rate of technological change, and *a fortiori* the rate of growth, is no longer taken a given from outside, but envisaged to depend on the depend on the ‘behaviour’ of agents, that is, on their preferences or tastes...In some contributions ...the emphasis is on the positive externalities of the actions of these agents.”(ibid.)

They however suggest an opposite view as to the theoretical perspective implicit in the theory. In another paper (Kurz and Salvadori, 1999) they “investigate those factors that counteract any tendency of the general rate of profit to fall [in the growth literature, old and new] ” (p.2) and conclude: “NGT shares some crucial elements of the classical approach to the problem of growth and distribution. Hence, it can be said that there is a ‘revolution’ in the proper sense of the word, that is, present-day growth theory is partly returning to the roots of the classical approach.” (p.2-3)

Kurz and Salvadori reach this conclusion focusing on the logic by which the rate of profit is determined and on the role played by the saving-investment mechanism in NGT models. Such a structure, they argue, poses a problem of

³ “Also described as ‘new’ growth theory (NGT) to indicate the claim to originality, some advocates are quiet explicit in their view that NGT will revolutionize the way economists think about certain problems. ... In their view, NGT is a basic innovation ...” (Kurz and Salvadori, 1999, p.1)

⁴ They argue that the approach has illustrious predecessors, such as the Crusonia plant model of Frank Knight and Ricardo’s corn model. Thus, the novelty and the theoretical advances of NGT is an highly debatable issue. It is also difficult to see how NGT could be a basis for a theory of economic history, given the purely pedagogical nature of the predecessors.

interpretation which highlights the similarity with classical theory.⁵ “Barro and Sala-i- Martin (1995, p.39) suggest that the AK model ‘becomes more plausible if we think of K in a broad sense to include human capital’. We advocate an alternative interpretation: in this model, as in the NGT more generally, endogenous growth is obtained by assuming that there is a technology producing labour, as in the classical economists. Following the later neoclassical tradition, Solow considered labour a nonaccumulable factor. This fact is now referred to as ‘human capital’ or ‘knowledge’. These names are simply evocations of this fundamental transposition.” (p. 31-2)

The different specifications of NGT models

Within NGT Cesaratto distinguishes two approaches. The first group, “The one sector or ‘AK’ model...relates the growth of labour productivity to capital accumulation” (p.783). He calls these “Pseudo-Harrod-Domar models”. In Romer (1986) “the externality that springs from capital accumulation permits a proportional growth of *all* factors in efficiency units, so that the *marginal* returns to the accumulable factor are constant along the secular growth path.” (ibid.)

The second approach he calls Neo-exogenous models and is based on Lucas (1988). The main characteristic is the role played by human capital which is introduced into the model as “the share of labour time diverted, on the basis of the preferences of the community between present and future consumption, from the production of production of corn to educational activities that will increase the efficiency of the forthcoming generation of labourers.” (p. 786)

Thus while in the first approach “The dominant idea is to drop the non produced factors in the production function so as to avoid any source of

⁵ They argue that NGT models “are models of *endogenous* growth and *exogenous* profitability”, thus reversing the determination between the rate of profit and the steady-state rate of growth typical of the Solow-Swan model. (p.25)

decreasing returns to the produced factor “ in the second “is to integrate Solow’s equation of technical change with a relationship between the rate of change of labour productivity and the choices of the community between present and future consumption .” (p. 782-3)

In other words, “The first class of models regards capital accumulation as the source of increasing returns. The second class of models looks at investment in education, R&D etc. as the source of technical change...” (p. 785) Thus, the saving decisions of the community *directly* affect the growth rate in the first case and *indirectly* in the second case. (p. 787)

The two approaches then diverge only to the extent that the association between the saving decisions and the rate of economic growth “is direct [via capital accumulation] in the ‘AK models’, and is postulated through the influence of the saving rate on the *pace* of technical change, through R&D, education etc. in the ‘neo.exogenous’ models.” 787

Kurz and Salvadori indicate a classification of these models which differs from that of Cesaratto.

“In this paper, we adopt the idea of ‘endogeneity’ employed in the NGT. According to Barro and Sala-i-Martin (1995) the characteristic feature of the NGT is that long-run growth is determined ‘*within the model*, rather than by some exogenously growing variables like unexplained technological progress’ (p.38, emphasis added). They add: ‘the key property of endogenous-growth models is the absence of diminishing returns to capital’(p. 39) Therefore, the way or mechanism by which diminishing returns to capital are avoided provides a criterion to classify the NGMs.” (Kurz and Salvadori, p.2)

They first single out a “class of models [which] set aside all nonaccumulable factors of production such as labour and land and assume that all inputs in production are accumulable, that is, ‘capital’ of some kind. The simplest version of this class of models is the so-called ‘AK model’ ”; then they

consider “a large class of models contemplating various factors counteracting any diminishing tendency of returns to capital.”(p. 28) ⁶

In the first sub-class they includes those which “attempt to formalize the role of human capital formation in the process of growth.”, (p. 28) thus Lucas model (1988); the models of the second sub-class “attempt to portray technological change as generated endogenously.”, (p.30) and there they consider Romer (1986).

It can be observed that Cesaratto labels neo-exogenous the human capital formation models because of the exogenous element constituted by the size of the sector producing human capital. For his argument it follows that the effect of savings is indirect, that is, via their “influence on the *pace* of technical change, through R&D, education etc...(p. 787).

More problematic is the association of the AK model with the contribution of Romer as done by Cesaratto. While Kurz and Salvadori stress that removing any accumulable factor as the distinguishing feature of the AK model, Cesaratto focuses instead on the direct influence of accumulation on the growth rates via endogenous technical change, which is then associated knowledge production and accumulation, a central feature of Romer contribution.⁷

Saving and externalities

These differences are however secondary with respect to the similar picture of the mechanism generating growth in NGT models. Kurz and Salvadori have pointed out that the departure from exogenous growth of the Solow type is the result of focusing on the behavior of agents. They also recall that “In the formalisations this influence is commonly reduced to that of the rate of time

⁶ There is also an intermediate group, which for the present purposes can be comprised in the first group.

⁷ However, there is no difference as to the the main point of Romer’s contribution; both authors refer to Arrow (1962) as the inspiration for Romer’s model , and Uzawa (1965) for Lucas model.

discount, or time preference, and the elasticity of substitution between present and future consumption” (1998, p.64)

There is no longer a given, exogenous saving propensity and the rate of capital accumulation is the result of an endogenous process of decision making involving intertemporal choice. But this unimportant. “It will turn out that different assumptions concerning saving behaviour are not essential to the argument. That is, it does not matter whether the propensity to save is exogenously given or whether it is determined via intertemporal utility maximization. (Kurz and Salvadori, 1999, p.2)

Thus, one cannot claim that having shown formally that the determination of the saving rate is endogenous, there is an endogenous process generating growth.⁸ The fundamental argument for endogenous growth is rather that explaining how accumulation of capital can result in constant (increasing) returns, therefore ensuring a long run positive growth rate.

In this respect it can be noted that the most important element emerging from the examination of the structure of the NGT models is the role of positive externalities associated with capital accumulation. Indeed, Kurz and Salvadori distinguish the two sub-classes of NGT models focusing either on “human capital formation” or “knowledge accumulation”. In either case “*positive external effects*” play an important part; they offset any fall in the marginal productivity of capital thus contributing an essential feature as to the mechanics of development envisaged by NGT.

From this point of view endogenous growth is the result of several plausible ways that permit to associate capital formation with some form of externality that ensures a steady flows of productivity increases such that there is growth and not a lapse into stationary state. This ensures bounded returns to capital, i.e. positive growth rates generated within the model. Externalities then

⁸ Because of the stress laid by Cesaratto on thrift, that is, on the saving decisions of the community as the principle distinguishing old and new growth theory, this point may be obscured.

proceed also from the saving decisions by means of some specific link established between capital accumulation and constant (increasing) returns.⁹

Thus, despite the differences there is a notable amount of agreement as to the analytical structure of the theory and the mechanism which ensures *endogenous growth*.

Summing up: one could say that in NGT endogeneity, i.e. the endogenous determination of the growth rate, is the outcome of three theoretical arguments. The first is the choice between consumption and saving which accounts *endogeneously* for the rate of saving. This however may not be fundamental, as we have seen above.

More important is the mechanism and the economic explanation of the link between savings and the constant returns to capital accumulation. In this respect it is clear that there are two arguments: 1) the externalities associated with accumulation associated with the accumulation of knowledge, in the various forms in which it can be obtained (R&D, innovation, entrepreneurship), or what we can call disembodied technical change, 2) the accumulation of human capital, linked, in a somewhat hard to define, way to formal education.

2. The notion of endogeneity in NGT

The exogeneity in endogenous growth theory

It is interesting to compare the conclusion which can be drawn from the two critical appraisals examined above with the point of view of an equilibrium theorist.

⁹ Kurz and Salvadori also point out that strictly speaking endogenous growth may obtain also without externalities. That is, increasing returns are not necessary. Constant returns will still be ensured by the accumulation of human capital and the accumulated stock of knowledge of the economy in the Lucas and Romer model, respectively.

F. Hahn's comments (1998) focuses explicitly the question of endogenous vs. exogenous variables within the effort at theorizing about growth. His critical assessment of NGT also deal with what Kurz and Salvatori, have called the "bold claims" of NGT to be the basis for a *theory of economic history*.

"There is no doubt that post-war growth theories provided a number of insights. But insights are not explanations... After a hiatus of some twenty years we have now returned to the study of these matters...and this time the intention is to explain 'more' than had been explained hitherto. This enlargement of the scope of the theory has led to the view that we are now engaged in finding an "endogenous" theory of growth" (p.1). Despite "a number of valuable insights...it seemed to me worthwhile to draw attention to the amount of exogeneity still remaining. Moreover the results do not seem robust to changes in the specification of the exogenous functions or parameters." (p. 2)

Much of Hahn's dissatisfaction with the endogenous theory of growth envisaged by NGT deals with the question in which knowledge is embodied in the analysis. In particular he regards as sources of exogeneity:

1) "the acquisition and use of knowledge, which embodies relatively recent procedures - research itself, publication, etc..." and the education in technical and scientific fields. (p. 2-3)

2) the (positive) externalities in the acquisition and use of knowledge, (the increasing returns of Romer); "but in general the production function of goods and knowledge are taken to be of a form which allows an eventual steady state (exponential growth). Here is another exogeneity." (p. 3)

3) information flows, "exogenous in most endogenous models." (ibid.)

Hahn considers an even broader issue, that of the exogenous factors which are implied in the nature of the literature which "in one form or another is macroeconomic": he distinguishes between:

a) Sectoral composition, in the sense that “There may be many sectors but the formulation allows rather simple aggregation even in the stochastic case...given the stochastic (Poisson) process of inventive opportunities postulated...very large structural changes are ruled out”. (p.3)

b) “time to change habitat and way of life. For instance, the process by which towns grow or decline. So here there is more exogeneity.” (ibid.)

The Schumpeterian approach of Aghion and Howitt (1998), which is considered in more detail, rises more questions concerning the analysis of R&D, in particular the mix between applied and fundamental research. “A & H sometimes seem to think that one can model this mix by changing the allocation of labour between the two activities” (p.2) This runs against “common observation”: it assumes that “all workers can do either.” Thus, “the ‘talent-composition’ of the labour force is important (or perhaps the cultural history of their economy) and so an exogenous element is introduced.” (ibid.)

More in general he observes: “It is clear that some of the more important parts are exogenous...” (p.5) Not only the parameters of the model (productivity of the research technology, the allocation of labour between production of intermediate goods and research and the degree of competition) “but the functional form, the postulate of risk neutrality, the homogeneity of the ability composition of labour, the perfect information of agents and the postulate that there is either a steady state or that markets clears at all dates.” (ibid.)

With respect to the use of equilibrium analysis he later observes “When we say that a variable z is endogenous to a model we mostly mean that it is determinable by equilibrium conditions.” (p.7) In growth theory, however, that involves expectations, risk attitudes, information flows. “So when one writes down equilibrium conditions one is bringing into the story many elements not explained by any theory.” Thus, “When we use the canonical paradigm of economic theory we are rarely in a position to attain purely endogenous results. Or rather what seems like those are not genuinely so.” (ibid.)

This is further explained dwelling of the questions raised by considering expectations, risk, and information.

Modeling of anticipated obsolescence and Schumpeterian temporary monopoly for the innovator, as done by Aghion and Howitt “depends on information available and on good telescopic faculties”. Together with relatively small risk aversion these are the characteristics of the Schumpeterian entrepreneur. But “the proportion of these in a population is exogenous”(p. 9).¹⁰ Moreover, “Risk-attitude and competence characterized the Schumpeterian entrepreneur. Their number Schumpeter believed to depend on on the culture of religion of the economy. ... But in any case R and D does depend essentially on people capable of generating new knowledge not only inside the R and D outfit but also outside it.” (p. 10) The generation of knowledge (and the knowledge based industries) “brings education into the picture and the whole is permeated by externalities.” (p.11)

The problem from the point of view of the economy is that “to recognize the benefit of an advance is almost as important as the advance itself...People with that kind of imagination are rare and certainly their representation in the economy is a matter of culture and largely exogenous for the economist. It is not clear whether one could regard it as an output of education.”(ibid.)

“But the basic point is (i) finding new information, (ii) whether and how it is transmitted, (iii) how widely it can be used.” The attention then shifts to the role of incentives. Calculation of rewards is “part of an ‘endogenous’ argument, but only part. Many of the relevant elements seem clearly exogenous.” (p. 11)

In general, “the rise of ‘science based’ industries itself depended on the progress of science which, in turn, depended on the evaluation of the benefits

¹⁰ It should also be noted that “In most endogenous theories *new products* are continuously appearing and it is not clear how past experience leads one to rationally expected demand curves” (p. 10)

it would confer. ... As a description these matters are very clear. How to convert this into an endogenous theory of growth is not. The very fast growth of scientific knowledge seems like an *exogenous cumulative process* ... This sort of thing is hard to embody persuasively in a functional form and even if it could be, it would be quite unclear whether it also embodies other scientific advances, e.g. superconductivity. Least clear is whether these various theoretical descriptions can be made to yield a steady state with exponential growth.” (p. 13)

Endogeneity rediscovered ?

Addressing directly the question of exogenous vs. endogenous aspects Hahn’s paper begins to define and distinguish what can from what cannot be accomplished using a certain methodological approach.

The purpose of endogenous growth theory is to *explain growth endogenously*. However, “The survey book by Aghion and Howitt ...seems to interpret ‘endogenous’ differently from the way I do, namely as *having a theory from which technical progress and growth can be derived*. [emphasis added] For instance Arrow’s ‘learning by doing’ (1962) or Kaldor’s technical progress function (1957) are such theories. But it, like almost everything in Aghion-Howitt, depends on special functional forms which are not supported by evidence- at least not by watertight evidence. But ‘endogenous’ growth theory gives a vast deal greater freedom to postulate relationships than does canonical equilibrium theory. I want to re-emphasise therefore that this is not an essay in criticism but one of a plea to think more carefully about what the very many often incompatible suggestions contribute to what might be called a theory of economic history.” (p.2)

The fact that in endogenous growth much is taken (and must be taken) as exogenous is not a result of the shortcomings of the theory itself. It rather

follows from the fact that “...both empirical information and analytical capacity are modest compared to the task of providing a *theory of economic history*...It is thus salutary to highlight our regions of ignorance sharply.”(p. 3)

Precisely because endogenous growth “should not be understood as a theory of everything that accounts for growth”(p. 1) the point is really what should be taken as endogenous (exogenous) when theorizing about long-term patterns of growth that conceivably are the basis of economic history. This explains why “Harrod and later Solow made technical progress ‘exogenous’. That is, they did not explain it as part of the theory.” (p.1)

Hahn makes reference to the stylized facts of economic development to remind us of how difficult is to fit them into formal theory. This strongly suggests that for the theory of growth to be a foundation for a theory of economic history it must accept a large number of exogenous factors. Indeed, “It is precisely our relative inability to measure (parameters values) leads to exogenous variables. That and *the immense complexity of an interdependent group of variables*.”(p. 5)

One may conclude that, while NGT may be capable of explaining formally why there no decreasing returns to capital accumulation, using at times plausible functional specifications, it cannot in general account for the processes they purport to represent and model. Thus, there are limits which one must bear in mind speaking of endogenous growth. This is true in general and in particular with respect to NGT.

These limits, as they emerge from Hahn’s analysis, are linked to questionable assumptions, that is, the way in which complex phenomena must be forced into the formal relationships of the theory. A second type of criticism concerns indeed the possibility (and appropriateness) of modeling processes which by their nature are exogenous to the theoretical analysis of the economist.

Hahn's paper singles out a series of sources of exogeneity, linked to the growth of knowledge, innovation, R&D, entrepreneurship. He stresses that they hardly fit into the functional forms of endogenous growth theory. At the same time his paper is interspersed with references to "episodes of growth", such as the steam engine, the internal combustion engine, electricity, computers, (p.8), references to technological breakthrough ("The D.N.A. revolution has transformed R and D in pharmaceutical industries and agrobusinesses", p.10) and to the difficulty at establishing electronic computers for civilian use (p.11).

All of this seems to suggest a treatment of stylized facts of economic development in a way of theorizing about growth which, while hard to fit into NGT, is still there to be built. Hahn instead seems to displace the analysis of these processes into the description of the facts of economic history.

His analysis suggests that many processes of determination are indeed outside the domain of economic theory. This may very well be true. However, to recognize the importance of the facts of economic history, and more in general of the description of development process together with the narrative of technical change and innovation, should not obscure the possibility of theorizing on the central tendencies of the process accounting for economic growth.

The series of sources of exogeneity pointed out by Hahn are that many processes of transformation. The theory should focus on them as the core of the process of economic development. When that is identified the exogenous factors can be considered within this fundamental mechanism, which in turn becomes the proper object of the theory. That is, the long term process of development underlying the secular growth path must then be seen in conjunction with the facts of economic history. This seems genuinely in tune with an endogenous growth theory which advances in the direction indicated by many economists and in particular by the classical tradition.

There are indeed a number of theories which sustain an endogenous view of growth. "...the Smithian and kaldorian traditions interpret endogenous growth as the interaction between the division of labour, inventive activity and market size. Marx and Schumpeter associated endogenous growth with the pressure of competition on the innovative behaviour of the capitalis and entrepreneurial classes, respectively...the endogenous aspect of economic growth refers to various institutional, social and economic mechanisms that may generate economic change whereas in EGT these mechanisms remain exogenous." (Cesaratto, p. 787) Kurz and Salvadori point out that "in some non-neoclassical approaches to the theory of accumulation and growth, the endogeneity of the growth rate has always been taken for granted. A brief look into the history of economic thought shows that from Adam Smith via Davide Ricardo, Robert Torrens, Thomas Robert Malthus, Karl Marx up to John von Neumann both the equilibrium and the actual rate of capital accumulation and thus both the equilibrium and the actual rate of growth of output as a whole were seen to depend on agent's behaviour, that is, endogenously determined." (1999, p.31)

3. The mechanics of development

Formal modeling and the underlying processes

From the point of view of the possibility of theorizing about the endogenous process shaping dynamics, the interest of the functional form used by NGT consists in the fact that they reflect a shift in the understanding of the main factors sustaining growth of market economies in the long-run. In particular, they redirect attention away from capital accumulation, in the sense of the creation of capacity, or plant and equipment, to immaterial resources, information, knowledge, human capital, in one word, knowledge. That forces to reconsider technical progress and break the analysis focusing on the specific transmission mechanisms by which it operates at the level of the industry and at the level of the economy.

The analytical problems arising from the effort to endogenize growth then have a formal side, and a more substantial side. Here resides much of the problem of the full comprehension of the advances and the limitation of the endogenous theory of growth contained in NGT.

From all the accounts it is clear that NGT aims to find an internal mechanism which generates economic growth. The formal problem narrowly defined is that growth cannot be generated within the neoclassical model, the ultimate reason being the diminishing returns to capital that set in when capital accumulation proceeds. This leads to call on exogenous factors sustaining the long term trend of accumulation. Thus, the problem arises within the mainstream approach to growth defined by the centrality of saving, the neglect of effective demand and the focus on the role played by factors proportions.

This formal problem has in fact a formal answer in NGT models. The formalization can be successful for the clearly stated purpose - i.e. generate growth from within the model.¹¹ The issue of endogenous vs. exogenous aspects attains a different perspective when discussing the underlying processes and phenomena treated formally by the theory. The extent in which NGT succeeds in overcoming the problem - i.e. showing that growth is endogenous- hinges not on the functional forms but more fundamentally on the plausibility of the mechanism envisaged by the models, thus on the underlying conceptual framework .

Indeed NGT models, beyond their stated purposes, lead us to question the “mechanics of development”. This contributes to uncover the obstacles to a theoretical analysis of development in advanced market economies, but at the same time highlight the limits of the theory.

In fact, the analysis above suggest that :

¹¹ There is then a problem with the theoretical uses of the model.

1) capital accumulation, in the sense of enlargement of the productive capacity, driven by population growth, is no longer the “engine of growth”; 2) technical change is not a black box, at least to the extent that modeling of distinct aspects the innovation process is attempted at the micro and macro level; 3) the focus is on the endogenously generated dynamics of productivity and on the factors accounting for the rate of productivity growth.

From this point of view what is important it is not the relationship between agents’ choice and endogenous determination of saving, but rather that established between saving and the accumulation of immaterial resources, such as *knowledge, in the various forms it can take* (R&D, innovation, formal education, entrepreneurship).

Saving and the production of knowledge: the engine of growth

To express the problem with a paradox it appears that the theory of growth is no longer a theory of capital accumulation in the traditional sense used by growth theory. And if capital accumulation, and embodied technical change, is no longer the engine of growth, what is ? From a substantial point of view the main message of NGT is that factors of growth, which are the representation of immaterial resources, such as knowledge and information. Thus, to make plausible the association of savings with the broad processes centered on the production of knowledge we need to specify an externality which needs to be tied to capital accumulation.

This only evokes the complexities of the processes centered on the production of knowledge and information typical of advanced market economies, a topic investigated in a growing literature and the externality is based on a generalization about phenomena vastly perceived as changing the landscape of production in advanced market economies. *This seems the*

*“revolution” NGT is addressing; it is taking place in the real world more than in the theory and method of analysis.*¹²

It appears clear why more than the single formal specification of the relationships on which the theory focuses what is relevant is the process of change they intend to represent. This, however, changes quite dramatically the meaning of the theory.

Here we find also the difficulty, for an endogenous determination of the growth rate must accept that many of the determinants of these processes remain indeed exogenous. More fundamentally, the theory does not seem to develop a formalization based on description of the processes. Formal relationships, as it was said earlier, is often “ad hoc” to meet the requirements of the theory.

Rather than a theoretical use of empirical evidence, or suggestions about such an empirical evidence, something evident in the calls on stylized facts of economic history by Hahn, the fundamental mechanism of development which explains and justifies the externalities which are in all accounts the very central element of the theory, rests on a broad generalization of some features of the development process of advanced market economies.

However, it becomes hard to sustain that NGT is an endogenous theory of growth when relying so much on the role of externalities. The view of growth NGT enhances is that of the self production of knowledge, which finds its way into the growth process and sustains it in the long run. But the focus on immaterial inputs and in particular the central role played by the production of knowledge suggest that indeed this is what needs to be explained endogenously. The attempt to model externalities encounter inevitably many

¹² One may note in passing how this theme is in line with the rethoric of the New Economy. Though vastly overstated by journalistic accounts, it appears that the theory has anticipated some phenomena while they were in an early stage of development.

difficulties. But the question is whether this is the most fruitful way to address the issue.

It then appropriate to recall Cesaratto when he says :“Technical change is generally depicted as a process of self generation of knowledge, with no interaction with other economic variables (with the exception of the saving rate. In the neo-exogenous models, endogeneity hinges only on a coefficient, placed in the equation that describes technical change... [which] remains a self-cumulative and unexplored mechanism (p. 787-8)

This fundamental limit of the approach is not a matter of specifying more appropriately the relationships of the theory, but clearly recognize the fact that the notion of endogeneity of NGT is of a very particular kind indeed.¹³

Cesaratto notes that “The exogeneity of technical progress was not felt to be an unfounded assumption in the years of big science.” (p. 777) In general, as confirmed by the persistent criticism of NGT by Solow, even without any myth about basic research, it makes sense to maintain (as Hahn suggests) that some aspects of technical change, for example, the input coming from science, should remain exogenous. On the other hand the suggestion contained in Arrow’s learning by doing (Arrow, 1962), i.e. “linking increasing returns to the empirical evidence of learning processes”(Cesaratto, p. 780), has nothing to do with big science, quite the opposite; it focuses precisely on the sources of technical change, the way knowledge is created and transformed in productivity improvements. And yet this does not lead to develop an argument about endogeneity other than the reference to increasing returns.

So while it is true that the new approach to growth at least speaks about factors which were previously neglected by mainstream theory, and actually owes to these factors its interest, this “variety of factors...is merely

¹³ If “the endogenousness comes from saying that...the allocation of time is endogenous, and if the allocation of time is enough to change the growth rates of the factors of production, then of course it will change the growth rate of output. There is nothing complicated or deep about that, it is just as simple as that.” (Solow, 1992, p. 21, in Cesaratto, p. 788, footnote)

superimposed on a very traditional view of economic growth” (Cesaratto, p. 788)

A careful analysis of at least some of the trend concerning the knowledge economy would help to improve formal modeling but would also suggest to re-discuss the representation of the growth process.

It must be stressed that it is not a matter of empirical testing of models. What we are discussing is the empirical evidence and the stylized facts which make plausible an endogenous growth mechanism and then allows to insert new processes into the theory of growth. The point is how to make use of the empirical evidence to establish a reasonable, useful abstraction.

4 . A theory of Economic History ?

Schumpeter’s theory of economic development

For a theory of growth the fundamental mechanism must indeed be endogenous, while the processes depend of various determinants. A system open to such determinations appears more capable to discuss the issues at hand.

Schumpeter's theory of economic development (1934) seems to be a good starting point for a similar approach to the analysis of the growth process.

Schumpeter aims at analyzing in the abstract the mechanism of growth and transformation on which the long-term viability of the system rests. This focus on the logic of economic development requires him to go beyond the comparative static method used by economic theory to analyze change. It also allows him to clearly distinguish between the theory of economic development and the facts of economic history.

Schumpeter's contribution is rather illuminating with respect to what should be endogenous and exogenous in the theory of growth. Indeed, given the claims

made by at least some of the NGT theorists, this helps also to clarify to what extent Growth theory in general, and NGT in particular, can be the foundation for a theory of Economic History.

The inherently static nature of economic theory is highlighted by Schumpeter's description of the system of economic relations as the "circular flow of economic life"(p.3), an analogy with blood circulation in the human body. The theory of the circular flow "describes economic life from the standpoint of the economic system's tendency towards an equilibrium position...and may be described as an adaptation to data existing at any time...The position of the ideal state of equilibrium in the economic system...always `striven after'...changes, because the data change. And the theory is not weaponless in face of these changes in data...These tools only fail...where economic life itself changes its own data by fits and starts."(p.62) The static theory "can only investigate the new equilibrium position after the changes have occurred."(p.63)

Thus, a different method and conceptualization of the competitive process are necessary for analyzing qualitative change and economic development, i. e. dynamics.

A change in the channels of the circular flow is a qualitative change, rather than a process of adaptation, and cannot be analyzed in reference to equilibrium positions. These are the truly crucial aspects economic theory ought to concentrate on. In Schumpeter words: "It is just this occurrence of the 'revolutionary' change that is our problem, *the problem of economic development in a very narrow and formal sense.*"

Thus, changes can be grouped into two broad categories: those which require a slow process of adaptation and those which call forth a qualitatively adjustment. In the first group are the disturbances of the static equilibrium, but also changes in the "non-social data (natural conditions), and "non-economic

social data (...the effects of war, changes in commercial, social, or economic policy)”).

This is a fairly clear statement for the discussion of endogeneity within the growth process. It suggests that the endogenous variables one ought to consider are the economic variables accounting for qualitative change, that is: changes in the circular flow, therefore in the structure of the economy. Indeed, the second criterion for their identification is that they arise "from within" economic life; otherwise we would have the paradox of the economy being driven not by its own dynamic, but “dragged along by the changes in the surrounding world.” (p.63) This reinforces the statement concerning the separation between economic variables, which should be internal to the theory, and the other variables that, though important for the actual pattern of growth, are not part of the mechanism of economic development.

At the same time one may note that this mechanism rests on the innovative entrepreneur who brings into being a "new combination", thus creating the conditions for profits above the average and inserting new dynamism into the competitive process. Technology development is the source of the discontinuous swarms of innovation and of the cyclical nature of economic expansion. In turn this calls into question the linkages between technology, disembodied knowledge and the development of science.

Exogeneity and autonomous development of science

The presupposition that innovation is exogenous in economic models flows from the idea that the innovation process is dominated by the input provided by technology and basic research. This The argument is that science development is largely autonomous from economic forces and that there is a limit to the effectiveness of sociological theories of knowledge.

William N. Parker's analysis of the contribution of technology to economic development in the West (1972) starts reconsidering *the inventive process*, along the lines of the analysis of A.P. Usher (1954).

"*The inventor* is obviously the product of the surrounding culture, nurtured in its values, endowed with its skills and technology. His mental stage is set with facts and theories from the engineering of his time, with the knowledge of materials, mechanisms and natural processes and properties. His 'greatness' as an inventor consists in a certain intuition or luck which leads him to focus on a problem which is both economically important and technically capable of solution by a novel combination of the means at hand" (p.64).

This view of the inventor drastically changes with the systematic application of science to production, which is typical of the post-war period. Whereas, "For much of the modern period, the sighting mechanism for invention has still been the inventor's mind, memory and observation, relatively unaided by theories about how the world is constituted" the development of science, first mechanics (XVII and XVIII century), later chemistry and electromagnetism (XIX century) and the atomic and genetic discoveries of the last decades, have provided "a powerful instrument-a sighting mechanism...for a technology."(p.67)

Technology is defined as "a set of interdependent inventions along different lines." Inventions can then be classified by their technical function-the need they intend to satisfy-and their scientific basis, namely, the principles and regularities embodied in the stage of science development which made them possible. Since "Nature gives out her secrets seriatim" and "the state of technology serves as a focusing force on the inventor," there is a path to science and technology development which, while determining the possible inventions, follows from the internal logic of "the way the human mind has attacked nature."

In its effort at understanding external nature “the course of its activity must be controlled, as an economist would say, largely from the supply side, i.e., from the existing constraints on what can be known rather than by what society needs to know.”

Parker stresses that "it is hard to see why the order of events in scientific development occurred as it did-going from the mechanical to the to the chemical and electrical to the sub-atomic and biochemical-because of economic necessity or social structure". The shifts occurring in science consequently confirm the "logical and psychological controls on the movements of science itself." ¹⁴

Conclusive remarks

Focusing on the issue of endogenous vs. exogenous variables affords a clarification of the relationship between the notion of endogeneity contained in NGT, the analytical structure of the theory and the problems it addresses.

Despite the various criticism concerning the novelty and the soundness of the approach the advancement with respect to previous growth theory can be located in the effort to formalize some aspects of the growth process previously lumped together into the notion of exogenous technical change. His contribution appears to be that of directing the attention to new questions arising in the development of advanced market economies and focused on the production of immaterial resources (information, knowledge, human capital), which find their way into the aggregate production function.

Endogeneity, however, appears the result of formal modeling concerning largely uninvestigated processes, so that modeling is often ad hoc and it is

¹⁴ “I doubt that Crick and Watson needed the incentive of monetary rewards to generate D.N.A information.” (Hahn, p. 11)

doubtful that it advances new knowledge to the mechanisms it wants to model. Thus the contribution appears more formal than substantial.

This type of assessment relates to the observation by Aghion:

”The main contribution of the new growth theory so far has been predominantly technical in nature. It is now possible to deal with increasing returns and imperfect competition in dynamic general equilibrium models which are simple as those developed in the recent industrial organization literature. This technological breakthrough has in turn made it possible to formalize a number of existing ideas concerning and development” (Aghion, 1994, p. 7)

Schumpeter view of dynamics suggests indeed ways in which theorizing would avoid the limitation of the approach. It would focus on the essential endogenous mechanism of growth without running into the problems pointed out by Hahn’s appraisal of NGT.

The focus on immaterial inputs and in particular the central role played by the production of knowledge suggest that indeed this is what needs to be explained endogenously. For instance, the fact that the path of science development is largely autonomous is the basis for the analysis of the way in which knowledge is internalized into the development process.

We witness instead a sort of paradox, with the claims of a NGT to endogenize the determination of the growth rate linked to a full array of issues which are dealt with in terms of external effects of accumulation.

The stress laid on the endogenous nature of the growth process has indeed a classical flavor, but it is doubtful that NGT models add a decisive argument in this respect. It is therefore possible that its fundamental importance, aside from the answer to certain problems internal to neoclassical growth theory, resides in the phenomena it evokes rather in the theory it presents.

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