Division of Labor and Economic Growth: from Adam Smith to Paul Romer and Beyond*

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Abstract

The aim of this paper is to put in historical perspective the recent models of endogenous growth based on division of labor, i.e. the models based on a multiplicity of intermediate goods, taken as representing the degree of specialization in an economy. The modern approach is analyzed with particular reference to Romer (1987, AER). We analyze the contributions of Adam Smith, Alfred Marshall, Allyn Young and Nicholas Kaldor on the issue. It will be argued that: (i) there exists continuity in such authors, as regards their view of economic growth based on division of labor; (ii) such line of thought is still providing insights to be developed, insights which have not received a completely exhaustive treatment by modern growth theory. Namely we refer to: the idea of growth as a process involving an increasing complexity of the economic system; the identification of the role played by demand; the nature of the growth process as a path dependent, cumulative process, and the related issue of the tendency towards an equilibrium. We conclude that the modern growth model based on division of labor, although constituting an important development, still leaves open some directions for research. Other recent models based on network externalities and local interactions may prove useful for complementary formalizations.

1   Introduction

Endogenous growth theory represents one of the most relevant developments in macroeconomics in recent years. The models of Romer (1986a) and Lucas (1988) first demonstrated that the long run rate of growth can be directly explained by agents' decisions, without resorting to some exogenous technological progress, as in the model of Solow (1956).

Among the plethora of models that followed the seminal papers of Romer and Lucas (see Barro and Sala-i-Martin, 1995, and Aghion and Howitt, 1998, for surveys), an old hypothesis reemerged: precisely, that the explanation of economic growth should be reconducted to increasing returns generated by the division of labor. As is well known, this was one of the main contributions of Adam Smith's *Wealth of Nations*, published in 1776. It was Romer (1987 and 1989) himself that reproposed this theory in the form of a particular endogenous growth model (see also Barro and Sala-i-Martin, 1995, Ch. VI). Actually, Romer was concerned with formalizing the theory of economic growth put forward in Young (1928), which represented a substantial advance and update of Smith's theory.

The aim of this paper is to put the Romer model in an historical perspective, by considering the evolution of the theory of economic growth as depending on division of labor. This attempt will be based on an analysis of the arguments developed by Adam Smith, as the father of the theory, Alfred Marshall, as the author who marked the passage from classical to marginalist economics, Allyn Young, as an isolated advocate of new directions for economics, and Nicholas Kaldor, as an important interpreter of Smith and Young[1].

We argue that the approach developed within the endogenous growth theory does not seem to fully capture essential elements of the process of economic growth depending on division of labor, elements identified by the mentioned authors. In particular, we indicate four problematic areas in the "new" theory in comparison with the "old": the use of an equilibrium approach instead of a disequilibrium approach; the bias towards the supply side and the partial neglect of the role of demand; an excessively important role attached to fixed costs; a vague use of the term "external economies", which may be instead replaced by "network externalities". In the discussion, we will also pay attention to the aspect of the compatibility between increasing returns and competition, arguing that from a reflection on the dynamics generated by the process of division of labor, it does necessarily follow that increasing returns and competition are incompatible.

Moreover we suggest that, in the works of Smith, Marshall, Young and Kaldor, certain elements of the dynamics of growth based on division of labor make such process interpretable in terms of a different modern approach, i.e. the "complexity approach" to economics (see, e.g., Arthur *et al.*, 1997). More specifically, growth generated by division of labor appears as a process based on *(local) interaction* among economic agents (individuals or firms); a process characterized by *increasing returns* and *path dependency,* and by *continual novelty* in terms of appearance of new firms and sectors. Also, as forcefully argued in particular by Allyn Young, this type of economic

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[1]We do not provide a full survey of the literature on division of labor and growth. An excellent one can be found in Yang and Ng (1998).

growth is likely to be best represented as an *out-of-equilibrium process*, in which "new potentials, new possibilities, are continually created, [so that] the economy operates far from any optimum or global equilibrium" (*Ibidem*, p. 4). The aggregate phenomenon of economic growth can thus be understood as the *emergent structure* of such an interactive system[2].

Consequently, it appears the possibility for growth theory to be integrated by theories developed within the "complexity approach" (like models based on network externalities and local interaction) and which, so far, have concerned the issue of macroeconomic growth only indirectly, for instance in the case of the study of technology diffusion (the most relevant exception is Durlauf, 1993).

The paper is organized as follows: Section (2) describes elements of the theory as developed by Adam Smith (Subsection 2.1), Alfred Marshall (Subsection 2.2), Allyn Young (Subsection 2.3), and Nicholas Kaldor (Subsection 2.4). Section (3) introduces the Romer (1987) model; Section (4) critically compares the old and new approaches. Section (5) returns on the relation between growth based on division of labor and the "complexity approach", and contains some concluding remarks.

2 The Smith-Marshall-Young-Kaldor Approach

We group the contributions of Adam Smith, Alfred Marshall, Allyn Young and Nicholas Kaldor to highlight the continuity among them. It is of course evident that Smith, Young and Kaldor are related, since it is not possible to mention Young without referring to Smith, and it must be remembered that Kaldor was a student of Young. As regards Alfred Marshall, we emphasize that certain ideas on economic dynamics, put forward specifically in Book IV of the *Principles of Economics*, make Marshall closer to his classical antecedent (i.e. Adam Smith) than to his neoclassical followers. We will also discuss how these authors dealt with the issue of the compatibility between competition and increasing returns.

2.1 Adam Smith

In the first three chapters and in other passages of *The Wealth of Nations*, Adam Smith advances the thesis that the a high level of division of labor is the most important explanation of the income level reached by developed countries. In particular economic growth, to be interpreted as growth in per

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[2]The terms in italics used in this brief description of growth based on division of labor are elements which generally characterize a "complex system", according to the *Introduction* to Arthur *et al.* (1997, pp. 3-4) and to Durlauf (1997). However, complete unanimity on what makes a system "complex" does not exist (see, e.g., Rosser, 1999, pp. 170-171).

capita income, has to be reconducted to two factors: labor productivity and the proportion of productive to unproductive workers[3].

Labor productivity, which is considered the most important of the two, essentially depends on the division of labor which: a) improves the *dexterity* of the worker; b) allows the worker to save the time necessary to switch among different activities; c) puts the worker in the condition of inventing machines to facilitate his job. In modern terms, we see how Smith had in mind the concepts of learning by doing, (point a)), set-up costs (point b))[4], and endogenous technological progress (point c)).

As regards point c), Smith does not put particular emphasis on the operations of ordinary workers, probably capable of some minor inventions, but suggests that more important are the cases of the specialization of individuals in producing machines, or in pursuing inventive activity. Here Smith especially refers to the process of division of labor *among* productive units (firms, departments,...), where two particular types of specialized workers may appear:

> "the makers of machines, when to make them became the business of a peculiar trade; ... those who are called philosophers or men of speculation, whose trade it is not to do any thing, but to observe every thing; and who, upon that account, are often capable of combining together the powers of the most distant objects. In the progress of society, philosophy or speculation becomes, like every other employment, the principal or sole trade and occupation of a particular class of citizens." (WN I.i, p. 14)

In this context therefore technological advances and, more generally, increases of the stock of knowledge, can be considered as *consequences of an increased division of labor* among and within firms, since they proceed at a certain speed only when (i) some classes of men become exclusively engaged in producing machines, or (ii) in producing knowledge or (iii) when workers concentrate on a particular phase of the production process[5].

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[3]According to this distinction, a worker is *productive* if his labor adds value to the materials he utilizes. As such, his labor is "fixed" in a good that may subsequently be exchanged with other labor. On the contrary, the worker is *unproductive* when he produces services which "generally perishes in the very instant of [his] performance, and seldom leave any trace or value behind [it], for which an equal quantity of service could afterwards be procured" (WN II.iii, p. 352). Examples of unproductive workers are: servants, musicians, lawyers, soldiers, churchmen, etc.

[4]Note that this set-up cost is not related to learning costs, but to the opportunity cost in terms forgone production for the time wasted to switch from one activity to another.

[5]These cases may lead to consider a standard classification of innovations. In particular, when workers are simply specialized, or are specialized machine makers, they are likely to produce *incremental innovations;* instead, when they are specialized in inventive activity, they may generate *radical innovations.*

Capital accumulation, fundamental issue for many (if not all) growth theories, should also be considered with respect to division of labor. First, for Smith competition forces entrepreneurs to seek the most profitable way of deploying capital, that is the most productive division of labor:

> "[t]he person who employs his stock in maintaining labour, necessarily wishes to employ it in such a manner as to produce as great a quantity of work as possible. He endeavours, therefore, both to make among his workmen the most proper distribution of employment, and to furnish them with the best machines which he can either invent or afford to purchase."(WN II.Intr, p. 292)

In general, capital accumulation and division of labor are intimately connected since not only capital accumulation permits division of labor, but also division of labor stimulates further accumulation of capital, as the following passage makes clear:

> "[a]s the accumulation of stock must, in the nature of things, be previous to the division of labor, so labour can be more and more subdivided in proportion only as stock is previously more and more accumulated. The quantity of materials which the same number of people can work up, increases in great proportion as labour comes to be more and more subdivided; and as the operations of each workman are gradually reduced to a greater degree of simplicity, a variety of new machines come to be invented for facilitating and abridging these operations. As the division of labor advances, therefore, in order to give constant employment to an equal number of workmen, an equal stock of provisions, and a greater stock of materials and tools than what would have been necessary in a ruder state of things, must be accumulated beforehand."(WN II.Intr, pp. 291-292)

Smith therefore stresses the fact that accumulation of capital in the growth process is not related to a mere replication of existing productive activities, but is inextricably linked to a qualitative change. A change which takes the form of new ways of subdividing labor within firms or among firms, when new branches of business are created, new products appear, etc.

Capital accumulation makes division of labor a *cumulative process*: further division of labor is permitted by the accumulation of capital, and cannot proceed unless some previous stage of division of labor has been reached. Notice also that, from the way Smith links capital accumulation to division of labor and thus to productivity, it does not automatically follow that an increase in the stock of capital must cause a decrease in the rate of profit. As Kurz and Salvadori (1999) note: "[a]n increase in the economy's capital stock as a whole need not have an adverse effect on the general rate of

profit. It all depends on how the real wage and the technical conditions of production are affected in the course of the accumulation of capital".

What constitutes the basic obstacle to economic growth is resumed in the famous Smith's statement, giving the title to Chapter III of Book I of *The Wealth of Nations*: "That the Division of Labour is Limited by the Extent of the Market". The reasoning of Smith is the following: specialization permits an individual to obtain a surplus product over subsistence for a particular good (or a small set of goods), but at the same time he cannot produce all the commodities he needs. Thus, he has the incentive to specialize if he possesses "power of exchanging" that surplus, i.e. if sufficient demand exists, permitting the individual purchase other goods, with the revenue accruing from selling of his surplus product. Note that the same logic applies to a firm: specialization of operations is profitable if there is demand for the higher quantity of goods that it can produce by specializing and, at the same time, there is the possibility to purchase outside the commodities the firm renounces to produce.

So, when we consider the fundamental importance attributed to Smith to the extent of the market, therefore to demand (both effective and potential, as we discuss below), we can say that technological progress and capital accumulation, strictly connected in a Smithian framework, are not only a pre-condition for the expansion of production, but are also conditioned by it. The accumulation of capital also influences the number of people put to work and thus the aggregate level of disposable income. We will return to this question when discussing the contribution by Allyn Young, who restated Smith's theory as: "the division of labor is limited by the division of labor".

Demand is important in another respect. First notice that for Smith there existed differences between manufacturing and agriculture in terms of the degree of division of labor attainable. In fact, since agriculture is characterized by a specific timing of every operation (seeding, harvesting, etc.): "it is impossible that one man should be constantly employed in any one of them." (WN I.i, p. 10). This can be related to the issue of the demand for different types of commodities when Smith notes that: "[t]he desire for food is limited in every man by the narrow capacity of the human stomach; but the desire for conveniencies and ornaments of buildings, dress, equipage, and household furniture, seems to have no limit or certain boundary." (WN I.xi, p. 183)

The joint consideration of the apparently trivial observations that the division of labor can be pursued more in industry than in agriculture, and that the demand for manufactures is basically unlimited, allows one to point out the importance of the structure of demand in Smith's theory of economic growth. This aspect is fully analyzed in Rosenberg (1968), who shows that Smith had a clear theory of the formation of tastes, and that this implied a connection between demand and growth.

In particular, Smith argues that in his time individuals desired manufactured goods because they represented means to secure respect and admiration. Since the primary needs to be fulfilled are essentially related to food consumption, in the study of demand for manufactures the attention of Smith had to turn to those persons (landlords, nobles) who, after consuming food, had a surplus to dispose of. Until the development of the manufacturing sector, this surplus was almost entirely spent in maintaining people, basically servants, as an alternative means to gain respect and admiration. As noted, this behavior could have at least two negative effects on growth: it reduced the markets for manufactured goods and increased the proportion of unproductive workers.

This state of things could not perpetuate with the advent of industry. In this sense, the development of an interior manufacturing sector or the opening of trade for foreign manufactures, could find a latent, potential demand on the part of the surplus disposers[6], who were ready to spend their surplus in those goods, renouncing to some of their servants. Since, as noted, this type of demand was almost unbounded, landlords had an incentive to increase productivity on their lands, in order to increase the surplus to spend in manufactured goods.

In this way a virtuous circle could be started: the presence of potential demand for manufactures stimulated the development of the industrial sector which, being characterized by a potentially infinite degree of division of labor, could make available increasing quantities of goods at lower prices, thus stimulating further demand[7]; unproductive workers could be released and become employed in the productive sector; productivity in the agricultural sector was also likely to increase, and this was considered another favorable precondition for the development of an industrial, urban sector since: "[t]he cultivation and improvement of the country ... which affords subsistence, must, necessarily be prior to the increase of the town, which furnishes only the means of conveniency and luxury."(WN III.i, p. 402)

From the previous discussion some facts emerge as part of the Smithian system of forces, explaining the progressive nature of wealthier countries: the desire of individuals for a theoretically infinite variety of manufactured goods, contrasted to a necessarily limited demand for food, and the impossibility of reaching an unlimited degree of division of labor in agriculture.

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[6]In this case a problem of coordination failure between manufacturers and consumers was not likely to arise. In other words, those deciding to start a specialized manufacturing activity, were almost sure to find an adequate demand for their products. The theme of potential demand will reappear in Young (1928).

[7]Smith also considered that the expansion of the manufacturing sector made available ordinary consumption goods, thus not just luxuries, to "the lowest ranks of the people" (WN I.i, p. 15). Therefore, demand for manufactures by surplus disposers can be considered as particularly important in the move from an agricultural to an industrial society. In this sense it is arguable that a major role to expenditures by workers could be attached in later stages of development.

They appear as "natural" facts, in the sense that they can be conceived as givens in Smith's theoretical framework. The very presence of increasing returns, generated by the process of division of labor, as pointed out by Kaldor (1972, p. 1242), is due to: "reasons that are fundamental to the nature of technological processes and not to any particular technology". Kaldor (*Ibidem*, p. 1241) also noted that: "for Smith the existence of a 'social economy' and the existence of increasing returns were closely related phenomena".

In fact, an important precondition for the development of division of labor in a society is: "a certain propensity in human nature: ... the propensity to truck, barter and exchange one thing for another." (WN I.i, p. 17). Smith (WN I.ii, p.20) adds:

> "without that disposition to truck, barter and exchange, every man must have procured to himself every necessary and conveniency of life which he wanted ... As it is this disposition which forms that difference of talents, so remarkable among men of different professions, so it is this same disposition which renders that difference useful."

Note that Smith maintained that individuals are similar at birth. The differences emerge "from habit, custom or education" (WN I.ii, p. 20), or from the occupations they choose. The fact that individuals have a natural predisposition for what can be defined as social interactions, make possible for individuals to specialize and to obtain gains from trading their surplus products. For Smith the choice of specialization, given a structure of social interactions, can be based on a process of learning: when an individual learns that he enjoys a higher consumption by exchanging a part of his production, i.e. he has the "certainty of being able to exchange all that surplus part of the produce of his own labour ... [he is encouraged] to apply himself to a particular occupation" (WN I.ii, p. 19).

In short, in the Smithian theory of growth we can individuate some basic elements:

1) industrial production is characterized by increasing returns, originating from division of labor;

2) the process of division of labor can reach more advanced stages in the manufacturing sector than in agriculture;

3) individuals demand a potentially infinite variety of manufactured goods;

4) individuals have a natural inclination for social interaction[8].

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[8] On this see the interesting discussion in Loasby (1996, pp. 305-307). What is disputed is the interpretation of this predisposition to interact as the result of rational, utility-maximizing behavior. See also Houthakker (1956, pp. 181-182): "Smith was carefully ambiguous about the question whether the propensity to truck can itself be reduced to more immediately rational considerations".

The consequence, as noted, is that growth appears as an endogenous, cumulative process, where progress builds on previous progress and creates pre-conditions for further growth.

An associated issue is the relation of this sort of process with the prevailing market form and, consequently, with the tendency for the economy towards an equilibrium. We know that the presence of increasing returns at firm level is incompatible with perfect competition, once this is referred to a situation where every producer takes the price of his good as given. The question of the compatibility between increasing returns and competitive equilibrium generated a heated debate started in the 20's with respect to the works of Marshall[9].

Since this debate was focused on the shape of cost and supply curves, it is worth considering a passage by Smith on this aspect:

> "[t]he increase of demand ... though in the beginning it may sometimes raise the price of goods, never fails to lower it in the long run. It encourages production, and thereby increases the competition of the producers, who, in order to undersell one another, have recourse to new divisions of labour and new improvements of art, which might never otherwise been thought of."(WN V.i, p. 271)

Therefore, it seems that Smith considered as a normal situation a long run negative relation between the price and the quantity of a good, generated by a competitive process among producers. If an extension of the market can cause a decrease in the price of a good, it can stimulate a further market extension, more division of labor, etc. This passage makes clear that Smith anticipated Joseph Schumpeter, for whom a negative relation between the cost and the quantity sold of a commodity is nothing more than the consequence of the introduction of "innovations", taking the form of utilization of previously existing resources in a novel way, generating a reduction in unit costs. For Schumpeter the introduction of innovations is what characterizes "competitive capitalism"[10].

As Richardson (1975) noted, for Smith competition operates in two contexts: in the gravitation process of prices towards their natural levels, and in the entrepreneurs'quest for the exploitation of new opportunities offered by division of labor, in particular *among* firms, the latter process

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[9]For a recent account of the debate, see Kurz and Salvadori (1995, pp. 28-33).

[10]See Schumpeter (1928, p. 378). From the standpoint of the single producer, the reasoning of Schumpeter is the following: short period cost curves are positively sloped; however, competition force capitalists to attempt to undersell their rivals, therefore to introduce innovations that lower the unit costs. This causes a downward shift of the cost curve. Other producers have the possibility to imitate this behavior and therefore can "cop[y] the methods of the disturber of the peace" (*Ibidem*, p. 379).

being inextricably linked to increasing returns. Richardson (*Ibidem*, p. 351) writes:

> "Smith offers us in effect both a theory of economic equilibrium and a theory of economic evolution: and in each of these competition has a key role to play. Within the *The Wealth of Nations* no obvious tension exists between the two theories, partly no doubt because they are sketched out in a manner loose enough to make it difficult to establish inconsistency. Later writers, however, in striving for greater analytical rigour, developed the theory of equilibrium in terms of a model of reality that is clearly very different indeed from that implicit in Smith's theory of evolution."[11]

The first context where competition has a role in Smith's analysis is static, in the sense that competition takes the form of a reallocation of productive resources (land, capital and labor), from activities where the actual price is below its natural level, to activities where it is above, until these differences disappear and an equilibrium situation is established. The second context is dynamic, in the sense that competition is related a change in the structure of the economy: as new opportunities for division of labor are exploited and new sectors and products appear (both consumption goods and intermediate, i.e., specialized machines). In other words, in the first case competition operates with a given pattern of division of labor, in the second it operates through an expansion of this degree.

The two mentioned competitive processes are therefore related, since one may say that the second basically activates the first, but they are fundamentally different. In any case, according to this double notion of competition, it can be argued following Richardson (*Ibidem*, p. 354) that there is not a contradiction in Smith, when he speaks of the joint presence of competition and increasing returns[12], as these are at the roots of his theory of "evolution", but: "[i]t may ... be that incompatibility between competition and increasing returns is made to appear ineluctable to the modern theorist by the nature of the model of economic reality in terms of which he habitually thinks." (*Ibidem*, p. 354)

Richardson (*Ibidem*, p. 351) goes further in claiming that what is questionable is taking the neoclassical interpretation of the first type of competitive forces studied by Smith, as a base to discuss growth: "what Smith could see in a glass, darkly, it took Walras, with his more refined technique, to bring fully into light"[13]. But Richardson (*Ibidem*, pp. 351 and 354) adds:

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[11]See also Marchionatti (1992).

[12]We will returns on this presumed contradiction when discussing the contributions of Alfred Marshall, Allyn Young and Paul Romer.

[13]This view is in reality problematic, as the Walrasian process seems to be radically dif-

"this view of the matter seems to be mistaken. *It appears plausible only so long as Smith's theory of economic evolution is left wholly out of account....*[p]erhaps therefore we need only remind ourselves that *Smith is advancing here* [i.e. in his discussion of economic evolution] *a disequilibrium theory in the sense that he views the economy as in a state of constant and internally generated change.* Perpetual motion results from the fact that the division of labour is at once a cause and an effect of economic progress ... It is therefore abundantly clear that Smith had a conception of the working of the economic system very different from that implicit in the formal models employed by modern equilibrium analysis."(Italics added).

We will see that Allyn Young will re-state the impossibility of taking an equilibrium approach to endogenous economic growth.

In conclusion, in assessing Adam Smith's growth theory, we can agree with Loasby (1996, p. 303) that: "if economics is to be faithful to Smith's central principle, it has to be, in Schumpeter's phrase, an economics of 'development from within' "[14]. We can add that Richardson is probably correct when he uses the term "evolution" instead of "growth" with respect to Smith. As the discussion so far should have made clear, when Smith talks about a growing economy, he has in mind an economy undergoing qualitative changes, moving from a simple to a more complex structure. Moreover, he pointed also to demand as a relevant factor in the growth process. Basically, this idea of economic growth will be rehabilitated by Allyn Young.

2.2   Alfred Marshall

In this Section we analyze some aspects of Alfred Marshall's thought on division of labor, increasing returns and competition. Marshall's contribution is relevant since he introduced original elements to deal with this complicated issue, elements which somehow have received less attention than those relative to the question of value. Namely we refer to the concept of "organic growth" to approach economic dynamics, and to the description of firms' dynamics in a sector as a population dynamics.

We consider the distinction which can be drawn between a "dynamic" Marshall, and a "statical" Marshall, based respectively on the contents of Book IV and Book V of the *Principles*. The latter Marshall is the one who generated much controversy on the compatibility of variable returns to scale,

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ferent from that envisaged by Smith, and other classical economist, as to the determination of equilibrium prices. See Kurz and Salvadori (1995, Ch.I).

[14]Loasby (*Ibidem*, p. 303), adds: "the growth of knowledge, the incompleteness of knowledge and the unintended consequences of human action should be prominent characteristics of an economics that builds on Smith's principles".

equilibrium and competition, while the former is the one who suggested several analogies between the evolution of an economic system and that of an organism. We argue that the most useful tools for an analysis of growth based on division of labor can be found in the "dynamic" Marshall, without attempting to thoroughly investigate how Marshall himself was concerned with weighting these two sides of his thought[15].

The basic point of this Section can be synthesized by a quotation from Loasby (1989), reported in Marchionatti (1992, p. 557): "much of what is in Marshall is far more clearly revealed if we approach him from Adam Smith rather than from modern microeconomics." In fact, in Marshall it is possible to encounter certain elements already discussed by Smith, like the possibility to reconcile increasing returns and competition, and the conception of the economy as a system where change is internally generated and constantly taking place. The relationship between Marshall's thought on dynamics and the "complexity approach" has been recently discussed also by Foster (1993) and Comim (2000).

It is possible to begin the analysis by remarking that Marshall identified *four* factors of production, and added a fourth factor, i.e. organization, to land, labor and capital. It is the consideration of organization as a factor of production that introduces the discussion on division of labor. After praising Adam Smith (Marshall, 1910, p. 240)[16], Marshall draws a parallel between the *superior* organisms, social and physical: they are both characterized by an increased specialization of their components parts, coupled with a "more intimate connection between them" (p. 241). Two keywords in this context are: "differentiation" and "integration". With respect to an economic system, the first is referred to the specialization of skills and trades, of knowledge and of machinery, the second to the emergence of forms of connections among productive units: credit markets, means and habits of communication, means of transportation of tangible goods (by sea, road and railway) as well as of intangibles, like spread of information by telegraph, post and printing-press.

This idea of the functioning of an economic system will be resumed later in the *Principles* when, in a much quoted passage, Marshall writes:

"economic problems are imperfectly presented when they are

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[15]Some authors argue that the "statical" Marshall was actually popularized by some of his followers, e.g. Pigou, while the *true* Marshall was the "dynamic" one. See, e.g. Marchionatti (1992, p. 579): "[t]his type of dynamic view [i.e. Marshall's], in which the dilemma [i.e. of the compatibility between increasing returns and competition] turns out to be unimportant, is the part of classical economic thought which Marshall appropriated ... It is with regard to this analysis that Marshall's followers - Pigou above all - and the cost controversy authors deeply diverged: so that in the twenties Marshall's dynamic approach went largely unrecognized. Among these economists the predominant idea of dynamics had nothing to do with the Marshallian one." See also Hart (1991) and (1992).

[16]Unless otherwise specified, the quotations that follow are from Marshall (1910), and will be indicated only by the page number.

treated as problems of statical equilibrium, and not of organic growth. For though the statical treatment alone can give us definiteness and precision of thought, and is therefore a necessary introduction to a more philosophic treatment of society as an organism; it is yet only an introduction."(p. 461)

Let us consider two related issues: the compatibility between increasing returns and competition, and the use of the concepts of equilibrium and disequilibrium. First of all, Marshall devotes many pages in Book IV of the *Principles* to the discussion of *internal* economies, identifying several reasons for a positive relation between the scale of production and efficiency, which manifests in decreasing costs and prices.

According to Marshall, large-scale production allows different types of economies: economies of machinery, economies of skill, economies of materials. The discussion provided concerns especially the first two. As regards economies of machinery, Marshall seems to have in mind mainly the issue of the fixed cost to be born when a new machine is adopted. In this sense a large firm, that is a firm selling a large output, has first of all the possibility to keep the machine steadily employed, also it has more resources to spend, easier access to credit and so on. The same reasoning applies to skill: a large output means that division of labor may be practiced. Another important advantage of large firms regards another type of division of labor: since large firms employ a large number of workers, some workers may become specialized in business management. He goes further in claiming that production under increasing returns is the natural condition of production in those activities which do not depend heavily on scarce natural resources (p. 318).

However, Marshall provides some reasons to maintain that the presence of increasing returns to scale does not necessarily lead to monopolization: i) some economies can be also *external* to the firm, that is they can be appropriated by other firms; ii) manufacturers mainly produce differentiated goods, the demand for which is negatively sloped, implying a definite limit to the expansion of the firm[17]; iii) due to the specialization of the goods produced, manufacturers meet increasing difficulties in marketing larger quantities of

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[17]Does this mean that Marshallian dynamics can be simply rendered in terms of the modern approach of monopolistic competition? There appears to exist some controversy on this point. Whitaker (1987, p. 356) argues: "The conception of competition in Marshall's manufacturing case is much closer to later ideas of imperfect or monopolistic competition than to modern notions of perfect competition. Products are differentiated and firms are not price takers, but face at any time downward-sloping demand curves". However, Hart (1992, p. 303) writes: "[a] satisfactory solution to Marshall's reconciliation problem [i.e. between increasing returns and competition] ... requires more than the formal inclusion of market imperfections into more elaborate equilibrium frameworks. It instead calls for techniques whereby the effects of dynamic processes can be adequately considered".

their products; iv) firms experience a life cycle: sooner of later even the most vigorous firms "age", and become less dynamic. Also, there constantly exist new firms which may threaten their established positions.

Firms in a sector are therefore compared to the trees in a forest: even if the older and taller trees have better access to light and air, this does not prevent younger trees to grow and to reach their height and age. Some trees reach this goal while others do not. In the same way, dynamics in an economic sector is such that "at any one moment some firms [are] in the ascending phase and others in the descending" (p. 317). Marshall was aware that the advent of joint-stock companies, which do not age with their founders, could reduce the force of this argument, but believed that it still retained importance for many trades[18]. The awareness of such firms' dynamics, which basically amounts to the distribution dynamics of the firms belonging to a sector, leads Marshall to the use of the fiction of a representative firm, when the issue is the determination of value.

Marshall introduces the concept of representative firms because he recognizes that in every period of time, every sector is characterized by a continuous movement of the firms it comprises. In this sense: "[the] representative firm must be one which has had a fairly long life, and fair success, which is managed with normal ability, and which has normal access to the economies, external and internal, which belong to that aggregate volume of production" (pp. 317-318).

Therefore, one of the most relevant steps taken by Marshall to solve the problem of compatibility between increasing returns and competition, was to resort to biological analogies. Strangely, this idea has received only scant attention in terms of formal models. A relevant exception is represented by Newman and Wolfe (1961). They adopt a nonstationary Markov Chain to account for the distribution dynamics of the firms in a sector, clarifying in this way the relation existing between the firm population dynamics and the representative firm.

This point is important in the sense that it is referred to the use of a new tool, i.e. a stochastic process, to study the Marshallian dynamics, which goes in the direction of studying economic dynamics in terms of "organic growth", overcoming in this way the limitations posed by the statical method[19], and put Marshall's analysis in close relation with the modern "complexity approach", in which terms like "population dynamics" are familiar and the use of stochastic processes is frequent.

Let us conclude with a quotation of Marshall on economic growth, which seem to include some elements of modern endogenous growth theory:

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[18]Negishi (1989, pp. 369-375) suggests that technologies, and not firms, can be considered as subject to a life cycle in the Marshallian dynamics.

[19]Marshall was in fact well aware of the shortcomings of this method, in particular in the study of increasing returns.

"There seems to be no good reason for believing that we are anywhere near a stationary state in which there will be no new important wants to be satisfied; in which there will be no more room for profitably investing present effort in providing for the future, and in which the accumulation of wealth will cease to have any reward. The whole history of man shows that his wants expand with the growth of his wealth and knowledge". (p. 223)

In the discussion including this passage wealth is considered in general and, Marshall notes: "we have no need to emphasize its uses as capital" (p. 220). That accumulation, in terms of what may be termed as the capital/labor ratio do not encounter diminishing returns is made clear immediately:

"with the growth of openings for the investment of capital there is a constant increase in that surplus of production over the necessaries of life, which gives the power to save...every increase in the arts of production, and in the capital accumulated to assist and support labour in future production, increased the surplus out of which more wealth could be accumulated ... Thus from step to step wealth and knowledge have grown and with every step the power of saving wealth and extending knowledge has increased"(p. 224).

2.3   Allyn Young

The celebrated article published by Allyn Young in 1928 still seems to interest economists since, for instance, it has been recently reprinted in Buchanan and Yoon (1994) and Heal (1999a). Young's analysis is important for at least two reasons: first, as remarked, it represented a significant return to Adam Smith's approach; in addition, it is directly considered the source of inspiration of the recent models of growth and specialization (see Romer 1986a).

The growth theory exposed by Young, although only verbally, aims at returning to the ideas of Adam Smith on the issue by focusing on two aspects of division of labor: the use of indirect or roundabout methods of production, that is the use of specialized machinery, and the division of labor among industries. We offer a re-evaluation of his paper in order to highlight the relevant elements of novelty of his approach, and the directions which in his view the theory of economic growth should have taken.

After a brief introduction, Young (1928, pp. 527-528) tackles the question of approaching increasing returns using the Marshallian distinction between internal and external economies. This distinction is considered "fruitful", because:

"in the first place it is, or ought to be, a safeguard against the common error of assuming that wherever increasing returns operate there is necessarily an effective tendency towards monopoly. In the second place it simplifies the analysis of the manner in which the prices of commodities produced under conditions of increasing returns are determined."

But Young (*Ibidem*, p. 528) immediately adds:

"[t]he view of the nature of the processes of industrial progress which is implied in the distinction between internal and external economies is necessarily a partial view. Certain aspects of those processes are illuminated, while, for that very reason, certain other aspects, important in relation to other problems, are obscured."

The explanation offered for this skepticism is that:

"although the internal economies of some firms producing, let us say, materials or appliances may figure as the external economies of other firms, not all of the economies which are properly to be called external can be accounted for by adding up the internal economies of all the separate firms."(*Ibidem*, p. 528)

This is because:

"[y]ear after year the firm, like its competitors, is manufacturing a particular product or group of products, or is confining itself to certain definite stages in the work of forwarding the products towards their final form. Its operations change in the sense that they are progressively adapted to an increasing output, but they are kept within definitely circumscribed bounds."(*Ibidem*, p. 528)

The last passage explains that Young, when considering increasing returns, does not refer to the exploitation of economies of scale, but to economies of specialization in relation to the extent of the market (we return on this question below).

In other words, the increase in the output of a firm is not considered functionally limited by an increase in its size, but has to be put in relation to what happens:

"[o]ut beyond, in that obscurer field from which [the firm] derives its external economies, [where] changes of another order

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are occurring. New products are appearing, firms are assuming new tasks, and new industries are coming into being. In short, changes in this external field are qualitative as well as quantitative. No analysis of the forces making for economic equilibrium, forces which we might say are tangential at any moment of time, will serve to illuminate this field, for movements away from equilibrium, departures from previous trends are characteristics of it. Not much is to be gained by probing into it to see how increasing returns show themselves in the costs of individual firms and in the prices at which they offer their products."(*Ibidem*, p. 528)

Thus Young does not believe that concentrating on a partial analysis of an individual (or representative) firm can be useful and, moreover, in this last passage he clearly departs from an equilibrium approach to economic growth and indicates a: "simpler and more inclusive view, such as some of the older economists" (*Ibidem*, p. 528), as appropriate for his investigation of increasing returns.

This leads him to a direct reference to Adam Smith, whose "theorem that the division of labour depends upon the extent of the market" (*Ibidem*, p. 529) is explicitly taken as the theme to be developed in his paper. Regarding the Smith's discussion of division of labor, Young specifies to be more interested in investigating: "the growth of indirect or roundabout methods of production and the division of labour among industries" (*Ibidem*, p. 529), than the division of labor inside firms (like in the famous pin factory described by Smith). That is, Young considers the division of labor mainly as the process leading to the introduction of capital goods (i.e. the use of indirect instead of direct labor), and to the increase of a network of interdependent productive units in which, as we will see, the number of units changes as well as their linkages in the growth process.

Young first analyzes the economies deriving from the use of specialized machines in production. In the discussion of Smith's idea that a specialized worker is likely to invent new tools or machines, Young stresses that what matters is that the simplification of some phases of the production process allows for the introduction of machines (a point also remarked by Smith himself and Marshall). Therefore, the main question is to understand when the firm decides to face the cost of a new, specialized machine, either by building it or by purchasing it from outside or, put it in other words, when the firm decides to use indirect rather than direct labor.

Young (*Ibidem,* p. 530*)* writes in a famous passage:

"[i]n the use of machinery and the adoption of indirect processes there is a further division of labour, the economies of which are again limited by the extent of the market. It would be wasteful to make a hammer to drive a single nail, ... It would be waste-

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ful to furnish a factory with an elaborate equipment of specially constructed [machines] to build a hundred automobiles."

Here we find the statement, emphasized also by Kaldor (1972, p. 1242), that the capital-labor ratio chosen by the firms depends on the extent of the market and not on relative factor prices. This point can also be considered in relation to the way Young discusses the problem of fixed costs, and to the place and weight he attributes to it, keeping in mind that, as shown below, fixed costs are central to the Romer model.

First note that it is only in this context that the issue of fixed costs can be assumed to have some importance for Young, since it is not explicitly mentioned elsewhere in his article. However, for Young it is the extent of the market that determines the decision to sustain a fixed cost for the introduction of machines, also because it is the extent of the market that determines the degree of simplification of workers' activities, and therefore allows the firm to introduce the machines that assist the worker.

Something more can be inferred from the short discussion by Young on the economies of the secondary order, that is those economies which may accrue to the firm when it produces "special appliances for making hammers or for constructing specialised machinery for use in making different parts of automobiles" (Young, 1928, p. 530). It is immediately stated that what matters for the firm's decision is again the level of production, that is "how many nails are to be driven and how many automobiles can be sold. In some instances, ..., though real, [these secondary economies] have only a secondary importance" (*Ibidem*, p. 530). For Young (*Ibidem,* p. 530):

> "[t]he derived demands for many types of specialised production appliances are inelastic over a fairly large range. If the benefits and the costs of using such appliances are spread over a relatively large volume of final products, their technical effectiveness is a larger factor in determining whether it is profitable to use them than any difference which producing them on a large or a small scale would commonly make in their costs. In other instances the demand for productive appliances is more elastic, and beyond a certain level of costs demand may fail completely. In such circumstances secondary economies may become highly important."

Thus, we are told that the extent of the market is the relevant factor. In other words, what matters for the decision of the firm which has a large market, is the high productivity of the specialized machine, so that the main question is the presence of an outlet for the increased production. The possibility of reducing the cost of such machines by producing them on a large scale is of secondary importance. For those firms which instead have

a small market, the cost is relevant, and therefore the reduction in costs of the specialized machines obtainable when they are produced on a large scale may be important for the decision of the firm to adopt them (in this case by equipping the factory with those "special appliances" mentioned above).

In short, it seems here that fixed costs are not central for Young and, in any case, their importance is subordinated to the extent of the market. This means that the fixed cost (the price of the capital good) should be considered in relative terms, that is relative to the extent of the market (Sandilands, 2000, p. 315).

For Young the economies of first order "which manifest themselves in increasing returns are *the economies of capitalistic or roundabout methods of production*" (*Ibidem,* p. 531, italics added). An important passage follows this statement:

> "these economies lie under our eyes, but we may miss them if we try to make of *large-scale* production (in the sense of production by large firms or large industries), as contrasted with *large* production, any more than an incident in the general process by which increasing returns are secured and if accordingly we look too much at the individual firm or even, as I shall suggest presently, at the individual industry."(*Ibidem,* p. 531. Italics in the original text)

Young therefore returns on what may be termed "macroeconomic increasing returns"[20], whose nature is not captured by concentrating only on representative firms and on their negatively sloped cost curves, but has be appreciated from an analysis of the entire economy, considered as a large interactive system. The market is in fact defined by Young as "an aggregate of productive activities, tied together by trade." (*Ibidem,* p. 533)

When Young (1928, p. 531) claims that: "the economies of roundabout methods, even more than the economies of other forms of the division of labor, depend upon the extent of the market", he refers to an: "inclusive view [of the market, which is not] an outlet for the products of a particular industry, and therefore external to that industry, but [i]s the outlet for goods in general. [Therefore:] the size of the market is determined and defined by the volume of production."(*Ibidem,* p. 533)

This immediately leads to the reformulation of Smith's theory in these terms: the division of labor is limited by the division of labor, since: "a large market [is nothing more] than buying power, the capacity to absorb a large annual output of goods" (*Ibidem,* p. 533). Although reminiscent of the Say's law, this statement is more far-reaching[21]: it states that both

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[20]This definition appears in Currie (1997).

[21]Young (1999b, p. 145) in fact criticizes Say's law as such: "[t]here is a sense in which supply and demand, seen in the aggregate, are merely different aspects of a single situation.

demand and supply are endogenously determined according to the level of division of labor prevailing[22].

The important implication is that:

> "the counter forces which are continually defeating the forces which make for economic equilibrium are more pervasive and more deeply rooted in the constitution of the modern economic system than we commonly realise. Not only new or adventitious elements, coming in from the outside, but elements which are *permanent characteristics of the ways in which goods are produced* make continuously for change. Every important advance in the organisation of production, [not only technical progress]..., alters the conditions of industrial activity and initiates responses elsewhere in the industrial structure which in turn have a further unsettling effect. This change becomes progressive and propagates itself in a cumulative way."(*Ibidem,* p. 531. Italics added).

We have already noted that the same idea, namely that the forces at the roots of the growth process are inherent to industrial activity, and are not related to a particular technology, was attributed to Smith by Kaldor. Also, for Young the endogenous forces which are activated generate disequilibrium, in the sense that there are no magnitudes which can a priori be considered fixed in the process of growth. This position will be taken up by Nicholas Kaldor.

Young (*Ibidem*, p. 533) therefore judges the standard apparatus of supply and demand as incapable of exploring this sort of dynamics, since they may: "divert attention to incidental or partial aspects of a process which ought to be seen as a whole"[23], and introduces the concept of reciprocal demand as something which, in his approach, most closely resembles the concepts he is criticizing.

The context he sketches is that of production carried out "competitively under conditions of increasing returns" (*Ibidem*, p. 534) which, at first

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It is for this reason that some of the older economists held that general overproduction is impossible - a theorem which, though not really erroneous, has proved to be misleading. The *effective* demand of the producers of one commodity for other products depends not only on how much they produce, but also upon the relative demand of other producers for that particular commodity as compared with other products. Only so far as the demand for a particular commodity is elastic is it true in any significant sense that an increase of its supply is an effective increase of demand for other commodities." Italics in the original text.

[22] This aspect is clearly assumed in models such as Yang and Borland (1991) and Yang (1999) where the agents are producers-consumers, and the structure of demand and supply is simultaneously determined with the degree of division of labor.

[23] In the LSE lecture notes taken by Kaldor, we read: "Seeking for equilibrium conditions under increasing returns is as good as looking for a mare's nest. Certainly the matter cannot be explained by this curve apparatus, which does not see things 'in their togetherness' ". See Young (1999a).

sight, appears as a contradiction. If interpreted in terms of the second type of Smithian competition this contradiction disappears. Blitch (1983, p. 364) notes that Young: "did not agree with Sraffa ... that the solution to the problem of increasing returns was to turn to theory of monopoly" and that he, like Adam Smith (and the "dynamic" Marshall), attributed more importance to the second type of competition mentioned by Richardson (1975).

Reciprocal demands among firms are characterized by a certain level of elasticity, to be interpreted as the capacity for the increased production of a good to elicit demand for other goods:

> "demand for each commodity is elastic, in the special sense that a small increase in its supply will be attended by an increase in the amounts of other commodities which can be had in exchange for it. Under such conditions an increase in the supply of one commodity *is* an increase in the demand for other commodities, and it must be supposed that every increase in demand will evoke an increase in supply."(Young 1928, p. 534. Italics in the original text.)

Notice that Young considers an exchange of goods against goods. The elasticities are different for different products, so growth in the economy will be different among sectors. In any case:

> "[e]ven with a stationary population and in the absence of new discoveries in pure or applied science there are no limits to the process of expansion except the limits beyond which demand is not elastic and returns do not increase."(*Ibidem,* p. 534)

The use of the concept of reciprocal demand once again addresses to the vision of the economy as made up of interdependent productive units, operating under increasing returns. Increasing returns, by making available increasing quantities of goods at lower prices, can stimulate the interaction among firms; interaction among firms in turn acts as stimulus to production, and thus to the securing of increasing returns.

Assuming that the growth process can be studied in terms of an equilibrium of "costs and advantages", for Young,

> "amounts to saying that no real economic progress could come through the operation of forces engendered within the economic system - a conclusion repugnant to common sense."(*Ibidem,* p. 535)

This is another strong claim against the use of an equilibrium approach to study growth, which, in Young's thinking, seems even to imply the impossibility of defining growth as an endogenous process. We reminded above that a similar point was made by Richardson with respect to Adam Smith.

The growth process, according to Young, although based on such strong mechanisms, can nevertheless encounter obstacles. Young mentions: the presence of non reproducible resources, the emergence of certain problems entailed by change (like the breaking of existing trades and relations), the time necessary to accumulate new capital (both human and physical), the presence of uncertainty and risks. However, some favorable factors can also be at work, like scientific progress applied to industry, the discovery of new natural resources or the increase in population.

In any case, if one has to indicate a single factor relevant for economic progress, that is the extent of the market and, Young points out: "no other hypothesis so well unites economic history and economic theory" (*Ibidem,* p. 536). The extent of the market relevant for the decisions of businessmen may well be potential. Indeed, for Young the attention paid by managers of the modern industries to potential market was a "great change" (*Ibidem,* p. 536), with respect to the past. Therefore: "the search for markets is ... a matter of ... finding an outlet for a potential demand" (*Ibidem,* p. 537).

Young (*Ibidem,* p. 537) then introduces the discussion of the process of division of labor among industries, by remarking that:

> "industrial differentiation has been and remains the type of change characteristically associated with the growth of production. Notable as has been the increase in the complexity of the apparatus of living, as shown by the increase in the variety of goods offered in consumers' markets, the increase in the diversification of intermediate products and of industries manufacturing special products or groups of products has gone even further".

If one recognizes the importance of this aspect of the division of labor, for Young (*Ibidem,* p. 538) it follows that: "the representative firm, like the industry of which it is a part, loses its identity". More important is the observation that: "the largest advantage secured by the division of labor among industries is the fuller realising of the economies of capitalistic or roundabout methods of production." (*Ibidem,* p. 539) In fact, in the process of division of labor among industries, whenever a new industry is created following an increase in the extent of the market for the good it produces, the firms in such industry can benefit from the larger industry output, in the sense that they may adopt specialized machines, i.e. roundabout methods of production. Again, for Young it is misleading to inquire into the causes of such economies at firm level in terms of "large-scale production" instead of "large production".

In conclusion, Allyn Young tried to bring growth theory back to the view of Adam Smith, and successfully represented the theory adding important updates and exploring some relevant implications. As for the relation with Marshall, Young was not completely persuaded by the distinction between

internal and external economies, and therefore adopted this distinction only in particular cases and with important specifications. However, his approach is similar to the view expressed by the "dynamic" Marshall, for instance with reference to the progress of an economic system in terms of increasing differentiation (and integration) of its components.

Maybe, the most distinctive feature of Young's approach was the conceptualization of the economy, that he choose to describe in his "togetherness"[24], being far from clear that he had in mind to consider the "togetherness" of the economy in terms of general equilibrium. Kaldor (1972, p. 1243) expressed the opinion that the Young's paper was: "so many years ahead of its time that the progress of economic thought has passed it by". It will be argued that his recent rediscovery by mainstream economics still left aside important aspects of his approach.

2.4   Nicholas Kaldor

In some of his late writings Nicholas Kaldor strongly criticized mainstream economics, i.e. economics based on the framework of general economic equilibrium (see Kaldor 1972, 1975, 1979, 1981, 1985). He indicated the works of Smith and Young as sources of alternative approaches to economic theory, in particular to the theory of economic growth.

Kaldor's line of attack concerns several points, but he firstly put forward a methodological argument: the necessity to firmly ground economic theorizing in empirical analysis. In particular, Kaldor criticized mainstream economics for building theories by logical deduction from a priori axioms. In contrast, he argued that economic theories should be based on induction from stylized facts, obtainable from preliminary analyses of statistical data (or even from casual observations, surveys, etc.).

This aspect underlies all of his criticisms. A possible way to present them is to organize the discussion around two questions raised by Kaldor. Specifically, he argued that: (i) in actual economies increasing returns play a much more fundamental role than constant returns to scale, and (ii) the principle of complementarity is more relevant than the principle of substitution.

Point (i) directly concerns economic growth and is the most relevant here. Point (ii) refers to the basic complementarity between different sectors of the economy in the process of development, and to the complementarity of capital and labor in the process of production. However, both are part of Kaldor's comprehensive economic theory and therefore the issue of increasing returns based on division of labor is not disjoint from a more general analysis of the functioning of market economies.

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[24] See for instance Currie (1997, p. 416) on the distinction between the Young approach based on the "togetherness" of economic phenomena, and the "one-thing-at-a-time theorizing" of mainstream economics.

Kaldor inferred the importance of increasing returns from certain stylized facts on economic growth in developed countries (see Kaldor, 1961). Thus, according to Kaldor, a theory of economic growth coherent with stylized facts should assume that production occurs under increasing returns to scale. Since this assumption was absent from the formulations of general economic equilibrium he was criticizing, Kaldor considered this theory as incapable of constituting the base for a theory of economic growth. Consequently, an alternative starting point for the analysis of growth had to be sought in Smith and Young, who took increasing returns seriously, by considering the process of division of labor.

The roots of increasing returns are to be found, as already mentioned, "in the nature of technological processes" (Kaldor 1972, p. 1242). Kaldor (*Ibidem*) indicates three sources of increasing returns: the economies of scale due to the three-dimensional nature of space, and two aspects of specialization: the substitution of direct for indirect labor (that is an increase in the capital/labor ratio), and learning by doing[25]. The last two are directly taken from the arguments of Allyn Young and depend on the process of division of labor. As regards the first, Kaldor made the example of a pipeline: when a stretch (of unitary length) of a pipeline is constructed, the increase in output (the liquid transported) is greater than the increase in inputs (the materials used up to build the cylinder). This example was meant to represent different types of plant-level economies of scale which directly follow from an increase in production.

Kaldor defined the economies deriving from the three-dimensional nature of space and those deriving from indivisibilities, "static" or "reversible", and those deriving from specialization "dynamic" or "irreversible" (see Kaldor 1966, p. 106, and Kaldor 1972, p. 1253)[26]. However, he played down the importance of indivisibilities.

In fact, Kaldor's discussions on increasing returns are always centered on Allyn Young and Adam Smith, who emphasized the role of economies of specialization. The economies of scale originating from indivisibilities are discussed in a way which will be important in analyzing the recent theory:

> "if indivisibilities were the sole cause of increasing returns,
> there would always be some level of production at which such
> scale economies were exhausted and 'optimum' scale production
> reached ... not all causes of increasing returns can be attributed

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[25] Kaldor (*Ibidem*) does not mention "learning by doing" in terms of an increase in workers' skills, but actually refers to "learning by using", that is to the continuous improvement in productivity, also through incremental innovations, deriving from the repeated use of pieces of equipment (like the steam engine), and to "learning by producing", that is to the improvement in the quality of machines following an increase in the quantity produced.

[26] The irreversibility of economies of scale obtained by division of labor, reorganization of production and introduction of new machines had already been noted by Marshall in Appendix H of the *Principles*.

to indivisibility of one kind or another and there is no reason to suppose that 'economies of scale' become inoperative above certain levels of production. There is first of all the steady and step-wise improvement in knowledge gained from experience - the so-called 'dynamic economies of scale' which have nothing to do with indivisibilities. But even in the field of 'static' ... economies ... the existence of a non-linear relationship between costs and capacity is inherent in the nature of *space,* and there is nothing 'indivisible' about space as such."(Kaldor 1972, p. 1253)

After stressing the relevance of increasing returns, Kaldor examined the consequences for economic theory. First of all, the concept of equilibrium interpreted as an optimal allocation of given resources, is seriously undermined. Kaldor (*Ibidem*, p. 1245), in this respect, is very explicit:

"[t]he whole issue, as Young said, is whether an 'equilibrium of costs and advantages' is a meaningful notion in the presence of increasing returns. When every change in the use of resources - every reorganisation of productive activities - creates the opportunity for a further change which would not have existed otherwise, the notion of an 'optimum' allocation of resources - when every particular resource makes a great or greater contribution to output in its actual use as in any alternative use - becomes a meaningless and contradictory notion: the pattern of the use of resources at any one time can be no more than a link in the chain of an unending sequence and the very distinction, vital to equilibrium economics, between resource-creation and resource-allocation loses its validity."

The conclusion is the following:

"[t]here can be no such thing as an equilibrium state with optimum resource allocation where no further advantageous reorganization is possible, since every such reorganization may create a fresh opportunity for a further reorganization." (Kaldor 1975, p. 355)

According to this argument alternative allocations of resources for given preferences and technologies, for instance allocations taking the form of different ways of subdividing labor, create new, specific ways to proceed to further subdivisions of labor which as Smith (WN, V.i., p. 271) wrote: "might never otherwise been thought of." Furthermore, as regards labor, Kaldor (1972, p. 1251) considered impossible to define a given "quantity" of labor. In fact, when labor is allocated in different manners its efficiency changes, considered the *nature* of the process of division of labor.

Thus, Kaldor viewed economic growth depending on increasing returns (stemming from division of labor) as a path-dependent process. Growth can be defined as a cumulative process, where progress builds on progress and failure builds on failure, a definition consistent with the polarization of the world economies in rich and poor. This tendency was appearing at the time Kaldor wrote, and is nowadays well documented (see, e.g., Quah, 1993).

The problems related to the very notion of general economic equilibrium are put in sharp relief also by considering the second issue mentioned above, i.e. the role of complementarity. First, there exists a complementarity between different sectors of the economy. In this respect Kaldor endorses the position already taken by Smith, according to which it is the growth of production of "food" in agriculture[27] which permits the development of an industrial sector, characterized by increasing returns[28]. The availability of food limits the number of workers which can be employed in manufacturing.

The process of development of an economy based on exchanges between these two sectors cannot be described in terms of equilibrium, since agriculture is a decreasing returns to scale sector, for the presence of land, and the real wage in manufacturing is constrained by the minimum subsistence level. This implies that the equilibrating forces assumed by mainstream theory cannot function properly. For instance, in the case of excess supply of manufactured goods relative to the supply of agricultural products, relative price of manufactures does not necessarily fall to clear the market, because this price is bounded from below by the minimum subsistence wage. If there is surplus labor in agriculture, which is the normal case for Kaldor since agricultural production is land-constrained and not labor-constrained, the price of manufactured goods cannot be, as noted, the market-clearing price and also the wage rate does not clear the labor market, since many of those employed in agriculture (or in an informal sector), will represent a constant excess supply of labor (or "disguised unemployment").

Therefore the economy cannot be resource-constrained, but demand-constrained. It is an increase in the demand for manufactures[29] that leads the capitalists to increase their demand for labor, which is unlimited since

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[27]By agriculture Kaldor in general meant the primary sectors including, e.g., mining.

[28]In general for Kaldor growth is a process based on "stages", with associated structural changes, much in the spirit of Smith. In fact, he individuated the possibility of obtaining a surplus from the agricultural sector as a first step towards growth and development. Then the process could follow the stages mentioned above with reference to Adam Smith, since also Kaldor (1981, p. 221) believed that: "industrial production in any one self-contained region is limited in its extent by the growth of agricultural surpluses which provide both the wage goods necessary for industrial employment and the sources of outside demand, which mainly sustain the growth of industrial products". The subsequent development of the secondary (manufacturing) sector was to be followed by the growth of a tertiary (service) sector, characterized by a reduced possibility to generate increasing returns. The point is fully developed in Kaldor (1966).

[29]In particular Kaldor attached importance to demand for exports, which can have a positive role on long run growth through the operation of the "foreign trade multiplier".

labor can always be drained from agriculture or from foreign countries, and their capital stocks. As regards the accumulation of capital, which complements labor in this context, Kaldor (1985, p. 67) wrote: "capital and output grow together. The capital/labor ratio is a by-product of high productivity resulting from large production; it has nothing to do with marginal productivities or marginal rates of substitution, concepts that only make sense under the wholly artificial assumption of constant returns to scale". Finally, if the increase in manufacturing production is accompanied by land-saving innovations, a virtuous circle of sustained growth can be started.

For these reasons, economic growth has the nature of an endogenous process where, on the lines indicated by Young who suggested to take "an inclusive view" of markets, demand and supply relations may generate a chain reaction involving different productive units and/or sectors. Interestingly, Kaldor (1972, pp. 1247-1250) put the role of intermediaries in relation to the effects of the different elasticities of reciprocal demands emphasized by Young[30]. Specifically, the intermediaries may contribute to the process of income generation characterizing the chain reaction among productive units mentioned above, through modifications in the *value* of the stocks of goods they hold[31]. Kaldor (*Ibidem*, p. 1252) also noted the necessity of a: " 'passive' monetary and banking system which allows the money supply to grow in automatic response to an increased demand for credit" for the functioning of such a growth process.

Finally Kaldor argued that the competitive process is more about creation and change, than about allocation guided by prices. He did not accept the definition of competition as a situation where agents merely take prices as given, but on the contrary attributed to agents a higher capacity of price-making (for instance through mark-ups). Interpreting competition as the stimulus for creation and change is essential for an understanding of the process of economic growth.

In the final passages of his 1972 paper, Kaldor wrote: "it is evident that the co-existence of increasing returns and competition - emphasized by Young and also by Marx, but wholly excluded by the axiomatic framework of Walrasian economics - is a very prominent feature of de-centralized economic systems but the manner of functioning of which is still a largely unchartered territory for the economist"(*Ibidem*, pp. 1251-1252).

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[30]The presence of "intermediaries" (or "merchants") between producers and consumers is another feature of actual economies which, for Kaldor, is overlooked by mainstream economics. These dealers have the important function of holding stocks of goods, and consequently play an important role in relation to price fluctuations and to the more general issue of signal transmission from consumers to producers and vice versa.

[31]For reasons of space we omit the details. See the reference indicated.

3 The Romer Model and Endogenous Growth Theory

In the development of endogenous growth theory, a model of growth and division of labor has been presented. Specifically we refer here to Romer (1987), appeared as a working paper in Romer (1986a), subsequently extended in Romer (1990a), and used in many works on growth and international trade.

This formalization is explicitly referred to the contributions of Allyn Young (and Adam Smith) but, as already mentioned, it seems based on a different approach and on a different set of assumptions. Our aim is therefore to closely scrutinize the modern model of growth and division of labor to check which features of the precedent contributions are conserved and what remains outside the picture. We will argue that, although constituting an important development, the modern formulation is not completely faithful to Smith and Young, in the sense that it does not capture certain theoretical elements advanced by such authors which seemed to point to different directions.

We begin by analyzing the way Romer presents the historical roots of his model. In doing so we also base on Romer (1989) and (1991). Romer (1991) sketches a history of growth theory, from Adam Smith to endogenous growth. He claims that in Smith there are two conflicting ideas: the first is that competition ensures an efficient allocation of given resources; the second is that growth is an endogenous phenomenon[32]. Since economists developed first the mathematics of perfect competition for its simplicity, they renounced to study growth as an endogenous process. We already noted that in Smith's (and Marshall's and Young's) approach this sort of problem does not necessarily arise: according to the concept of dynamic competition, it was possible for them to talk about a process of endogenous growth, based on increasing returns deriving from division of labor, in presence of competition[33].

However, the incompatibility between perfect competition and endogenous growth would open the way to consider the process of division of labor, as it is linked to endogenous growth, in a non-competitive framework, unless one resorts to the Marshallian concept of external economies to preserve price taking behavior by the firms, while allowing for the presence of increasing returns. In his model of growth and specialization, we shall see that Romer solves this problem in an original way, by postulating the presence of a non-competitive sector in a context where aggregate production

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[32] A similar premise in stated by Kim (1989, p. 692) and Heal (1999b, p. *xiii*).

[33] Yang and Ng (1998, p. 20) do not agree with this presumed incompatibility either. They argue: "[m]any economists claim that Smith's notion of economies of scale is incompatible with the invisible hand. However, Smith never used the concept of economies of scale which is imposed on him by others."

appears as if it is characterized by external economies.

In particular, Romer (1991, p. 88) argues that Young "[l]ike Marshall, ..., called the beneficial effects arising from the introduction of a new good [seen as a form of division of labor] a positive external effect. Consequently, he tried to describe a model of growth driven by aggregate increasing returns that were external to individual firms", and that: "Marshall and Young choose to describe specialization in terms of competitive equilibrium with externalities" (Romer 1989, p. 108). Romer specifies that the introduction of new goods is not strictly equivalent to a Marshallian external economy (like "trade knowledge"), but its consideration, as noted, can lead to models which behave exactly like models with true externalities[34].

Therefore, when the focus is on the introduction of new goods, fixed costs become part of the picture because it is reasonable to assume the presence of a fixed cost when a new production is started[35]. The presence of fixed costs makes the extent of the market important since, as long as there is not sufficient demand to cover them, the new good is not introduced. Romer (1989, p. 108) claims that Marshall and Young's story would be told in a "more rigorous way in a model with fixed costs."

These new goods are differentiated, so Romer resorts to the framework of monopolistic competition, where differentiation of goods is coupled with competition by potential producers. Thus, firms have market power but earn zero profits in equilibrium. Once this is admitted, the delay in the exploitation of Smith and Young ideas is explained by the technical difficulties involved in building dynamic, general equilibrium macro-models with non-competitive behaviors[36], as well as the strict adherence to the Solow model, based on perfect competition and constant returns to scale, even in the light of its shortcomings[37].

Now we briefly present the main features of the Romer model, leaving for the next Section a discussion of his approach in relation to that of Smith, Marshall, Young and Kaldor. From the previous introductory notes, some differences should already be clear, like the use of an equilibrium and not of

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[34]One of the main points of Romer (1987) is to demonstrate the isomorphism between a model of specialization and a model with externalities, like his (1986b) growth model.

[35] Romer (1990a) assumes that new goods are designs to be used in the production of intermediate goods. Such designs entail a fixed research cost.

[36]Romer (1989, p. 70) in fact accepts the view that: "[g]rowth is a general equilibrium process".

[37]Basically, Romer refers to the inadequacy of Solow's model, which explains growth only by the growth of capital and labor, when it is considered the large "residual" resulting from cross-country regressions, and to his incompatibility with purposively conducted research activity. In fact, under the assumption of constant returns to scale, all the aggregate product is exhausted in the remuneration of labor and capital according to their marginal products. In this case, since nothing is left to remunerate technological advances, which have the nature of non-excludable goods, a competitive structure can not support endogenous technological progress and, consequently, endogenous growth. For this reason, only exogenous technological progress was compatible with the Solow model.

a disequilibrium approach.

The model in Romer (1987) has two sectors: one producing intermediate goods and one producing a final good, which can be consumed. Intermediate goods are produced with the same technology using a capital good, Z, owned by consumers in a given quantity. Their production entails a quasi-fixed cost, that is no production at zero costs is feasible. The final good is produced under constant returns to scale, using intermediate goods and labor. In the intermediate sector, a regime of monopolistic competition prevails: firms have market power on the good they produce but earn zero profits in equilibrium.

What is relevant is the functional form chosen to describe final good production, which must be such that "having more available [intermediate] goods is useful" (Romer, 1989, p. 108). This can be obtained with the following specification of the production function[38]:

$$Y = L^{1-\alpha} \cdot \int_{\Re_+} x(i)^{\alpha} di \qquad (1)$$

Here Y is the final good, L is labor, $x(i)$ is the quantity of the good i, and $0 < \alpha < 1$. Thus the marginal product of each intermediate good is decreasing.

The range of intermediate inputs used could theoretically be infinite, but the fact that their production entails a fixed cost in terms of Z, whose quantity is given, guarantees that it is finite. From (1), it is possible to show that, if all goods are produced in the same quantity $\overline{x} = N/M$ (which is the case here because of the symmetry of the model), where N is the total amount of intermediate goods and M is the range produced, the production function becomes:

$$Y = L^{1-\alpha} N^{\alpha} M^{1-\alpha}. \qquad (2)$$

From equation (2) we see that output can increase without bound with M.

The integration of a power function in equation (1) is the specific form in which intermediate goods are assembled in this model for production of the final good[39]. Such form implies that: "a new type of product is neither a direct substitute for nor a direct complement with the types that already exists ... the independence of marginal products ... is important because

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[38]This type of functional form was introduced by Dixit and Stiglitz (1977) to specify a utility function where agents prefer variety in consumption. Ethier (1982) proposed to utilize it for a production function.

[39]The more general form for equation (1) is:

$$Y = L \int_{\Re+} g\left(\frac{x(i)}{L}\right) di$$

where it is required that $g(.)$ is increasing and strictly concave, with $g(0) = 0$.

it implies that discoveries of new types of goods do not tend to make the existing types obsolete." (Barro and Sala-i-Martin, 1995, p. 213)[40].

To generate dynamics in this model, it is necessary to establish a mechanism which supports a growing M. This is obtained by assuming that Z can be accumulated following the rule:

$$\dot{Z} = Y - c \tag{3}$$

where c is the consumption level of an individual, who maximizes the total discounted utility:

$$\int_0^\infty U(c(t))e^{-\rho t}dt \tag{4}$$

where ρ is the intertemporal discount rate, and the instantaneous utility function $U(c)$ is isoelastic. Individuals choose a maximizing path for consumption and savings, which are invested in Z and rented to the intermediate sector; they also inelastically supply a fixed amount of labor.

Romer specifies a particular form of the function $g(.)$, and of the cost function for the intermediate goods producers[41]. Then he shows that the equilibrium condition for the monopolistically competitive sector is $M(t) =$

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[40]In the literature it appears another functional form to aggregate intermediate goods, the so-called CES specification. That is, the production function can be expressed by:

$$Y = L^{1-\alpha} \cdot \left\{ \left[\int x(i)^\theta di \right]^{\frac{1}{\theta}} \right\}^\alpha$$

where θ is a parameter reflecting the elasticity of substitution among different intermediate inputs, given by $\epsilon = 1/(1 - \theta)$. When $0 < \theta < 1$, goods are imperfect substitutes (i.e. $1 < \epsilon < \infty$); when $\theta = 1$ goods are instead perfect substitutes. Note that the formulation in equation (1) is simply obtained by putting $\theta = \alpha$. In the CES case, when all intermediate goods are produced in the same quantity $\bar{x} = N/M$, we obtain:

$$Y = L^{1-\alpha} \cdot N^\alpha \cdot M^{\frac{\alpha(1-\theta)}{\theta}}$$

in which output can increase without bounds in M as long as $0 < \theta < 1$. A general form for this type of production functions is the following:

$$Y = L^{1-\alpha} \cdot \left[\int x(i)^\theta di \right]^\gamma \cdot \left[\int x(i)^\delta di \right]^\tau$$

which respectively preserves the homogeneity of degree α in $x(i)$ and the positive relation between M and Y if the following conditions are satisfied:
i) $\gamma\theta + \tau\delta = \alpha$, $0 < \alpha, \theta < 1$;
ii) $\gamma + \tau > \alpha$.
The form chosen by Romer corresponds to the case in which: $\theta = \alpha, \gamma = 1, \tau = 0$. The case of a CES specification is obtained when: $\gamma = \alpha/\theta, \tau = 0$.

[41]In particular, $g(.)$ is strictly concave on the interval $[0, x_0]$ and has a constant slope equal to 1 on the interval $[x_0, \infty)$. In addition: $g(0) = 0$ and $g'(x_0) = 1$. The intercept on the vertical axis obtained by prolonging the slope equal to 1, is indicated by G. The cost function is $h(x) = (1 + x^2)/2$.

$Z(t)$, since the quantity of the intermediate goods produced in equilibrium is $\overline{x} = 1$, and that the following relation:

$$\frac{\dot{Y}}{Y} = \frac{\dot{c}}{c} = \frac{\dot{Z}}{Z} = \frac{1-\rho}{\sigma} \tag{5}$$

is the solution for the consumer problem. Here σ is the reciprocal of the elasticity of intertemporal substitution. For growth to take place, it is assumed that $\rho < 1$, where 1 is the rate of return on savings. Note that it is assumed that the consumer solves his problem of allocating income between consumption and savings taking the path $M(t)$ as given, though he contributes to it through the accumulation of Z.

When $\sigma = 1$, Romer obtains that the consumption level in equilibrium is $c(t) = (G + \rho)Z(t)$ so that an increase in impatience leads to an increase in the level of consumption, a decrease in the level of savings and a reduction of the long run growth rate. This equilibrium growth rate is suboptimal because of the presence of a non-competitive sector; consequently, policy could be effective by raising savings.

Finally, Romer (1987, pp. 61-62) highlights that: "this model is not one with a true positive externality, but it nonetheless behaves exactly as if one were present ... the economy will behave as if there is a form of exogenous, labor augmenting technological change". In fact he shows that, when $g(.)$ is a power function and $N(t)$ and $M(t)$ are proportional to $Z(t)$, the equation (2) can be rewritten as:

$$Y(t) = M(t)^{1-\alpha}(L(t)^{1-\alpha}N(t)^{\alpha}) = AZ(t)L(t)^{1-\alpha} \tag{6}$$

where the constant A collects all the other constants.

From this it can be seen that the production function for aggregate output, although postulated as a constant returns to scale function, actually behaves as if an external effect were present. Normalizing L to 1 returns the form of the familiar AK function which can be considered as the base for "the simplest endogenous growth model"(Barro and Sala-i-Martin (1995), p.38).

4   Comment

We have seen how the formulation of the idea of growth based on division of labor has evolved, from the early formulation of Adam Smith, through the elaborations of Alfred Marshall, Allyn Young and Nicholas Kaldor, to the recent reconsideration in the context of an endogenous growth model, due to Paul Romer.

It is fair to say that Romer himself is often cautious as to his simplifying hypothesis, but it seems that some of his claims cannot be safely taken for granted, in particular when he refers to Allyn Young. It is true that he is faithful to Young in that he presents a way to formalize how an increase in

the "roundaboutness" in production, that is in the number of intermediate goods which insert between the primary resource and the final good, can increase the growth rate, producing a sort of "macroeconomic" increasing returns. However, it appears that this is done in a different perspective from Young's.

In particular we concentrate on a comparison between Romer and Young, being understood that the latter's contribution is linked to Smith, Marshall and Kaldor, and make four claims on the differences that seem to emerge: 1) Romer chooses an equilibrium approach against the disequilibrium approach of Young; 2) the Romer model is essentially supply-oriented and demand does not play an essential role as in Young; 3) the emphasis on fixed costs is different; 4) Young was more cautious than Romer on the use of the concept of Marshallian external economies. Let us consider more carefully these claims.

4.1   Equilibrium or disequilibrium?

First of all, we saw that the Romer model is cast into an intertemporal equilibrium setting, while from the analysis of Young's theory proposed in Section (2.3), it appears that he strongly rejected the equilibrium approach to study endogenous economic growth. Young seemed on the contrary to point at a disequilibrium theory of endogenous growth, and we suggested that also the original theory of Adam Smith can be interpreted in this way.

In the representation of the productive process, Romer maintains the "one way avenue" from given resources to final output, though by means of an intermediate sector. It is not clear that this can be taken as a faithful representation of the economy which Young had in mind, when he talked about the necessity to consider the economy as an "interrelated whole", where feedbacks, for instance in the form of "reciprocal demands", among productive units operating under increasing returns are continuously displacing the tendency towards equilibrium, when this is interpreted in an allocative sense[42].

In the Romer model, there are two allocation problems: the first regards the allocation of the given resource Z among the intermediate goods producers; the second is the allocation problem of consumers between consumption and saving. The first problem is solved imposing the zero profit condition in the intermediate sector: in this case what results is the equilibrium range of intermediate goods, which is finite in every period due to the assumptions

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[42]Moreover, interdependence among sectors in the Romer model appears in the sense that the final good is produced by means of intermediate goods in one period, and becomes a factor of production for them in the following period if not consumed. Again, this does not seem to be the story told by Young on the reciprocal effects triggered by increases in supply, which stimulate increases in demand, which in turn become increases in supply by other firms, etc.

that they have a quasi-fixed cost in terms of Z, whose quantity is given. The second one is solved by utility maximization on the part of consumers, given the paths of the rental price for Z and the price for the consumption good.

The intermediate goods producers, although facing an indivisibility, have a U-shaped average cost curve; we know that the presence of a non-convexity in the production set, caused in this case by an indivisibility, can be at the roots of increasing returns, but here this tendency is counterbalanced by the presence of increasing marginal costs originating the U-shaped average costs curve[43]. Thus, the condition of competitive equilibrium can be established, even if it takes the aspect of a monopolistically competitive equilibrium. Let us recall again what Kaldor (1972, p. 1253) noted: "if indivisibilities were the only sole cause of increasing returns, there would always be some level of production at which such scale economies were exhausted and 'optimum scale' production reached."[44] This is exactly what happens to the intermediate inputs producers in the Romer model.

In any case, production is never assumed to take place under increasing returns, due for instance to the continuous re-organization of the production process, to learning by doing, to improvements in the technology, as emphasized by Smith, Young, Marshall and Kaldor. We have remarked in Section (2.4) how Kaldor argued against the equilibrium approach. In the Romer model increasing returns appear in the aggregate, as for Young, but they are generated by a series of equilibrium conditions and depend on a particular hypothesis on the way intermediate inputs are assembled in the production function for the final good.

4.2   Supply-side or demand-side?

In the Romer model consumers save and invest in Z, this permits the increase in the range of intermediate goods (considered in this context as an increase in division of labor) which in turn increases production and income. Remember that in the intermediate sector there are firms potentially active, but the decision of these potential intermediate firms to produce is not due

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[43]In particular, the cost function chosen by Romer, $h(x) = (1+x^2)/2$, implies a marginal cost $h'(x) = x$.

[44]Young (1999b, p. 144) is also very explicit on the fact that increasing returns do not depend on the presence of fixed costs: "[t]he factors which give rise to increasing returns should not be confused with the circumstance that in many industries certain outlays (e.g. for plant and equipment) have to be incurred in advance or with the further circumstance that in a growing industry such outlays are ordinarily considerably larger than the volume of output immediately in prospect would require...with a progressive increase of output there will be a progressive diminution of costs per unit of output, because the general, supplementary, or 'overhead' costs will be spread over a large number of units ... this condition ... should not be confused with a true condition of increasing returns, for this last condition is to be found only when a gradual increase in output is attended, in the long run, with genuine economies."

to a sudden increase of demand for their good: that demand is always existing because of the form of the production function for final goods. They can become operative once the quantity available of Z makes it possible; than it is savings that foster growth.

The causation goes from the increase in the division of labor, that is in number of intermediate goods supplied to the final good sector, which is permitted by savings, to an increase in Y, which is income earned by consumers and subsequently consumed or invested. Thus, the growth of Y is constrained by the supply of intermediate goods, in turn constrained by the availability of the primary resource Z.

Can this process be interpreted as "the division of labor is limited by the extent of the market"? What is certainly true here is that the division of labor is limited by fixed costs. However, from the discussion in Section (2.3), it appears that the accent was posed by Young mainly on another question: that is on the possibility to adopt more capital-intensive, highly productive methods conditional on the possibility to sell a large output. In this case it is the absence of demand that limits the division of labor; Young seemed to be less concerned with possible resource-constraints faced by the firms. In this he can be more probably interpreted as Keynesian, as for Keynes investment could be carried out before savings were available; the latter would have subsequently been generated by the increase in income following the investment. This point was also made by Kaldor (1972, pp. 1247-1250), in a discussion of the connections between the Young approach and Keynesian theory[45].

4.3   Which role for fixed costs?

The latter point is also related to the question of the role of fixed costs in Young's theory. As noted, Young seemed to be aware of them, but played down their role. Sandilands (2000, p. 315) comments on this issue: "Young did not say that specialization is limited by the presence of fixed costs, though he did say that specialization increasingly took the form of greater roundaboutness in the economy as whole. In his theory, fixed costs and increased roundaboutness are not so much a constraint on growth as its consequence."

In other words, the issue for Young (and for Smith) was the creation of a market or the extension of existing ones. For Romer, as we noted, the potential market for all intermediate goods exists already: in every period an infinite quantity of intermediate goods is demanded.

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[45]Also recall that Smith identified a specific role for demand, not only in relation to the extent of the market, but also in relation to the passage from a traditional to an industrial economy. See Section (2.1).

4.4 External Economies or Network Externalities?

Romer claims that, as reported in Section (3), Young and Marshall discussed specialization in terms of competitive equilibrium with positive external effects. From the quotation in Section (3), and from the discussion of point 2) above, this interpretation does not seem to be correct. Young did not talk about a process taking place under competitive equilibrium, at least in the way Romer adopts it, and at the same time considered the adoption of the Marshallian distinction between internal and external economies, as giving just "a partial view" on the growth process.

It may well be that, when considering the positive effect generated outside a productive unit, in that "obscurer field" as Young called it, a more appropriate concept than external economy for the Young's theory is that of *network externality*. Consider the following definitions, taken from Economides (2000):

> "*Networks*: networks are composed of complementary nodes and links. The crucial defining feature of networks is the complementarity between the various nodes and links. A service delivered over a network requires the use of two or more network components. *Network externality*: a network exhibits network externalities when the value of a subscription to the network is higher when the network has more subscribers. In a traditional network, network externalities arise because a typical subscriber can reach more subscribers in a larger network. In a virtual network, network externalities arise because larger sales of component A induce larger availability of complementary components B1, ..., Bn, thereby increasing the value of component A. The increased value of component A results in further positive feedback. Despite the cycle of positive feedbacks, it is typically expected that the value of component A does not explode to infinity because the additional positive feedback is expected to decrease with increases in the size of the network."

In the Young framework, for a producer, the development of the number "of subscribers to the network" (the "interrelated whole" of activities), means an increase in its potential output (extent of the market) if demands of the other goods are elastic: that is, an increase in their supply calls for an increase in demand for the good in question. Therefore, the increase in production, as noted, may stimulate the creation of another industry, that is an increase in the size of network, which provides the activation of other feedbacks. Otherwise, due to a process of reorganization of production, the increase in production may lower the price of the good, stimulating further demand. Plus, the increase in production means an increase of demand for

inputs, than other stimuli to the system. With respect to the above definition of network externality, the focus should be put on the aggregate results of this process in terms of endogenous growth.

In the case of the process of division of labor, the network effects should however be understood in a particular sense. In fact, the choice to specialize in the production of a particular good depends on the choice of others of specializing in different goods. In this respect thus we can call the benefit from specialization connected to other agents' choices of specializing in something else as a *conformity effect* (in the sense that different agents make the choice of specialization)[46], but keeping in mind that the specialization is in different activities. In this sense the *positive feedback effect* (see Agliardi, 1998) that may reinforce the outcome of agents'choices should be understood correspondingly: the choice of agents to specialize is mutually reinforcing, but they are involved in different activities, and therefore, e.g., adopt different technologies.

5   Concluding Remarks

Summing up the arguments put forward in the previous Section, we believe that the Romer model did successfully catch some aspects of the growth dynamics generated by the division of labor. However, in the re-evaluation of the contributions of Adam Smith, Alfred Marshall, Allyn Young and Nicholas Kaldor offered, other relevant issues seem to point to different possible formalizations. That this still remains an open field for research can be inferred for example by a comment provided by Heal (1999a, p. *xxiii*) who, after presenting the main features of Young's growth theory, writes: "[t]his seems an interesting intuition, broadly consistent with casual empiricism, and *not captured by any formal growth models*. It has some resemblance to evolutionary models in biology, where evolution leads to increasing complexity and longer food chains" (Italics added).

Moreover, from an historical point of view, the Romer model of growth and specialization has been recently criticized by Sandilands (2000, p. 315), for not being able to: "fully capture Young's view of the links between fixed costs, specialization, external economies, and the economy-wide external returns that make growth a semi-automatic, self-perpetuating process".

As we mentioned in the Introduction, the recently developed "complex approach" to economic dynamics appears as a natural environment to study growth based on division of labor, along the lines suggested by Smith, Marshall, Young and Kaldor. We can retrace in the works of such authors some elements which are the standard ingredients of models of "complex dynam-

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[46]Typically, conformity effects are such that the benefits of an action, for example the adoption of a technological standard (see, e.g., Arthur, 1987), increase in the number of those making the same choice.

ics". Let us recall the most important ones, which we encountered when discussing the dynamics of growth based on division of labor: "complex models" are characterized by increasing returns and path dependency[47]; such models generally feature interaction among the agents, local or global, which cannot be reduced to the indirect interaction which take place by means of market-clearing prices. In short, while in standard neoclassical economics agents derive all information from market prices, models based on local or global interaction consider the interdependence of the actions of the agents[48], as is the case for the decisions of agents to specialize as results from the discussions in Smith, Marshall and Young[49].

Other important features are: the so-called aspect of "perpetual novelty" and the related issue of "out-of-equilibrium dynamics" (see the *Introduction* to Arthur et al., 1997, p. 4), and the idea of irreducibility of the system, meaning: "that ... the behavior of a complex system disappears when we try to reduce the system to a simpler one" (Agliardi, 1998, p. 5). Both aspects are clearly present in the approach followed by Young, with his emphasis on the impossibility of approaching economic growth as an equilibrium process and his insistence on the inadequacy of concepts like "representative firm" or "representative industry", whose behaviors are normally "scaled up" to obtain descriptions of the aggregate in much contemporary economics[50]. Endogenous growth in the aggregate, when it takes place, should arise as a

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[47]Is there path dependency in the Romer model? The answer is affirmative in the sense that the model displays lack of convergence, since economies starting poor because they do not specialize stay poorer than economies that start richer because they produce a larger range of intermediate goods. However, this type of model does not feature path dependency in the strict sense since there are not cumulative effects: if the saving rate, e.g., increases with a decrease in an exogenous factor like the time discount rate, the growth rate increases, but this *per se* does not preclude the saving rate to decrease in subsequent period due to a change in the same parameter of the opposite sign.

[48]See Kirman (1999) for a careful discussion on the topic of interactions among agents, which includes game theory, the field where typically agents' actions are interdependent. In the case of specialization, we have seen that for what concerns the choice of specialize, the neighborhood of an agent is important in the sense that the agent (or the firm) must be able to find the goods which are not produced after the choice of specializing but are nonetheless demanded. After specialization has taken place, it is also important the maintenance of the neighborhood and possibly its expansion. In both cases this means that to secure an increase of the neighborhood is important, since that represents an extension of the market, potential and actual.

[49]In particular recall the arguments of Smith on the "natural tendency" for social interaction, and the discussion of Marshall (and Young) on "differentiation" and "integration" of the parts constituting "superior" economic systems.

[50]Consider also the introduction to the concept of complexity reported in (Agliardi, 1998, p.6): "A remarkably good definition of what makes a system 'complex' is provided by Philip Anderson, the Nobel laureate physicist...: complexity is the science of 'emergence'; that is, it is about how large interacting ensembles exhibit collective behaviour that is very different from anything one might have expected from simply scaling up the behavior of the individual units". This seems again to fit nicely the description of the economy provided by Allyn Young.

by-product of the interaction among the productive units or, put in terms of the "complexity approach", it should represent one of the possible *emergent structures* of the system.

What can we expect from an alternative formalization based on such features? The possibility to treat aspects which are not dealt by the Romer model: the modelling of the dynamics as a process; the modeling of the role of demand (since demand and supply are on the same footing, as in models studying business cycles adopting the self-criticality approach, such as Bak *et al.*, 1993 and Scheinkman and Woodford, 1994), and the connected downplay of the role of fixed costs (if our interpretation of Smith and Young is correct); a correct definition of the type of externalities which are at work (network, in the special sense we defined, against generically external). Further work will attempt to demonstrate that such hypotheses are more than speculations.

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