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The Economics of Intangibles

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Abstract

The recent evidence is that most industries and the economy in general are experiencing important changes as a result of the diffusion of information and communication technologies, making more intense knowledge flows across firms and across the world possible. Firms are undertaking organisational changes that make them look like networks, characterised by outsourcing, decentralisation of decision-making, multiple nodes since the network is constituted both internally (relationship between the firm's units) and externally (relationships with competitors, suppliers, distributors, etc.). In the meantime, firms are looking for new ways of reporting on their performance, with attempts to evaluate their intangible assets, including the capability to innovate, as well as both individual and organisational knowledge and competencies.

Meanwhile, scholars in economics are developing new theoretical frameworks to better consider knowledge creation and technological change than in the past. R&D, organisation, human capital, knowledge, are all important assets of the firm which are difficult to measure but the increasing reliance of firms on these assets to ensure performance raises the issue of what does economics has to say about intangible assets and, if the theoretical framework is not completely adequate to consider them, how could they be better taken into account.

The aim of this paper is precisely to address the latter issue: after providing empirical evidence of the rise of intangible assets, we ask what economics has to say about intangibles and make a reflection on how to develop the economics of intangibles.

1. Introduction

The recent evidence is that most industries and the economy in general are experiencing important changes as a result of the diffusion of information and communication technologies, making more intense knowledge flows across firms and across the world possible. Firms are undertaking organisational changes that make them look like networks, characterised by outsourcing, decentralisation of decision-making, multiple nodes since the network is constituted both internally (relationship between the firm's units) and externally (relationships with competitors, suppliers, distributors, etc.). In the meantime, firms are looking for new ways of reporting on their performance, with attempts to evaluate their intangible assets, including the capability to innovate, as well as both individual and organisational knowledge and competencies. Some firms have gained leading competitive position thanks to organisational innovations, as shown by the example of Japanese firms in the car industry in the 1980s mainly (Labory, 1997), but such organisational innovations are not considered in the traditional reports on the firms' assets and performance.

Meanwhile, scholars in economics are developing new theoretical frameworks to better consider knowledge creation and technological change than in the past. Increasing evidence is provided that the traditional theory of the firm and some of the assumptions of the homo economicus are not generally valid (for instance, Bowles et al.,1998, 2001). R&D, organisation, human capital, knowledge, are all important assets of the firm which are difficult to measure but the increasing reliance of firms on these assets to ensure performance raises the issue of what does economics has to say about intangible assets and, if the theoretical framework is not completely adequate to consider them, how could they be better taken into account.

The aim of this paper is precisely to address the latter issue: after providing empirical evidence of the rise of intangible assets, we ask what economics has to say about intangibles and make a reflection on how to develop the economics of intangibles.

A first point to note is that intangible assets are difficult to define. For instance Lev (2000) defines intangible assets as claims to future benefits that do not have a physical or financial (stock or bond) embodiment: a patent, a brand, a unique organisational structure. For Lev, intangible assets are knowledge assets.

Such a definition is clear but the problem is that it leads to a very wide categorisation: everything which is not physically or financially embodied is intangible. Consequently, innovation, organisational practices or human resources can be considered as intangible assets. However, these assets are also generators of intangible assets: human capital creates ideas and therefore generates innovations; a flexible organisation may allow more autonomy to its members who have scope to

collect information, interact more with each other and generate more ideas, hence higher innovation. In fact, intangible assets appear to result from a combination of generators: for example, a patent, i.e. an innovation, results from R&D activity, human resources (engineers' creativity and competence) and organisational assets (the structure of the team of the engineers, their motivation, the possibilities for communication influence the performance of the research activities as shown by Henderson and Cockburn, 1996).

The consequent confusion is that intangible assets comprise a wide variety of assets which are created in turn by a wide variety of intangible (and tangible) assets. Another source of confusion appears to be the fact that intangible assets are generally embedded in physical assets, such as products or technology.

The literature outlines that intangible assets are not new; what is new is the importance they have taken in recent years. Most often quoted factors are first, the steep rise in the market-to-book value of many firms parallel to small rise in the value of their physical assets; the difference is claimed to result from intangible assets. Second, globalisation (hence more intense competition) and the diffusion of information and communication technologies favour the rising importance of intangible assets in that the former implies the increasing use by firms of non-price strategies (differentiation, product innovation), while the latter favours directly the development of intangible activities (higher skilled personnel and services). Third, the diffusion of new organisational practices. Here again it is not clear what we are talking about: for instance, is the diffusion of new organisational forms the result of the rise in intangible assets or the cause?

The paper is structured as follows. First, evidence on the increasing importance of intangibles is provided in the second section, pointing to the limitations of existing indicators. The third section reviews the economic literature to show how intangible assets are considered in such a framework. On this basis, the fourth section provides some reflections on an economic theory of intangibles.

2. Evidence of the increasing importance of intangibles

Given the confusion as to the nature and characteristics of intangible assets, there are no perfect indicators. Intangible assets have been partially measured using a number of proxies, including R&D spending, employment in information and communication technologies, public spending in education, and so on. For instance, estimates prepared by Kendrick and reproduced by Abramovitz and David (OECD, 1996) show that the share of tangible capital in the total stock of capital in the US economy fell from 65% to 46.5% over the period 1929 to 1990, while the share of intangible capital rose from about 35% to 54%. This is argued to provide evidence that in the

context of the emerging knowledge economy and changes in the nature of competition, firms have not reduced the overall capital formation but rather have shifted resources into intangible capital.

Table 1. Capital stock and capital/output ratio in the US 1929-1990

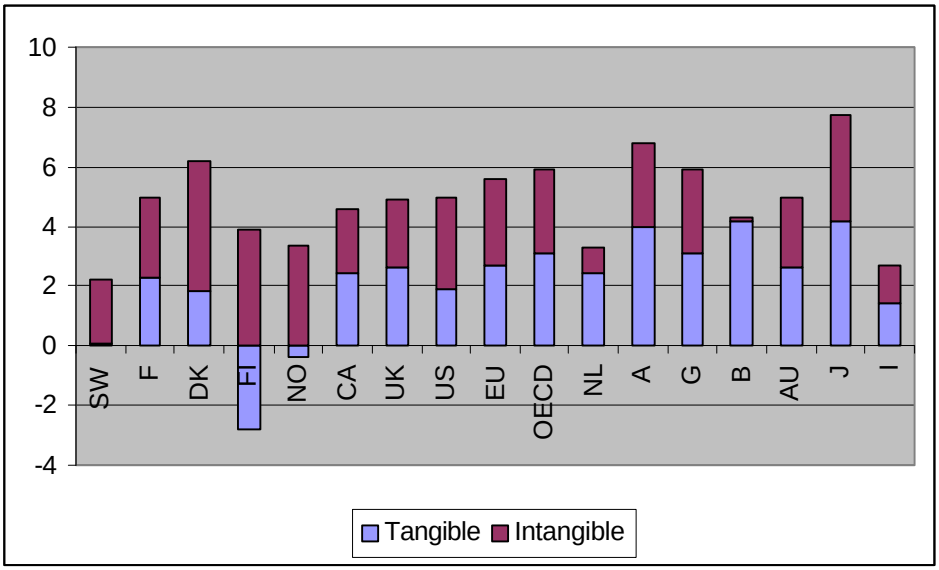
	1929	**1948**	**1973**	**1990**
Share of total capital stock %				
Tangible capital	65.1	57.8	50.2	46.5
Intangible capital	34.9	42.2	49.8	53.5
Capital/GDP ratio				
Tangible capital/GDP	7.4	6.3	5.4	5.9
Intangible capital/GDP	4.0	4.6	5.3	6.7
Total capital/GDP	11.4	10.8	10.7	12.6

Source: OECD, 1996

Figure 1 compares investment in tangible versus intangible assets across OECD countries, in terms of average annual growth rates over the period 1985-1995. Overall, compared to the US, the EU has higher annual average growth rates in investment, but the US has a higher proportion of intangible investments relative to tangible. In Europe, the Scandinavian countries show higher rates of growth of intangible investments; the case of Finland is noticeable since it shows negative growth of physical capital and a very high growth rate of investments in intangibles, the highest rate among all reported countries.

Figure 1. Investment in tangibles and intangibles as a % of GDP, 1985-1995.

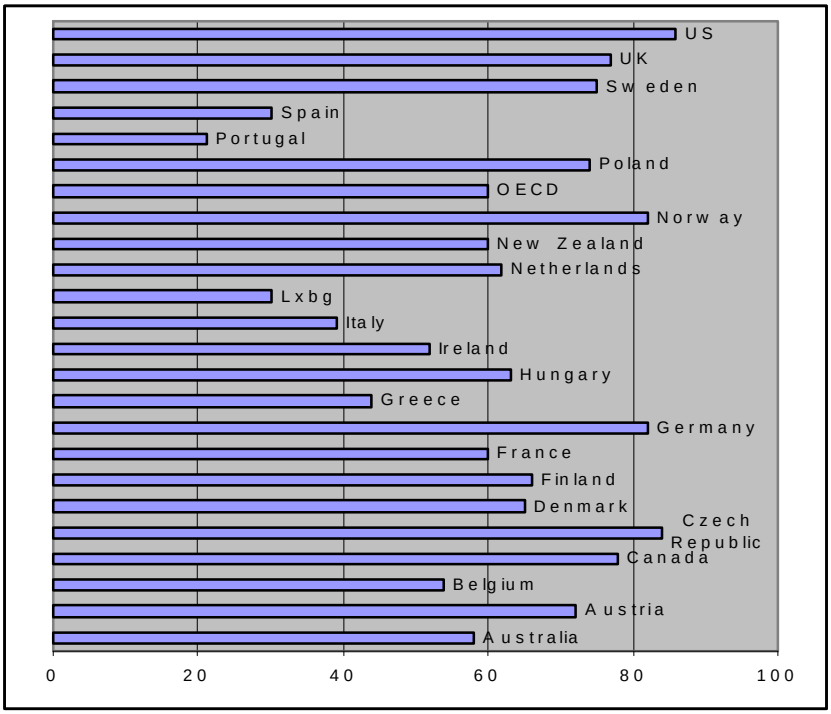
Annual average growth rates



Note: Tangibles are total gross fixed capital formation; intangibles are knowledge-related assets, i.e. R&D, public spending in education and software. (source: Vickery, 2000).

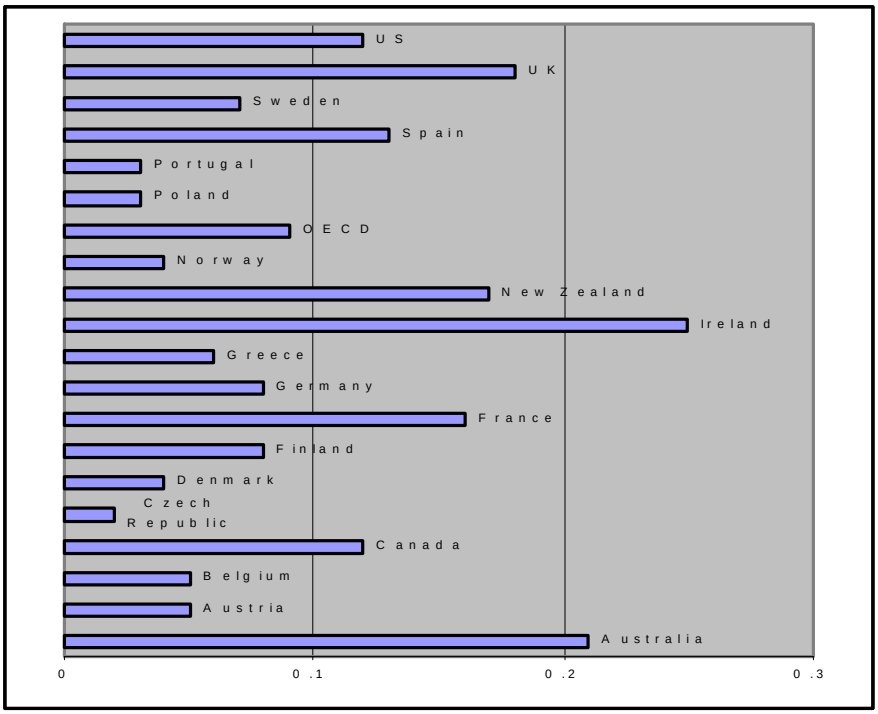
Human capital is difficult to measure and existing measures are imperfect. The graph below reports the educational attainment of the population as a percentage of the total population aged 25-64, in 1996, in tertiary education only. National figures are not directly comparable since educational systems differ. For instance, Germany is characterised by high training within enterprises, and this is not captured in the data. The US has a high rate of educational attainment in tertiary education but has poor education for intermediate levels of qualifications.

Figure 2. Educational attainment of the population, as % of pop aged 25-64, 1996 or latest available year (tertiary education)



Source: OECD, 1998

Figure 3. Flows of graduate in science and engineering as % of total employment 1996 or latest available year



Source: OECD, 1998

Overall, the composition of employment is shifting towards more white-collar occupations and higher levels of qualifications.

The value of high technology exports from OECD countries has grown considerably over the last decade, exceeding the growth rates in other manufacturing areas. Between 1990 and 1996, exports by OECD countries of high-tech industries (aerospace, computers, electronics, pharmaceuticals) and medium-high-tech industries (cars, chemicals) grew by 7% a year, as compared to 5% for other types of goods. Investment in information and communication technologies (ICT: hardware, software, services and telecommunications expenditure) averaged 7% of GDP in OECD countries in 1997. The bulk of such expenditure are accounted by telecommunications.

Both in terms of employment in the ICT sector and value added created in that sector, the US is taking the lead, as shown in the below table.

Table . Share of country in total OECD

	Employment	**Value added**
Australia	1.5	1.2
Austria	1.3	0.8
Belgium	1.0	0.8
Canada	3.4	2.9
Czech Republic	1.2	0.5
Finland	0.7	0.5
France	5.3	3.9
Germany	7.6	7.5
Hungary	1.2	0.6
Italy	5.2	4.5
Japan	**16.1**	**12.8**
Korea	3.6	5.3
Netherlands	1.6	1.2
Norway (1995)	0.6	0.3
Portugal	0.7	0.5
Sweden	1.4	1.0
UK	8.7	6.9
US	**35.3**	**48.8**
EU	**34.7**	**27.6**
OECD	100.0	100.0

Source: OECD ICT Report, 1998.

As a conclusion, there seems to be a lead of the US in terms of investment and creation of value in intangible assets. Intangibles however are difficult to measure and only imperfect proxies are used to give an idea about their extent (Buigues et al., 2000, Lev, 2000). In our view this reflects the lack of underlying economic theory of intangibles. As shown in the next section, economics has considered intangibles but not in a unified manner.

3. What economics says about intangibles

Before attempting to provide a discussion of the properties and policy implications of intangibles, it might be useful to review what economics has to say about them. Economics considers intangibles in four main aspects: human capital, innovation, organisation and knowledge. We discuss these in turn.

3.1. Organisation

The consideration of organisation as a factor for differential performance across firms has recently experienced renewed interests, due to the evidence of organisational changes diffusing in firms of most countries. In particular, the development of new databases on firms' organisation, based on surveys to managers and sometimes employees, has provided new insights on the importance of new organisational practices, their determinants and effects.

The surveys ask how the firm is organised, including questions on the number of hierarchical levels, the average number of subordinates per head, the extent of team work, job rotation, incentive systems, etc. Often it is asked how is the organisation now and how it has changed in the last few years, in order to get an idea of changes in the organisation. Such surveys provide qualitative data on organisation changes and new work practices that have been analysed by both labour economists and industrial economists. Such data incur a number of problems of measurement error (answers might be exaggerated and therefore produce biases in the statistical and econometric computations) or selectivity biases. Data are often not representative of the whole industry in the whole country, surveys being confined to particular sectors (mechanical industry in the German ISI study, see Coriat, 1999) or particular regions. However, some nationally-representative databases have been compiled in a number of countries, including (not exhaustively) the US, UK and France.

In the US, the National Employer Survey (NES) has been conducted in different years in the decade 1990 (1994 and 1996). It is based on questionnaires sent to American firms in all sectors,

asking questions about some aspects of the production system, such as the adoption of just-in-time, work organisation (the use of quality circles, job rotation, team work, etc.), about remuneration systems (profit-sharing or other forms of remuneration), and so on. Various authors have analysed such data, and have found that a relatively small but significant part (about a third) of US firms have adopted such practices, that adoption depends primarily on the sector and firm dimension, and that adoption has a positive impact on productivity (Black and Lynch, 1997, 2000, Cappelli and Neumark, 1999, as well as Osterman, 1994, and Ichniowski et al. 1997, 1999, on other sets of US data).

In the UK, the survey is the Workplace Industrial Relations Survey (WIRS), based on questionnaires sent to employers, and conducted in different years: 1980, 1984, 1990 and 1998. In 1998, the respondents of the 1990 survey were traced back and interviewed again, generating a first panel dataset, and employees were also interviewed, so that the survey became WERS (Workplace Employee Relations Survey; see Millward et al., 1999, Cully et al., 1999, for a review). In addition, the 1998 survey was extended to include employees as respondents. The focus of these survey is workplace organisation and industrial relations; however, a number of questions allow to draw insight on the link between technology, organisation and performance, as shown by the work of Michie and Sheenan (1999) on the impact of organisational change on product and process innovation.

In France, different surveys have been conducted (see Greenan and Mairesse, 1999, for a review). One survey is REPONSE (work relations and firm negotiations) which was first conducted in 1993 (Coutrot 1996, Coutrot and Malan, 1996). The survey TOTTO was conducted in 1987 and 1993 and aims at identifying the relationships between work conditions and worker and workplace characteristics, on the basis of questionnaires sent to workers only. A number of surveys concentrate on technological and organisational changes, without considering internal labour market features. One example is the SESSI survey conducted by the Ministry of Industry in 1993 on organisational changes (Greenan, 1996) and another is the COI (Organisational Changes and Computerisation) which Greenan and Mairesse (1999) analyse.

Overall, studies of the data find a broad direction of changes in organisations,[1] characterised by higher communication (both horizontal and vertical), flatter hierarchy, higher interactions with the environment (suppliers, competitors,…) at the level of firm structure; concerning work organisation,

[1] Of course such studies incur problems of robustness, due to measurement problems, endogeneity and selectivity, typical of survey data (see Leoni-Cristini-Labory, 2000 for a technical review). However, a number of studies (e.g. Ichniowski, 1997, 1999, Black and Lynch, 1997, 1999, Greenan and Mairesse, 1999, control for econometric problems).

higher decentralisation, higher task integration and lower specialisation; internal labour markets have more complex remuneration systems (profit sharing, pay for skill, etc.), higher selection (screening) and more training, and industrial relations improve, in that trust tends to be established between the management and workers. Most studies (Arthur, 1992, 1994; Black and Lynch, 1997, 2000; Ichniowski, 1997, 1999; Greenan and Mairesse, 1999) on the various datasets find that the organisational practices (such as teamwork, job rotation, low number of hierarchical level, pay for performance, and so on) form clusters and must be implemented together to produce positive productivity effects. The latter analyses of productivity generally assume that organisational changes add to usual productive factors (labour and capital) in the production function.[2] However, no theoretical rationale for such production functions are given. The only theoretical reference mentioned in some studies is the supermodularity literature (Milgrom and Roberts, 1990, 1995), which idea is that it is the complementarity between practices which makes their joint adoption profitable, complementarity being defined as a case in which the adoption of one practice raises the marginal profit of adoption of other practices. The problem is that such a theory justifies ex-post why some practices may be adopted together, but does not predict ex-ante what practices will form a cluster. The analyses of the effects of organisational changes on performance generally concentrate on productivity effects (except for Ichniowski et al. 1997, 1999, who analyse the effects on product quality and on profitability) and effects on wages (with mixed results, see Leoni-Cristini-Labory, 2000, for a review). This results in a lack of consideration of the costs of organisational changes. Besides, the studies generally have data on performance for the next few years after organisational changes, so that long term effects on performance are not captured. Kato - Morishima (2001) on Japanese data finds that employee involvement schemes and employee share option programmes take seven years to have positive effects on performance.

Overall therefore, there is evidence of widespread organisational change. Being based on opinion surveys and given the lack of theoretical background on organisational practices, data are not comparable across countries: questions differ and even management concepts differ across countries. However, broadly about a quarter of larger firms have shifted to the new structures. Adoption depends on the size of the firm (larger firms do more OC), the intensity of competition (OC is more widespread among firms competing in international markets), and the sector.

Hence the way firms organise, that is the way they coordinate resources and build and develop the capacity to renew product or innovate must be taken into account in any analysis of firm

[2] Leibenstein (1966, 1975) can be considered as the pioneer in such productivity studies, since he seems to have been the first to argue that the productivity differences observed across firms with similar technology might be due to organisational factors. He developed the concept of X-inefficiency, meaning organisational slack.

competitiveness; in general, organisation therefore appears to be an important intangible asset of the firm.

Organisational innovations (OI) are not clearly understood, neither their causes nor their patterns nor their effects (Labory, 2000). The empirical literature does not discuss causes for OI at length. Reasons mentioned are the diffusion of information and communication technologies or the increasing intensity of competition inducing firms to concentrate on non price factors of competitiveness. The widespread hypothesis is that OI are adopted because they raise firm performance, but the way in which they do so is not discuss at length, reflecting the lack of theoretical development that could guide empirics (Labory, 2000). Kato suggests that leadership may play an important role in OI. Thus Panasonic adopted joint labour management committees before most other Japanese firms partly due to the progressive and creative mind of its founder, K. Matsushita. The fourth section will consider again these issues and interpret them in light of our interpretative framework of intangible assets.

3.2. Human capital

In the new organisation, the nature of work changes and a higher skilled workforce is required (Caroli – Van Reenen, 1999, Caroli – Greenan – Guellec, 2001, Thesmar – Toenig, 2000). This means low-skilled workers are either trained to gain new skills or are fired and replaced by higher skilled workers. However, even after the adjustment is done, it seems that firms continue training programmes, job rotation and other features that mean that the nature of work could be changing. Work was rather repetitive and monotonous, work is now enriching, requiring constant evolution and adaptation. Hence human capital appears to be more important now than under fordism. Rajan and Zingales (2000) argue that human capital is the key to competitiveness in the new economy.

The human capital theory emphasises the notion that individuals are investors: they invest in education in order to achieve higher incomes in the years to come. Human capital is an asset similar to physical or financial assets. Becker (1975) and Schultz (1969) in their seminal work have stressed that human resources are a major production factor and contribute to a large extent to productivity increases. Another advantage is that investment in human capital provides positive externalities (benefits not reflected in private incomes) in that it fosters the efficient acquisition and transmission of knowledge. Thus Romer (1989) shows that the initial level of literacy does help predict the rate of investment and indirectly the rate of growth of a country.

In short, the contribution of human capital theory is summarised by Mincer (1989): “human capital plays a dual role in the process of economic growth: i) as a stock of skills – produced by education and training – it is a factor of production co-ordinated with physical capital and with ‘raw’ (unimproved, unskilled) labour, in producing total output; ii) as a stock of knowledge it is a source of innovation, a basic cause of economic growth”.

The theory is well developed in terms of contractual issues and incentives of employees to exert effort (Lazear, 2000 and the review of the economics of personnel), under problems of information asymmetry. The heterogeneity of employees in terms of ability is considered in theoretical models, but the problem is empirical: the ability or competence of workers and the knowledge they master is difficult to measure and, as shown in the previous section, proxied by educational levels in empirical research. This excludes innate abilities not learnt at school and training and skill development during the working life. If human capital is a key to innovation and to the development of intangible assets, such issues would need to be addressed in more details. For instance, in the “new” economy, whether and what competence/knowledge should be emphasised in the educational system, what type of training should be given to low-skilled workers, what relationships between some institutions (e.g. universities and firms) should be favoured, and so on.

3.3. Innovation

In many industries the rate of product renewal and of product differentiation has increased in recent years, making innovation a key to competitiveness. According to Lev (2000), “innovations are created primarily by investments in intangibles. The new products, services, and processes that are generated by the innovation process (e.g. new drugs, etc.) are the outcomes of investment in R&D, acquired technology, employee training, customer acquisition costs, etc. When such investments are commercially successful and are protected by patents or first-mover advantage, they are transformed into intangible assets creating corporate value and growth.”

Traditionally, innovation studies have mainly focused on R&D activities and on process innovation, with the expenditure on R&D assumed to determine the rate of innovation, and on the determination of optimal patent (see Ulph, 1995, Malerba, 2000, chapter 14, for a review; Gilbert – Shapiro, 1990). The basis of the economics of innovation is the analysis of the market failures associated with the market for ideas. Geroski (1995) outlines three main market failures associated with the market for ideas. First, spillovers (externality) arising because of the public good character of knowledge. Thus knowledge is in many respects both non rival (the use by one agent does not impede the use by another agent) and non excludable (the producer of a new knowledge cannot

prevent other agents to use the knowledge although they do not pay for it). This creates the problem of appropriability, in that it is difficult to prevent other agents from taking advantage of a given innovation. The evolutionary theory disagrees with the non excludability of knowledge, arguing that some knowledge (tacit) is difficult to imitate (Pavitt, 1995). The second market failure is non-convexity due to increasing returns (innovation has large fixed costs but low or zero marginal costs): marginal cost is then lower than average costs, and marginal cost pricing is not viable (firms therefore try to monopolise the market). Third, risk and uncertainty inherent in the innovation process which may lead to underinvestment in innovation. There are three types of uncertainties in R&D: technological (is it possible to do what we would like to do?), commercial (will there be a market for this new product?) and competitive (will competitors produce better innovation?).

A resulting problem is that it is difficult to price ideas: it is difficult to give a price to an idea before knowing it. However, once one knows the idea, there is no need to buy it any longer (Arrow, 1974). Hence the market tends to undervaluate innovation, which leads to low returns to innovation and therefore reduces this incentives to innovate. Arrow (1962) made the first steps in formalising the economic incentives to innovate within an equilibrium framework. He showed that incentives to innovate are higher under competition than under monopoly.

The public policy problem is that it is efficient to have maximum diffusion of knowledge, since marginal costs are nil, but maximum diffusion means low incentives to innovate (tradeoff). The problem of spillovers has been at the heart of policy recommendation by economists: suggested policies have been subsidies (in order to maintain incentives to innovate and ensure diffusion), R&D cooperation and patents. Patents provides legal protection of the innovation. However, they have been shown in the empirical literature (Griliches, 1990, Pavitt, 1995) to be undervalued and imperfect since, in particular, they do not protect process innovation, the latter being better protected by lead time, secrecy and first-mover advantages.

In formal models, spillovers are assumed to be a parameter that allow innovation by one firm to have effects (via cost reduction) on other firms. The parameter is generally exogenously given and there is no clear story on its determinants. Empirical research has attempted to measure spillovers but without much success. Generally R&D by other firms in the industry is added in the productivity equation (that measures the productivity effects of R&D). If the variable turns out to have a significant coefficient, there is spillover (defined as knowledge flow not accounted for in transactions, i.e. externalities). Such a procedure is imperfect in that it incurs problems of aggregation (the spillovers may arise between two firms only and not between all firms in the industry), and it excludes some spillovers, such as the spillovers arising between industries and

between the firm and its suppliers. In addition, some knowledge flow can be unintentional and not external and therefore there is no problem for the return to innovation. In fact, in order to measure spillovers one would need to evaluate the importance of different channels through which information flows: publications, employees changing firm, reverse engineering, and so on. The extent to which knowledge flows through these channels depends on the capacity of the receivor, the nature of knowledge, the incentives of individuals. Levin et al. (1987) have provided empirical evidence on the efficacy of a number of knowledge flows in their survey of the conditions for appropriability. They found that independent R&D is often cited as an effective way to learn knowledge from rivals, as well as licences. Other studies show that such channels are numerous and varied and differ according to the sector and the dimension of the firms.

A branch of economics, the evolutionary theory (Nelson and Winter, 1982; Dosi et al., 1998, 2000) has stressed that innovations are continuous and cumulative by nature and are mainly combinations of techniques rather than completely new products or processes or systems, which means that a firm's learning process is localised, cumulative and dependent on the accumulation already embodied in its products. The point of view of analysis is therefore essentially dynamic and emphasises variety as a source of economic development. It is the heterogeneity among firms which makes evolutionary change possible and, like in biology, the focus of evolution is adaptation to changing environments. In industries, such adaptation is realised through learning processes. In order to stay competitive, firms and individuals are involved in complex learning processes, where not only the funding of R&D is essential, but also the gathering of public and proprietary (patented information and firm-specific knowledge) "know-how" through shop-floor production, marketing, training, inter-firm agreements, joint ventures, strategic alliances and consortia, licensing, trade marks, copyright, etc.

From this perspective, "policy is about enhancing the creative process" (Metcalfe, 1995), and this is mainly done by creating the appropriate environment (or "milieu", ref.) for the creation and diffusion of knowledge. The notion of systems of innovation is key: it is a set of institutions (firms, governments, universities, etc.) which jointly and individually contribute to the development and diffusion of new technologies and which provide the framework within which governments form and implement policies to influence the innovation process. Within such systems non-market relationships are important. The main concern of the policy maker is therefore to create the appropriate range of institutions and the mechanisms for establishing appropriate relations between them. However, the focus so far has rather been on national systems of innovation. In the context of globalisation and

regional integration, such as in the EU, one can ask whether the nation is the appropriate level to define the system of innovation.

This can be compared with (or referred to) the notion of industrial atmosphere of Marshall. Marshall outlined agglomeration economies arising in 'local systems' of industries:

> *"When an industry has thus chosen a locality for itself, it is likely to stay there long: so great are the advantages which people following the same skilled trade get from near neighbourhood to one another. The mysteries of trade become no mysteries; but are as it were in the air, and children learn many of them unconsciously…() The advantages f variety of employment are combined with those of localised industries in some of our manufacturing towns, and this is a chief cause of their continued growth" (1890, book IV, chapter X, paragraph 3).*

The marshallian concept of industrial atmosphere thus refers to non-trade relationships arising in such 'local systems'. Marshall also mentions the importance of the historical process in shaping such an industrial atmosphere. Such an atmosphere cannot be easily transferred and provides benefits which are difficult to reproduce. Marshall shows the irreversibilities associated with external agglomeration economies and with the dynamics of localised collective learning .He also stresses the dynamic and complex characteristics of markets:

> *"Here every economic force is constantly changing its action, under the influence of other forces which are acting around it. Here changes in the volume of production, in its methods, and in its costs are ever mutually modifying one another; they are always affected and being affected by the character and the extent of demand…() In this world therefore every plain and simple doctrine as to the relations between cost of production, demand and value is necessarily false: and the greater the appearance of lucidity which is given to it by skilful exposition, the more mischievous it is" (1890, book IV, chapter V, paragraph 2).*

Innovating means creating of knowledge. Knowledge is an important intangible asset, as discussed in the next section.

3.4. knowledge

The common denominator in the discussions of intangible assets and their various generators and forms may be knowledge. Innovation is a creation of new ideas, hence of knowledge. Human capital is a stock of knowledge and ability to create new knowledge. The advantage of organisation may stem primarily from their ability to co-ordinate knowledge exchange and creation.

Knowledge has not been very much discussed in mainstream economics. The focus has been on information, because in order to be treated as a good, knowledge must be put in a form that allows it to circulate and be exchanged. The main transformation considered by economists is the transformation of knowledge into information, i.e. the codification of knowledge. Information is knowledge reduced to messages that can be transmitted to decision agents. The view that the distinction between information and knowledge is not meaningful dates back to the approach of Arrow (1962), who considers knowledge as equivalent to information and as a public good.

Evolutionary economists (Nelson – Winter, 1982, Dosi - Marengo, 1994) have a different view of knowledge (see Gambardella – Pammolli, 2000, for a review). They highlight the importance of the learning processes by which knowledge is created and underline its contextual features. An important point is that knowledge is not necessarily easily transferred. Even scientific knowledge is not systematically tranferred, and is replicated with high costs: different scientists in a different laboratory may not produce the same result.

Knowledge is not a scarce resource: it can be expanded infinitely. In practice, the knowledge set is limited by the capacity of human mind. Hence knowledge generates increasing returns to scale: knowledge is cumulative. As stressed by Grossman and Helpman (1994), "knowledge is cumulative, with each idea building on the last, whereas machines deteriorate and must be replaced".

Knowledge may be non excludable: codified knowledge is non excludable and can be appropriated if not protected by legal rights. Tacit knowledge is imperfectly appropriable: product reengineering may allow a company to discover the tacit knowledge embedded in the new product of a rival firm; hiring an employee from the rival firm may also allow to acquire both codified and tacit knowledge (intangibles) of the rival. Hence there can be spillovers. This partial excludability (fuzzy property rights) property of intangibles is important. According to Lev (2000, p 55), "exploiting the potential of a machine to the fullest is a manageable engineering task. Making full use of the tacit knowledge residing in the brains of employees is considerably more challenging. Only when such knowledge is coded (in manuals or artificial intelligence programmes) and systematically shared with other employees is the value of knowledge fully exploited to the benefit of the company".

Knowledge is difficult to grasp also because it can take various forms: it can be embedded in products, protected by legal rights or can take the form of organisational assets. This create problems for its evaluation. It is difficult to say how much knowledge is embedded in a product, and it is difficult to say how much knowledge contributes to the performance of a firm.

Another characteristic of knowledge it that it is intimately linked to networks: knowledge builds and diffuses in networks of relationships between individuals and organisations. In order to

collect new information and knowledge it is important to set up networks with many nodes in order to have access to different sources of knowledge, but not too many nodes otherwise the problem of overload may occur, implying delays in knowledge processing and therefore decision-making. (Radner, 1992, 1993; Bolton and Dewatripont, 1994; Caillaud et al., 1995; Marschak and Reichelstein, 1998; Garicano, 2000).

4. The economics of intangibles: issues

There is no clear single or set of theories of intangibles. In economics, different intangible assets tend to be considered separately, and the relation between them is not clear. Economics being a theory of exchange, the tendency has been to turn all assets into goods and services, that can be priced and exchanged. The problem with intangibles is that there are difficult to evaluate, to imitate and exchange and often no market exists for them (e.g. knowledge). Human capital is analysed as a good exchanged on labour markets. Knowledge and innovation (i.e. the creation of knowledge) are analysed pointing to market failures. Innovation is not well understood in particular because of the difficulty to grasp what is behind spillovers, as stressed in section 3.3.

Another question raised by the empirical evidence of section 2 is to what extent intangibles are becoming key factors for competitiveness in all sectors, even traditional ones. Intangibles might be becoming key assets everywhere, but to different degrees; perhaps not all components of the intangible capital have the same importance in all sectors. For instance, the characteristics shared by firms in mature markets of intense competition to maintain market shares and create market niches are sometimes generalised to the whole economy (e.g. Ducharme, 1998), but this might not be completely true.

In fact, what is needed is a deeper look into the nature and effects of intangible assets. Empirical research is needed to guide such conceptual reflections. We provide below the first steps of such an analysis.

4.1. What changes are we talking about?

The evidence provided in the second section is that among economic activities, research and development, training of personnel and the use of ICT are becoming predominant relative to investments in physical capital; firms are requiring higher quality rather than higher quantity of the workforce. These might just be signs that the average education of the population is increasing, that the ICT sector is booming and that the amount of research and development activities are increasing

because some sectors, such as pharmaceuticals, energy, transport, are attempting to innovate and gain competitive positions. This does not raise fundamental questions for the theory of economics, only the issue of better measuring such assets.

More interesting are the changes arising in the organisation of production. Firms are concentrating on core activities, outsourcing some activities, decentralising authority within their hierarchies, which are becoming flatter. To a certain extent the nature of work at lower levels of the hierarchy is changing, in that workers are increasingly involved in teams, hence need to develop relational competencies, as well as being involved in problem solving, hence more analytical competencies are required of them. In our view, these changes are the fundamental changes that need to be taken into account, in particular since they might have fundamental policy implications.

4.2. Why the rise in intangible assets now?

One can say that the major changes in the extent of the market that occurred over the last two (or three) decades have resulted from a major technological change, the "third industrial revolution": the development of computers and information and communication technologies. Such technological change has had two major implications. First, it has eased globalisation, that is the competition in different markets in the world (or world-wide for a number of industries) and to compete against more rivals. Second, it has allowed new strategies to be implemented (or old strategies to be better implemented), in particular non price strategies: increasing vertical and horizontal product differentiation, that is, higher quality and more variety respectively. ICT indeed allow higher amount of information to be collected and processed, and therefore more knowledge creation, more innovation. Another strategy is frequent product renewal, also eased by the ability to collect and process large amounts of information on markets, consumers' tastes, and so on.

The extent of the market has increased not only in terms of geographical market, but also in terms of relative power, since the number of competitors has increased. Another consequence of the development of the above-mentioned technologies has been the development of new productive tools, such as CAD/CAM, robots, and so on, that have made possible a number of changes in the division of labour, i.e. the organisation of production, such as the flexible production system.

In order to provide some basis for the analysis of intangibles, we think one must go back to Smith. Bianchi (1984, 1991), examined the industrial restructuring of the late 1970s and 1980s in the light of the Smithian analysis of the organisation of production and market power. More precisely, he showed that the introduction of the flexible production system, allowing to combine economies of scale and economies of scope, and the reorganisation of production cycles responded to changes in

the extent of the market, where the latter term is intended in the Smithian definition of extent of the power relations between rivals. He showed that what was lacking in economics to fully account for such industrial changes was a focus on the organisation of production as endogenous to competition.

Such analysis is more than ever pertinent nowadays. Intangible assets raise puzzles for economics only insofar as a theory focusing on exchange and not on the organisation of production cannot properly include intangibles. The next section discusses the nature of intangibles in order to show the pertinence of the analysis by Bianchi.

4.3. What are intangibles?

In the management literature, intangibles are defined as "sources of probable future economic profits lacking physical substance, which are controlled, or at least influenced, by a firm as a result of previous events and transactions (self-production, purchase or any other type of acquisition) and may or may not be sold separately from other corporate assets" (Garcia-Ayuso, 2001, p5). The sources of future profit are primarily the three elements that constitute the intellectual capital of the firm:

- the human capital is comprises the knowledge, skills, experience and abilities that employees have and that the firm does not own (and looses of the employee leaves the firm); examples are innovative capacity, creativity, know-how, professional experience, employee flexibility, motivation, satisfaction, learning capacity, loyalty;
- the structural capital is the pool of knowledge that stays in the firm when employees leave (organisational routines and procedures, systems, culture, etc.); examples are innovation capacity, organisation flexibility;
- the relational capital (or social capital?) consists in the resources related to the external relationships of the firm, such as those with customers, suppliers and R&D partners; examples include image, alliances, customer loyalty, customer satisfaction, market power, environmental activities.

The important property of such assets as skills, experience, abilities, image and the benefits of the different relationships the firm set up with other institutions is that (a) they are created by a combination of tangible and intangible assets; and that (b) they are not, and cannot be, exchanged on markets nor contracted. For instance the image of the firm results from investment in advertising and promotion activities (tangible), as well as from the human capital (competencies) of the marketing personnel and the organisation of the marketing department, that is the co-ordination of marketing activities with other activities carried out in the firm, and the knowledge flows allowed

by the organisational structure. The latter two assets, human capital and organisational capital are intangible assets. Concerning (b) above it is quite straightforward to show that skills, know-how or relations cannot be priced and no market exists for such assets. However, there is widespread evidence that such assets do matter for firm performance.[3]

One could argue that at least some intangible assets can be priced and exchanged on markets, although imperfectly. However, the point is that they appear to be essential for the activities and the creation of value for a firm, yet they have not been properly accounted for in economics.

The implications of such a definition on the properties of intangible assets are the following:

1. **complexity**: intangible assets result from complementary decisions on organisational structure; human resources management (selection, training, motivation, etc.); innovative effort (research team, product concept, etc.); marketing (to identify consumers' needs or tastes); and so on;
2. **high cost**: due to the complexity (requires to incur costs of changing organisation, of training, of R&D, of marketing,…); big part is **sunk** (hence barrier to entry);
3. **Dynamics** (flow): the intangible capital is inherently dynamic, in that it does not have a static value, at a certain point in time, but its value results from the future potential gains it can generate. Some of the activities necessary to generate the intangible asset are not priced, do not require to incur a cost (e.g. having a good idea); intangible assets often do not have a value now but are important because they may yield value in the future (for instance, a particular organisational structure, an idea for a new product, a particular relationship of the firm with a university, etc.);
4. **Risk and uncertainty**: due to the above characteristics, the investment in intangible capital is highly risky and uncertain.

Notice that the third characteristic may imply that the only way to evaluate the intangible capital of a firm is to assign a probabilistic value. The intangible capital is measured by the probability distribution of its future value, which depends on past success, products in the pipeline, quality of human resources, etc.

An important characteristic of intangibles is their complex nature: they are created by carrying out (not necessarily intentionally) a set of complementary (intangible and tangible) activities. For instance, innovation results from organising a team of researchers (organisation), selecting and motivating the researchers (hiring procedures and incentive systems respectively), acquiring machines and computer necessary for the research, and so on. Another insightful example is that of a

[3] See the literature on the productivity and profit effects of organisational change: for instance, Black – Lynch, 1997, 2000; Greenan – Mairesse – Topiol-Bensaid, 1999; and the literature reviewed in section 3.1.; the literature on endogenous growth, for instance Romer, 1990; Young, 1993; Guellec – Ralle, 1993; Caballero – Jaffe, 1993).

local system of small and medium sized firms that produces for a niche market and regularly realises product innovations: such a system creates value by bringing together and setting up a network between the various firms (suppliers, assemblers, specialists in design and research, etc.), by having human resources ready to set up their own firm once they have acquired work experience, by gaining from being embedded in a local community where everybody more or less knows each other or at least shares the same language, norms and values, thereby facilitating exchanges. The biomedical valley of Mirandola (Lipparini-Lomi, 1999, Biggiero, 2001) is an example. This characteristic implies that intangible assets are highly specific and cannot be easily transferred: in order to acquire an intangible asset such as the capacity to innovate of a competitor, a firm would need to adopt the organisational practice of the competitor, hire the same human resources or train and motivate its own human resources to try and make it acquire the same competence as the competitor, buy the same machines and equipment necessary to carry out research, set up the same links with other institutions, for instance with some university lab, and so on.

4.4. On the organisation of production and the extent of the market

In order to understand such issues it might be useful to go back to Smith. In particular, the heart of the matter might be the dynamic relationship between the internal division of labour and variations in market conditions.

Smith explained such a relationship using the example of a public mourning which suddenly raises the demand for black cloth; the result is that “the market is under-stocked with commodities, not with labour; with work done, not with work to be done” (Smith, 1776, p 52). In fact, when demand changes what is important is the work to be done, not the work done (i.e. the commodities), because the work to be done represents the capability to adjust production to demand fluctuations, a capability to undertake a productive function to produce a good.

Bianchi analyses the diffusion of the flexible production system in light of this analysis. In the 1980s, many large, vertically integrated companies producing goods in the mass production system had to change their production system in order to be able to increase their product differentiation at reasonable costs. The flexible production system was invented by Japanese car companies and allowed to produce different models on the same production line, thanks to their sharing common platforms and being differentiated at later stages of the production process. European firms adopted this technique in the 1980s and had to restructure, mainly through the increasing use of robots. According to Bianchi (1984, 1991), such changes led to increase the *work to be done* of the firm relative to its *work done*.

In the end of the 1980s therefore, the relative positions of firms on markets change due to the arrival of new entrants (e.g. Japanese producers in the car industry), and therefore firms change their organisations in order to implement new strategies, mainly higher product differentiation. Products are more heterogeneous, the time to market has to reduce, and this creates a need to make the work to be done organic.

In the mass production system with homogenous goods, the work to be done is equivalent to the work done; in the flexible production system, the work to be done is more important than the work done.

In the classical analysis the extent of the market has a dynamic character; the power of exchanging , i.e. the market power resulting from competition, is directly related to the division of labour, that is, the internal organisation of labour, because the possibility to respond to an effective demand which is realised at a given time on the market depends on the capacity and time to adjust the internal organisation of production relative to competitors. Each important improvement in the organisation of production alters the functioning conditions of industrial activity and produce reactions in other sectors of the industrial structure which, in turn, have reorganising effects.

In the 1990s, firms have continued adjusting production organisation. In particular, after the strategy of automation of the factories of the 1980s, the focus is shifted back to human resources and production reorganised accordingly. Thus even Toyota realises the failure of the completely automated factory in the early-1990s and changes organisation by refocusing on human resources (Labory, 1997). European firms also operate such a focus, so much so that the keywords in management are now personnel competence and learning, knowledge management, etc. The empirical evidence in section 3.1. shows that firms have been or are still experiencing important organisational changes. The major changes can be summarised as follows.

Organisational practices which are generally found to be associated are the following.

- Work organisation:

  Team work; Job rotation; problem-solving groups; TQM (total quality management).

- Internal labour markets:

  “strong” selection, using various types of tests and other screening procedures; both on and off-the-job training; profit-sharing, bonus and pay for competence also for workers and team rewards.

- Wider organisation:

  A low number of hierarchical layers, intense communication between (in particular, between management and workers or worker representatives) and within layers and the decentralisation

of responsibility (more autonomy to lower hierarchical levels); higher outsourcing and collaborative agreements with other firms, including competitors.

In short, the firms are adopting changes which make them look like networks (Labory, 1997; 2002), because they are characterised by higher decentralisation of decision making; higher task integration; lower degree of task specialisation; lower functional separation; more collaborations between firms; outsourcing and more intense communication within and between firms.

Our interpretation is that the work to be done has become even more important than in the 1980s. When demand changes frequently and strategies are rapid product renewal, product innovation, low time to market, the organisation has to be flexible to adapt to changes, quickly solve problems and respond to consumers' needs.

Such work to be done might be the essential intangible asset of the firm.

4.5. Implications for industrial economics

The major implication of the above analysis is that firms differ, mainly in terms of intangible assets. They build different knowledge sets and capabilities, which determine their work to be done, that is, the ability to adapt to changes in demand. Therefore, the rise in intangibles raises a more fundamental problem than the problem of measuring intangible assets such as innovation, human capital and organisation. The problem is to understand precisely how such work to be done is constituted and can change. It is determined by complementary investments and activities: definition of the division of labour into different activities; co-ordination of such activities; decision on which activities to keep in-house and which to outsource; collaborations with other firms on R&D projects, etc. As shown in the previous sections, such complementarities are not well understood, despite the work of Milgrom and Roberts (1990, 1995).

In terms of productivity studies, such issues are translated as follows. The importance taken by intangible assets as knowledge and human capital raises the issue of including intangible capital in production function analyses, and this has started to be done (see section 2). However, there is also a need to better understand how both tangible and intangible factors interact to yield improvements in productivity. The supermodularity theory of Milgrom and Roberts provide a rationale for why the whole is more than the sum of the parts. However, they do not explain why the whole comprises particular elements and not others, and how they combine to produce effects. For example, the training of personnel, combined with pay for performance, less hierarchical levels, decentralisation, more intense communication, outsourcing of some supplying work, and so on, are shown to combine

to produce positive productivity effects (Black and Lynch, 1997, 2000; Ichniowski, 1997 1999, etc.). But why?

Industry studies generally find a significant firm specific effect which is not captured in tangibles: costs, R&D expenditure, training costs, the average education level of the workforce, and so on. Empirical studies of profitability find wide variations in profits across firms and across time. Therefore, the hypothesis of equalisation of profits is not confirmed and cannot be interpreted as temporary divergence from equilibrium since differences persist over time (Chandler, 1990; Mueller, 1986). Scherer (1987) argues that firms that build up a "reputational capital" charge a premium and develop a customer base at lower prices relative to rivals. Other studies explain the variation in profits by collusion or structural barriers to entry (Bain, 1956; Comanor – Wilson, 1967, Collins - Preston, 1969; Demsetz, 1973; Weiss, 1974). However, the latter studies often incur the problem of sample selection bias, being based on samples of surviving firms only. Other issues in empirical studies include the measure of profitability: Bain (1956) used the rate of return to stockholders' equity as a measure of profitability, although he would have preferred rate of return on sales. Stigler (1963) prefers the rate of return on capital, because it is the marginal rate of return on capital that drives the movement of resources from one investment opportunity to another. Hall-Weiss (1967) argue that the rate of return on equity is appropriate since it reflects what managers acting in owners' interests should maximise. In the most recent studies (over the last decade), preference is given to the price-cost margin because of its game-theoretical foundations (Martin, 1993). Generally, the advertising-sales ratio, market shares, market concentration, firm size (proxy for economies of scale) determine profitability. Market share as a significant determinant can be interpreted as firm specific effects, specific firm assets (intangibles?) that positively affect the capacity of the firm to maintain or gain market shares hence profitability. In other cases the constant has positive and significant coefficient and might reflect intangible assets. However, to our knowledge there is no precise explanation of these firm specific effects; one direction of research outlined in section 3.1. has been to look at the effects of organisation changes on productivity and profitability; the finding of significant and positive effects provides evidence of the importance of structural capital (and also human capital).

The economics of intangibles might also be useful to explain an important puzzle of industrial dynamics. Geroski – Mazzucato (2001) show that the evolution of the number of firms in an industry displays a pattern not explained by the theory: neither the argument of a relationship between market size and market structure nor the entry attraction of positive profits are supported by the data. The observed evolution (of the US car industry over a very long period) is that of an initial rise in the

number of firms which has the hallmarks of a bubble, followed by reduction as market size increases. Hence initially the new technology or product raise large interest and many firms enter the market; soon a selection process leads to a rapid decrease in the number of firms, and only the firms that manage to adapt well remain. Could the economics of intangible explain such patterns? It might be that at the initial market phase only the firms which build enough intangible capital remain in the market; and that there is a negative relationship between firms' intangible assets and the number of firms in the industry. At this stage of research, we leave the question open.

4. Conclusions and policy implications

Intangible investments and assets are complex, uncertain, costly, and not fully valued now because they take value in the future (at least partly). Their consideration in economics has been so far rather partial and reductive. However, their increasing importance with the diffusion of information and communication technologies and globalisation make it high time to try and improve their treatment in economics. We think that they represent essential assets, that did not need to be considered in economics in the past, when the organisation of firms was stable, workers were little skilled and had wages attached to jobs, products were standardised; in such a case, the physical capital and the physical part of labour were (almost) enough to account for productivity and performance. At present intangible assets, which cannot always be valued because a price cannot always be attached to them, have become key factors for competitiveness and the productivity and performance of firms and economies cannot be assessed by physical and financial capital alone. In the words of Smith (1776), intangible assets represent the work to be done, that is, the capability of firms to adapt to changes in demand. The study of intangibles is likely to provide the source of the explanation of firm-specific effects that have been outlined in the empirical literature on industry productivity and profitability, hence the essence of the famous "residual" in studies of economic growth.

Intangible assets are created by combining a number of complementary activities: R&D, education, motivation, organisation, relations; it is difficult to predict ex ante what is the optimal combination that produces innovation, entrepreneurship and growth. Such properties might imply that the appropriate policy is that which create linkages, between economic actors, institutions and so on; the conditions for linkages to develop have to be determined and put in place. The conditions for the right linkages and therefore intangible assets to develop might be the existence of proper incentives (equal bargaining power and complementary activities which provide the conditions for co-ordination of activities and exchange of knowledge), and sanctions (to avoid opportunistic

behaviour); in other words, adequate level of form of social capital. Policy makers should create the conditions for linkages to develop rather than setting up the linkages, because the complexity of intangibles make it difficult to predict which linkages are necessary and it might be better to let economic actors try and select linkages. Complementarities should be taken into account in formulating policy. They mean interactions between different policies, but also side-effects of particular policies on other sectors or other complementary activities; for instance intellectual property rights limit access to some knowledge by not only directly involved actors but also all actors whose activities are complementary. In terms of property rights, what matters with intangibles might be control rather than ownership; more precisely, the discussion in this paper shows that the organisation of production expand beyond firms' legal boundaries, so that what matters is the control of some assets by making them dependent, but not necessarily owning them; in other words, there are other barriers to entry than intellectual property rights, and the capability to build, maintain and develop networks might be an important one. In other words, when linkages are important what matters is not the ownership of assets but the control of assets. For instance, human capital cannot be owned, but can be controlled by making it dependent in a relationship; the firm cannot own its human resources but make them dependent by making it profitable for them to relate to the firm and its activities. Another example is that innovative activities: firms do no longer seek to own all laboratories that make R&D, but establish relations with outside laboratories where control results from making such laboratories dependent. Such dependency results from the development of complementary activities: the firm derives advantage from access to the innovation capacity of the lab, while the lab gains from access to the firm's marketing and distribution capacity.

We intend to address those issues in more depth in future research.

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