

MARX ON DIVISION OF LABOUR AND TECHNICAL PROGRESS.

JEL CLASSIFICATION: B1, B2, B5, O3, O4.

HISTORY OF ECONOMIC THOUGHT, TECHNOLOGICAL CHANGE, ECONOMIC GROWTH

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* I am most grateful to Carlo Panico for his friendly help and advice. Responsibility for the content of the paper is, of course, entirely mine.

The aim of this paper is to reconstruct Marx's analysis of the development of the forces of production --of the dynamics of the social productivity of labour-- in terms of the interaction between the development of division of labour, both 'in manufacture' and 'in society', and technical progress.

Marx's analysis provides the most consistent and developed antecedent of Allyn Young's view of 'increasing returns and economic progress' and, more generally, of the view implied in the principle of cumulative causation as developed by Nicholas Kaldor¹. Both Young and Kaldor acknowledge that their analyses are based on Adam Smith's vision of economic growth centred on the development of division of labour as determinant of efficiency, and, in particular, on his proposition that "the division of labour is limited by the extent of the market". Yet, it is only Kaldor who makes a mere passing mention to Marx; in establishing the principle of cumulative causation as a view of the economic process and of the workings of the market mechanism alternative to that implied by the mainstream equilibrium framework, he refers to the "co-existence of increasing returns and competition--emphasised by Young and also by Marx"².

Kaldor's account of the principle of cumulative causation is to be seen as a hypothesis on the normal path of extended reproduction of the system centred on the interaction between the structural dynamics of the conditions of production and demand. In this view, economic progress is a causal, circular and cumulative process of technical and structural change, which, as it results from forces 'engendered within the economic system', is essentially endogenous. As for the dynamics of the conditions of production --of efficiency-- Kaldor considers the joint effect of Young's increasing returns, learning and technical progress.

Increasing returns constitute the core of Young's view of economic progress. The central proposition of his analysis is the notion that the dynamics of efficiency in manufacturing is determined by the dynamics of division of labour which, in turn, depends on the expansion of markets; in this view, the extension of division of labour leads to an increasing efficiency through two interrelated channels, namely, an increasing use of roundabout methods of production --increasing mechanisation of productive activities-- and a progressive division and specialisation of industries --division of labour among industries. According to Young, the increasing division of labour, by breaking up complex industrial processes into simpler parts, leads to the introduction and progressive use of machines as well as the invention of new types; besides, "in the making and use of machinery there is involved a further division of labour" (Young, 1928, p. 230; 1929, p. 796). Thus, Young establishes a clear interdependence among division of labour and mechanisation (and technical progress). The process involved and the economies derived from it depend on the extent of the market. Yet, it does not entail a big size of individual firms or industries but their increasing differentiation and specialisation. It is in this

¹See Young, 1928 (as reprinted in K. Arrow and T. Scitovsky, (eds), 1969) and 1929, and Kaldor, 1966, 1972, 1978, 1978b, 1979, 1981, 1981b, 1985. For a discussion of the principle of cumulative causation, both in itself and in relation with the analysis of the classical economists, see Ricoy, 1987, 1994, 1998.

²Kaldor, 1972, as reprinted in Kaldor, 1978, p. 195.

sense that mechanisation is intrinsically linked to the progressive subdivision and specialisation of industries --to the progressive social division of labour (Young, 1928, pp. 231, 236, 237-8). This aspect of increasing returns refers essentially to the disintegration, both horizontal and vertical, of existing industries as well as to the creation of new ones, which result in an increasing differentiation and complexity of the industrial structure (Young, 1928, pp. 236-7, 238). On this basis, efficiency, as determined by the interrelated processes of mechanisation and structural change, which, in turn, refer to the expansion of manufacturing as a whole, appears as a dynamic, macroeconomic-structural phenomenon.

In a cumulative causation view, technical progress is conceived as a process of search and experiment, of analysis and resolution of problems along the iterative chain 'R&D-production-demand', which results in the development of technology and in the acquisition of experience, knowledge and mastery; as such, it is, in itself, a learning process³. Moreover, in this view, technical progress is intrinsically linked to accumulation, structural change and the dynamics of demand. As such, it appears as an endogenous, path dependent and cumulative process of a macroeconomic-structural nature; this latter nature follows from the interdependence and complementarity, both sectoral and technological, that characterises the industrial structure.

Marx's view of the development of the forces of production --of the social productivity of labour-- is based on a detailed analysis of the *evolution* of the conditions of production from those characterising the *handicraft system* previous to the emergence of capitalist relations to those characterising *manufacture* proper to the conditions of *modern industry* based on production by means of *machinery*. Yet, Marx's analysis embodies a conception of such a development of much wider significance and validity. At the core of the analysis is the view that the dominant form or tendency underlying the development of the forces of production is the progressive automatisisation or mechanisation of social production, that is, its progressive reduction to forms progressively more automatic or mechanic. This tendency is intrinsic to the objective aim and determining motive of capitalist production, namely, the self-expansion of capital to a progressively extended scale. The fundamental notion here is the progressive rationalisation and improvement of the labour process as a process of production of capital, that is, its progressive adaptation to the specific requirements --to the inner logic-- of capitalist production. It entails freeing the labour process from the restrictions imposed by the limits and imperfections of the human labour force, be they natural or acquired, and its designing and performing according to laws based on scientific and technological criteria; that is, it entails the substitution of the human labour force as the central element of the production process and the progressive development of production on the basis of machinery, which, in itself, allows and requires the systematic application of science in productive activities. In Marx's conception, production on the basis of machinery not only implies an increasing efficiency in the labour

³Kaldor himself does not provide a detailed analysis of technical progress. Yet, the view expressed in the text is implied in his critique of the conventional production function approach --of the growth accounting framework, or more generally, of the 'technological-push' approach-- as well as in the alternative view implied in his 'technical progress function' which he relates directly to 'Verdoorn's law' and which he identifies with that implied in Arrow's learning function. See Ricoy, 1994.

process --creation of relative surplus-value-- but also endows the system with an increasing elasticity in its productive capacity which promotes the inherent tendency of capital to prolong and intensify the working day --creation of absolute surplus-value. Thus, machinery endows the system with an increasing elasticity and potential for expansion, and, therefore, it promotes the self-realisation of capital, i.e., its progressive self-expansion on an extended scale. Once modern industry achieves a degree of development such that machinery is itself produced by means of machinery, and, hence, it "is erected on its own technical basis", social production becomes susceptible of a continuous and progressive process of technical change, and, at the same time, it acquires a capacity for expansion which is only limited by the growth of markets and by the supply of raw materials.

Shaikh (1978), in his discussion of the choice of technique in relation to the law of the falling rate of profit, just states the fundamental tendency towards progressive mechanisation of production arguing that such a tendency is inherent to the inner nature of capitalist production. By his part, Rosenberg (1974, 1976b) discusses that tendency as an essential requirement for the application of science in the productive sphere. In this paper, I complement and extend both these analyses and, at the same time, put forward other elements conforming Marx's conception of the dynamics of efficiency which clearly point to a cumulative causation view of it. In the first section, I provide a detailed discussion of Marx's analysis of the development of the forces of production under capitalist relations in terms of 'cooperation', 'manufacture' and 'machinery and modern industry'. The main aim of the section is to present Marx's conception of such a development as evolutionary process centred on the interaction between division of labour, mechanisation and technical progress. In this view, the form (organisation) of the process of production --the method of production or 'technique'-- depends on the nature of 'capital', of the means of production used; accordingly, the changes in the method of production that may occur are mostly the result of technical progress, and, as such, belong to the dynamics of the system. This view is a clear antecedent of that put forward by Kaldor in his critique of the neoclassical production function which is summarised in his dictum that "one cannot distinguish movements along a production function from shifts in that function". In the second section, I present Marx's conception of technical progress as an evolutionary process of accretion of knowledge with respect to, and of cumulative improvement of, the various elements --material, human, organisational-- conforming productive activities, and which evolves through the interaction between the development of science and the learning process which results from experience in production. In the third section, I discuss the interrelation envisaged by Marx among division of labour in given industries, technical change and social division of labour, the role of the extent of the market, and the resulting view of efficiency as a macroeconomic-structural phenomenon. In the final section, I discuss the interdependence between the development of the conditions of production, the process of accumulation and the expansion of markets. In this regard, the key role of competition must be considered; in effect, when Marx's analysis of the dynamics of the system on the basis of the interaction between accumulation of capital and the development of the forces of production is seen from the perspective of individual capitals, competition appears

as a fundamental driving force in such dynamics. Paraphrasing Kaldor's view of the workings of the market, it can be said that competition is a social mechanism whose main function is to "transmit impulses to economic change, and thereby, *create* more resources through enlarging the scope for specialisation and the division of labour [and technical progress]" (Kaldor, 1978, p. xxv).

1. Development of the Conditions of Production. Cooperation, Manufacture and Machinery System. Division of Labour, Mechanisation and Technical Progress.

In Marx's conception, the development of the conditions of production appears essentially as evolutionary in the sense that the new develops gradually out of what already exists. In his view, when capitalist relations initially emerge, neither 'the general character of the labour process' nor 'the particular methods employed' are altered in any significant way (Marx, 1867, p. 184). The only difference in the conditions of production rests on the concentration and cooperation of a large number of workers under the control of individual capitalists and on the increase in the scale of production that such concentration implies. As Marx puts it, "the workshop of the medieval master handicraftsman is simply enlarged. At first, ... the difference is only quantitative" (Marx, 1867, p. 322). Indeed, this entails a greater outlay of capital, both variable and constant, and, hence, a greater accumulation by any individual capitalist (Marx, 1867, p. 330).

Thus, in Marx's view, capitalist production does not lead initially to any technological change; the technical conditions of the labour process are the same as those characterising handicraft production. The only fundamental change in the conditions of the labour process refer to the social relations prevailing in it --development of the basic 'wage labour-capital' relationship (see Marx, 1867, pp. 330-3). Yet, the concentration and cooperation of workers bring about an increase in the intensity and efficiency of production; in this sense, the labour process is characterised by the presence of increasing returns. According to Marx, this can occur because the 'combined working-day'

".. heightens the mechanical force of labour, or extends its sphere of action over a greater space, or contracts the field of production relatively to the scale of production, or at the critical moment sets large masses of labour to work, or excites emulation between individuals and raises their animal spirits, or impresses on the similar operations carried on by a number of men the stamp of continuity and many-sidedness, or performs simultaneously different operations, or economises the means of production by use in common, or lends the individual labour the character of social labour .."⁴ (Marx, 1867, p. 329)

The first fundamental changes in the technical conditions and in the organisation of the labour process resulting from capitalist production take place with the development of 'manufacture' or 'cooperation based on division of labour'. As a form of (social) production⁵, 'manufacture'

⁴As for the 'economies in the use of the means of production', see Marx, 1867, pp. 324-5.

⁵In Marx's view, however, manufacture "never grows into a complete technical system on its own foundations". (Marx, 1867, pp. 347-8). See below.

evolves from the "decomposition of handicraft production". In this regard, Marx distinguishes two different processes. On the one hand, 'manufacture' arises from the concentration in one workshop under the control of a single capitalist of labourers working in various independent handicrafts producing different commodities with different uses which, at the same time, are parts used in the production of a given commodity⁶; as Marx argues, "very soon an important change takes place"; the independent handicrafts "become stripped of their independence" and get transformed into specialised, "supplementary partial processes" in the production of the given commodity (Marx, 1867, pp. 336, 338). On the other hand, 'manufacture' arises from the "most elementary form of cooperation", that is, from the concentration in a single workshop of workers belonging to independent handicrafts producing one and the same commodity; again, as Marx argues, those handicrafts get split "into is various detail operations" which are "assigned to a different artificer, and the whole of them together are performed simultaneously by the co-operating workmen. This accidental repartition gets repeated, develops advantages of its own, and gradually ossifies into a systematic division of labour" (Marx, 1867, pp. 337, 338).

Thus, as regards the technical conditions of production, 'manufacture' is characterised by the introduction and further development of division of labour (Marx, p. 338); it entails the decomposition --the simplification, specialisation and subdivision--of handicraft production into its various detail processes and the allocation of different workers to each of them; as such, it is characterised by the formation and development of the "specialised detail labourer" and by its articulation in a single working mechanism, the "collective labourer" which "is the machinery specially characteristic of the manufacturing period" (Marx, pp. 348-9). Moreover, given the sequential nature of production, carrying out the labour process involves the need to coordinate its constituent detail processes in such a way that each of them results in specific levels of production in given times. In this sense, 'manufacture' is characterised by a greater (and increasing) 'continuity, regularity and intensity' of the process of production; in Marx's words,

"The labour-time necessary in each partial process, for attaining the desired effect, is *learnt by experience*; and the mechanism of manufacture as a whole is based on the assumption that a given result will be obtained in a given time. It is only on this assumption that the various supplementary labour-processes can proceed uninterruptedly, simultaneously, and side by side. It is clear that this direct dependence of the operations, and therefore of the labourers, on each other, compels each one of them to spend on his work no more than the necessary time, and thus a *continuity, uniformity, regularity, order, and even intensity of labour*, of quite a different kind, is begotten than is to be found in an independent handicraft or even in simple co-operation." (Marx, 1867, p. 345; emphasis added)

As such, this form of production requires the establishment of determined and fixed quantitative relations (proportions) among the different partial processes. Thus, to the qualitative division of labour in the process of production it corresponds a specific quantitative division among its

⁶See Marx example of carriage-making, Marx, 1867, pp. 336-7.

different parts; in this sense, 'manufacture' is characterised by the introduction and development of 'technical laws of necessity' which regulate the execution of the labour process.

"The division of labour, as carried out in Manufacture, not only *simplifies* and *multiplies* the qualitatively different parts of the social collective labour, but also creates a *fixed mathematical relation* or ratio which *regulates the quantitative extent* of those parts --i.e., the relative number of labourers, or the relative size of each group of labourers, for each detail operation. It develops, along with the qualitative subdivision of the social labour-process, a *quantitative rule and proportionality* for that process." (Marx, 1867, p. 346; emphasis added)

In addition, the development of division of labour leads to changes in the instruments of labour which result from the difficulties experienced in production with their unchanged form; in particular, the simplification, specialisation, differentiation and improvement of the instruments of labour are consequence of their necessary adaptation to the simplified and specialised detail processes resulting from division of labour.

".. so soon as the different operations of a labour-process are disconnected the one from the other, and each fractional operation acquires in the hands of the detail labourer a suitable and peculiar form, *alterations become necessary in the implements* that previously served more than one purpose. The *direction* taken by this change is determined by the *difficulties experienced in consequence of the unchanged form of the implement*. Manufacture is characterised by the *differentiation* of the instruments of labour --a differentiation whereby implements of a given sort acquire fixed shapes, adapted to each particular application, and by the *specialisation* of those instruments, giving to each special implement its full play only in the hands of a specific detail labourer. ... The manufacturing period *simplifies, improves, and multiplies the implements of labour, by adapting them to the exclusively special function of each detail labourer*. It thus *creates* at the same time one of the *material conditions for the existence of machinery*" (Marx, 1867, p. 341-2; emphasis added)

Thus, in Marx's view, division of labour allows, conditions and induces mechanisation and technical progress⁷. But, division of labour, in turn, also depends on technical progress. According to Marx, the 'most adequate form' of the division of the process of production into its constituent specialised detail processes --hence, the specific quantitative proportions among them-- is determined at first by experience in productive activity; in other words, the 'technical law' regulating the labour process --the adaptation of division of labour to the requirements of the single productive mechanism as a whole-- is established at first experimentally. Once the organisation of production so established consolidates itself, any additional variation results directly from modifications in the instruments of labour.

" .. the division of labour peculiar to manufacture .. *acquires the best adapted form at first by experience* .. and then strives to hold fast that form when once found, and here and

⁷See below.

there succeeds in keeping it for centuries. Any *alteration* in this form, except in trivial matters, is solely *owing to a revolution in the instruments of labour.*" (Marx, 1867, p. 363-4; emphasis added)

The relation between division of labour, mechanisation and technical progress envisaged by Marx is one of the core elements of both Young's notion of increasing returns and of Kaldor's view of the dynamics of efficiency. Along with this relation, from the previous arguments, two more elements belonging to the core of Marx's conception of the development of the conditions of production can be singled out. First, the view of technical progress as a process of analysis and resolution of problems in the sphere of production --as a learning process⁸. Again, this is the view implied in Kaldor's account of the principle of cumulative causation. Second, the interrelation established between division of labour and technical progress implies that the form (organisation) of the process of production --the method or technique of production-- depends on the nature of 'capital', of the means of production used. This latter view reappears in Marx's analysis of the 'economy in the employment of constant capital', where, in addition, the method of production is seen to depend on the level of activity and on accumulation of capital⁹; besides, in this analysis, 'capital' and labour as elements ('factors') of production are seen as essentially complementary¹⁰. In this view, the changes in the form, method or technique of production that may occur are mostly the result of technical progress; as such, those changes belong to the dynamics of the system. This view is precisely that advanced by Kaldor in his critique of the neoclassical production function, which is summarised in his dictum that 'one cannot distinguish movements along a production function from shifts in that function'¹¹.

In sum, in Marx's conception, 'manufacture' based on division of labour constitutes a first step in the process of rationalisation and improvement of (social) production as a process of production of capital. As Marx argues,

"By decomposition of handicrafts, by specialisation of the instruments of labour, by the formation of detail labourers, and by grouping and combining the latter into a single mechanism, division of labour in manufacture creates a *qualitative gradation, and a quantitative proportion in the social process of production*; it consequently creates a definite organisation of the labour of society, and thereby *develops at the same time new productive forces in the society*. In its specific capitalist form --and under the given conditions, it could take no other form than a capitalistic one-- manufacture is but a *particular method of begetting relative surplus-value, or of augmenting at the expense of the labourer the self-expansion of capital* --usually called social wealth, "Wealth of Nations", & c." (Marx, 1867, p. 364; emphasis added)

⁸On this, see next section.

⁹This dependence is explicitly established in the analysis of both 'simple cooperation' and 'manufacture and division of labour'; see Marx, 1867, pp. 330, 346, 348, 353, 359-60.

¹⁰See Marx, 1894, Ch. 5. In this regard, it should be noted that Kaldor refers to the essential complementarity both between activities and between 'factors of production', arguing that neoclassical theory ignores them while "elevates the 'principle of substitution' ... to the 'be-all' and 'end-all' of all economic activity"; by contrast, he recognises, classical economists were well aware of these complementarities. See Kaldor, 1979, p. 278.

¹¹See, for instance, Kaldor, 1978a, pp. ix-x, 35-36. For a discussion of Kaldor's views, see Ricoy, 1994.

Yet, from the perspective of the development of capitalist production, 'manufacture' still entails a fundamental restriction. For, an essential characteristic remains: the human labour force continues to be the central element in social production. As Marx argues, "whatever may have been the particular starting-point, its final form is invariably the same --*a productive mechanism whose parts are human beings*" (Marx, 1867, p. 338). Thus, social production continues to be dependent on the characteristics, capacities and skills, be they natural or acquired, of the human being. In fact, 'manufacture' still has its fundamental basis in the handicraft system; in Marx's words,

"For a proper understanding of the division of labour in manufacture, it is essential that the following points be firmly grasped. First, the decomposition of a process of production into its various successive steps coincides, here, strictly with the resolution of a handicraft into its successive manual operations. Whether complex or simple, each operation has to be done by hand, retains the character of a handicraft, and is therefore *dependent on the strength, skill, quickness, and sureness, of the individual workman in handling the tools. The handicraft continues to be the basis. This narrow technical basis excludes a really scientific analysis* of any definite process of industrial production, since it is still a condition that each detail process gone through by the product must be capable of being done by hand and of forming, in its way, a separate handicraft. It is just because handicraft skill continues, in this way, to be the foundation of the process of production, that each workman becomes exclusively assigned to a partial function, and that for the rest of his life, his labour power is turned into the organ of this detail function." (Marx, 1867, pp. 338-339, emphasis added).

Due to 'its narrow technical basis', manufacture is very limited in its potential of expansion; as a consequence of the limits imposed by the imperfections of the human labour force as central element of (social) production, manufacture "never grows into a complete technical system of its own foundations" (Marx, 1867, pp. 347-8) and, hence, into a 'system susceptible of a continuous improvement in its constituent aspects'. As Marx argues,

"... manufacture was unable, either to seize upon the production of society to its full extent, or to revolutionise that production to its very core. It towered up as an economic work of art, on the broad foundation of the town handicraft, and of the rural domestic industries. At a given stage in its development, the *narrow technical basis* on which manufacture rested *came into conflict with requirements of production that were created by manufacturing itself.*" (Marx, 1867, p. 368; emphasis added)

The full development of the labour process as a process of production of capital --the adaptation of (social) production to inner logic of capital-- depends on the progressive substitution of the human labour force by machinery and on the continuous development of production towards more and more mechanised levels. In this view, the crucial step in the process of rationalisation of social production is taken with the introduction and progressive development of a system based on the use of machinery --with the emergence and progressive development of the 'factory system' or 'modern industry'.

Yet, in Marx's view, 'manufacture' is, at the same time, the fundamental basis on which the system centred on the use of machinery is erected. As he establishes at the end of his analysis of 'manufacture', right after his argument on manufacture's 'narrow technical basis',

"One of [manufacture's] most finished creations was the workshop for the production of the instruments of labour themselves, including especially the complicated mechanical apparatus then already employed. A machine factory, says Ure, "displayed the division of labour in manifold gradations --the file, the drill, the lathe, having each its different workman in the order of skill". *This workshop, the product of the division of labour in manufacture, produced in its turn-machines. It is they that sweep away the handicraftsman's work as the regulating principle of social production.* Thus, on the one hand, the technical reason for the life-long annexation of the workman to a detail function is removed. On the other hand, the fetters that this same principle laid on the domination of capital, fall away." (Marx, 1867, p. 368; emphasis added)

Previously, in the context of the same analysis, Marx refers explicitly to the fundamental role that in the development of the machinery system was played by the exceptional use of some simple machines in the manufacturing period as well as in earlier periods; in his own words,

"Early in the manufacturing period, the principle of lessening the necessary labour-time in the production of commodities was accepted and formulated: and the use of machinery, especially for certain simple first processes that have to be conducted on a very large scale, and with the application of great force, sprang up here and there. Thus, at an early period in paper manufacture, the tearing up of the rags was made by the paper-mills; and in the metal works, the pounding of the ores was effected by the stamping mills. The Roman Empire had handed down the elementary of all machinery in the water-wheel. The handicraft period bequeathed to us the great inventions of the compass, of gunpowder, of type-printing, and of the automatic clock. But, on the whole, machinery played that subordinate part which Adam Smith assigns to it in comparison with division of labour. The sporadic use of machinery in the 17th century was of the greatest importance, because it supplied the great mathematicians of that time with a practical basis and stimulant to the creation of the science of mechanics."¹² (Marx, 1867, p. 348).

As already pointed out, the manufacturing period, as a consequence of division of labour, i.e., of the decomposition of production in constituent specialised detail processes that it implies, results in the simplification, specialisation, differentiation and improvement of the instruments of labour; and, as Marx argues, "*it thus creates the material conditions for the existence of machinery*" (Marx, 1867, pp. 341-2). In this regard, Marx refers to machines and to their development as follows

"The machine is a unification of the instruments of labour 'When, by the division of labour, each particular operation has been simplified to the use of a single instrument, the linking-up of all these instruments, set in motion by a single engine, constitutes --a machine.' (Babbage, *Traité sur l'Economie des Machines*, etc., Paris 1833). Simple tools, accumulation of tools; composite tools; setting in motion of a composite tool by a single

¹² Notice that here it is implied Marx's view of the development of science or of technology as partly dependent on the problems found in production. See next section.

hand engine, by men; setting in motion of these instruments by natural forces; machines; system of machines having one motor; system of machines having one automatic motor – this is the progress of machinery."¹³

Again, division of labour in manufacture allows, conditions and leads to the introduction and further development of production on the basis of machinery --progressive mechanisation of social production. The two-sided nature of manufacture as a restriction in the development of capitalist production and as fundamental basis of such a development is evident in Marx's analysis in the chapter on "machinery and modern industry". In the first section of the chapter, Marx discusses at length 'the development of machinery' along the lines sketched in the previous quote. As regards the process production of a particular commodity, Marx sees the development of the 'factory system' as an evolutionary process from "simple cooperation of machines of the same type", where "the product is entirely made by a single machine performing all the various operations previously done by one handicraftsman with his tool", to a "complex system of machinery" characterised by "cooperation based on the division of labour among different machines", where the process of production is conformed by a series of specialised and successive detail processes being performed by a given machine; as Marx argues in this regard,

"A real machinery system .. does not take the place of these independent machines, until the subject of labour goes through a connected series of detail processes, that are carried out by a chain of machines of various kinds, the one supplementing the other. *Here we have again the co-operation by division of labour that characterises Manufacture; only now, it is a combination of detail machines.* The special tools of the various detail workman ... are now *transformed* into the tools of specialised machines each constituting a special organ, with a special function, in the system". (Marx, 1867, p. 379; emphasis added).

Again, 'manufacture', as it entails the development of division of labour, appears as the starting point of the factory system based on the use of machinery. As in 'manufacture', carrying out the process of production by means of machines implies the need to coordinate the specialised detail processes conforming it; in fact, due to the sequential character of these processes, it requires the establishment of determined and fixed quantitative relations (proportions) among them, and, hence, among the different machines performing each of them.

"In those branches of industry in which the machinery system is first introduced, *Manufacture itself furnishes, in a general way, the natural basis for the division, and consequent organisation, of the process of production.* [...] Each detail machine supplies raw material to the machine next in order; and since they are all working at the same time, the product is always going through the various stages of its fabrication, and is also constantly in a state of transition, from one phase to another. Just as in Manufacture, the direct co-operation of the detail labourers establishes a *numerical proportion between the special groups*, so in an organised system of machinery, where one detail machine is constantly kept employed by another, a *fixed relation* is established *between their numbers, their size, and their speed*". (Marx, 1867, pp. 379, 380; emphasis added).

¹³ Quoted in Rosenberg, 1974, p. 720, footnote 14.

Yet, while in 'manufacture', the continuity of the process of production is merely the result of division of labour, in 'modern industry' it is a technical imperative intrinsic to the own nature of the machine. Thus, in so far as the continuity of production determines its effectiveness and its perfection, it follows that its efficiency depends on the level of automatisisation and, hence, on the degree in which it is freed from the intervention of the labour force.

"The collective machine, now an organised system of various kinds of single machines, or groups of single machines, *becomes more and more perfect, the more the process as whole becomes a continuous one*, i.e., the less the raw material is interrupted in its passage from the first phase to its last; in other words, the more its passage from one phase to another is effected, *not by the hand of man, but by the machinery itself*. In Manufacture isolation of each detail process is a condition imposed by the nature of division of labour, but in the fully developed factory the continuity of those processes is .. imperative." (Marx, 1867, pp. 380-1; emphasis added).

Thus, the fundamental difference between 'manufacture' and 'modern industry' rests on the subjective or objective nature of their respective basis. In manufacture, the nature of production is subjective as its organisation is based on, and, hence, its performance is limited by, the necessary allocation of the different specialised detail labourers; this subjective nature of manufacture is intrinsically defined by its dependence on the intervention of man as the central, regulating element of the labour process. By contrast, in 'modern industry', the organisation of production is strictly objective; once machinery substitutes the human labour force as the regulating element of the process of production, the logic of the latter --the necessary technical laws which define both the different detail processes and their articulation in a single productive mechanism-- becomes independent of the subjective foundations involved by its designing and performing on the basis of the human labour force; in this way, the process of production gets freed from its dependence on the characteristics --capacities and skills-- of the human being as its central element. In sum, in 'modern industry', carrying out the process of production on the basis of machinery allows and, at the same time, requires its analysis and design according to objective rules based on scientific and technological criteria.

".. an essential difference at once manifests itself. In Manufacture it is the workmen who, with their manual implements, must, either singly or in groups, carry on each particular detail process. *If .. the workman becomes adapted to the process the process was previously made suitable to the workman. This subjective principle of the division of labour no longer exists in production by machinery*. Here, the process as a whole is *examined objectively*, in itself, that is to say, without regard to the question of its execution by human hands, it is analysed into its constituent phases; and the problem, *how to execute each detail process, and bind them all into a whole, is solved by the aid of machines, chemistry &c*. But, of course, in this case also, *theory must be perfected by accumulated experience on a large scale*."¹⁴ (Marx, 1867, pp. 379-80; emphasis added).

¹⁴Notice that in this conception of Marx the relation between science and production is one of interdependence. Notice also that this implies a view of technical progress as a process of *analysis and resolution of problems*, i.e., as a *learning process*. See below.

As Marx argues later on,

"The implements of labour in the form of machinery necessitate the *substitution of natural forces for human force*, and the *conscious application of science*, instead of the rule of thumb. In Manufacture the organisation of the social labour-process is purely subjective, it is a combination of detail labourers; in its machinery system, Modern Industry has a *productive organism that is purely objective*, in which the labourer becomes a mere appendage to an already existing material condition of production. In simple co-operation, and even in that founded on division of labour, the suppression of the isolated, by the collective, workman still appears to be more or less accidental. Machinery ... *operates only by means of associated labour, or labour in common*. Hence the *co-operative character* of the labour-process is, in the latter case, a *technical necessity dictated by the instrument of labour itself*." (Marx, 1867, pp. 386; emphasis added).

On this view, production on the basis of machinery involves a tendency towards the equality and uniformity of the different labours, which, in turn, implies a greater degree of substitution among them. Hence, production by means of machinery endows the system with a higher (and increasing) degree of continuity and flexibility; in Marx's words,

"Along with the tool, the skill of the workman in handling it passes over to the machine. The capabilities of the tool are emancipated from the restraints that are inseparable from human-labour power. Thereby the technical foundation on which is based the division of labour in Manufacture, is swept away. Hence, in the place of the hierarchy of the specialised workmen that characterises manufacture, there steps, in the automatic factory, a tendency to equalise and reduce to one and the same level every kind of work that has to be done by the minders of the machines. [...] When the machinery, as a whole, forms a system of manifold machines, working simultaneously and in concert, the cooperation based upon it, requires the distribution of various groups of workmen among the different kinds of machines. But the employment of machinery does away with the necessity of crystallising this distribution after the manner of Manufacture, by the constant annexation of a particular man to a particular function. Since the motion of the whole system does not proceed from the workmen, but from the machinery, a change of persons can take place at any time without an interruption of the work. The most striking proof of this is afforded by the *relays system* Lastly, the quickness with which machine work is learnt by young people, does away with the necessity of bringing up for exclusive employment by machinery a special class of operatives." (Marx, 1867, pp. 420, 421; emphasis in the original)

In sum, according to Marx,

"machinery squeezes itself into the manufacturing industries first for one detail process, then for another. Thus, the *solid crystal of their organisation, based on the old division of labour, becomes dissolved, and makes way for constant changes*". (Marx, 1867, p. 461; emphasis added).

In this view, production on the basis of machinery not only implies an *increasing continuity and efficiency* (productivity) in the labour process --production of relative surplus-value-- but also endows the system with a higher (and increasing) *elasticity of productive capacity* and, hence, with a higher (an increasing) *flexibility* in its utilisation; in this sense, it promotes the inherent

tendency of capital to prolong and intensify the working day --production of absolute surplus-value (see, Marx, 1867, pp. 371, 403, 404-5, 409, 410, 412). Thus, machinery endows the system with an increasing elasticity and potential for expansion, and, therefore, it promotes the own realisation of capital --its progressive self-expansion on an extended scale.

Yet, from the perspective of the economy as a whole --of social production as a process of production of capital--, the system is still restricted in so far as its characteristic instrument, the machine, continues to be produced by 'manufacture'. In this view, the full development and improvement of 'modern industry' requires that '*machinery be itself produced by means of machinery*'.

In effect, at first, machinery, which is progressively used in the production of the different commodities, is produced by means of the specialised and skilled labour characteristic of the manufacturing period; as Marx argues graphically,

"There were mules and steam-engines before there were any labourers, whose exclusive occupation it was to make mules and steam-engines; just as men wore clothes before there were such people as tailors. The inventions of Vaucanson, Arkwright, Watt, and others, were, however, practicable only because those inventors found, ready to hand, a considerable number of *skilled mechanical workmen, placed at their disposal by the manufacturing period.*" (Marx, 1867, p. 382; emphasis added).

Manufacture appears here again as the "immediate technical foundation of Modern Industry"; as Marx argues, "in the natural course of things, the factory system was raised on inadequate foundations" (Marx, 1867, p. 382). In effect, in spite of the increasing use of machinery in production, the internal dynamics of the system is still restricted in so far as the production of machinery itself is carried out on the subjective basis characteristic of manufacture; in other words, the dynamism of the factory system, its potential for expansion, is still limited in so far as the production of its characteristic instrument, and, hence, the social process of production, continues to be dependent on the capacities and skills of the labour force and, in particular, of those of a handicraft type; in Marx's words,

"Modern Industry was crippled in its complete development, so long as its characteristic instrument of production, the machine, owed its existence to personal strength and personal skill, and depended on the muscular development, the keenness of sight, and the cunning of hand, with which the detail workmen in manufactures, and the manual labourers in handicrafts, wielded their dwarfish instruments. Thus, apart from the dearness of the machines made in this way, a circumstance that is ever present to the mind of the capitalist, *the expansion of industries carried on by means of machinery, and the invasion by machinery of fresh branches of production, were dependent on the growth of a class of the workmen, who, owing to the almost artistic nature of their employment, could increase their numbers only gradually ...*" (Marx, 1867, p. 382-3; emphasis added).

Moreover, given the ever increasing need to solve the problems experienced with the use of machinery and the ensuing need to adapt it to the specific requirements of the different

processes of production through the continuous improvement of its constituent parts, the factory system appears limited in its possibilities of development and expansion as a consequence of the restricted technological basis on which manufacture rests; as Marx argues, "at a certain stage of its development",

"..... Modern Industry *became technologically incompatible with the basis furnished for it by handicraft and Manufacture*. The increasing size of the prime movers, of the transmitting mechanism, and of the machines proper, the greater complication, multiformity and regularity of the details of these machines, as *they more and more departed from the model of those originally made by manual labour*, and acquired a form, untrammelled except by the conditions under which they worked, the perfecting of the automatic system, and the use, every day more unavoidable, of a more refractory material, such as a iron instead of wood--*the solution to all these problems, which sprang up by the force of circumstances*, everywhere met with a stumbling-block in the *personal restrictions, which even the collective labour of Manufacture could not break through, except to a limited extent*. Such machines as the modern hydraulic press, the modern power-loom, and the modern carding engine, could never have been furnished by Manufacture."¹⁵ (Marx, 1867, p. 383; emphasis added).

Thus, given the requirements derived of its own internal development and the ever increasing use of machinery involved, the factory system

"had to root up this ready-made foundation, which in the meantime had been elaborated on the old lines, and to build up for itself a *basis that should correspond to its methods of production*. [...] Modern Industry had therefore itself to take in hand the machine, its characteristic instrument of production, and to construct machines by machines. It was not till it did this that it built up for itself a *fitting technical foundation and stood on its own feet*. Machinery, *simultaneously with the increasing use of it ... appropriated, by degrees, the fabrication of machines proper*.'" (Marx, 1867, pp. 382, 384; emphasis added).

In Marx's view, it is only once that 'modern industry' achieves a degree of development such that its characteristic instrument of production, machinery, is itself produced by means of machinery, and, hence, it "is erected on its own technical basis", that social production becomes susceptible of continuous improvement in its technical conditions and in its constituent parts, i.e., becomes susceptible of a *continuous and progressive process of technical change*' (see Marx, 1867, p. 381, 461) while, at the same time, it acquires a capacity for expansion which is only *limited by the growth of markets and by the supply of raw materials*.

"So soon ... as the factory system has gained a certain breadth of footing and a definite degree of maturity and specially so soon as its technical basis, machinery, is itself produced by machinery so soon, in short, as the general conditions requisite for production by the modern industrial system have been established, this mode of production acquires an *elasticity, a capacity for sudden extension by leaps and bounds* that finds no hindrance except in the *supply of raw material and in the disposal of the produce*." (Marx, 1867, pp. 450-51, emphasis added).

¹⁵Notice again the view of technical progress as a process of *analysis and resolution of problems* in the sphere of production and as an *evolutionary process of improvement* of the different aspects of production.

2. Technical Progress.

In Marx's conception, technical progress is specific and characteristic of 'modern industry' as a form of social production based in the use of machinery. As we have just seen, it is only with the introduction and development of machinery as regulating element of production, and, in particular, once machinery itself is produced by means of machinery, that social production becomes susceptible of continuous improvement in its technical conditions and in its constituent parts. In this regard, *science* becomes an active and determining element in production; as Marx argues, "modern industry ... makes science a productive force distinct from labour and presses it into the service of capital" (Marx, 1867, p. 361). Similarly, in his analysis of the 'conversion of surplus-value into capital', Marx establishes that science is a fundamental driving force in the dynamics of efficiency and, hence, in the self-expansion of capital; in this context, he refers explicitly to the continuous development and improvement of the different elements of constant capital as well as to the new applications that such a development entails.

"If the productiveness of labour has, during the using up of these instruments of labour, increased (and *it develops continually with uninterrupted advance of science and technology*), more efficient and (considering their increased efficiency), cheaper machines ... replace the old. The old capital is reproduced in a more productive form, apart from the *constant detail improvements* in the instruments of labour already in use. ... Every advance in Chemistry ... multiplies the number of useful materials and the useful applications of those already known, those *extending* with the growth of capital *its sphere of investment*. ... *science and technology give capital a power of expansion independent of the given magnitude of the capital actually functioning.*" (Marx, 1867, p. 605; emphasis added)

As already seen, the introduction and development of machinery as the regulating element of production allows and, at the same time, requires, its analysis, organisation and execution on the basis of scientific and technological criteria; in short, the 'factory system' allows and requires the "conscious application of science" in productive activities.

"Along with the development of the factory system ... production in all .. branches of industry not only extends, but alters its character. The principle, carried out in the factory system, of *analysing the process of production into its constituent phases*, and of *solving the problems thus proposed* by the *applications of mechanics, of chemistry, and of the whole range of the natural sciences*, becomes the determining principle everywhere. Hence, machinery squeezes itself into the manufacturing industries first for one detail process, then for another. Thus the solid crystal of their organisation, based on the old division of labour, *becomes dissolved, and makes way for constant changes.*" (Marx, 1867, p. 461; emphasis added)

Again, in contrast with the subjective principle regulating division of labour in 'manufacture', in 'modern industry', the organisation of production is strictly objective; as Marx argues,

"Here, the process as a whole is examined objectively, in itself, that is to say, without regard to the question of its execution by human hands, it is analysed into its constituent phases; and the problem how to execute each detail process, and bind them all into a whole, is

solved by the aid of machines, chemistry &c. But, of course, in this case also, theory must be perfected by accumulated experience on a large scale." (Marx, 1867, p. 380)

According to Marx, freeing social production from the subjectivity inherent to division of labour in 'manufacture' and the ensuing need of analysing the different processes of production into its constituent phases give rise to the development of 'technology' as a specific field of enquiry.

".. even down into the eighteenth century, the different trades were called "mysteries" (mystères); into their secrets none but those duly initiated could penetrate. Modern Industry rent the veil that concealed from men their own social process of production, and that turned the various, spontaneously divided branches of production into so many riddles, not only to outsiders, but even to the initiated. The principle which it pursued, of *resolving each process into its constituent movements*, without any regard to their possible execution by the hand of man, *created the modern science of technology*. The varied, apparently unconnected, and petrified forms of the industrial processes now resolved themselves into so many *conscious and systematic applications of natural science to the attainment of given useful effects*. Technology also discovered the few main fundamental forms of motion, which, despite of the diversity of the instruments used, are necessarily taken by every productive action of the human body; just as the science of mechanics sees in the most complicated machinery nothing but the continual repetition of the simple mechanical powers." (Marx, 1867, p. 486; emphasis added)

These arguments of Marx contain what can be considered the core of his conception of technical progress. In this regard, two main elements can be singled out: first, the interaction between the development of science and the own dynamics of production; second, the view of technical progress as a process of analysis and resolution of problems in productive activities and the implied notion of learning through experience. Thus, in this view, technical progress appears as a continuous process of analysis and resolution of problems in the sphere of production which takes place on the basis of the interaction between science and the accumulated knowledge resulting from experience in the execution of production and from the analysis and resolution of problems itself; it is precisely in this latter sense that it can be argued that, in Marx's view, technical progress constitutes a path-dependent process. On the other hand, as a result of such a process, technical progress is, at the same time, an evolutionary process of modification and improvement of the process of production taken as whole as well as of its individual constituent aspects or conditions. As stated in the introduction of the paper, this view constitutes a clear antecedent of that implied in the principle of circular and cumulative causation as developed by Kaldor. On the other hand, as I have argued elsewhere, this view is also a clear antecedent of those advanced among others by Rosenberg (1976, 1982), Sahal (1981), Nelson and Winter (1977, 1982), and Dosi (1984, 1984b, 1988)¹⁶.

As already seen, in Marx's conception, 'manufacture', as it makes possible and induces the emergence of 'modern industry', plays an essential role in the development of capitalist production. This role is again made evident in his analysis of the development of machinery,

¹⁶On this, see Ricoy (1994).

where Marx refers explicitly to the *evolution* of particular machines or techniques from their first models which, in their basic design and characteristics, derived from the instruments and techniques of the manufacturing period; and, in this regard, he argues that this process requires both the development of science and the accumulation of practical experience.

"The power-loom was at first made chiefly of wood; in its improved form it is made of iron. *To what an extent the old forms of the instruments of production influenced their new forms at first starting* is shown by amongst other things, the most superficial comparison of the present power-loom with the old one, of the modern blowing apparatus of a blast-furnace with the first inefficient mechanical reproduction of the ordinary bellows, and perhaps more strikingly than in any other way, by the attempts before the invention of the present locomotive, to construct a locomotive that actually had two feet, which after the fashion of a horse, it raised alternately from the ground. It is only after *considerable development of the science of mechanics, and accumulated practical experience*, that the form of a machine becomes settled entirely in accordance with mechanical principles, and *emancipated from the traditional form of the tool that gave rise to it.*"¹⁷ (Marx, 1867, p. 383, footnote; emphasis added)

Marx puts forward the same argument with reference to the motive power or to its generating mechanism; again, the evolutionary nature of the development of machinery and, hence, of the process of technical change is made evident; moreover, here, Marx establishes explicitly his fundamental view of 'manufacture' as the basis of the scientific and technological development characteristic of 'modern industry'; in his own words,

"Of all great motors handed down from the manufacturing period, horse-power is the worst, partly because a horse has a head of his own, partly because he is costly, and the extent to which he is applicable in factories is very restricted. Nevertheless, the horse was extensively used in the infancy of the Modern Industry. ... Wind was to inconstant and uncontrollable, and besides, in England, the birthplace of Modern Industry, the use of water-power preponderated even during the manufacturing period. In the 17th century attempts had already been made to turn two pairs of millstones with a single water-wheel. But the increased size of the gearing was too much for water-power, which had now become insufficient, and *this was one of the circumstances that led to a more accurate investigation of the laws of friction.* In the same way the irregularity caused by the motive power in mills that were put in motion by pushing and pulling a lever, *led to the theory, and the application, of the fly-wheel, which afterwards plays so important a role in Modern Industry. In this way, during the manufacturing period, were developed the first scientific and technical elements of Modern Mechanical Industry.*" (Marx, 1867, p. 376-7; emphasis added)

¹⁷In the same line, Marx, later on, writes: "If we now fix our attention on that portion of the machinery employed in the construction of machines, which constitutes the operating tool, we find the manual implements re-appearing, but on a cyclopean scale. The operating part of the boring machine is an immense drill driven by a steam-engine; without this machine, on the other hand, the cylinders of large steam-engines and of hydraulic presses could not be made. The mechanical lathe is only a cyclopean reproduction of the ordinary foot-lathe; the planning machine, an iron carpenter, that works on iron with the same tools that the human carpenter employs on wood; the instrument that on the London wharves, cuts the veneers, is a gigantic razor; the tool of the shearing machine, which shears iron as easily as a tailor's scissors cut cloth, is a monster pair of scissors; and the steam-hammer works with an ordinary hammer head, but of such a weight that not Thor himself could wield it." (Marx, 1867, p. 385)

In the same line, and in relation to the development of science, Marx argues:

"The sporadic use of machinery in the 17th century was of the greatest importance, because it supplied the great mathematicians of that time with a practical basis and stimulant to the creation of the science of mechanics." (Marx, 1867, p. 348)

These arguments constitute clear evidence not only of the evolutionary nature of technical progress but also of its dependence on the problems experienced in productive activities. Notice also that, here, Marx conceives the development of science itself as partly dependent on those problems. On this basis, and taking into account the objective nature of 'modern industry' and the need of decomposing and analysing the labour process into its constituent detail processes according to technical and scientific criteria, technical progress appears clearly as a process of technological learning resulting from the analysis and resolution of problems in the sphere of production. Again, this view is made evident in the following argument which refers to the problems experienced in the production of machines by means of machines, where Marx also points to the relations of *technological interdependence and complementarity* among different sectors¹⁸.

"The most essential condition for the production of machines by machines was a prime mover capable of exerting any amount of force, and yet under perfect control. Such a condition was already supplied by the steam-engine. But at the same time it was necessary to produce the geometrically accurate straight lines, planes, circles, cylinders, cones and spheres, required in the detail parts of the machines. *This problem Henry Maudsley solved* in the first decade of this century by the *invention of the slide rest*, a tool that was soon made automatic, and *in a modified form was applied to other constructive machines besides the lathe, for which it was originally intended*. This mechanical appliance replaces ... the hand itself produces a given form by holding and guiding the cutting tool along the iron or other material operated upon. Thus it became possible to produce the forms of the individual parts of machinery 'with a degree of ease and accuracy, and speed, that no accumulated experience of the hand of the most skilled workman could give'⁽¹⁾. [(1) Cf. 'The Industry of Nations', Lond., Part II., p. 239]" (Marx, 1867, p. 385; emphasis added)

And in a footnote, Marx goes on,

"This work also remarks: 'Simple and outwardly unimportant as this appendage to lathes may appear, it is not, we believe, averring to much to state, that its influence in improving and extending the use of machinery has been as great as that produced by Watt's improvements in the steam-engine itself. Its introduction went at once to perfect all machinery, to cheapen it, and to stimulate invention and improvement'." (Marx, 1867, p. 385, footnote)

The 'continual improvements' both of commodities and of methods of production acquire full significance in the capital goods sector; for, technical progress in that sector plays a key role in the dynamics of the efficiency of the economic system¹⁹. The relevance of these improvements

¹⁸On this see next section.

¹⁹See next section

rests on the cheapening of machinery, on the production of more efficient machines of the same type and on the innovation process; as Marx argues, these phenomena entail an increase in the rate of "moral depreciation" --obsolescence-- of machinery already in use.

" .. in addition to the material wear and tear, a machine also undergoes, what we may call moral depreciation. It loses exchange-value, either by machines of the same sort being produced cheaper than it, or by better machines entering in competition with it. In both cases, be the machine ever so young and full of life, its value is no longer determined by the labour actually materialised in it, by the labour-time requisite to reproduce either it or the better machine." (Marx, 1867, p. 404)

And, Marx goes on

"When machinery is first introduced into an industry, new methods of reproducing it more cheaply follow blow upon blow, and so do improvements, that not only affect individual parts and details of the machine, but its entire build." (Marx, 1867, p. 404-5)

In this context, Marx quotes Babbage who, on the basis of rough estimates, establishes that

" ... the first individual of a new invented machine will cost about five times as much as the construction of the second." (Marx, 1867, p. 405, footnote 1)

Rosenberg suggests that there is, in Marx's analysis, a sort of 'life cycle' hypothesis as regards both the development of machinery and its methods of production²⁰. When introduced, new machines, as they have not yet been subject to a rigorous analysis of their performance under actual conditions of production, are usually inefficient. As a result of such an analysis a sequence of improvements follows which refer both to the basic structure of machines and to their constituent parts, and, hence, to their operating characteristics. Once they have acquired a stabilised form, technical progress centres on their methods of production which results in a falling cost of reproduction. Thus, in the first stages of its 'life cycle', machinery is subject to a high rate of obsolescence (see Marx, 1894, p. 113-4). Again, technical progress appears as a process of analysis and resolution of problems; moreover, we find here a sort of combined hypothesis of '*learning by doing*' and '*by using*' which points to the need for a close interaction between makers and users of machinery. This view also points to the existence of an essential *uncertainty* in the adoption of new techniques; in this regard, Marx refers to

"1) the great difference in the cost of the first model of a new machine and that of its reproduction (... see Ure and Babbage)²¹. 2)The far greater cost of operating an establishment based on a new invention as compared to later establishments arising *ex suis ossibus*. This is so very true that the trail-blazers generally go bankrupt, and only those who later buy the buildings, machinery, etc., at cheaper prices make money out of it. It is ... generally the most worthless and miserable sort of money capitalists who draw the greatest profit out of all new developments of the universal labour of the human spirit and their social application through combined labour." (Marx, 1894, p. 104)

²⁰See Rosenberg, 1976b, as reprinted in Rosenberg, 1982, pp. 49-50.

²¹Here Marx refers to A. Ure, The Philosophy of Manufactures, London, 1855, -Ed., and to Ch. Babbage, On the Economy of Machinery and Manufactures, London, 1832, pp. 280-81. -Ed.

3. Social Division of Labour. Extent of the Market. Macroeconomic-Structural Nature of Efficiency.

Another central element in Marx's view of the development of the forces of production rests in his view of the dynamics of social division of labour as interrelated with those of division of labour in particular processes of production and technical progress. As stated, this interrelation constitutes the second element at the core of Young's notion of increasing returns. According to Marx, the production and circulation of commodities are a prerequisite of capitalist production as the latter presupposes a certain degree of development of the process of exchange and of social division of labour. In turn, capitalist production extends and intensifies social division of labour; as he establishes, "this mode of production, once it is assumed to be general, carries in its wake an ever increasing division of social labour" (Marx, 1893, p. 33). This process takes place already through the development of division of labour in 'manufacture'.

"... division of labour in manufacture demands that division of labour in society at large should previously have attained a certain degree of development. Inversely, the former division reacts upon and develops and multiplies the latter" (Marx, 1867, p. 353).

And, as Marx goes on, the introduction and development of division of labour in integrated industries which produce either different commodities --horizontal integration-- or one single commodity and the corresponding inputs --vertical integration-- leads to their *subdivision and specialisation* as independent industries.

"If the manufacturing system seize upon an industry, which, previously, was carried on in connection with others, either as a chief or as subordinate industry, and by one producer, these industries immediately separate their connection, and become independent. If it seize upon a particular stage in the production of a commodity, the other stages of its production become converted into so many independent industries. It has already been stated, that where the finished article consists merely of a number of parts fitted together, the detail operations may re-establish themselves as genuine and separate handicrafts. In order to carry out more perfectly the division of labour in manufacture, a single branch of production is, according to the varieties of its raw material, or the various forms that one and the same raw material. may assume, split up into numerous, and to some extent, entirely new manufactures." (Marx, 1867, p. 353)

Also, the development of division of labour in manufacture, as it leads to the differentiation of the instruments of labour, promotes a further development of social division of labour through the *differentiation* of the industries which produce those instruments (Marx, 1867, p. 353).

The interrelation Marx establishes between division of labour in 'manufacture' and 'in society' is closely related to Smith's proposition that "the division of labour is limited by the extent of the market". For, as I have argued elsewhere (Ricoy, 1994), this proposition is intrinsically linked to the characterisation of social production as 'commodity production' --as a 'commercial society' in Smith's terminology--, that is, a system based on social division of labour and organised through exchange. The basic idea in this regard rests on the continuous interaction that takes place [the

interdependence that exists] between the development of social division of labour [diversification and specialisation of industries] and the development [intensity] of the process of exchange that results from the increasing dependence among industries [of their integration] through the market mechanism. This is but the manifestation of the development of the economic system as a system of '*production of commodities by means of commodities*'. It should be noted that Kaldor recognises that "for Smith the existence of a 'social economy' and the existence of increasing returns are closely related phenomena"²². It is in this sense that Marx's view that the conditions of realisation of surplus-value --conditions of sale-- are limited by "the proportional relations of the various branches of production" (Marx, 1894, p. 244) is to be understood; as he argues as regards the creation of absolute surplus-value,

"[it] is conditional upon an expansion ... of the sphere of circulation. The *surplus-value* created at one point requires the creation of surplus-value at *another* point, for which it may be exchanged. ... A precondition of production based on capital is ... *the production of a constantly widening sphere of circulation*, whether the sphere itself is directly expanded or whether *more points within it are created as points of production*."²³ (Marx, 1939, p. 407; italics in the original)

Moreover, in the context of the previous discussion on social division of labour, Marx refers explicitly to density of population as a prerequisite of division of labour and to its dependence on the development of the means of communications. In the same line, Marx sees the opening of external markets as a factor inducing division of labour. (Marx, 1867, pp. 352-4).

The progressive extension of division of labour in 'society' acquires its full relevance with the emergence and development of the 'factory system' based on the use of machinery. In this context, the *input-output relationships* and the *intersectoral demands* that such a system entails, acquire special significance. In effect, the generalisation of the use of machinery all through the different industries, given the increase in productivity and, hence, in production involved, leads to an *increasing demand for means of production*, which, in turn, allows and induces the *progressive subdivision, specialisation and differentiation* of the producing sectors.

"as the use of machinery extends in a given industry, the immediate effect is to increase production in the other industries that furnish the first with means of production. [...] When machinery is applied to any of the preliminary or intermediate stages through which the subject of labour has to pass on its way to completion, there is an increased yield of material in those stages ... In proportion as machinery ... increases the mass of raw materials, intermediate products, instruments of labour, &c, the working-up of these raw materials and intermediate products becomes split up into numberless branches; social production increases in diversity. The factory system carries the social division of labour immeasurably further than does manufactures, for it increases the productiveness of the industries it seizes upon, in a far higher degree." (Marx, 1867, pp. 443, 444)

Similarly, the process of innovation in the machinery producing industries and the increasing

²²Kaldor, 1972, as reprinted in Kaldor, 1978, p. 181. See also Kaldor, 1979, pp. 283-4.

²³See next section on 'creation of relative surplus-value'.

demand for machines lead to the *subdivision and specialisation* of those industries and to the progressive development of division of labour in each of them.

"As inventions increased in number, and the demand for newly discovered machines grew larger, the machine-making industry split up, more and more, into numerous independent branches, and division of labour in these manufactures was more and more developed."
(Marx, 1867, p. 382)

On the other hand, 'modern industry', as it implies a higher level of efficiency and, hence, a higher surplus-value, leads to an increasing capitalist consumption, both in volume and in variety, which, in turn, leads to an increasing diversity of social production; at the same time, it promotes --requires-- the construction and continuous improvement of all sorts of public works as well as the introduction and progressive development of new goods and new sectors of production²⁴ (Marx, 1867, p. 445). Also, the development of the 'factory system', given its intrinsic tendency to expansion, requires the substitution of "the means of communication and transport handed down from the manufacturing period" (Marx, 1867, p. 384).

In this view, efficiency, as determined by the interrelated processes of division of labour, both 'in manufacture' and in society', and technical progress, appears as a *macroeconomic-structural* phenomenon. This nature of efficiency is inherent to a system of *production of commodities by means of commodities*. In this system, technical progress in the industries producing means of production plays a key role in the (global) dynamics of efficiency. This is made evident in Marx's analysis of the "economy in the employment of constant capital", where, along with the 'savings in its application', he considers the 'savings yielded by the continuous improvement of machinery' (Marx, 1894, Ch. V). A distinctive feature of these improvements is that, although they result from technical progress in the producing sectors, their effect manifests itself in the sectors making use of machinery. Thus, technical progress in the capital goods sector results in an increased productivity and/or in cost reductions in the using sectors.

"the development of the productive power of labour in any *one* line of production, e.g., the production of iron, coal, machinery, ... etc., which may again be partly connected with progress in the field of intellectual production, notably natural science and its practical application, appears to be the premise for a reduction of the value, and consequently of the cost, of means of production in *other* lines of industry, e.g., textile industry, agriculture, etc." (Marx, 1894, p. 81; italics in original)

In this way, a higher level of efficiency in the capital goods sector, in so far as it results in a lower price of those goods, leads to a reduction in the value of capital invested, and, hence, to a higher rate of profit in the using sectors.

"The increased profit received by a capitalist through the cheapening of, say, cotton and spinning machinery, is the result of higher labour productivity; not in the spinnery, to be sure, but on cotton cultivation and construction of machinery. [...] It is the development of the productive power of labour in its exterior department, in that department that supplies

²⁴On this see next section.

it with means of production, whereby the value of the constant capital employed by the capitalist is relatively lowered and consequently the rate of profit is raised." (Marx, 1894, pp. 80, 82)

These arguments of Marx make it clear the fundamental relevance of the *interindustry relations* from the perspective of the dynamics of the economic system as a whole, which, on the other hand, is intrinsically implied in his own view of the social process of production as a circular process in which the output of one sector is, in turn, the input of another; again, this is a feature inherent to a system of production of commodities by means of commodities. As Marx argues, the dependence of the value of the means of production used in one sector on the increases in productivity in the producing sectors is 'self-evident',

"since a commodity which is the product of a certain branch of industry enters another as a means of production. Its lesser or greater price depends on the productivity of labour in the line of production from which it issues as a product, and is at the same time a factor that not only cheapens the commodities into whose production it goes as a means of production, but also reduces the value of the constant capital whose elements it here becomes, and thereby one that increases the rate of profit." (Marx, 1894, p. 81)

In the last analysis, the increases in productivity just considered are the result of the 'the progressive development of the industrial sector as a whole'; thus, the sectors making use of the means of production benefit from the advantages derived from the process of subdivision and specialisation of industries, that is, from the development of social division of labour, including science as part of it. In this sense, the analysis of Marx makes it clear the fundamental nature of efficiency as a macroeconomic-structural phenomenon.

"The characteristic feature of this kind of savings of constant capital arising from the progressive development of industry is that the rise in the rate of profit in *one* line of industry depends on the development of the productive powers of labour in *another*. Whatever falls to the capitalist's advantage in this case is once more a gain produced by social labour ... Such a development of productive power is again traceable in the final analysis to the social nature of the labour engaged in production; to the division of labour in society; and to the development of intellectual labour, especially in the natural sciences. What the capitalist thus utilises are the advantages of the entire system of the social division of labour." (Marx, 1894, p. 81-2; italics in the original, emphasis added)

The macroeconomic-structural nature of efficiency acquires its full relevance once the relations of *technological interdependence and complementarity* among sectors are considered. According to Marx, an innovation in a given sector may give rise to a similar innovation in other sectors; similarly, the introduction and the development of an innovation in a given sector may require and, hence, promote or induce a complementary development in other sectors. In this sense, technical progress in one part of the system depends and, at the same time, induces technical progress in other parts.

"A radical change in the mode of production in one sphere of industry involves a similar change in other spheres. This happens first in such branches of industry as are connected together by being separate phases of a process, and yet are isolated by the social division

of labour, in such a way, that each of them produces an independent commodity. Thus spinning by machinery made weaving by machinery a necessity, and both together made the mechanical and technical revolution that took place in bleaching, printing and dyeing imperative. So too, on the other hand, the revolution in cotton-spinning called forth the invention of the gin for separating the seeds from the cotton fibre; it was only by means of this invention that the production of cotton became possible on the enormous scale at present required."²⁵ (Marx, 1867, pp. 383-4)

4. Development of Forces of Production. Accumulation. Expansion of Markets. Competition.

As already stated, in Marx's view, the development of the conditions of production through cooperation, division of labour and the introduction and progressive development of machinery is intrinsic to the objective aim and determining motive of capitalist production, namely, the production of surplus-value to a progressively extended scale. In short, such a development is inherent to the development of capitalist production itself.

"When considering the production process we saw that the whole aim of capitalist production is appropriation of the greatest possible amount of surplus-labour, in other words, the realisation of the greatest possible amount of immediate labour-time with the given capital, be it through the prolongation of the labour-day or the reduction of the necessary labour-time, through the development of the productive power of labour by means of co-operation, division of labour, machinery, etc. ..." ²⁶ (Marx, 1959, Part II, pp. 521-2)

As we have seen, according to Marx, the dominant tendency underlying the development of the forces of production is the progressive automatisisation or mechanisation of social production in so far as it entails its progressive rationalisation and improvement as a process of production of capital. In other words, the development of the forces of production through division of labour and technical progress allows, conditions and promotes the self realisation of capital.

".. capital and its self-expansion appear as the starting and the closing point, the motive and the purpose of production; ..production is only production for *capital* .. the methods of production employed by capital for its purposes ... drive towards unlimited extension of production, towards production as an end in itself, towards unconditional development of social productivity of labour .. unconditional development of the productive forces of society ..." (Marx, 1894, p. 250, italics in the original)

In this view, the development of the forces of production constitutes a key element in the dynamics of the economic system as whole. The other key element in such dynamics is

²⁵ With regard to these relations; the previous argument (p. 18) in which innovations taking place one sector find their way into other sectors should be taken into account.

²⁶ As Marx argues with regard to machinery, to its introduction and progressive improvement, it is not only "the most powerful means for increasing the productiveness of labour" but also it is "the most powerful means for lengthening the working day ... It creates, on the one hand, new conditions by which capital is enabled to give free scope to this its constant tendency, and on the other hand, new motives with which to whet capital's appetite for the labour of others." (Marx, 1867, p. 403). As already argued, the development of the forces of production entails an increasing efficiency in the labour process --'production of relative surplus-value'-- but also endows the system with a higher (and increasing) *elasticity of productive capacity* and, hence, with a higher (an increasing) *flexibility* in its utilisation; in this sense, it promotes the inherent tendency of capital to prolong and intensify the working day --'production of absolute surplus-value'.

accumulation of capital --the 'conversion of surplus-value into capital'. As Marx argues as regards the transformation of the 'possessor of money' into a capitalist.

"The expansion of value, which is the objective basis or main-spring of the circulation M-C-M, becomes his subjective aim, and it is only in so far as the appropriation of ever more and more wealth in the abstract becomes the sole motive of his operations, that he functions as a capitalist, that is as capital personified and endowed with consciousness and a will. Use-values must therefore never be looked upon as the real aim of the capitalist; neither must the profit on any single transaction. The rest-less never ending process of profit-making alone is what he aims at. This boundless greed after riches, this passionate chase after exchange-value, is common the capitalist and the miser ... *The never-ending augmentation of exchange-value ... is attained by the .. capitalist by constantly throwing it afresh into circulation.*" (Marx, 1867, pp. 152-3; emphasis added)

Thus, in Marx's view, the dynamics of capitalist production rests on accumulation of capital and on the development of the forces of production --of the social productivity of labour; in this regard, Marx sees the process in terms of the 'reciprocal interaction' among these two elements.

"... the mere quantitative increase in capital at the same time implies that its productive power grows. If its quantitative increase is the result of the development of productive power, then the latter in turn develops on the assumption of a broader, extended capitalist basis. *Reciprocal interaction takes place* in this case. Reproduction on an extended basis, accumulation, even if originally it appears only as a quantitative expansion of production --the use of more capital under the same conditions of production-- at a certain point, therefore, always represents a qualitative expansion in the form of a greater productivity of the conditions under which reproduction is carried out. Consequently, the volume of products increases not only in simple proportion to the growth of capital in expanded reproduction." (Marx, 1959, Part II, p. 522; emphasis added)

As implied in this argument, the dynamics of the system based on the interaction between accumulation of capital and the development of the forces of production implies, and requires, the continuous expansion of production. As such, the whole process requires the market to expand accordingly.

".. *constantly expanding production* <it expands .. for two reasons; firstly because the capital invested in production is continually growing; secondly because the capital is constantly used more productively; in the course of reproduction and accumulation, small improvements are continuously building up. There is a piling up of improvements, a *cumulative development of productive powers*> *requires a constantly expanding market* ..." (Marx, 1959, Part II, p. 522; emphasis added)

In short, the dynamics of the system centred on the self-expansion of capital and, as such, determined by the interaction between accumulation of capital and the development of the forces of production depends on the expansion of markets --on the expansion of demand. As Marx argues

"... the process of circulation sets in motion new forces independent of the capital's magnitude of value and determining its degree of efficiency, its expansion and contraction". (Marx, 1893, pp. 38-9)

Or as he argues in Volume III of Capital,

"The conditions of direct exploitation, and those of realising it, are not identical. They diverge not only in time and place but also logically. The first are only limited by the productive power of society, the latter by the proportional relation of the various branches of production and the consumer power of society". (Marx, 1894, p. 244)

In this regard, and with reference to the production of relative surplus-value, i.e., that based on "the increase and development of the productive forces", Marx establishes the overriding need of expanding the "consuming circle", of creating new consumption, through,

"firstly, [the] quantitative expansion of existing consumption; secondly: [the] creation of new needs by propagating existing ones in a wide circle; *thirdly*: [the] production of *new* needs and [the] discovery and creation of new use values." (Marx, 1939, p. 408; emphasis in the original)

According to Marx, this leads to

"the exploration of all nature in order to discover new, useful qualities in things; universal exchange of the products of all alien climates and lands; new (artificial) preparation of natural objects, by which they are given new use values. The exploration of earth in all directions, to discover *new things of use as well as new useful qualities of the old* ... the development of the natural sciences to their highest point; likewise the discovery, creation and satisfaction of *new needs arising from society itself*; the cultivation of all the qualities of the social human being, production of the same in a form *as rich as possible in needs, because rich in qualities and relations* the creation ... of labour with a new use value; the development of a constantly expanding and more comprehensive system of different kinds of labour, of different kinds of production, to which a *constantly expanding and constantly enriched system of needs* corresponds." (Marx, 1939, p. 409; emphasis added)

When Marx's analysis of the dynamics of the system on the basis of the reciprocal interaction between accumulation of capital and the development of the forces of production is seen from the perspective of the different individual capitals, *competition* appears as a fundamental driving force in such dynamics. Paraphrasing Kaldor, competition constitutes a social mechanism which 'transmits impulses to economic change and, thereby, creates more resources through enlarging the scope for specialisation, division of labour and technical progress'.

As already established, in Marx's view, the objective basis of capital, namely, the self-expansion of value on an progressively extended scale --the "never-ending augmentation of value"-- constitutes the subjective aim and the determining motive of each individual capitalist; as Marx argues in his analysis of "the conversion of surplus-value into capital",

".. so far as he is personified capital, it is not values in use but and the enjoyment of them, but exchange-value and its augmentation what spurs him into action. Fanatically bent on making value expand itself, he ruthlessly forces the human race to produce for production's sake; he thus forces the development of the productive powers of society." (Marx, 1867, p. 592)

And, competition makes the subjective aim of individual capitalists a requisite of their own survival as such; in this sense, competition appears as an external coercive mechanism forcing capitalist into a continuous process of accumulation.

"As such, [the capitalist] shares with the miser the passion for wealth as wealth. But that which in the miser is a mere idiosyncrasy, is, in the capitalist, *the effect of the social mechanism, of which he is but one of the wheels*. Moreover, the development of capitalist production makes it constantly necessary to keep increasing the amount of the capital laid out in a given industrial undertaking, and *competition makes the immanent laws of capitalist production* to be felt by each individual capitalist, as *external coercive laws*. It compels him to keep constantly extending his capital, in order to preserve it, but extend it he cannot, but *by means of progressive accumulation*." (Marx, 1867, p. 592; emphasis added)

Thus, each individual capitalist, in his urge to expand his own capital and forced to do so by the mechanism of competition, tends continuously to expand the production of commodities and to develop a competitive edge over his rivals so as to enlarge his market share.

"it is in the nature of capitalist production that: 1. each particular capital on a scale which is ... determined by the endeavour to realise as much labour and therefore as much surplus-labour as possible and to produce the largest possible quantity of commodities with a given capital; 2. each individual capital strives to capture the largest possible share of the market and to supplant its competitors and exclude them from the market --*competition of capitals*." (Marx, 1959, Part II, p. 484; italics in the original)

In this view, the behaviour of each individual capitalist is characterised by a continuous tendency to develop and improve the conditions of production so as to cheapen the commodities produced in such a way as to lower its 'individual value' below the corresponding 'social value' resulting from the average conditions of production of the sector implied.

"... distinctive feature of the capitalist mode of production is the production of surplus value as the direct aim and determining motive of production. Capital produces essentially capital, and does so only to the extent that it produces surplus-value. ... Production for value and surplus-value implies ... the constantly operating tendency to reduce the labour-time necessary for the production of a commodity, its value, below the actually prevailing social average. The pressure to reduce cost-price to its minimum becomes the stronger lever for raising the social productiveness of labour ..." (Marx, 1894, pp. 880-1)

In effect, a capitalist who introduces a new method of production --be it through a greater division of labour or through the introduction or improvement of machinery-- and who, as a consequence, increases the productivity of labour in such a way as to lower the 'individual value' of his commodities below their 'social value' appropriates himself of an 'extra' surplus-value and, at the same time, develops a competitive advantage over other capitalists.

"One capitalist can drive another from the field and capture his capital only by selling more cheaply. he must produce more cheaply, that is, raise the productive power of labour as much as possible. But, the productive power of labour is raised, above all, by a *greater division of labour*, by a more universal introduction and continual improvement of

machinery. The greater the labour army among whom labour is divided, the more gigantic scale on which machinery is introduced, the more does the cost of production proportional decrease, the more fruitful is labour. Hence, a general rivalry arises among the capitalists to increase the division of labour and machinery to exploit them on the greatest possible scale." (Marx, 1891, p. 38; italics in the original)

According to Marx, the 'competitive advantage' so developed becomes effective in the market and, hence, becomes a real threat for competitors, if, in fact, the innovating capitalist sells his commodities at a price lower than their 'social value'. Moreover, due to the innovation itself, his need to sell has increased as his capacity to produce and the value of his investment have both increased; thus, in order to enlarge his market share, the innovating capitalist is required to sell at a price that, although higher than the 'individual value' of his commodities, which means that he still makes an 'extra' profit, is lower than the corresponding 'social' value.

"If ... by a greater division of labour, by the utilisation of new machines and their improvement, by more profitable and extensive exploitation of natural forces, one capitalists has found the means to produce with the same amount of labour or of accumulated labour, a greater amount of products, of commodities, than his competitors how will this capitalist operate? He could continue to sell at the old market price; this would, however, be no means of driving his opponents from the field and of enlarging his own sales. .But, in the same measure in which his production has expanded, his need to sell has also increased. The more powerful and costly means of production that he has called into life *enable* him, indeed, to sell his commodities more cheaply, they *compel* him, however, at the same time, *to sell more commodities*, to conquer a much *larger* market for his commodities; consequently, our capitalist will sell more cheaply than his competitors. Moreover, he attains the object he wishes to attain, if he puts the price of his goods only a small percentage lower than that of his competitors. He drives them from the field, he wrests from them at least a part of their sales, by underselling them." (Marx, 1891, pp. 38-9; italics in the original)

Yet, other capitalists, to the risk of being eliminated from markets, are obliged by the 'coercive law of competition' to follow suit, to introduce, or even to improve, the new method of production --the new machinery or the new division of labour. Hence, once the new method is generalised, the 'social value' of the commodity will equal the new 'cost of production', or even will be reduced below it.

"However, the *privileged position* of our capitalist is not of long duration; other competing capitalists introduce the same machines, the same division of labour, introduce them on the same or on larger scale, and this introduction will become so general that the price .. is *reduced* not only *below its old*, but *below its new cost of production*." (Marx, 1891, p. 39; italics in the original)

Thus, once the new conditions of production become 'dominant' and, hence, the effective price of commodities equals the new 'cost of production', both their subjective urge to expand and competition make, again, individual capitalists intend to extend the scope of division of labour and introduce new machinery on an extended scale in order to achieve an additional reduction in their cost of production. The competitive race for profits and market shares has no finishing line,

and, in fact, renews itself again and again; as Marx argues, once the price of commodities falls to the level of the 'cost of production' corresponding to the new method,

"the capitalists find themselves, therefore, in the same position relative to one another as *before* the introduction of the new means of production, and if they are able to supply by these means double the production at the same price, they are *now* forced to supply the double product below the old price. On the basis of this new cost of production, the same game begins again. More division of labour, more machinery, enlarged scale of exploitation of machinery and division of labour. And again competition brings the same counteraction against this result. We see how in this way the mode of production and the means of production are continually transformed, revolutionised, *how the division of labour is necessarily followed by greater division of labour, the application of machinery by still greater application of machinery, work on a large scale by work on still a larger scale.*" (Marx, 1891, pp. 39-40; italics in the original)

Therefore, according to Marx, given the generalisation of the new method of production, given its higher productivity and the greater absolute value of investment, capitalists are forced again to expand production; this, along with the constant threat of competition, makes them try to develop a new 'competitive advantage' --a new reduction of their 'cost of production'--through the improvement of machinery and through a new extension of division of labour; in this way, the same process as before repeats itself indefinitely.

"However powerful the means of production which a capitalist brings into the field, competition will make these means of production universal and from the moment when it has made them universal, the only result of the greater fruitfulness of his capital is that he must now supply *for the same price* ten, twenty, a hundred times as much as before. But, as he must sell perhaps a thousand times as much as before in order to outweigh the lower selling price by the greater amount of the product sold, because a more extensive sale is now necessary, not only in order to make more profit but in order to replace the cost of production --the instrument of production itself, as we have seen, becomes more and more expensive-- and because this mass sale becomes a matter of life and death not only for him but also for his rivals, the old struggle begins again *all the more violently the more fruitful the already discovered means of production are. The division of labour and the application of machinery, therefore, will go on anew on an incomparably greater scale.*" (Marx, 1891, p. 40; italics in the original)

5. Concluding Remarks.

In this paper I provide a reconstruction of Marx's analysis of the development of the forces of production --of the social productivity of labour. This development is seen as an evolutionary process of modification and improvement of the social conditions of production, which takes place through the interaction of division of labour in given processes of production, technical progress and social division of labour. As such, it is intrinsically linked to capital accumulation and depends on --requires-- and induces the expansion of markets. This view of Marx provides the most consistent and developed antecedent of Young's view on "increasing returns and economic progress" and, more generally, of the view implied in the principle of circular and cumulative causation as developed by Kaldor.

In Marx's view, the fundamental tendency of the development of the forces of production is the progressive automatisisation or mechanisation of social production which entails freeing it from the restrictions imposed by the human labour force and its designing and performing according to scientific and technological criteria. The fundamental notion in this regard is the progressive rationalisation and improvement of social production as production of capital. This process takes place through the evolution from 'cooperation' to 'manufacture' to 'modern industry'. Along with the above tendency, I distinguish in Marx's analysis three main elements which point to a cumulative causation view of efficiency and discuss each of them in turn. First, the view of such evolution as centred on the interaction between division of labour, mechanisation and technical progress. Division of labour entails the subdivision of production into specialised detail processes, the establishment of specific proportions among them, and the simplification, specialisation, differentiation and improvement of the instruments of labour; as such, division of labour allows, conditions and leads to mechanisation and technical progress. In turn, technical progress conditions and leads to division of labour. On this basis, the changes in the form or method of production that may occur are mostly the result of technical progress and, as such, belong to the dynamics of the system. Second, the view implied of technical progress as a continuous process of analysis and resolution of problems in the sphere of production which takes place on the basis of the interaction between science and the accumulated knowledge resulting from experience in production and from the analysis and resolution of problems itself; as a result, technical progress is, at the same time, an evolutionary, path-dependent process of modification and improvement of the various elements conforming productive activities. Third, the interrelation Marx establishes between the dynamics of social division of labour and those of division of labour in particular processes of production and technical progress. It is in this context that Smith's (and Young's) proposition that "division of labour is limited by the extent of the market" must be placed; for the basic idea here rests on the continuous interaction that takes place between the development of social division of labour and the development of the process of exchange that results from the increasing dependence among industries through the market mechanism. This is but the manifestation of the development of the economic system as a system of production of commodities by means of commodities. Indeed, the input-output relationships and the intersectoral demands acquire special significance in this context. In this view, efficiency appears as a macroeconomic-structural phenomenon. This nature follows from the interdependence and complementarity, both sectoral and technological, that characterises the industrial structure. In this regard, the development of an efficient capital goods sector acquires full relevance in terms of the dynamics of efficiency all across the economic system.

In the last section of the paper, and taking a broader perspective, I consider Marx's view on the interdependence among the development of the forces of production, capital accumulation and the expansion of markets. In this view, the dynamics of the economic system is based on the 'reciprocal interaction' between capital accumulation and the development of the forces of production, and, as such, it depends on --is limited by-- the expansion of markets. Finally, I discuss Marx's view of competition as fundamental driving force of such dynamics.

REFERENCES.

- Dosi, G. 1984. Technical Change and Industrial Transformation. London: Macmillan.
- Dosi, G. 1984b. "Technological paradigms and technological trajectories. The determinants and directions of technical change and the transformation of the economy", in C. Freeman (ed.), Long Waves in the World Economy. London: Frances Pinter.
- Dosi, G. 1988. "The nature of the innovative process", in Dosi, G., Freeman, C., Nelson, R., Silverberg, G. y Soete, L. (eds.), Technical Change and Economic Theory. London: Frances Pinter.
- Kaldor, N. 1966. Causes of the Slow Rate of Growth of the United Kingdom: an Inaugural Lecture. Cambridge: Cambridge University Press.
- Kaldor, N. 1972. The irrelevance of equilibrium economics, Economic Journal, Vol. 82, December, pp. 1237-55.
- Kaldor, N. 1978. Further Essays on Economic Theory. London: Duckworth.
- Kaldor, N. 1978b. Further Essays in Applied Economics. London: Duckworth.
- Kaldor, N. 1979. Equilibrium theory and growth theory, in M. J. Boskin (ed.), Economics and Human Welfare: Essays in Honour of Tibor Scitovsky. London: Academic Press.
- Kaldor, N. 1981. Discussion, in D. Currie, R. Nobay, D. Peel (eds.). Macroeconomic Analysis. London: Croom Helm.
- Kaldor, N. 1981b. The role of increasing returns, technical progress and cumulative causation in the theory of international trade and economic growth, Economie Appliquée, Vol. 34, n° 4, pp. 593-617.
- Kaldor, N. 1985. Economics without Equilibrium. Cardiff: University College Cardiff Press.
- Marx, K. 1867. Capital. A Critique of Political Economy. Vol. I. New York: International Publishers. 1967.
- Marx, K. 1893. Capital. A Critique of Political Economy. Vol. II. New York: International Publishers. 1967.
- Marx, K. 1894. Capital. A Critique of Political Economy. Vol. III. New York: International Publishers. 1967.
- Marx, K. 1939. Grundrisse. Harmondsworth: Penguin, 1973.
- Marx, K. 1959. Theories of Surplus-Value. Part II. Moscow: Progress Publishers. 1968.
- Marx, K. 1891. Wage Labour and Capital, Moscow: Progress Publishers. 1952.

- Nelson, R. R. and Winter, S. G. 1977. "In search of a useful theory of innovation", Research Policy, Vol. 6, nº 1, pp. 36-77.
- Nelson, R. R. and Winter, S. G. 1982. An Evolutionary Theory of Economic Change. Cambridge, Mass: Harvard University Press.
- Ricoy, C. 1987. "Cumulative causation", in Eatwell, J., Milgate, M. and Newman, P. (eds.), The New Palgrave. Vol. I, pp. 730-36. London: Macmillan Press.
- Ricoy, C. 1994. Value, Division of Labour, Technical Progress and Effective Demand: the Principle of Cumulative Causation and the 'Surplus Approach'. Doctoral Thesis. Universidad de Santiago de Compostela. (In Spanish).
- Ricoy, C. 1998. "Cumulative causation", in H. D. Kurz and N. Salvadori (eds.), The Elgar Companion to Classical Economics. Vol. I, pp. 202-8. Cheltenham: Edward Elgar.
- Rosenberg, N. 1974. "Karl Marx on the economic role of science", Journal of Political Economy, July-August, pp. 713-728; reprinted in Rosenberg, N. Perspectives on Technology. 1976.
- Rosenberg, N. 1976. Perspectives on Technology. Cambridge: Cambridge University Press.
- Rosenberg, N. 1976b "Marx as a student of technology", en Monthly Review. 28, July-August, pp. 56-77; reprinted in Rosenberg, N. Inside the Black Box: Technology and Economics. 1982.
- Rosenberg, N. 1982. Inside the Black Box: Technology and Economics. New York: Cambridge University Press.
- Sahal, D. 1981. Patterns of Technological Innovation. Reading, Mass: Addison-Wesley.
- Shaikh, A. 1978. "Political economy and capitalism: notes on Dobb's theory of crisis", Cambridge Journal of Economics, Vol. 2, nº 2, pp. 233-51.
- Smith, A. 1776. An Inquiry into the Nature and Causes of the Wealth of Nations. The University of Chicago Press. 1976.
- Young, A. 1928. Increasing returns and economic progress, Economic Journal, Vol. 38, December, pp. 527-42; as reprinted in K. Arrow y T. Scitovsky, (eds.), Readings in Welfare Economics. 1969. Homewood, Ill.: Irwin.
- Young, A. 1929. Capital, The Encyclopædia Britannica, 14^a edn.