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GROWTH MODELS WITH SCHUMPETERIAN MICRO-FOUNDATIONS

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Resumo
O presente texto aborda um conjunto de modelos de crescimento autodenominados de Schumpeterianos, mais particularmente, modelos evolucionários e alguns dos "novos modelos de crescimento endógeno". Através da comparação dos conceitos de tecnologia de que partem as duas famílias de modelos, bem como das proposições de política econômica que se seguem, os autores buscam aferir a legitimidade de sua filiação a Schumpeter.

Abstract
This paper approches a set of self-denominated Schumpeterian growth models, more precisely, evolutionary and some of the "new endogenous growth model". The authors attempt to evaluate whether both families of models claim legitimately to be rooted into Schumpeterian economics, by taking into account the ways by which they define technology and derive policy implications.

Introduction

The scope of this paper is to evaluate some recent contributions to growth theory and modelling according to the following criteria: how do important stylised facts about technology and development enter the model assumption; which are some relevant policy implications deriving from alternative modelling styles; and, finally, whether a variety of alternative models claim legitimately to be rooted into Schumpeterian economics.

The latest critical viewpoint is relevant because of the frequency of Schumpeterian references in the recent growth literature, and the high variety of interpretations of such a heritage. On the one hand, following the unorthodox micro-foundations developed by Authors like Herbert Simon and Nelson & Winter

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(1982), some papers belonging to the evolutionary field have started to deal with growth issues (namely, Chiaromonte & Dosi 1992; Dosi et al., 1993). And it is well known that contemporary evolutionary economics claims a post-schumpeterian positioning in the theoretical arena (see e.g. Freeman, 1988).

On the other hand, a major promoter of the Endogenous Growth approach has labelled as "neo-schumpeterian growth" the latest contributions to such a field (Romer 1994 referring to Romer, 1987b; 1990a). Similar theoretical assumptions can be found in Grossman & Helpman (1991:42) as well.

It is clear that these two claims are possibly contradictory, even if one allows for the variety of approaches to an economics of technology and growth in Schumpeter.

Actually, there are at least three sets of propositions by this Author that must be considered in order to evaluate the legimitacy of these claims: first of all the different stylisations of the innovative agent as the entrepreneur or the large firm vertically integrating R&D (respectively, Mark I and Mark II according to Phillips, 1971); secondly, the idea of temporary rents from innovation as a mechanism for technology appropriability, a key concept although at that time it was not yet supported by precise micro-foundations about technology generation and diffusion; and, thirdly, the strong opposition of the late Schumpeter (1942, ch.6) to the empirical relevance of the monopolistic competition equilibrium. As we will argue in the following, the new inputs from Industrial Organisation studies into growth theory must be evaluated from this perspective, whether they contribute to modelling a Schumpeterian or a Chamberlinian competitive process, with quite alternative and not so easily compatible implications.

Beyond such a dynamic competition there are some stylised facts from the real world, about development factors and facts, namely the displacement of the technological frontier. It has been recently argued (Foray, 1995) that there are two alternative traditions in the economic conceptualisation of science and technology: one stemming from Arrow (1962a; 1969) and another one from Richardson (1960; 1972). The issue to be discussed here is which kind of informations and knowledge systems are embedded into technology, and how they affect the ease, cost and prices for their comunication and transfer across agents. This analysis is very briefly and quickly dealt with by Endogenous Growth theorists, while it can be deepened by now due to the cumulative advances in our understanding of the coupled dynamics of technology and the economy (Chesnais, 1992).

Theoretical implications are also relevant in the inherent mechanics of growth models: Endogenous ones fitting into a General Competitive Equilibrium framework on the one hand, Evolutionary ones claiming the possibility of analysing far-from-equilibrium growth paths. A major aspect here is the theoretical alternative between Walras and Keynes, about the clearing of labour markets which are playing a key role in old and new growth theories. In this paper we will not extend our scope to the entire analytical and theoretical frameworks into which different development mechanics are embedded. Therefore our focus upon the basic technology-growth interaction leaves aside many other interesting questions such as: who are the innovating agents, how their behavioural rules might be adequately defined, which functional constraints they face, at the micro level; and which equilibrium and optimality conditions apply to the innovating and growing macro-system.

If we add the different policy and welfare implications of alternative models and versions, we end up with a stylised alternative between mainstream Endogenous Growth (EndG) models inspired by Chamberlin-Arrow-Walras, and Evolutionary (EvoG) ones claiming a Schumpeter-Richardson-Keynes line of derivation. Among the different questions to be faced, there is also the following one: are such packages sticky ones, or is it possible to recombinate the same analytical tools differently but still coherently?

In what follows, Section 2 will review the two broad areas where some sets of stylised facts are assumed by scholars to be a relevant representation of the evidence challenging development theory and growth models: the interdependence between technology and aggregate growth, and the way technology enters the microfoundations for such an aggregate growth mechanism.

In the conclusion, we will suggest some quite preliminary evaluations of: the policy implications of alternative growth models, their theoretical coherence and nature, and their adequacy to explain the stylised facts of contemporary world development.

1. Technology and growth: stylised facts

1.1 Development: a new focus for growth theory

In his provocative contribution to a substantial revision of neoclassical growth theory, Lucas (1988) introduces since from the start an impressive list of empirical observations in search of a theory. Among them are:

(a.i) sustained growth, with regular patterns in space and time (as for the latter, one might refer to growth phases or broken trends evidences: Coricelli et al., 1991);

(a.ii) sustained diversity in income per head: even when adjusted for price levels, real products per head in 1980 still diverged by a factor of 13 in between India and OECD average in 1980 (Summers & Heston, 1984; 1988);

(a.iii) a lack of correlation between the two former variables, therefore a well-established failure of the neoclassical hypothesis of cross-country convergence, which can no more be attributed to occasional disturbances or imperfections;

(a.iv) the absence of a unique pattern of growth for all countries, due to the forces of change and their irreversibility;

(a.v) plus a residual of observable facts, such as externalities in technology accumulation and spatial interactions, that aggregative modelling cannot fully capture but a proper theory of development should account for.

After this amazing opening up of the debate for a new research programme, it seems to us that Endogenous Growth scholars have adopted a reductionist approach to the scope of the new school, for example when listing the relevant stylised facts to be explained by a neo-schumpeterian model as follows (Romer, 1994):

(b.i) there are many firms in a market economy;

(b.ii) discoveries differ substantially from ordinary commodities, since they share some public goods features (non-rivalry and incomplete excludability);

(b.iii) different scale effects characterise the replication of physical activities or of technology-related intangibles;

(b.iv) the aggregate of discoveries is endogenous, due to intentional and unintentional technology creation activities;

(b.v) price making, market power and Schumpeterian extra-profits are observables.

According to this reductionist view, the research agenda gradually and incrementally expanded from neoclassical growth, accounting for Facts (b.i) to (b.iii), to the incorporation of Fact (b.iv) by early EndG models, and up to (b.v) in their second generation.

On the other hand, a typical EvoG agenda would necessarily or most likely include:

(c.i) global divergence, regional convergence and persistent differences: a grouping of all five Lucas´ stylised facts; plus:

(c.ii) evidences supporting the hypothesis (Dosi et al., 1993) that technology affects growth patterns both directly and via trade flows; technology creation being, since from the First Industrial Revolution, distributed worldwide and across firms with a highly skewed density;

(c.iii) technology being also far from a free or even a semi-public good (versus Romer´s fact b.ii), due to its tacit and paradigmatic features;[1]

(c.iv) interactive market forms dominate over perfect or imperfect competition (reinforcing but also qualifying Romer´s b.v);

(c.v) the relevance of technical, economic and social norms and of the institutional forms of society in the analysis of development; and, at least as hypotheses to be tested, some further implications of (c.i) to (c.v) such as:

(c.vi) "science policy lemma": the degrees of freedom in the world system allow for science and technology policies to affect growth, at least locally (in a country or a world region), and/or:

(c.vii) "dependency theory lemma" derived from the axiom of a dual centre/periphery pattern in the establishment of technological standards and paradigms (e.g. Furtado 1994): in one of its possible formulations, it adds the following constraint to the latter hypothesis: "an adequate technological dynamics would be impossible in developing countries, unless sustained by major changes in the political and economic system worldwide" (Cimoli & Dosi, 1992:43). One has also to notice that this second Lemma, that we will discuss in the Conclusion, should nowadays be furtherly qualified, in order to incorporate the puzzling evidence of the alternative technology and growth patterns in Asian NICs and in Latin America (Dosi et al., 1993; Canuto, 1993; 1994).

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1 By "tacit" features of technology, Nelson & Winter (1982) mean some elements of specific knowledge that are both necessary for a sufficiently efficient use of each technology and embodied in firm´s routines and pesonnel. That tacit knowledge cannot be acquired or transferred by means of handbooks or any other codifiable forms of knowledge, because its nature is practical, and not propositional knowledge. Tacit knowledge is hardly translated into explicit or formal one, such as a blueprint, and therefore cannot be easily diffused as either public information or private intellectual property. The concept was introduced by Polanyi (1967). Canuto (1995) summarizes how a specific line of micro-foundations can be derived from this view. On technological paradigms see Dosi (1982).

1.2 The slow diffusion of a superior view of technology: a dual, tacit and formal, operational knowledge system

At the root of EndG modelling we find an effort to incorporate some of the results achieved by technology scholars into a dynamic and general equilibrium framework. Nonetheless, it strikes also the idiosyncratic way to filter and select such results, for example with an undue emphasis and oversimplification about the magnitude and direction of "spillover" effects, assuming new technologies being semi-public goods with very low appropriability.[2] We argue here that these biases reflect and amplify, due to their over-simplification, a more general double trend, in economic theory over the last three decades, to conceptualise technology mainly as an informational commodity, and information as a quasi-public good: a view that does not capture the deeper understanding of technology dynamics that is by now accepted in the specialised literature. Briefly speaking, EndG theorists do summarise badly this neoclassical and mainstream view of technology by reducing it straightly to a quasi-public good; this is the way they pose the problem: as the ´paradox´ of a nonrival and only partially excludable good, knowledge, which is privately produced.

Foray (1995) shares our view and argues that economists faced an alternative in the 1960s, when they might have accepted the view of technology either as scarcely appropriable information or as an activity inducing cross-firm cooperation. While Arrow´s (1962b) paper on learning by doing is a recurrent source in the EndG literature, we might argue that the contemporary Arrow´s (1962a) paper is even a more profound source of inspiration (see note 2). We find in the latter the first proposal of an informational view of technology, implying its inadequate (suboptimal) appropriability. Richardson (1972), in his pioneering contribution to a theory of cooperative networks, opposes to Arrow the argument that the imperfection and opportunism in the technology licensing market might often induce firms to cooperate, as a superior alternative to vertical integration across research and production.

What is interesting here is that Richardson traces directly the rationality of cooperation (as an alternative to spot transactions or vertical integration, to buy or

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2 Grossman & Helpman (1991:17) refer to Arrow´s (1962a) informational view of technology in order to argue that "technological spillovers may be very important to the growth process. The general information that researchers generate and cannot prevent from entering the public domain often facilitates further innovation". Although they distinguish generic from specific technological information, it seems that technology always reduces to information. This leads them to agree with Romer (1990a) in identifying two typical R&D outputs: blueprints (designs for new commodities) and contributions to the public knowledge stock (*ibidem*, p.57).

make) back to the existence of firm-specific capabilities, so anticipating a very wide stream of literature on innovative networks that will take off with the problem-setting contributions by Hippel (1978); Lundvall (1984) and Teece (1986). And, even more surprisingly, he derives this concept from a critique of production functions and a non-informational view of economically useful knowledge as generic but mostly specific know-how in technology, managerial and marketing areas, that is "appropriate knowledge, expertise and skills" (Richardson 1972:888). And he finally concludes that:

> *"Technology cannot always be transferred by simply selling the right to use a process. It is rarely reducible to mere information to be passed on but consists also of experience and skills. In terms of Professor Ryle's celebrated distinction, much of it is 'knowledge how' rather than 'knowledge that'. Thus when one firm agrees to provide technology to another it will, in the general case, supply not only licenses but also continuing technical assistance, drawings, designs and tools." (ibidem, p.895).*

While Arrow influenced the mainstream economic theory of innovation, Richardson's arguments are now re-evaluated by the currently accepted conceptualisation in technology studies. This new view defines a technology as a system of operational or practical knowledge, where tacit aspects (know how) play a larger role than in those propositional knowledge systems (know what and why), which allow sometimes for a complete formalisation, therefore for a codification into sets of informations without residuals (Arcangeli, 1995; see also note 1 here).

A major implication is that by its nature tacit knowledge is inducive only of local and slow spillovers, and its informatisation for the sake of faster and long-distance communication implies high costs of learning, formalisation and transmission. A typical test of this implication is the strategy and behaviour of multinational firms: while facing high technology transfer costs in their early growth phase, they have afterwards concentrated their efforts in the formalisation of internal tacit knowledge and in the use of telecommunications (or more exactly tele-computing, computer-to-computer communication) in order to spread across their plants this stream of (largely firm-specific) tacit-to-formal knowledge (Arcangeli & Genthon, 1995).

Different disciplinary or theoretical approaches to technology studies do converge today to stressing this institutional nature of technology as the root of many observed facts in innovation and in the apparent slowness of diffusion (embedded into costly and constrained learning processes). Grossman & Helpman

(1991, 1994) seem sometimes to be aware of some of these costly and bounded processes, in large part explained by the cognitive concept of technological capabilities proposed by Richardson (1972); but what is missing here is first of all the derivation of this empirical evidence from its root which is, at this stage of technology studies, adequately explained by the firm capabilities approach.

This view is scarcely captured by EndG stylisations in general: let us see some important examples, among the high variety of attempts to define and model technology development. In conceptual terms, Lucas (1988) opens up the two ways of incorporating the phenomenon either as a new productive factor, knowledge, or as an externality. On the second line of argument he tells us the most interesting things, by referring to an original urban economist such as Jacobs (1969; 1984): he even dares to accept her view that economic life is creative as art and science, a proposition with a Schumpeterian and even a neo-Austrian flavour (a line of formal micro and macro modelling on these lines has been developed by Amendola & Gaffard, 1986).

After this initial setting of the research programme, EndG modelling expertise has cumulated by reworking or recombining such alternative operational definitions of technology as: spatial diffusion of an aggregate technology frontier A(t) (Barro & Sala i Martin, 1992), learning-by-doing à la Arrow (1962b) only (Romer, 1987a), human capital only (Mankiw et al., 1992), education and learning-by-doing (Lucas 1988), education and R&D (Marrevijk et al., 1992), the allocation of human capital in between research and production (Romer, 1990a, 1990b), and cost-reducing process innovations à la Arrow (1962a) (Grossman & Helpman, 1991, ch.4; Aghion & Howitt, 1992). A dominant feature in many EndG model versions is Becker´s Human Capital concept, that is a standard neoclassical approach which can hardly be accepted without discussion and rediscovered in retard as a useful complement to Solow´s physical capital, exactly when the literature has already produced robust alternative explications of the demand for education, for example in terms of search processes in labour markets with informational asymmetries.

But, more important, a disjoint duality between intentional production of knowledge and unintentional spillovers (or externalities) still persists, reflecting an inadequate understanding of the peculiar underlying "joint duality" of tacit and formal components in a technology or engineering system, as distinct from a scientific or a purely informational one. Romer (1986), for example, starts the series of his contributions by separating roughly an appropriable (a(j)) and a non-excludable (A) knowledge section, following Griliches (1979). Then he proceeds incorporating also the non-rivalry feature (1987b; 1990a; 1990b; 1994) of the "input" of new designs for intermediate goods, in a Dixit & Stiglitz (1977) framework of increasing product differentiation which is supposed (also by Grossman & Helpman, 1991, chs.3, 4; Young, 1993) to have a neo-schumpeterian flavour. This assumption is subject to two orders of critical considerations.

First, the mechanics of product differentiation has not much in common with product or process innovation, even if one allows for a technological trajectory to be well-established and the dégrees of uncertainty consequently reduced by reliable technological expectations. It is the inherent Schumpeterian innovation process which is different from a Chamberlinian product differentiation moving along a quality ladder (defined by transforming orthogonally a horizontal segment à la Hotelling into a vertical and infinite ladder). The nature of uncertainty in the search process changes when a variety of activities of exploitation of scientific principles, R&D, design and engineering, and the learning processes before and after the comercialisation of the innovation must deal with an infinite, unknown and (beyond the one-dimensional metaphor) multi-dimensional technology space. If it is vertical innovation, and not just lateral differentiation, some Knigthian element of structural, and not just parametric uncertainty must be at stake (as remarked by Solow, 1994:52).

Second, the nature of this random search process cannot resemble anyway an R&D production function with some purely stochastic disturbances: as the R&D scholars know very well, no one can establish even a stochastic regular pattern linking inputs to outputs for most R&D activities. Nor it would be acceptable, unless without some qualifications, such an R&D production function to emerge in the aggregate.

Interestingly, Romer (1990a, eq.3; 1990b, eq.4) assumes that the stock of cumulated knowledge is an input into such a function, together with human capital applied to search and a productivity parameter (average research success per unit) of the human capital applied to the recombination of existing knowledge into a new product design. Chiang (1992:274) objects that this specification brings to an error in the order of magnitude of the balanced (i.e. Harrod-neutral) stationary state of the system; he is not right because the large number entering in the numerator of the steady state growth equation (absolute number of skilled labour or units of human capital) is weighted by the average productivity parameter, giving the (supposedly small) number of new discoveries.

We argue here that the following objections and qualifications seem to be economically relevant in this respect:

(i) in this formalisation of the technological search process there is no asymmetry, not even a frequency distribution of success probability across the researchers population (leading to a stochastic dynamic formulation of the problem), due to the representative agent axiom;

(ii) we might interpret such a "representative researcher" success parameter as reflecting all the institutional (international and national innovation systems-related) factors affecting accessibility to the knowledge stock. Although appealing and allowing for an interpretation incorporating some arguments about the knowledge stock proposed later on by David & Foray (1994), this formalisation is still unconvincing, because it is a production function, underestimating the nature of uncertainty in R&D, as we argued above;

(iii) in its original formulation, unless modified as the Author admits worth to be done (Romer 1990a:S83), and for example along David & Foray lines, it presupposes a pure public good character of existing knowledge, that is a quasi-instantaneous (or, in discrete time, a one-period) depreciation of new knowledge into a public good;

(iv) even corrected with some smoothing of the decay, this awkward axiom reflects the bias towards a low-appropriability, blueprint or informational view of technology, shared also by Grossman & Helpman´s models (although these Authors refer often to empirical evidence on technology which is inconsistent with such a view).

(v) Finally, a paradox arises here: a blueprint technology, purely formal (informational) in content, would be entirely appropriable let us say for one or a few (according to (iv)) periods, and there is no reason why it should; after its fast or smoothed decay, it would enter a public library and be costlessly accessible. Only this second assumption is coherent with its purely formal nature, but it is at odds with the entire available evidence we have on infant (one-year old), young technology or anything alike. Let us refer e.g. to the evidence about international transfer by age of technology collected by Mansfield & Romeo, showing that on average a technology was diffused internationally after 6 years from innovation to subsidiaries in developed countries, after 10 years to subsidiaries in developing ones, and after 13 years through licensing to developing countries (Safarian & Bertin, 1986:140, tab. 9.3).

Therefore the micro-stylisation assumed in this brand of EndG models inspired by Dixit & Stiglitz doesn´t make economic sense. Actually, in the real economy the reasons for partial appropriability are rooted in a collective[3] (but not

3 See Silverberg (1990).

at all "public") advance of the knowledge frontier and in the socially determined distribution channels of such a knowledge stock: a far-from-market, in fact a nested-networks and institutional social mechanism, in science as in technology, that all the literature in a number of disciplines has shown to us in decades of studies on the organisation of science and technology systems.

In this context, it is no surprise that at the end of the search process and innovation chain, "who gains what" is not the outcome of a lottery process, as it is often supposed, underestimating too many economic and institutional determinants, by the game-theoretic literature on R&D (in any case a much more relevant area, when compared to the poor stylisations of research and new products design in the EndG stream). The innovative firm as a locus of cognitive processes, search routines, coordination efforts along the innovation chain, and cooperative learning within and across its boundaries: this is the most typical recipient of extra-profits from successful innovations according to the much richer and more rigorous micro-foundations of EvoG models, from Nelson & Winter (1982) onwards. They undoubtedly fit better the stylised facts we know today about technology, although they give us a particular, focussed and certainly not the only possible interpretation of such facts.

Once we add some non-deterministic cumulativeness in the transition from one innovation race to the next one, we are ready for endogenising market structure into innovation (or viceversa). An approach pioneered also, in a neoclassical equilibrium framework (therefore with a different view from Nelson & Winter, 1982; Dosi 1988a:1158), by Dasgupta & Stiglitz (1980a; 1980b), and at the origin of many significant advances in Industrial Organisation studies, that EndG scholars ignore by referring only to innovation-unrelated product differentiation models. A vague and thin reference to cumulative processes can be found perhaps, to our knowledge, only in Young (1993), when he is assuming the probability of success in the next race to be affected by current R&D expenditures; the foundations of a much more robust modelling approach to this particular aspect might be found, among many relevant contributions to capturing the phenomena of self-organisation and cumulative causation in techno-economic systems, also in Cohen and Levinthal´s capability-related concept of ´learning by doing R&D´. But this would introduce a self-reinforcing asymmetrical process that is not admitted by the general equilibrium framework.[4]

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4 See Solow (1994:52) arguing that innovation might be cumulative, because of the complementarity between successive innovations.

Finally, if we consider the late Chamberlin, refining if not abandoning the weak concept of a scarcely differentiated "large group", he is also at the origin of the interaction and strategic approach to oligopoly. But this is not the same story as with monopolistic competition: it is an alternative one (Possas 1985, ch.1), as Schumpeter (1942) had pointed out earlier. Hiding behind an eclectic Chamberlin+Schumpeter mask, more suitable to their general equilibrium framework along Chamberlin+Triffin (1940) lines, Romer, Grossman and Helpman end up missing that there is a much more interesting convergence ongoing today: the one between Industrial Organisation and Evolutionary Economics around the common identification of some basic components of the kind of Schumpeterian competition which is endogenous in contemporary dynamic oligopolistic markets (Dosi, 1988a; Delbono, 1990; Jacquemin, 1987). But we have now to consider the question mentioned earlier in the introduction: whether such an extension of the scope, or alternative micro-foudations of EndG theory, from Chamberlin-Arrow to Schumpeter-Richardson, is really compatible with the General Competitive Equilibrium approach that identfies this stream of literature. This leads us into the final evaluation of the analytical and normative characters of new growth models which follows.

Conclusion

Let us briefly consider two order of (theoretical and normative) observations about the state-of-the-art of new, post-neoclassical growth theory, in an epoch in which thinking about development is not certainly at its peak (or perhaps at an inferior one?)[5]. On the one hand, we have seen that the two prevailing modelling styles might be reconducted to theoretical assumptions that show up as alternative, internally coherent but mutually exclusive blocks.

On the other hand, although the literature is not yet so robust as to sustain with solid new arguments one or another development policy, most Authors go very quickly (with an unconvincing hurry) to expliciting legitimately their policy tastes and to arguing upon them on the basis of the internal logic of their tested or untested models (a very strange epistemological attitude which is nothing new in economics!). Some lines of evaluation of the policy implications from some more representative models might therefore illuminate, perhaps not the analytical

5 See Canuto (1994, ch.2) for a comparison between development pioneers and the "new" orthodoxy of development economics.

frontier, but the Zeitgeist in the sense of Schumpeter, or at least some growth scholars´ value options.

As for the analytical side, we might conclude that each of the two major new growth approaches we have been discussing here is somehow internally coherent. As for the stylisation of technological facts, the evolutionary approach has a genetic superiority since it has been developed "endogenously" within the stream of technology studies, aside with benchmarks such as Mowery & Rosenberg´s (1979) solution to the demand-pull vs. science-push debate over technology growth, and the related discovery of the importance of idiosyncratic internal heuristics and institutional facts, namely during "paradigmatic shift" or standard-setting and exploratory phases of this growth (Dosi, 1982; David, 1985; 1986), when purely economic factors have weaker effects and sub-optimal standards can fit into market niches with hysteresis.

There is room for improving the representation of technology within Endogenous Growth models; nonetheless, there are boundaries to such an expansion, due to the constraints imposed by theoretical coherence: weakening Arrow´s view of technology allowing departures from a neo-Chamberlinian view of dynamic competition, but more substantial neo-Schumpeterian elements challenging a neo-Walrasian general framework which is essential to the identity of this school. Schumpeter (1919) himself was not capable of performing his task of reconciling his view with Walras in a stationary state, and it seems unavoidable that Schumpeterian dynamics violate some Walrasian axioms. Neither the oligopolistic interdependence seems to be a way of relaxing these constraints, because when aggregating from industry to general equilibrium the indeterminacy and hence the normative irrelevance of the analysis is at stake.

Coming to the normative implications, EndG substitutes for previous neoclassical convergence models predicating the irrelevance of growth policies, equilibrium growth being optimal. But the outcomes (Grossman & Helpman, 1994:37) are contradictory within a neoclassical framework, since on the one hand Schumpeterian rents violate efficient marginal cost pricing; on the other hand optimal resources allocation (e.g. of human capital between R&D and production in Romer, 1990a; 1990b) would require a still higher appropriability of such rents, perhaps with institutional norms reinforcing intellectual property rights. This would increase "inefficiency" on the previous side, and also reduce knowledge distribution, hence innovation and diffusion rates (David & Foray, 1994; Foray, 1995).

As for direct (not via technology) growth policies, such as industrial and trade ones, the Zeitgeist reflected in EndG is clearly the "neoliberal" one, while EvoG, on the contrary, argues about the possibility to explain variances across Developing Countries with institutional and policy variables. The aim of this unorthodox view is clearly to justify national and regional policies, far from accepting as socially optimal the observed globalisation patterns (Chesnais, 1994), or adopting a sort of global pessimism such as the one incorporated in Dependency Theory (already challenged by Mello, 1982). Nonetheless, the analytical support for such implications would require that evolutionary scholars were able to integrate pure modelling frameworks with a non-ad-hoc approach to the institutional frameworks: a direction exemplified by the hypothesis of substituting the qualitative concept of National Innovation System for the mere quantitative effort in R&D, as an explanatory variable of technology-intensive trade patterns.

Moreover, the stylised facts of an acceleration of both formal education and tacit learning, laying behind successful National Innovation Systems, impose also to EvoG, in our view, to bypass a mere growth account and to tackle development issues. Also because, by abandoning Walrasian optimality criteria, other welfare measures are required, such as the ones discussed in the recent debates and research about sustainability or human development. Is education (health) a value in itself, or only instrumental to a human capital vision? Incorporating this issue would be an important and desirable characterisation of non-neoclassical models.

Finally, EndG liquidates too easily direct growth policies: even if unselective fiscal incentives to investment were irrelevant, the arguments used by Romer (1990a, 1990b) point towards the relevance of selective and/or educational policies. As for his implication that ceteris paribus only the allocation of human capital between two activities matter for maximising growth (which, as Grossman and Helpman correctly argue, is not always optimal), depends directly from a simplifying assumption (equation 3 and 4, respectively, in the quoted papers, that we have already discussed above) about the growth rate of A, where one assumes: technology to be a blueprint (for a critique see Dosi 1988a); and a deterministic view of the relation between the stock of knowledge A(t) and the innovation rate, a view shared also by the similar Chamberlinian model proposed by Grossman & Helpman (1991, chs. 3, 4, the latter chapter introducing a stochastic component in the process innovation search). Even accepting that equation, but interpreting the human capital productivity parameter, as suggested above, according to Foray (1995; David & Foray, 1994), one would identify policy measures and institutional designs for more efficient knowledge-distribution systems (a key policy variable both in Japan and Korea) as means of achieving higher balanced and sustained equilibrium growth for a closed economy.

In this respect, Grossman & Helpman (1991, ch.8) also allow for asymmetries, hystereses and path-dependency to appear in an international trade context, but only as "local self-organisation", that is regional perturbations of a world equilibrium path: this would also justify regional technology accumulation policies, as an alternative to the orthodox argument pro-regional integration only.

An argument still holding according to Romer (1990a:S98; 1990b:351, where he can derive it only in the limit-case of two symmetrical economies!) who thinks that learning, redesigning or reverse engineering in the South would mean "reinventing the wheel" (mere duplications), exactly because he misses a correct capability view of technology acquisition and creation, and this leads him to apply, for the allocation of human capital, Ricardian static efficiency criteria to a Schumpeterian growth problem (Dosi, 1988b). Going for one moment beyond Schumpeterian time perspectives, into Fernand Braudel´s and Sergio Buarque de Hollanda´s ones, we dare to answer to Romer that, had the Incas reinvented the wheel, perhaps history would have changed in the colonialist era, and the social environment for development wouldn´t be exactly the same today. And quantitative history might eventually have tested our scenario!

The policy perspective suggested by Grossman & Helpman is more tolerant, but it sticks to general equilibrium axioms extended to the multi-country case, a problem that was fashionable in regional and trade economics some decades ago, with important outcomes achieved by Takayama and Judge, and with implications about the long-run optimality of reducing regional inequalities by Mougeot. Anyway, by excluding inter-firm asymmetries, Grossman & Helpman are obliged not to represent the other relevant institution facing the regional (EU, NAFTA, MERCOSUL or ASEAN) policy authority: the multinational or global network firm (Chesnais, 1994).

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