

# Division of Labor and Growth: from Adam Smith to the New Growth Theory

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Note preparate per la riunione del gruppo di ricerca "Temi classici nelle moderne teorie della crescita". Napoli, 14-16 Novembre 2000

## 1 Introduction

The theory that economic growth is explained by the degree of division of labor was one of the main contributions of Adam Smith's *Wealth of Nations*. Recently, this idea reappeared in the context of the New Growth Theory (NGT), in the form of a particular formal model, presented by Romer (1987), and discussed also in Romer (1989) and Barro and Sala-i-Martin (1995, Ch.VI).

As the latter is considered the modern analytical formulation of an idea not completely formalized so far<sup>1</sup>, it is worth considering how this can be taken for granted, given the often remarked differences between classical and neoclassical economics<sup>2</sup>. Moreover, Kurz and Salvadori (1998) maintain that modern formulations of endogenous growth theory are often re-presentations of old classical ideas, simply cast in different framework, so this may also raise doubts on the novelty of the NGT approach.

In these notes, we do not provide a full survey of the literature on division of labor<sup>3</sup>, but focus on a comparison between the recent contributions of Paul Romer (1987, 1989), and the older formulations of the theory, in particular with that provided by Allyn Young (1928). In fact, the latter, as will be argued, substantially advanced and updated Smith's theory, in his time partially obscured by the advent of Marshal-

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<sup>1</sup>Alternative formalizations of the relation between growth and division of labor have been recently presented by Yang and Borland (1991), Yang (1999) and Kelly (1997), but they have not become equally popular.

<sup>2</sup>See Kurz and Salvadori (1995) on value and distribution.

<sup>3</sup>An excellent one is provided by Yang and Ng (1998).

lian static supply-and-demand approach. Marshall himself will also be given attention, for his *Principles* contain some relevant passages written in Smith's spirit. We will also consider the important contributions of Nicholas Kaldor (1972, 1975) on this subject, but only with references to some of his works, even if he probably deserves a section on his own<sup>4</sup>.

The paper is organized as follows: Section (2) contains a description of Smith's theory, (Subsection 2.1), and how it evolved through the works of Marshall, (Subsection 2.2) and Allyn Young, (Subsection 2.3). Section (3) introduces the Romer model; Section (4) critically compares the old and new approaches; Section (5) concludes.

## 2 The Smith-Marshall-Young Approach

### 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 most important explanation of the well-being of developed countries lies in the high level of division of labor they attained. Economic growth, to be interpreted as growth in per capita income, has to be reconducted to two causes: labor productivity and the proportion of productive to unproductive workers<sup>5</sup>.

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) permits the worker to save the time necessary to switch among different activities; c) puts the worker in the condition to invent machines to ease 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)<sup>6</sup>), and endogenous technological progress (point c)).

As to the latter, Smith does not put particular emphasis on the operations of ordinary workers, probably capable of some minor inventions, but indicates that it is more important the case of the specialization of individuals in producing machines or pursuing inventive activity, which

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<sup>4</sup>This will presumably be done in a subsequent version of these notes.

<sup>5</sup>According to this distinction, a worker is productive if the product of his work can be exchanged with other labor; otherwise he is unproductive, that is his work resolves itself in some service (Smith includes in the latter category servants, officers, soldiers, churchmen, etc. See Smith, 1976, pp. 351-352). This distinction has to be put in relation with the acceptance by Smith of the theory of value based on *commanded labor*, according to which: "[t]he value of any commodity...is equal to the quantity of labour which it enables...to purchase or command" (Smith, 1976, p.34). This distinction can be considered irrelevant today, since service workers' product is undeniably much more valuable than in Smith's times.

<sup>6</sup>Note that this set-up cost has not to do with learning costs, but purely with the opportunity cost of forgone production in the time wasted to switch from one activity to the other.

today would be termed Research and Development. Here Smith especially refers to the process of division of labor *among* productive units (firms, departments..), where it may happen that two particular types of specialized workers 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.”<sup>7</sup>

Then, technological progress and, more generally, the increase in the stock of knowledge available in a society, are treated in this context in a particular way: they can be considered as a *consequences of increased division of labor* among and within firms, since they proceed at a certain speed only when, respectively, some classes of men become exclusively engaged in its pursuit, or when they, being concentrated on a particular phase of the production process, ”are much more likely to discover easier and readier methods of attaining any object,...than when [their attention] is dissipated among a great variety of things.”<sup>8</sup> In the first case it may be that the activity brings to *radical innovations*, in the second to *incremental innovations*.

Capital accumulation, the other fundamental issue for many (if not any) growth theories, is important in the explanation of growth in consideration of its link with division of labor. First, for Smith, it is competition that forces entrepreneurs to use their capital to find the best way of subdividing 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 endavours, 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.”<sup>9</sup>

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<sup>7</sup>Smith (1976), p.14.

<sup>8</sup>Ibidem, p.13.

<sup>9</sup>Ibidem, p.292.

Moreover, not only accumulation of capital 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.”<sup>10</sup>

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.

Then, capital accumulation makes division of labor to take the form of 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. Note also that, from the way capital accumulation is linked by Smith to division of labor and then to productivity, it does not follow automatically that an increase in the stock of capital must cause a decrease in the rate of profit. See Kurz and Salvadori (1999), pp. (??): ”[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 *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

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<sup>10</sup>Ibidem, pp. 291-292.

for a particular good (or a small set of goods), but at the same time he cannot produce all the commodities he needs. Then, he has the incentive to specialize if he possesses "power of exchanging" that surplus, i.e. if sufficient demand for it exists, letting the individual purchase other goods, with the revenue coming from the disposal of his surplus product. Note that the same logic applies to a firm: specialization of operations makes sense 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 it renounces to produce.

So, when we consider the fundamental importance attributed to Smith to the extent of the market, then to demand (both effective and potential, as we discuss below), we can say that the crucial aspects of technological progress and accumulation of capital, strictly connected in a Smithian framework, appear at the same time conditioned on the possibilities of expansion of production, which are affected by increases in demand, and not just as a pre-condition for it. In fact, the accumulation of capital also influences the number of people put to work, then the aggregate level of disposable income. We will return to this question when discussing the contribution of Allyn Young, who re-stated Smith's theory as: "the division of labor is limited by division of labor".

Demand is important in another respect. First, we note that, for Smith, there were 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."<sup>11</sup> This can be put in relation with 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 conveniences and ornaments of buildings, dress, equipage, and household furniture, seems to have no limit or certain boundary."<sup>12</sup>

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, permits to observe how for Smith the structure of demand could be important in explaining economic growth. This point is fully analyzed in Rosenberg (1968), who puts in evidence that Smith had a clear theory of the formation of tastes, and that this implied a connection between demand and growth.

In particular, Smith explained that individuals desired manufactured

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<sup>11</sup>Ibidem, p.10.

<sup>12</sup>Ibidem, p.183.

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 mean to gain respect and admiration. As noted, this behavior could have at least two negative effects on growth, according to the theory of Smith: it reduced the markets for manufactured goods and increased the number 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<sup>13</sup>, 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, then stimulating further demand<sup>14</sup>; unproductive men 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: "[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."<sup>15</sup>

From the previous discussion, some "natural" facts, like the desire of individuals for a theoretically infinite variety of manufactured goods, in

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<sup>13</sup>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).

<sup>14</sup>Smith also considered that the expansion of the manufacturing sector made available ordinary consumption goods, than not just luxuries, to "the lowest ranks of the people" (Smith, 1976, p.15). The demand for manufactures by surplus disposers can be considered as particularly important in the move from an agricultural to an industrial society.

<sup>15</sup>Smith (1976), p.402.

opposition with a necessarily limited demand for food, or the impossibility of reaching an unlimited degree of division of labor in agriculture, emerge as part of the Smithian system of forces explaining the progressive nature of wealthier countries. The very presence of increasing returns, generated by the process of division of labor, as pointed out by Kaldor, is due to: "reasons that are fundamental to the nature of technological processes and not to any particular technology"<sup>16</sup>. Kaldor also noted that: "for Smith the existence of a "social economy" and the existence of increasing returns were closely related phenomena"<sup>17</sup>. 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."<sup>18</sup>

In short, in the Smithian theory of growth we can individuate some "givens":

1. industrial production is characterized by increasing returns, originating from the progressive division of labor;
2. the returns from division of labor cannot be fully secured in agriculture, as in the manufacturing sector;
3. individuals demand an unlimited variety of manufactured goods;
4. individuals have a natural inclination for social interaction<sup>19</sup>.

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 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 its good as given. The question of the compatibility between increasing returns and competitive equilibrium generated a heated debate, started in the 20's with the publication of Sraffa (1926) who, specifically, indicated the logical

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<sup>16</sup>Kaldor, (1972), p.1242.

<sup>17</sup>Ibidem, p.1241.

<sup>18</sup>Smith (1976), p.402.

<sup>19</sup>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), p. (?): "Smith was carefully ambiguous about the question whether the propensity to truck can itself be reduced to more immediately rational considerations".

incompatibility between increasing (and decreasing) returns and partial equilibrium analysis, criticizing the solution proposed by Marshall based on the distinction, discussed below, between internal and external economies<sup>20</sup>.

Since this debate was focused on the shape of costs 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.”<sup>21</sup>

Then, 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 by 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. That this can be considered as a long run negatively sloped supply curve is questionable, because it is generated by a competitive process coupled with some features of technological and organizational change.

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, the latter process being inextricably linked to increasing returns.

Richardson (1975, 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

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<sup>20</sup>Sraffa pointed out that, in order to talk about increasing returns, one had to abandon partial equilibrium or address to monopoly. For a recent survey on this debate see Aslanbegui and Naples (1997).

<sup>21</sup>Smith (1976), Volume 2, p. 271.



of a model of reality that is clearly very different indeed from that implicit in Smith's theory of evolution."<sup>22</sup>

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<sup>23</sup>, in the sense that competition is related to a change in the structure of the economy: as new opportunities for division of labor arise, new sectors and new products appear (both consumption goods and intermediate, 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. In fact, if for example the actual price is above natural price in the market for a good, competition may take the form of an entry of firms which can replicate the productive process of the incumbent firms; this generates an increase of actual supply which brings down the price to its natural level, where price equals costs plus the normal profit. However, since some opportunities to divide labor are always unexploited, competition may take the form of creation of a specialized firm undertaking a part of the production process of the good in question. This new firm may at first earn profits above the normal level, then stimulating entries of other firms and, with respect to the good to the production of which it cooperates, it allows an increase in its normal quantity that can be supplied, a reduction of its cost of production and of its natural price.

The two competitive processes indicated are therefore related, as 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, that there is not a contradiction in Smith, when he speaks of the joint presence of competition and increasing returns<sup>24</sup>, 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

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<sup>22</sup>See also Marchionatti (1992).

<sup>23</sup>"[Smith has] a dynamic notion of competition which anticipates in important respects the views on competition of authors such as Marx and Joseph Schumpeter". Kurz and Salvadori (1999), p. ??.

<sup>24</sup>We will return on this presumed contradiction when discussing the contributions of Paul Romer.

of which he habitually thinks.”<sup>25</sup>

Richardson 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. In fact, Richardson (1975, p.531) concedes that: ”what Smith could see in a glass, darkly, it took Walras, with his more refined technique, to bring fully into light”<sup>26</sup>. But, he adds:

”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.”<sup>27</sup>

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’ ”<sup>28</sup>. We can add that Richardson is probably right 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 seems to point also to demand as a relevant factor in the growth process. Basically, this idea of growth will be rehabilitated by Allyn Young.

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<sup>25</sup>Richardson (1975), p.354.

<sup>26</sup>This view is in reality problematic, as the Walrasian process seems to be radically different from that envisaged by Smith, and other classical economist, as to the determination of equilibrium prices. See Kurz and Salvadori (1995).

<sup>27</sup>Richardson (1975), pp. 531 e 534. Italics added.

<sup>28</sup>Loasby (1996, 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”.

## 2.2 Alfred Marshall

[to be written].

The basic point of the Section is synthesized by Loasby (1989), quoted 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."

Some relevant quotations relative to the argument to be developed are the following:

Marshall (*Principles*, p.461): "economic problems are imperfectly presented when they are 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. The Statical theory of equilibrium is only an introduction to economic studies; and it is barely even an introduction to the study of progress and development of industries which show a tendency to increasing returns. Its limitations are so constantly overlooked, especially by those who approach it from an abstract point of view, that there is a danger in throwing it into definite form at all. But, with this caution, the risk may be taken."

Marchionatti (1992, p.566) describes the problems that Marshall considers in relation to the possibilities of increasing sales, after his discussion of the many sources of internal economies of scale achievable by the firms. He writes: "[i]f our analysis is correct, it follows that the tendency induced by the existence of increasing returns to scale cannot continue to its extreme consequence: monopolization can at most be partial, and temporarily limited. The never-ending product and technological innovation process, which for Marshall too, represents the deep dynamic nature of modern economy, prevents it...So the predominant market structure in the Marshallian analysis is neither perfectly competition, nor monopoly; it is rather a set of intermediate positions determined through the movement between these two opposite poles, and is induced by actual innovative competition."

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" On this Kaldor (1972, p.1241) notes: "[t]o be fair,

Sraffa's critique had more relevance to the 'Marshallian school' at Cambridge (and particularly to Pigou) than to Marshall himself who always expressed considerable doubt about the applicability of the theory of 'normal price' to the case of increasing returns"

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## 2.3 Allyn Young

Allyn Young (1928) is a celebrated article which 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 noted, it marked a significant return to Adam Smith's approach and, in addition, it is directly considered the source of inspiration of the recent NGT models<sup>29</sup> of growth and specialization. A review of the article is proposed here to present his theory, in order to contrast it with Young's classical predecessors and neoclassical followers.

After a brief introduction, Young 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."<sup>30</sup>

But he 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."<sup>31</sup>

The explanation offered for this skepticism is that:

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<sup>29</sup>For example, in the working paper version of Romer (1987), the model was introduced in the title as a model of "Growth as Described by Allyn Young". See Romer (1986a).

<sup>30</sup>Young (1928), pp.527-528.

<sup>31</sup>Ibidem, p.528.

”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.”<sup>32</sup>

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.”<sup>33</sup>

The last passage is important since it explains that Young, when thinking about 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 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.”<sup>34</sup>

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<sup>32</sup>Ibidem, p.528.

<sup>33</sup>Ibidem, p.528.

<sup>34</sup>Ibidem, p.528.

Then Young does not believe that concentrating on a partial analysis of an "individual 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"<sup>35</sup>, as appropriate for his investigation of increasing returns.

This brings him to a direct reference to Adam Smith, whose "theorem that the division of labour depends upon the extent of the market"<sup>36</sup> 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"<sup>37</sup>, than the division of labor inside firms (like in the famous pin factory). That is, Young considers the division of labor mainly as the process leading to the increase of a network of interdependent productive units, where the number of units changes as well as their linkages.

This process generates the more important type of increasing returns. Before proceeding in their discussion, another type of economies, termed by Young "secondary order economies", are described. These are the economies deriving from the use of specialized machines in production. In fact Young, while commenting the idea of Smith that a specialized worker is likely to invent new tools or machines, stresses that what matters here is that the simplification of some parts of the production process permits the introduction of machines (a point also remarked by Smith and Marshall). Then, the main point 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 decide to use indirect rather than direct labor.

Young (1928, p.530) writes:

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

Here we have the statement, emphasized also by Kaldor (1972, p.1242),

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<sup>35</sup>Ibidem, p.528.

<sup>36</sup>Ibidem, p.529.

<sup>37</sup>Ibidem, p.529.

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 sees 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 modern neoclassical model.

It is immediately stated that what matters for the firm's decision to adopt a specialized machine, is 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 economies] have only a secondary importance"<sup>38</sup>. This is the case when:

"[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."<sup>39</sup>

Then, we are told that the extent of the market is the relevant factor the firm considers in the choice of substituting labor with capital; this also 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.

In other words, what matters for the decision of the firm to adopt a machine, is not just its cost, but its high productivity; consequently, the main question is the presence of an outlet for the increased production. In short, it seems here that fixed costs are discussed only marginally by Young: in particular in the analysis of what he calls secondary order economies and, in any case, their importance is subordinated to the extent of the market.

For Young the economies of first order "which manifest themselves in increasing returns are *the economies of capitalistic or roundabout methods of production*"<sup>40</sup>. An important passage follows this statement:

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<sup>38</sup>Ibidem, p.530.

<sup>39</sup>Ibidem, p.530.

<sup>40</sup>Ibidem, p.531. Italics added.

”..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.”<sup>41</sup>

This is remarkable because it is specified that Young is thinking about ”macroeconomic increasing returns”<sup>42</sup>, not to be seen by concentrating only on representative firms and on their negatively sloped cost curves, but to be appreciated from an analysis of the entire economy, considered as a large interactive system. The market is in fact defined by Young (1928, p.533) as ”an aggregate of productive activities, tied together by trade.”

Note, as mentioned above, that Young stresses the difference between the *economies of large-scale production*, related to the size of the individual firm or industry, and the *economies of large production*, referred to the extent of the whole market, that is to the size of the network of productive units. On this point, Sandilands (2000, p.316) quotes Young from the lecture notes taken by Kaldor at LSE<sup>43</sup>: ”[t]he reduction of costs in a firm increasing its output is not due to any connection between prime and supplementary costs but to totally different causes. Large production, not large scale production permits increasing returns.”

When Young (1928, p.531) claims that the division of labor among industries is limited by the extent of the market (”even more than the economies of other forms of the division of labor”), 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. [Then:] the size of the market is determined and defined by the volume of production.”<sup>44</sup>

This immediately brings 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”<sup>45</sup>. Though reminiscent of the Say’s law, this statement is more far-reaching<sup>46</sup>: basically it says that

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<sup>41</sup>Ibidem, p.531. Italics in the original text.

<sup>42</sup>This definition appears in Currie (1997).

<sup>43</sup>These notes have been published in the *Journal of Economic Studies*, (1990).

<sup>44</sup>Ibidem, p.533.

<sup>45</sup>Young (1928) p.533.

<sup>46</sup>Young (1999b, p.145) in fact criticizes the Say’s law as such: ”[t]here is a sense



both demand and supply are endogenously determined according to the level of division of labor prevailing<sup>47</sup>.

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.”<sup>48</sup>

We have already noted that the same idea, 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.

Young (1928, p.533) 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”<sup>49</sup>, and introduces the concept of reciprocal demand as something which, in his approach, most closely resembles what he is criticizing.

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in which supply and demand, seen in the aggregate, are merely different aspects of a single situation. 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.

<sup>47</sup>This aspect is clearly assumed in models like Yang and Borland (1991) or 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.

<sup>48</sup>Ibidem, p.533. Italics added.

<sup>49</sup>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).

The context he sketches is that of production carried out "competitively under conditions of increasing returns"<sup>50</sup> which, at first 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, attributed more importance to the second type of competition mentioned by Richardson (1975)<sup>51</sup>.

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."<sup>52</sup>

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."<sup>53</sup>

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 act as stimulus to production, and then 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 (1928, p.535),

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<sup>50</sup>Ibidem, p.534.

<sup>51</sup>See also Kaldor (1972, p.1251): "it is evident that the co-existence of increasing returns and competition - emphasised by Young and also by Marx, but wholly excluded by the axiomatic framework of Walrasian economics - is a very prominent feature of de-centralised economic systems but the manner of functioning of which is still a largely uncharted territory for the economist."

<sup>52</sup>Young (1928), p.534. Italics in the original text.

<sup>53</sup>Ibidem, p.534.

”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.”

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, though based on such strong mechanisms, can nevertheless encounter obstacles. Young mentions: the presence of non reproducible resources, the emergence of some 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<sup>54</sup>.

In any case, if one has to indicate a single factor relevant for economic progress, that is the extent of the market and, Young (1928, p.536) points out: ”no other hypothesis so well unites economic history and economic theory”. The extent of the market relevant for the decisions of businessmen may well be potential since: ”the search for markets is..a matter of...finding an outlet for a potential demand”<sup>55</sup>

In conclusion, the growth theory exposed by Allyn Young, though only verbally, seems to contain elements of originality which, as will be shown below, have been only partially incorporated by endogenous growth theory. He tried to bring growth theory back to the view of Adam Smith, and successfully re-presented it with important updates. Maybe, the most distinctive feature of his approach was the vision of the economy, that he choose to describe in his ”togetherness”<sup>56</sup>.

Nicholas Kaldor, writing in 1972, 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”<sup>57</sup>. It will be argued that his recent re-discovery by mainstream economists still left aside important aspects of his approach.

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<sup>54</sup>The latter is mentioned with caution by Young, and rightly one may say, since an important piece of evidence nowadays widely accepted, is the negative relation between population growth and per capita income. See for instance Romer (1989), pp.67-68.

<sup>55</sup>Young (1928), p.537.

<sup>56</sup>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.

<sup>57</sup>Kaldor (1972), p.1243.

### 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 (1990), and used in works like Rodriguez-Clare (1996), Ciccone and Matsuyama (1996), Peretto (1999), and many others.

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 what keeps of the precedent contributions and what leaves out. It will turn out that, though constituting an important advance, still it is not completely faithful to Smith and Young.

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<sup>58</sup>. 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 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<sup>59</sup>.

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 appears as if it is characterized by external economies.

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<sup>58</sup>A similar premise is stated in Kim (1989, p.692) and Heal (1999b, p.xiii).

<sup>59</sup>Yang e 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."

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"<sup>60</sup>. 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 bring to models which behave exactly like models with true externalities<sup>61</sup>.

Then, when the focus is on the introduction of new goods, fixed costs become part of the picture because it is reasonable to assume their presence, when a new production is started<sup>62</sup>. 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 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. Then, firms have market power but in equilibrium earn zero profits. 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<sup>63</sup>, 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<sup>64</sup>.

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<sup>60</sup>Romer (1989), p.108.

<sup>61</sup>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.

<sup>62</sup>In Romer (1990) new goods are designs to be used in the production of intermediate goods, and they entail a fixed research cost.

<sup>63</sup>Romer (1989, p.70) in fact accepts the view that: "[g]rowth is a general equilibrium process".

<sup>64</sup>Basically, Romer refers to his incapability to explaining growth only by the growth of capital and labor, due to the large "residual" resulting from cross-country regressions, and to his incompatibility with purposefully conducted research activity since, 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.

We now 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 and Young. From the previous introductory notes, some differences should already be clear, like the use of an equilibrium and not of a disequilibrium approach.

The Romer (1987) model 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, and entail 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 they 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 goods is useful"<sup>65</sup>. This can be obtained when intermediate goods are not close substitutes in final good production, for instance when the production function is<sup>66</sup>:

$$Y = L^{1-\alpha} \cdot \sum_{i=1}^{\infty} x(i)^{\alpha} \quad (1)$$

if the various intermediate inputs are indexed by positive integers, or:

$$Y = L^{1-\alpha} \cdot \int_{\mathbb{R}_+} x(i)^{\alpha} di \quad (2)$$

if they are indexed on the real line. In both cases,  $Y$  is final good,  $L$  is labor,  $x(i)$  is the quantity of the good  $i$ , and  $0 < \alpha < 1$ . Then the marginal product of each intermediate good is decreasing.

The number, or the range on the real line, of intermediate inputs used could be theoretically infinite, but the fact that their production entails a fixed cost in terms of  $Z$ , whose quantity is given, guarantees that it is finite. Taking as reference equation (2), it is possible to show that, if all goods are produced in the same quantity  $\bar{x} = N/M$  (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, or the number of goods in the case of equation (1), the production function becomes:

$$Y = L^{1-\alpha} N^{\alpha} M^{1-\alpha}. \quad (3)$$

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<sup>65</sup>Romer (1989), p.108.

<sup>66</sup>This form of aggregating goods is due to Dixit and Stiglitz (1977), who used it to specify a utility function where agents prefer variety in consumption. Ethier (1982) introduced the possibility to consider it as a production function.

From equation (3) we see that output can increase without bound with  $M$ .

The power function appearing in equations (1) and (2) is a specific form of the function  $g(x(i))$ , which represents the way intermediate goods are aggregated: in general it has to be strictly concave, with  $g(0) = 0$ . In the case of a power function, it features additive separability, which 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 it implies that discoveries of new types of goods do not tend to make the existing types obsolete."<sup>67</sup> Note finally that the inverse demand function for intermediate goods is proportional to the derivative of  $g(\cdot)$ .

At this point what matters is to establish a mechanism which supports a growing  $M(t)$ . This is obtained by assuming that  $Z$  can be accumulated following the rule:

$$\dot{Z} = Y - c \quad (4)$$

where  $c$  is the consumption level of an individual, who maximizes the

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<sup>67</sup>Barro and Sala-i-Martin (1995), p. 213.

Another way of aggregating intermediate goods used in the literature is based on the so-called CES specification (see for instance Rodriguez-Clare, 1996):

$$Y = L^{1-\alpha} \cdot \left\{ \left[ \sum_{i=1}^M x_i^\theta \right]^{1/\theta} \right\}^\alpha$$

where  $M$  is the number of intermediate goods used, and  $\theta$  is a parameter reflecting the elasticity of substitution among different intermediate inputs, given by  $\epsilon = 1/(1-\theta)$ . It is assumed that  $0 < \theta < 1$ , that is goods are imperfect substitutes (i.e.  $1 < \epsilon < \infty$ ); when  $\theta = 1$  goods are instead perfect substitutes.

When every good is produced in the same quantity  $\bar{x}$ , we obtain:

$$Y = L_i^{1-\alpha} \cdot \left\{ [M\bar{x}^\theta]^{1/\theta} \right\}^\alpha = L^{1-\alpha} \cdot \left\{ M^{1/\theta}\bar{x} \right\}^\alpha$$

Now call the aggregate quantity of intermediate goods  $N = M\bar{x}$ , so that  $M^{1/\theta}\bar{x} = M^{\frac{1-\theta}{\theta}} N$ . Then we have:

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

Here we see that, if  $0 < \theta < 1$ , that is if the intermediate goods are not perfect substitutes, output increases with  $M$ . Otherwise, when  $\theta = 1$ , that is when intermediate goods are perfect substitutes, the production function reduces to:

$$Y = L^{1-\alpha} \cdot N^\alpha$$

which is a standard Cobb-Douglas production function. Of course, what matters here is not the number of intermediate inputs, but their total quantity.

total discounted utility:

$$\int_0^{\infty} U(c(t))e^{-\rho t} dt \quad (5)$$

where  $\rho$  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 aggregation function  $g(\cdot)$ , and of the cost function for the intermediate goods producers<sup>68</sup>. Then he shows that the equilibrium condition for the monopolistically competitive sector is  $M(t) = Z(t)$ , and that the following relation:

$$\frac{\dot{Y}}{Y} = \frac{\dot{c}}{c} = \frac{\dot{Z}}{Z} = \frac{1 - \rho}{\sigma} \quad (6)$$

is the solution for the consumer problem. Here  $\sigma$  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, in every period, an increase in impatience leads to an increase in the level of consumption, a decrease in 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) notes 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 if  $g(\cdot)$  is a power function,  $N(t)$  and  $M(t)$  are proportional to  $Z(t)$  and the equation (3) can be rewritten as:

$$Y(t) = M(t)^{1-\alpha}(L(t)^{1-\alpha}N(t)^\alpha) = AZ(t)L^{1-\alpha} \quad (7)$$

where the constant  $A$  collects all the other constants.

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<sup>68</sup>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  $h(x) = (1 + x^2)/2$ .



From this it can be seen that the production function for aggregate output, though postulated as a constant returns to scale function, actually works 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"<sup>69</sup>.

## 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 and Allyn Young, to the recent reconsideration in the context of an endogenous growth model, due in particular 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. However, it appears that this is done in a different perspective from Young's.

In particular, we 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.

1) First of all, we saw that the Romer model is cast into an intertemporal equilibrium setting, while in the passages from Young quoted 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 "inter-related whole", where feedbacks, for instance in the form of "reciprocal

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<sup>69</sup>Barro and Sala-i-Martin (1995), p.38.

demands”, among productive units operating under increasing returns are continuously displacing the tendency towards equilibrium, when this is interpreted in an allocative sense<sup>70</sup>.

In fact, 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 number of intermediate goods, which is finite in every period due to the assumptions 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, though 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<sup>71</sup>. Then, the condition of competitive equilibrium can be established, even if it takes the aspect of a monopolistically competitive equilibrium. As 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."<sup>72</sup> 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 in-

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<sup>70</sup>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.

<sup>71</sup>In particular, the cost function chosen by Romer,  $h(x) = (1 + x^2)/2$ , implies a marginal cost  $h'(x) = x$ .

<sup>72</sup>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."

creasing 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 and Marshall. 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.

Then, the aforementioned tension between perfect competition, in terms of price taking behavior, and increasing returns does not actually appear: in the Romer model there are increasing returns for aggregate production and non-competitive behavior, but increasing returns (and endogenous growth) in the aggregate depends directly on the way intermediate goods are aggregated. The fact that they are produced non-competitively has first of all welfare consequences.

Kaldor (1972, 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.”

”There 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.”<sup>73</sup>

The point is that, with an amount of resources to be allocated, given preferences and technologies, each of two different allocations, for instance taking the form of two different ways of subdividing labor, create new, specific ways to proceed to further subdivisions which, as Smith (1976, Volume 2, p. 271) said, ”might never otherwise been thought

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<sup>73</sup>Kaldor (1975), p.355.

of.” Then, as Kaldor noted, the process of division of labor is history dependent and uncertainty has a role<sup>74</sup>.

2) In the Romer model consumers save and invest in  $Z$ , this permits the increase in the number of intermediate goods (considered in this context as an increase in division of labor) which in turn, due to the way intermediate goods are assembled, 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 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 the supply of intermediate goods, which is permitted by savings, to an increase in  $Y$ , which is income earned by consumers and subsequently consumed or invested. Then, 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; moreover, it is also true that the presence of fixed costs is a sufficient condition for the division of labor to be limited by the extent of the market<sup>75</sup>.

However, from the discussion in Section (2.3), it appeared that the accent was posed by Young mainly on another question: that is on the possibility to adopt more capital-intensive, highly productive methods conditionally 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 be subsequently be generated by the increase in income following the investment<sup>76</sup>.

3) The latter point is also related to the question of the role of fixed costs in Young theory. As noted, Young seemed to be aware of them,

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<sup>74</sup>It seems here that the question is whether the production set is given and, of course, completely known, or not.

<sup>75</sup>On this see also Edwards and Starr (1987).

<sup>76</sup>Kaldor (1972, pp. 1247-1250) discusses the connections between the Young approach and Keynesian theory. It is interesting to note that Kaldor expresses the idea of the necessary presence of a passive monetary system for the Young system to work; this in the light of the reasoning of Young himself, based on exchange of goods against goods.

but played down their role, restricting them to a discussion of secondary order economies, and neither in all cases. Sandilands (2000, p. 315) comments on this: "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."

4) Romer claims that, as reported in Section (3), Young and Marshall talked about specialization in terms of competitive equilibrium with positive external effect. 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 in 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 the appropriate concept of externality for the Young theory is that of *network externality*. Consider the following definitions: "*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."<sup>77</sup>

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. Then, 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 reorga-

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<sup>77</sup>Economides (2000).

nization 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.

## 5 Concluding Remarks and Agenda for Further Research

If the above criticisms to the NGT model of growth and division of labor are correct, it naturally remains the task to provide an alternative model, which should be closest to Smith, Marshall and, especially, Young.

That this still remains an open field for research can be inferred for example by the following comment provided by Heal (1999a, p.xxviii). After presenting the features of Young's growth theory, Heal 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 NGT 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". From an analytical point of view instead, Yang and others (see Yang and Borland, 1991, Yang and Ng, 1993, or Yang, 1999) have proposed a formalization of Smith and Young completely different by the one offered by Romer. The latter model focuses on individual's specialization, in models where the key elements are transaction costs and returns from specialization.

From the discussion, it seems that a model of endogenous growth based on division of labor, developed along the lines suggested above, should feature these minimum elements: productive units operating under increasing returns, which take the form of decreasing cost curves, also subject to downward displacements. This should capture the specialization taking place inside firms, eventually activating a process of division of labor among firms, which in turn should be represented through an increase of the number of productive units; these may or may not establish links with existing firms, then eventually stimulating their production and further division of labor. The model should display path dependency: as Kaldor stressed, once a certain pattern of division of labor is established, new possibilities appear, which would not have appeared

had another pattern be chosen previously. Moreover, due to increasing returns, once a pattern is chosen, the economies that accrue may "lock-in" the system. Finally, it is reasonable to suppose that uncertainty has a role. Endogenous growth in the aggregate, when takes place, should arise as a by-product of the interaction among the productive units.

In the following, we list some recent works that will be considered as references for future work, along with the field of "network economics" mentioned in the end of the last section:

The model presented by Bak et al. (1993) and Scheinkman and Woodford (1994), which constitutes an application to economics of the concept of Self Organized Criticality, borrowed from physics. The model aims at demonstrating that an economy can display persistent fluctuations even when it is hit by constant aggregate demand shocks. What interests here it first of all the way the economy is represented: it is composed on single productive units that have local interactions in terms of demand and supply; production is characterized by strong nonconvexities due to indivisibilities.

The dynamics takes place in the form of chain reactions among the productive units, producing under increasing returns (though given by indivisibilities and not originating from dynamic economies like those generated by specialization), following exogenous increases in demand. This aspect makes the model reminiscent of the discussion of Young (and Kaldor), of the process of growth as generated by reciprocal interactions of supplies and demand among productive units, characterized by increasing returns.

In this sense what can be done is to explicitly study the process of endogenous growth in a this formal context, for instance considering an endogenous evolution of the linkages among productive units as well as their number (in the model mentioned the structure of the interactions is given, while the number of units grows exogenously).

The model of Durlauf (1993), which features local technological spillovers and temporal complementarities among productive units. Here, in every period, the production set for firms is different according to its choices and to those of the firms interacting with it. The fact that production in the past affects current technology captures the intuition that spending time using a technology improves its productivity.

A certain number of industries is given in the model; each industry appears through its representative member firm. The dynamics of the model is developed through the imposition of a probabilistic structure on the firms' choices as to output and technique; they appear as conditional probabilities, conditioned on past choices, on the choices of interacting

firms, and on productivity shocks. Then the choice of technique appears as a transition probability

The model can have multiple equilibria, according to the degree of technological complementarities. It is also presented in a version that accommodates the case of take-off of an economy due to the presence of a leading sector.

However, though containing desirable characteristics, there is not an explicit problem of reciprocal demands and of specialization; in fact the number of industries is fixed and interactions take the form of productivity spillovers and not of diversification of productive activities, which themselves create another type of complementarity.

The book by Agliardi (1998), which reviews the literature on "Positive Feedback Economies", appears as relevant for the present purposes. Consider for example the introduction to the concept of complexity reported (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 to fit nicely the description of the economy provided by Allyn Young, in particular applies to his criticisms of the use of representative firms and industries, whose behaviors is normally "scaled up" to obtain descriptions of the aggregate<sup>78</sup>.

As in Durlauf (1993), the emphasis here is on "network effects" related to the use of technologies, which is the case when the adoption of a technology by many users increases the probability of adoption by others. This sort of situation may generate increasing returns to adoption, whose presence implies that: " 'history matters' in the sense that the equilibrium outcome is history-dependent: the resulting equilibria cannot be understood without knowing the pattern of adoption in earlier periods". We have seen in Section (4) that Kaldor described the process of division of labor as originating a much similar situation.

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<sup>78</sup>An interesting way of avoiding the use of representative firms was proposed by Newman and Wolfe (1961) who, following Marshall, considered the continuously changing structure of firms in an industry (like the 'trees in a forest'), by direct reference of the entire distribution of firms. In this case the dynamics of the entire distribution was studied by a non-homogeneous Markov Chain.



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