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SCIENCE AND TECHNOLOGY IN TODAY'S ECONOMY

THE FOURTH STAGE IN THE ORGANISATION OF PRODUCTION

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ABSTRACT : The historical context determines for most part the order of priority of the scientific phenomena to study, the techniques (methods and tools) to use, as well as the social use which will be made of the results. Classical Economists highlighted three stages in the transformation of the production forces of capitalism: meetings of workers isolated under the same management, followed by the division of the work and the differentiation of the tasks, then by the clear separation between intellectual and manual work. This paper presents the fourth stage in the productive organisation: an organisation based on the spatial de-concentration of the achievement of this production and on decisional, financial and informational centralisation that the applications of contemporary science allow. Concerning the organisation of labour, this fourth moment is characterised by the combination in the same group of staff paid by the company itself and a salaried staff paid by other organisations, but appropriated by the company which makes use of the said group. This fourth stage is the one of the unprecedented marketability of science, organised as a network by enterprises and states in a clear technological aim.

RESUME : Le contexte historique conditionne pour une grande partie l'ordre des priorités sur le plan scientifique et technique ainsi que sur le plan de l'application des résultats de la recherche. Les économistes classiques ont mis en évidence trois moments historiques durant lesquels les forces de production du capitalisme se sont transformées : le regroupement des travailleurs isolés sous le même commandement a été suivi par la division du travail et la différenciation des tâches, puis par la séparation claire du travail intellectuel du travail manuel. Ce document présente le quatrième moment de l'organisation productive : une organisation fondée sur la déconcentration spatiale de la réalisation de la production et sur la centralisation décisionnelle, financière et informationnelle permises par les avancées scientifiques et techniques actuelles. Concernant l'organisation du travail, ce quatrième moment est caractérisé par la combinaison dans un même collectif de salariés appartenant à une entreprise et d'autres qui appartiennent à d'autres entreprises mais dont le travail est réalisé pour le compte de la première entreprise. Le quatrième moment est lié à une marchéisation sans précédent de la science, organisée en réseau par les entreprises et les Etats dans un but clairement technologique.

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INTRODUCTION

All science would be superfluous if the appearance and the essence of things became confused (Marx, 1976, Volume III , p.739). The research of the essence of things is generally commonly accepted as being the aim of the scientific activity but the historical context determines for the most part, the order of priority of the things and the phenomena to dissect, to understand and to know, the techniques (methods and tools) to use to penetrate the essential, as well as the social usage which will be made of the essence extracted. At the moment in time when, according to Marx (1977, volume II, p.220), "industry has already reached a very high level (...), invention becomes a branch of business, and the application of science to the immediate production determines the inventions, at the same time as soliciting them". Then, for Habermas (1973, p.43), "with the arrival of industrial research on a large scale, science, technique and exploiting found themselves part of the same system". Capitalism provided the framework for the systematic application of science to production, which in turn gave impetus to the development of scientific knowledge concerning laws of nature and of the world. Capitalism redirects, in accordance with a productive end, a reserve of scientific and technical knowledge built up, making science a productive strength at the service of capital. "Giving a scientific character to production is therefore the tendency of capital..." (Marx, volume II, 1977, p.187).

It is interesting to reconsider some aspects of the current debate on science, technology and competitiveness through the historical method of analysis, in order to better understand the subtle changes in methods of appropriation and the marketization of science in clearly global commercial and industrial aims. We will propose first of all a framework of analysis of innovation, or of the application of science to production, in today's capitalism. We will compare the analysis of the systemic connections between science, innovation and the society, to the recent developments in the liberal thinking to show that the economists supporting the plausibility of the market, incorporate into their theory larger and larger parts of classical ideas. We will defend subsequently the idea of the "fourth moment of the organisation of the capitalist production"; an organisation based on the spatial de-concentration of the achievement of this production and on the decisional, financial and informational centralisation that the applications of contemporary science allow. We will attempt at the same time to study in particular the controversial thesis of the "economy based on information or on knowledge".

The second part of this paper will be devoted to demonstrating certain particularly important, current processes in the application of science to production. Innovation is an economic act whose success depends on the involvement of a large number of public and private institutions. But the role of the state has never been so explicit in the constitution and organisation of the required means for the application of scientific knowledge to production. We will refer first of all, to the theoretical justification of the economists supporting the heavy involvement of the state, in the transformation of general knowledge into production knowledge to discuss the appearance and application of a new framework of accumulation. These theoretical theses and the proposals as far as economic policies which result from them are concerned, will lead us to present several characteristics of these framework of accumulation and to argue the economic and social limits which the device for systematic instrumentalisation of science encounters.

1. THE MYTH OF INNOVATION: FROM THE FORMATION TO THE PRIVATE APPROPRIATION OF PRODUCTION RESOURCES

Science, in the same way as technique, is always historical. But in capitalism, science is considered as a tank of knowledge from where technique feeds (see the excellent Nef, 1953). It is considered as a tank of forces of production because the work process has become "a technological application of science" (Marx, 1977, Volume II, p.220). The growth in the size of the company and the amount of capital held or raised has furthered the enrollment of science in immediate production. a) The domestic markets of the big industrial and international countries are getting bigger, b) the social division of labour is extended c) Enterprises, in a context of competition, have to bear rising total costs d) Enterprises focus their strategy on, on the one hand, the achievement of high external economies[1] (or externalities) and on the other hand on business intelligence in order to benefit from all profit opportunity. The application of science to the economic activity of such and such a company or group of companies, makes innovation the main function of growth and commercial strength.

1.1. Science, externalities and innovation

The liberal and neo-liberal economic thinking has, only very recently, been able to find some arguments to justify forming, in the aim of making them available to private firms, scientific and technical resources. The liberal economists are quick to thank R. Solow [1956] who started new methods of research into the links between technology and growth.

Firstly, as a residual factor of growth,[2] new techniques have become a very popular subject of research with the new-liberals. During the 90's, the American administration, launched very ambitious technological civil programmes, and thus justified the implementation of an economic, financial and legal device for the transfer of scientific resources from the public to the private sector (see Clinton and Gore,1993).

The standard neo-classic growth model was changed drastically by the introduction of technical progress and innovation in the liberal approaches to accumulation. To consider for example, that the activities giving birth to the diffusion of technical and scientific information have a positive impact (in terms of creation of wealth and profits) which is greater collectively than individually is a significant advance compared with the mechanical and ahistorical equilibrium of the original model. The question of economic repercussions on the community, of individuals' actions, especially concerning scientific production and commercial development, points us towards the socio-holistic approach to the economy applied successfully by the classical authors. Innovation, more particularly, defined by J. Schumpeter (1935) as a new "combination of productive resources", corresponds to a process of generation and private appropriation of a set of resources (scientific, technical and financial) which, combined by the company or a group of companies, results in new products,

[1] The usual term is that of externalities which can be defined (with A. Marshall, 1906) as being positive or negative effects, which involve an activity of an economic agent outside this activity or that the agent is subjected to from outside. The most attractive for a company is to achieve, in a setting favourable to investment, substantial external savings, without having to bear the slightest cost that its activity creates for the community as a whole (pollution or various nuisances). It is important therefore, to underline, that taking private property for granted, the private agent will create various effects on the local community, but in return, he will expect from the community means and opportunities to enlarge his property (assets) or where necessary, to defend it.

[2] As a residual factor, technical progress contributes to the part of economic growth which cannot be explained by the evolution in the volume of the production factors (capital and labour).

the opening of new markets and new organisation. The conception of new products is a very important element in innovation. It is here that the large firms, with huge resources at their disposal, have a great advantage. They can fund research teams and experiment with a large number of innovations in the hope that one of them will stand out from the crowd, wrote J. Robinson in 1977. The supply creates its own demand thanks to the insight and the fighting spirit of the entrepreneur, then of the large firm. The second stage of the innovation process (appropriation) prevails these days over the first one (the generation). The company tends to take advantage of its environment rather than to invest in it, for instance, in all the stages of technological creation; which can be explained by the fact that the investments in the acquisition (appropriation) of production resources are less costly than those devoted to the formation of these resources. Which also makes the new-liberals say that the collective profitability of the capital can be high, whereas the private profitability can become insufficient.

If the neo-classical economists struggled to get out of their model's dead end, a long time ago Marx himself and the economists who applied his method showed, as did L. Karpik (1972), that science, becomes the base of industry; it is in this way that "heteronomous science" (which corresponds to the research applied to both the experimental development of new techniques and production methods and to finished goods) marks time on "autonomous science" (let's say basic research with no recognised private profit-making aims). The production process therefore determines the appearance of new techniques and defines their use. To do this, it directs the application of the scientific knowledge and defines the boundaries of scientific research. An organic relationship is thus created between science, technique and Society. And it is in this that technology (and innovation), as a transformation of knowledge into production and accumulation knowledge, is a social fact.

Let us follow Karl Marx's reasoning. First theoretical statement: capitalism cannot exist without revolutionising constantly the means of production, and therefore the production relations, that is to say all the social relations. The means of production required to produce the different goods (destined for consumption or for production), after they have been adapted and used for private purposes to be transformed into capital, tells us a lot about the state of the social relations. The quantitative expansion and the efficiency with which the capital is developed as fixed capital, broadly indicates to what extent the capital is developed as capital, as being the power over the living work and to what extent it is subjected to the production process in general (Marx, 1977, volume II, p.187). The technological use of science is the essential factor in the development of fixed capital; this being an index which shows to what extent the universal social knowledge has become a direct productive force. The development of (fixed) capital enlarges the scale of production at the same time as prompting this enlargement, requiring in parallel the specialisation and the overlapping of different work forces which are more and more complicated: simple work/complex work, living work/dead work, socially necessary work, collective work... Salaried work, and the salaried class as a capitalist norm of participation in the accomplishment of production and the social organization (or ...disorganization) (Boutillier, 1999-1), becomes the driving force behind accumulation.

Second theoretical statement: the general development of the production forces is the development of all the means (material and immaterial) that science in the hands of the capital, injects into the production, natural forces, in the form of means of production, enabling higher usage value with less work (Marx, 1976, Book I, p.231 and onwards). Science becomes capital under the pressure of the competition and possible political and

social disputes. The authority of the capital and the power on the market of a given company depends on its capacity to make profits, to accumulate. Innovation is therefore essential in the daily battle that firms undergo to avoid the numerous barriers (lack of demand, increase in price of production resources, emergence of new competitors, social problems, restricting regulations , etc.) which can block the road to prosperity. Science is therefore called upon more and more; the new technology which it will create must be more efficient (allowing a greater mastery of the work process) and must achieve new exchange values (i.e.guarantee accumulation). The speed of the renewal of the capital is dependent on the accumulation barriers which play a major role in defining the integration of science into both production and the general development of the forces of production.

Third theoretical statement: For Marx, competition requires a continual increase in capital and imposes pervading laws of capitalist production as external coercive laws to each individual capitalist (Marx, 1976, Book I, p.241). To limit the risk of disappearing (through over-investment in relation to the solvency of the market in question), the firm must innovate and at the same time grow. Depreciation and centralisation go hand in hand. Innovation links the two together: it allows the depreciation of the already old capital whose profitability has slumped; it creates a favourable climate in which to make further investments and it favours "creative destruction" (Schumpeter) and the involvement of finance, the merging of capital (centralisation) forming huge companies so that the capital and its development appear as the starting point and the end, like the motive for and the objective of the production. For this reason, the capitalist economy tends to develop its production forces as though it only had the absolute power of the company as a limit. But this tendency enters into permanent conflict with the restricted objective, taking advantage of the existing capital (Marx, 1977, volume II, p.213). The periodic crises mean the "destruction of part of the existing production forces"[3]. The resumption of accumulation after the said destruction, will not be possible without thorough modification of the foundations and the norms of accumulation (new social organization of work, new competition rules, ... new technology, new institutional forms of management and economic regulation).

1.2. The fourth stage in the capitalist production organisation

As soon as the capital takes over the social production, the technical progress reflects the more or less significant changes (marginal or radical) in the techniques and the production methods, together with the social organisation of the working process and thereby the historical type of society (Marx, 1976, Book II, p.51). The three stages in the transformation of the production forces of capitalism (meetings of workers isolated under the same management, that of the holder of the capital, followed by the division of labour and the differentiation of the tasks with the setting up of a salaried management team in the factories, then by the clear separation between intellectual and manual work which determine the status of scientific and technical workers compared with the immediate commercial objectives of the production process) are conceptually linked to the formation and the evolution of the "collective worker".

Capital instigates cooperation among the workers for the accomplishment of a given production. It creates in this way collective of workers all the while depriving the staff of any role in the organization of their work, and of any control over their contribution (value added)

[3] About a century later, J. Schumpeter was to describe as "creative destruction" the process of destroying old capital by new productive combinations which create, from their introduction to the market, new opportunities for profit and investment (Schumpeter, 1979).

to the production, finally of any role in evaluating the use value that their workforce represents for the capital. A. Smith's spirit lurks: the machine was created by the division of labour. He also remarked that the specialisation of labour will lead the worker to discover sooner or later the means to reduce the difficulty of his task. But these "minor innovations" are not the only ones; according to A. Smith, other inventions are a consequence of the work of scientists which consists in observing distinct physical and technical processes (A. Smith, 1976). These inventions, when marketed, will represent the major innovations of the future.

The stages of the capitalist production organisation therefore precede the technical transformations and transform science into a productive force and define technology as production knowledge. Innovation and more particularly, technology, said J.K. Galbraith (1967), undergoes a major organisational effort, but it is also the result of the organisation. This basis of perception of the evolution of production forces under the constraints of accumulation has inspired some of the neoclassical economists. The positive externalities, the increasing returns or even the human capital are the concepts which illustrate in different words the state of the collective of workers and the state of the socialization of the capitalist production such as it has been noticed since the beginning of the eighties. The current phenomenon of an "knowledge-based economy" (see for example, Foray, 2004) are the continuation of the formalization of the scientific and technical knowledge and of the organization of science as a domain for accumulation whose origins date from the middle of the 19th century. Indeed, with the creation of schools and specialised publications, knowledge and all sorts of scientific and technical information is diffused. We go therefore progressively from a series of empirical results, logically organized, to a strictly scientific knowledge which results from experiments willingly carried out, not more uncertainly endured" (Gille, 1978, p.785).

However, what we must emphasize is that the explanation that the superiority of the social return on investment in research and in innovation in companies in comparison to the return on the individual capital, lies in the increase in the number of factors determining the profit-making potential in a given company. These factors (education, environment, health, finance, inter-industrial relations, communication, requirements and aspirations, ...) of a general nature influence the marginal cost of a company or an operation and with everything equal, have an effect on the return on the capital invested. The firm, in a competitive situation, be it apparent or latent, must appropriate these factors or, at least monitor their impact on the profitability, or even better, take advantage (abundant production resources which could be taken over, the opening of new markets) the non-commercial logic which these factors generate and reproduce (and nowadays this is how innovation is defined).

The firm, by investing in R&D, or by taking over small innovative companies, or by collaborating with other companies as strong as itself (joint research programmes, cross licensing,...) or with government research bodies (universities, for instance), appropriate knowledge which is the essential factor of competitiveness. Large companies consider that the knowledge which is vital for competitiveness entirely covers fundamental knowledge and insist that the university research institutes, with whom they sign research partnerships, accept their own criteria on who should be considered as 'public' or 'private' (Chesnais, 1986).

It is the fourth stage in the organization of production: the combination in the same group of staff paid by the company itself and a salaried staff paid by other organizations, but appropriated by this company which makes use of the said group. The company keeps control of the group which is itself composed of productive capacity, trained and employed in various

areas and by various social production entities (Laperche, Uzunidis, 1999). This deconcentration of the constitution and the management of the private work groups affects all institutions. The diversification of the canals of scientific and technical knowledge and information transfer from public training centres for production resources (e.g. universities) towards the companies is proof of this; the refinement of the legal and financial system for the appropriation of the value constituted in the public sector by the company is further proof of this; the multiplication of the different levels of social status and salaries of the salesmen of all sorts of manual and intellectual competence is yet more proof.

The large controlling firm (or on a joint basis several large companies) constitutes the crux of the deployment of the production process. Having concentrated its means of production, defined and divided up the production tasks and put together directly controllable collective of workers, it is becoming these days a decentralised organization and management centre for its production resources. Capitalist production operates at the moment as if the power exercised by a firm on the market (and the coordination of the functions and activities that it can impose on it) was a factor of economic power (and of centralisation of the ownership of the capital) more important than the power given by its own assets (scientific, technical, industrial and financial).

But this is forgetting that this firm's power is a result of its financial capacity and of its potential concerning information. By "information potential" we mean scientific, technical, industrial, financial, commercial, political, sociological, etc. which a company has access to and can transmit to the market. Information and finance together, enable the constitution and management of working groups which are geographically dispersed and remote (investment in interindustrial cooperation relations, in protecting the technological assets, in the appropriation of scientific knowledge and the creation of new products, in the coordination, using telematic means, of the different activities, etc.) (see Uzunidis and Boutillier, 1997; Laperche 1998).

Technological innovations are today the outcome of this centralising deconcentration process. They also provide the possibility for the process to be achieved and to prove itself more efficient (in relation to the costs of large amount of capital) than the huge factory which employs hundreds of people. The debates on the "networks" that we will look at afterwards focus as much on the flexibility (to create or destroy production capacity according to the economic circumstances) that the large firm's decentralised management of the production provides, as on the increase in the firm's capacity to appropriate a large quantity of resources without investing in their formation. The large firm has turned into a centre of concentration of the production resources, but also of formation and flexible coordination of collective of workers, depending on the accumulation requirements and the fluctuation of markets. It calls for cooperation and goes on towards this convergence by applying the strategies of growth and integration[4].

[4] To grasp the entire current theoretical ideas of the liberal economists, it is important to bring together certain ideas that they propose. For example, the theory of knowledge and skills must be associated with those of the "government of enterprise" (A. Schleifer, W. Vishney, 1997) which describes the strong involvement that (financial) institutional shareholders have, in the day-to-day running of a large firm …of a substantial proportion of its capital. The profitability in the short and medium term of the capital committed by these is the most common evaluation criterion of the president and of the technostructure which has the decision-making power in this company. Exercising this power requires numerous business skills (A. Chandler) judged themselves by the managers' ability to take advantage of the group of "living strengths" of the firm and by their aptitude to integrate external elements.

This coordination and innovation process, both flexible and evolutionary, imposes on the firm the pressing need to be provided with the different types of technological and intellectual means to acquire and combine uninterrupted flows of material and immaterial resources. The "knowledge theory" applied to the company says: the ability to adapt and the efficiency of the company depends on its cognitive categories, on the interpretation codes of the information itself, on the tacit skills and its procedures in solving the problems it encounters (Dosi, Nelson, Winter, 1999). The scientific, technical and industrial information as a system of knowledge (Knowledge-capital) which is articulated, formalised and likely to be communicated or transferred, is a means of production, identifiable as such (Laperche, 2001-1, Laperche 2005) the use of which provides innovation for the economic process and the accumulation of capital. The task of the "technostructure" consist therefore of finding the balance between managing the "partnerships" and developing the internal instruments of organization (see Laperche, Galbraith, Uzunidis, 2006).

2. MARKETIZATION OF SCIENCE AND THE NEW ACCUMULATION CONTEXT

By accumulation context, we mean the forms, the methods and the means of competition and of cooperation between the economic players which enables the achievement of the production process, i.e. the setting up of similarity between the social relations of production with the productive forces (Uzunidis, 2000).

This framework requires state intervention which promotes and guarantees the explicit drawing up of coherent rules in order to organize public and private economic activity and, in our case to facilitate the industrial application of science. The organisation of labour and of the economy on the whole must change, in order to be able to respond to the need for the capital to be renewed rapidly and in return, to allow the society to absorb or digest (depending on the usual commercial criteria), the progress of science and technology. If the institutional transformations of regulation are not enough to make market relations, of profit and of property, correspond with the scientific strength of production "the capitalist envelope bursts" or "the walls crumble away" (Schumpeter, 1942).

2.1. Socialisation of the production and innovation "networks".

The role of the state in the socialisation regulation of the capitalist production for private purposes of innovation and accumulation is essential and specific (Uzunidis, 2003). State intervention has already gone beyond the very traditional fields of application and funding of a scientific and technical policy, in the centre of which, we find on the one hand, public centres of learning and research and on the other hand, the production of arms. The behaviour of the state regarding the issue, resembles more and more that of the big financial and industrial groups and the strong links of interdependence between these influential bodies justify the transfer of resources from the public to the private sector. This is possible if the state draws up a policy of innovation, i.e. the promotion of all scientific means of research, of development of application and of technological choice to allow the creation of new products and new procedures in the industry, based on the socialisation of the costs and the privatisation of profits.

State intervention can take different forms: financial assistance for activities which generate resources which can be taken over individually or collectively by private interests; creating devices allowing the private reappropriation of the return on the investment in research and

development (e.g. patents which do not hinder the distribution of innovations); the application of cooperation procedures between public and private bodies with the objective of funding the feasibility of a private investment project likely to have wide-scale economic repercussions (see Lucas,1988; Romer, 1990; Barro,1990; for a clear and synthetic presentation of the theories of "endogenous growth" Guellec and Ralle, 1995; Aghion and Howitt, 1998).

Faced with the complexity of the private innovation process, M. Castels (1996, 1997, 1998) went as far as to maintain, quite cleverly, that the fundamental unit of the economic system is no longer the entrepreneur, the family, the firm or the state, but the network composed of different organizations. Regarding innovation, the division of labour and the very refined specialisation of skills in scientific research and experimentation, remove any possibility of autarkical organisation of the technological production. The network unfolds as a private form of organisation of the instrumentalisation of science. Partnerships between companies and between state research bodies and companies, and a whole panel of technical, financial and commercial contributions, illustrate the theories of the classical economists (e.g. A. Smith and K. Marx) for whom as fast as the capital takes over the social production (and enlarges its market by appropriating the resources at the time), we witness technical transformations and changes in the social organisation of the production.

The creation of a pool of productive capacity able to be appropriated at any time by companies, is considered by the contemporary economists to be the fundamental aspect of state intervention in accumulation. Let us look at the thinking of Branscomb and Keller (1998): stating that creating and circulating information improves the results of a national economy (and the large firms that it is made up of), they put forward the idea that the traditional scientific and technological policy (focused on the funding and the realization of major programmes in research and development, primarily in the areas of defence, energy, space or medecine) has been replaced by one of research and innovation. In order to be fruitful in terms of competitiveness, this policy has to target as much the realisation of public research programmes (or ones receiving public funding) as the circulation of their results to the "users" (the competitors). The state has to guarantee the efficiency of the privatisation procedures (the "commercialization") with regulations (protection of patent rights, anti-monopoly measures, etc.), fiscality, the budget, etc. in order to favour the accumulation of "social capital". With this term, American economists conceptualize the process of transferring value from one company to another, from public bodies to private concerns (without explicit reference to the effects of domination and inequality, except in the case of a monopoly, i.e. in the commercial field. They agree to discuss the discriminating and restricting positions linked to innovation, to the size of entreprises and the mobilization of capital; they also conceptualize creating a "stock" (pool) of resources which are shared under this many-sided, multi-functional cooperation which involves several partners.

The network, created in this way can be a cause but also the consequence of the socialisation of the production which must be achieved thanks to various contributions, and in times of high rotation of capital, to a continual flow of information and scientific and technical knowledge. According to these economists, the state must encourage the creation of networks to boost innovation and competitiveness among firms. The consecutive reduction of investment and transaction costs for large firms and of the risk associated with the possible wrong choice in scientific investments (made by the combined investments of the firms making up the "network") are the two arguments which justify the state's involvement and the creation of a new accumulation framework. But these arguments are concealed in the neo-liberal thinking by macro-economic factors of competitiveness. The competitiveness of a

national economy, measured by its ability to create clusters of innovation, depends mainly on its scientific, technological, financial and commercial links which are components of networks (see above). The said networks must be coordinated by their own initiatives and by the institutional accumulation framework put in place for them. Getting further away from the original theory, the contemporary economists offer us the concept of a "national system of innovation" which can be described, according to S. Metcalfe (1995), as the group of different bodies which contribute jointly or separately to the development and to the diffusion of new technology and which create a setting in which the governments devise and apply measures made to encourage the process of innovation. What it is in fact, is a group of commercial and non-commercial organizations undertaking to apply science to production and to do all the "incidental" jobs linked to the realization and circulation of technology; the whole of this being coordinated by the state.

The fact is that the new accumulation framework favours the expansion of the technological capital of the large firm in the same way that it guarantees its improvement and its productivity (innovation, opening new markets, profits) on a national and international scale.[5] This is probably the reason why the link (with many theoretical and ideological consequences) between marketization and capital centralization through these so-called networks has not been clearly established in the contemporary neo-liberal theory.

2.2. Modes and prospects of marketization of scientific research

The OECD, after convincing itself that we are heading towards a "knowledge economy" based on permanent innovation, itself dependent on the networks and cooperation, "notably between science and industry", emphasizes that policies of innovation in large industrial countries favour the funding of research carried out under the supervision and control of industry, reform their university systems to make them compete so as to improve the supply of scientific and technical services available for firms, encourage the mobility of researchers and their involvement in business (OECD, 2000).

In all big countries, basic research is mainly carried out in universities and research centres financed by the state. To make the university logic compatible (the researcher's career and ambition, the teaching, scientific evaluation of research results etc) with that of industry, the new accumulation context applied to science (Uzunidis, 2001 (a)) consists of the following characteristics: a) the reduction in public funding and the contractualization of the research, where the criterion of "return on investment" determines the choice of projects and the follow up of the work carried out; b) the creation of centres to commercialize research in universities, where the "centres of excellence" look after the contracts, patents, licensing and the creation of technological companies; c) the drawing up of a private status for the researcher who wishes to integrate a research team or to leave one to set up his own business, take advantage of "his" patent (or that of the centre which employs him) or change jobs; d) the development

[5] The OECD measures innovation "globalization" a) by investments in R&D and the taking out of patents by the foreign subsidiaries in a given country; b) by the technological alliances between companies on an international level which can be in the form of a simple exchange of licenses or setting up joint research subsidiaries; by publishing articles and holding patents for international collaboration (OECD,1999). Networks, or the socialization of the production of scientific or technical knowledge, along with their application to productive purposes follow and provide the trend towards the international centralization of capital. "Small countries" (to use the OECD terminology), which are very active in scientific matters (Ireland, the Netherlands, Switzerland) turn their "innovation device" into one of the main assets in attracting foreign technological investments. "Large countries", helped by their financial markets, give an essential nature to these partnerships in the evaluation of the competitiveness of their economies and any other national economy (Uzunidis, 2001(b)).

of financial institutions for innovation and for the creation of innovating firms to a capital risk or capital investment type.

The average proportion of basic research in university research amount to about 50% in the OECD countries but is decreasing progressively. On the other hand, companies are funding less and less fundamental research projects, banking on what the universities can bring in: A vicious circle of tendential degeneration of science. However, firms are funding a major proportion of innovation but they also benefit from favourable statutory and fiscal measures, mainly for the application of networks of innovation. We notice "a drop in the number of research projects with intellectual curiosity as their sole motivation" (OECD, 1998). Those who defend the idea of "networks" maintain that universties can find them beneficial in so far as they guarantee career openings for their future graduates and obtain financial assistance; firms benefit from the network by improving their access to better- trained human resources and to sources of new ideas. The OECD underlines that certain barriers remain for the network's efficiency to be complete: the status of civil servant which many researchers have, the evaluation of the public research which is still done on the basis of work published and not on what contribution the researcher has made to industry… For the marketization of science to become a compulsory norm of innovation, OECD (often using the example of the US), having acknowledged that "the state powers" are not in a position to create networks ex nihilo, proposes to the states "setting up support programmes for the networks in the long term…" (OECD, 2000, op. cit.) Would these programmes be capable of countering the damage done by the waste of scientific and technical resources that we see nowadays?

This type of policy proposing scientific production resources to companies, goes beyond a simple transfer; it reduces the chances of survival of "independent science" exhausting without renewing – which is not in the interest of companies – the pool of future productive forces! The economic regulation using the networks and the social management of the fourth stage of the capitalist production organization brings flexibility to the markets and to the innovation process, but makes the systematic application of science detrimental in the long term: Is there not a danger of accumulation hitting a snag regarding the scarcity of basic knowledge? It is true that "in the long term we will all be dead" (Keynes), but the financial logic which dominates the creation and improvement of technological capital (associating scientific and industrial knowledge and innovation engineering) helps the large firms to select those scientific applications which could have the highest profitability in the short term; these firms speculate in this manner, leaving aside knowledge to lie fallow. Fluctuations on the stock market, at the end of the 1990's illustrate this: the "technological values" have lost between 40% and 60% from the spring of 2000 to the summer of 2001, depending on the industrial country (the US, the EU, Japan).

We are therefore in an economy based on the short term, because in draining the scientific pool, the firm (or the network), even in the case of a monopoly, does not have the time to establish its influence through customer loyalty for a certain time (as long as possible) for a sufficient clientele (keeping the customer informed and making its product indispensable); another firm, anticipating the movement, injects into the market its own "technological values", it destabilizes the system, which overloads on capital, takes refuge in finance. This short-sightedness limits the scope of the market solvency and represents a barrier to finding profitable alternatives.

Will the targeted innovation programmes, defined (and financed) jointly by the governments and the large firms, be able to restore hope in seeing a come-back in a long term accumulation

process and avoid “the dilemma of stagnation”? By having a pool of scientific and technological knowledge, industrially formed, intending to be applied over a longer period than that required by the rival sectors, arms production in big countries tells us a lot about the role the state plays in encouraging and creating networks. During the “cold war” years, the industrial policies of the US, Great Britain and France were based on the creation of new technology within the framework of the big programmes of armament. The relaxing of the rules governing the innovation linked to the defence and decompartmentalization of the “militaro- industrial complex” created a new concept (at the same time that the American administration was being convinced of the importance of the circulation of knowledge to rival industries from fundamental knowledge sources – universities and armaments): the “industrial and technological basis of defence” (OTA, 1991). This is defined as “the group of people, organizations, technological know-how and production capacity involved in the design, the development, the production and the maintenance of arms and defence equipment…”.

The “innovation-arms network” are probably the strongest in an open and economy in the hands of financiers (Bellais, 2000). This network facilitates long research and technological experimentation under the cover of competitive and financial “short termism”; it arranges domains for the investment of public and private capital and creates vectors for the transfer of scientific and technological resources to competitive industries. It is true that many start-ups at the beginning were created in information technology thanks to the special relationship that the American army had nurtured with certain big universities and companies in the country. The increase in the defence spending at the beginning of the century in the large arms-manufacturing countries confirms the importance that the state grants the military regarding technology.

But is the Industrial and technological defence base really a defence against the marketability of science, is it not more of a crisis shock-absorber and a step up to new capitalist adventures? It could be the same with health (the state system allowing future commercial applications for genetics) or with the environment (the state system creating opportunities for improving ecology). What is important though, is the network i.e. the device, in the new accumulation framework, for the socialization by the market (contract) and for the coordination by the big firms and the state, for productive and profitable purposes of the scientific research activities.

The network not only monopolizes the inventiveness of science, but also guides it depending on its accumulation restrictions and objectives. For example “anticipated standardization” (Foray, 1990; Laperche, 2001). To control the pace of technological applications of science, big firms which dominate a market, in association with research institutes, create technical norms before the technology is really operational. Alternative technology is therefore eliminated, competitive barriers consolidated and reinforced and the centralized property safeguarded. In this case, the dominating firm or firms lean on the network, not to impose or declare their technological and financial power, but most often to express it in costly and very risky sectors. Whether they are in information technology (software, components), telecommunications (mobile phones) or genetics (interpreting genes), the big firms, by adapting, combining and protecting the scientific production knowledge and by standardizing their use, exercise their technological and financial power over the scientific activity: they direct, according to their plans, the choices and the research projects and look after their future commercialization. Defined and constituted in this way, the supply has to create its own demand. The support that the state gives to the network also aims to guarantee markets and to discreetly involve the public or private consumer in the concept of profit-making.

CONCLUSION

The new era of capital is not so much apprehended by the technological progress, but by the new way in which the production process is organised and developed. The industrial applications of science are the result of this, but also what prompts accumulation, the means to succeed and also the cause of crises.

We have proposed the idea of the "fourth stage of the organization of capitalist production" and have spoken on "the new accumulation framework" which is linked to it. Starting with an historical analysis and with a particularly critical view of the past and present liberal thinking, we have noticed that this opinion is making enormous progress thanks to the see-saw effect: free enterprise on the one hand, state intervention on the other. We can consider as a whole the development of the market, the socialization of the production and the centralization of the capital. The current theories of networks, externalities, competition and innovation are based on an acquired principle: the benefits of the market, and on common finding that the market, must not only be developed, organized and regulated, but that it must also be created and preserved.

The socialization of capitalist production has indeed taken on such dimensions that from now on, the appropriation of the technological elements gathered by the large companies is less costly than the raising of capital for their formation. The big firms are becoming, using relations of power, convergence centres for science and techniques, which they combine to supply their innovation process. To get from the stage of the concentration of production to the current stage of the contractual integration of the centralized property, capitalism has invented a new accumulation framework; the economic policies of "contesting the monopolies", privatization, flexible work management, international financiarization and integration have to a certain extent succeeded in depreciating the old capital, but they have also created the context of securitization and marketability of all individual and collective assets (science is of course part of this). In these conditions how can we be surprised by the regulatory power of finance? The system works by trial and error, finance facilitates the task. But in doing so, it directs the applications of science to production, it becomes a selection criterion to the research programmes and at the same time it weakens the potential for radical system innovations.

We described the current stage of capitalism in previous publications (Uzunidis, 2000) as "managerial", because the power of decision was entrusted to the employees, managing both the economy and public affairs. The age of the "captains of industry" is a bygone era. State management of innovation which the neo-classical economists are calling for, shows that on the one hand that the appropriation of scientific resources by companies is considered as one of the State's main economic reasons and on the other hand that the obstacles to accumulation become insurmountable without the organizing and planning role of the state. The introduction of commercial logic into scientific research falls within the scope of an innovation policy; but more surprisingly, so does the economic efficiency of the "network".

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