The Networked Enterprise in Innovation Networks and the Roles of Intellectual Property Rights

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Abstract The paper focuses on the roles of intellectual property rights (IPRs) in the networked enterprise. The issue raised implies to better understand the role of IPRs not only in the strategy but also in the organization of the networked enterprise. The paper shows that IPRs have several roles in the networked enterprise. The first one can be called a '*coordination role*', making easier the relationships between all the fragmented parts of the networked enterprise. The coordination role is gaining ground in the context of collaborative innovation (innovation networks). The second role is the '*incentive/defensive role*', aiming at protecting and thus giving incentives to the constitution of the networked firm's innovation potential, called here 'knowledge capital'. The third role is an '*offensive'* one which largely contributes to define the place of the networked enterprise within the innovation network to which it usually belongs. The paper concludes by stressing the relationship between the roles of IPRs for networked enterprises and the strengthening of IPRs at the global level.
Key words networked enterprise, innovation network, intellectual property rights, innovation, knowledge capital

1 Introduction

"Put simply, patents and copyrights are often the crown jewels in a high tech company's collection of assets" C. Shapiro (2003, p.391)

The big hierarchical firm seems to be part of past history. In 1949, the Ford Motors Company was described in the *Encyclopedia Britannica* as a huge company, owning mines, railroads, hevea plantations, ships, electric plant, foundry, cement works, hospitals, professional schools… etc [8]. Michelin or Renault in France, and many other companies in various sectors and countries had also the same profile of big integrated companies.

Nowadays, the terms of 'networked enterprise', 'hollow corporation', 'fragmented company', 'Fabless', 'vertical disintegration' and 'modularity' express a new reality. First of all, most companies are more and more concentrated on a very small part/ or on small parts of the value chain: conception/design of new products (final products, or intermediary goods), production (of pieces or final assembling); commercialisation (services). Secondly at each step of the value chain (conception, production, commercialisation), most firms try to reduce the ownership of assets to the core activities (the most profitable but also often the most risky) and use contractual relations to manage the rest of the activities. However, these big changes do not mean that only one organizational model –the networked firm- survive. In the MIT vast enquiry 'how we compete?', some cases of integrated companies have been found in various sectors, as for example Zara in the clothing sector which remains very integrated, or Samsung and Sony in the electronic sector [8].

In spite of the diversity of organizational models that can be found in the economic reality, there is no doubt that the organization and the management of activities as a network have gained ground. The organization and the strategy of the networked firm have already been well study in sociology [11, 44] economics and management of innovation and of organizations [see notably 57, 12, 73, 70, 24, 7, 8]. In this paper, we rather want to focus on the role of intellectual property rights (IPRs) in the networked enterprise. IPRs are often studied in relation to the innovation dynamics and strategy, notably focusing on the incentives and strategic roles of IPRs [21, 64, 65, 66, 67, 39]. The coordination role of property rights has been put into light by the transactions costs and neo-institutional theories of the firm [14, 15, 68, 75, 1, 32]. Here, we want to better understand the roles of IPRS from a strategical but also from the organizational point of view, in the particular case of the networked enterprise.

We show that IPRs have several roles in the networked enterprise. The first one can be called a 'coordination role', making easier the relationships between all the fragmented parts of the networked enterprise. This coordination role is moreover revealed to be fundamental in a context of collaborative innovation, i.e. the construction of innovation networks. The second role is the incentive/defensive role,

aiming at protecting and thus giving incentives to the constitution of the networked firm's 'knowledge capital' [38], i.e. the set of scientific and technical information produced, acquired, combined and systematized by one or several firms for productive pruposes. The third role is an 'offensive one' which largely contributes to define the place of the networked enterprise within the networks of firms to which it usually belongs. Thus, this paper not only shows the role of IPRs in the organization and the strategy of the networked enterprise but it also puts into light the fact that the organization of the firm as a network[1] is an important factor that explains the strengthening of IPRs at the global level.

The rest of the paper is organized as follows. Part 2 comes back to the origin of the networked enterprise and defines its main characteristics. Part 3 presents the 'coordination role' and the 'incentive/ defensive role' of IPRs in the networked enterprise, which is gaining ground in a context where more and more firms and institutions are taking part in the constitution of a firm's knowledge-capital. Part 4 presents the 'offensive role' of IPRs, which is determining in the definition of the status of the enterprise (as a leader or a follower) inside the networks of firms. Finally part 5 concludes the paper by stressing the fact that the new forms of organization of enterprises largely explain the recent evolution of IPRs legislation.

2 The Organization of the Networked enterprise: Origin and Definition

2.1 From the Hierarchical to the Networked Enterprise

The main explanations to the change from the integrated and hierarchical company to the networked enterprise are related to the crisis of the Fordist model of production, the deregulation of markets and the diffusion of information technologies.

The crisis of the Fordist model of production begins at the end of the 1960s and is characterized by the saturation of markets for undifferentiated goods. In a more open environment, big integrated firms bear increasing 'bureaucratic costs' and have difficulties to adapt. The necessity to adapt to a changing and diversified demand grows and shows the main change in the competition grounds, from the price in the Fordist model of production to innovation in the flexible model of production. Innovation, that is new combinations in the terms of Schumpeter [62, 63], has become a fundamental objective of the firm, imposed by competition. This idea is commonly shared by business theories [57, 71, 74].

The opening and liberalisation of markets that begins at the end of the 1970s, aimed at fighting against the economic crisis characterized by the conjunction of inflation and unemployment. These policies have been developed and diffused through international organizations (WTO, IMF and World Bank) [48, 49]. The liberalisation of markets (goods and services, labour, finance) opened new markets for firms but also made easier the organization of the production process on an international scale, not only through the creation or purchase of new subsidiaries (internal and external growth) in different countries but also through the signature of contracts with suppliers and subcontractors located in different parts of the world.

Thanks to the progress and the diffusion of information technology, the global management of production - in real time - becomes possible. In fact, information technology binds the scattered units of the networked enterprise. The use of modern information technology reduces the cost of data transfer and facilitates the location of units abroad, as well as national and international partnerships.

2.2 The Characteristics of the Networked Enterprise

A large modern corporation can be sketched as a network of units linked together in the aim of producing goods and services (final or intermediary production). Some of the units are owned by a central firm (usually a holding company) and the other kinds of activities are linked by contract (partnerships, subcontracting, licensing, franchising) (see figure 1).

In the networked enterprise, the central firm focuses on its core activities (usually the ones that will reinforce its innovation capacity and more globally the ones which are at the basis of the definition of firm's strategy). These core activities are wholly owned by the central firm. The achievement of the other activities (for example the production of parts of the final products, the commercialisation of final goods) is mainly managed through contracts with other more or less independent entities (subcontractors, licences, franchises etc.). The fully outsourced activities mainly concern the ones that deal with the implementation of the firm's strategy. Thus, the central firm can be considered as a designer or an architect of global network. The expression 'network architect' is for example used by the Renault Group to describe its main activity.

[1] We mainly refer here to big firms in the industrial sector. We shall note that industrial SMEs are often part of networked enterprises, as well as SMEs specialized in services to industry.

Networked enterprises have gained greater flexibility, thus enabling them to adjust to the evolution of the demand. The networked enterprise associates internal and external flexibility. Internal flexibility deals with the management of work within the company: the enterprise focuses on a stable core of managers in R&D, financial and administrative departments. It uses more diverse forms of work and contracts of employment (in terms of working time, salaries, place of work, job content) to manage the other employees. To this greater internal flexibility are associated increased options in the ways firms manage their assets at the international level (external flexibility). The globalization of corporate strategies refers to their liberty or flexibility in the management of human, financial, scientific and technical assets at international level. Networked enterprises are organized at a global level, taking advantage of the competitive advantages of potential host territories. Holding companies are located in areas with low or even non existing taxation. Research and development laboratories are set up in areas where financial, scientific and technical resources are abundant. Production plants select attractive countries in terms of specialization and labour costs as well as transport infrastructures. Goods are marketed in all financially solvent areas worldwide.

Internal and external flexibility have important impact on the functioning of the working groups and then on the system of motivation: the worldwide dispersion of the members of the technostructure makes it more difficult for them to identify with the specific objectives of the organization (as for example innovation, growth of sales, of size, etc.). The organic solidarity [in Durkheim's words, see 20] that ties the members of working teams is closely related to physical vicinity, which information technologies reproduce only very imperfectly. Financial motivation would thus come back as the main motivation in the big global firm compared to the motivations of the workers of the technostructures of the end of the 1960s [25]. If identification and the wish to adapt are present, the pecuniary motivation however represents the universal objective of the members of global working teams, all the more as the evolutive character of networks makes employees more vulnerable to the possible strategic changes decided by big multinational firms (naturally, the employees who are far from the decision making centres are hit first, but executives are also more frequently hit by reorganizations) under the pressure of institutional stockholders. The increase of opportunist behaviours at the end of the 1990s and the beginning of the 2000s can thus be understood as the result of this undermined cohesion within the large corporation [69, 18, 37].

The increasing role of finance in economics [56, 2] can be observed in the management of companies [24, 47]. The different steps of financial market deregulation and liberalization have produced an interconnected global market. New types of investors (pension funds, insurance companies, investments funds) are investing in big enterprises worldwide. Due to their main activity (e.g. managing employee's pension funds), they feel less concerned by the development of such companies than by the amount of the dividends to be received. Their fluctuating behaviour (they 'vote with their feet'), dependent on the level of the price earning ratio, has important implications in the management of such corporations. In particular, the objective of profit maximization, linked to the increase of the shareholder's value, comes back has one the most important. The "Profitability imperative" is the result of this new context. It means that in order to keep the precious new institutional investors, managers of big globalized corporations have to boost shareholder value. The increase of the shareholder value will moreover be profitable to them, as they have often become, thanks to the stock options plans, shareholders of the companies they manage. This profitability imperative is a powerful reason of the erratic boundaries of networked enterprise, which are transformed by processes of mergers/acquisitions and outsourcing/relocations.

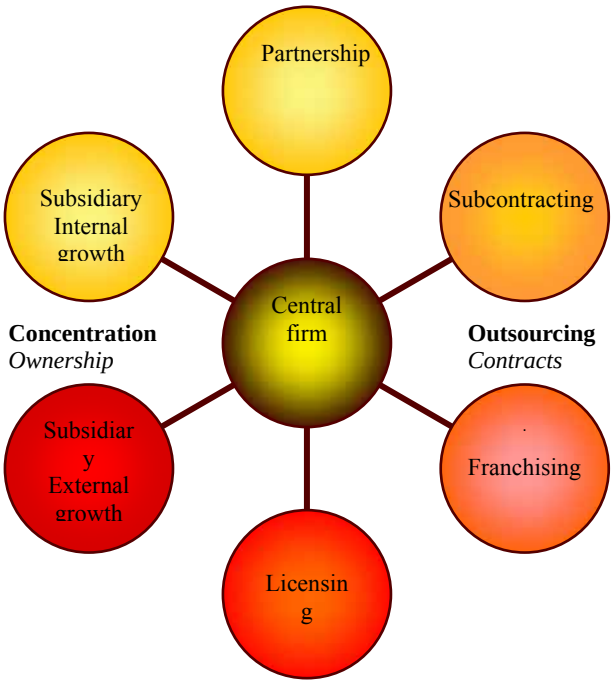

Figure 1 The Networked Enterprise

3 The Coordination Role and the Incitative / Defensive Roles of IPRs in the Networked Enterprise

3.1 The Coordination Role of IPRS

IPRs include industrial property rights, that is to say, patents, trademarks, industrial models, and the protection of trade secrets. They also include copyright protection. The patent is a temporary monopoly (which lasts 20 years) given to an inventor, as an acknowledgement of the invention, whether a product or a process in all field of technology, provided that it is new, involve an inventive step and is capable of industrial application. A trademark protects words, names, symbols, sounds, or colours that distinguish goods and services from those manufactured or sold by others and to indicate the source of the goods. Trademarks, unlike patents, can be renewed forever as long as they are being used in commerce. A design patent may be granted to anyone who invents a new, original, and ornamental design for an article of manufacture. Trade secret laws protect individuals and businesses against the misappropriation of trade secrets by improper means. Copyrights protect works of authorship, such as writings, music, and works of art that have been tangibly expressed.

The networked enterprise means the reintroduction of market in the functioning of the enterprise / compared to integrated firms, where hierarchy is considered as an alternative to market [14]. This reintroduction of market reveals transaction costs, which are caused by the imperfection of markets: information search, finding the suppliers, negotiation of contracts, execution of contracts [14, 75]. In this context, IPRs, just as certification and logistics integration [7], play an important role in the coordination of activities, clarifying the relationship and thus reducing the transaction costs between the central firm and the different units that compose the networked enterprise. The ownership of trademarks for example - but also of course of patented inventions or design- plays like a signal for the central firm or for potential suppliers that shows the quality of the enterprise's products and services. In other words, trademarks may increase the reputation of the central firm and of potential suppliers that would be chosen thanks to the IPRs they own. In the case of subcontracting and in franchising contracts, licences[1] allow the different units to use the patented invention, or the protected trademark or design usually owned by the central firm. Licences are usually considered as producing productive efficiency (to produce proprietary products efficiently; to let others use the intellectual property as inputs to innovation (research tools); to resolve blocking situation and to enable the development of complementary

[1] A Licence is an agreement whereby the owner of intellectual property authorizes another party to use it.

inventions). This third reason being most of all important in the context of collaborative innovation, studied below [64, p.162]. IPRs thus allow the diffusion of technology within the enterprise and gives incentives to the production of specific assets. In the case of R&D partnerships where specific assets are built jointly (co-contracting or contracts between the central firm and a research lab for example), shared patents reduce the possibility of opportunist behaviours (hold-up situations) between the co-contractors.

In other words, the definition of IPRs may facilitate exchanges by reducing transaction costs, as in the Coase theorem [15, 68][1]. However, it does not mean that the allocation of resources will be in every case efficient as the transaction costs do not completely disappear, a situation that would only occur in a context of pure and perfect competition. That is to say that the choice to outsource activities or not will depend on the comparison between the transaction costs and the gains of exchange, where IPRs play an important role.

The coordination role of IPRs is all the more important as, in recent years, innovation has become a collaborative process, linking together several firms and institutions. The building of the networked enterprise's innovation capabilities, its 'knowledge capital' is achieved through innovation networks.

3.2 From Coordination to Incitation in the Context of Collaborative Innovation

We define the "knowledge capital" as the set of scientific and technical knowledge and information produced, acquired, combined and systematized by one or several firms for productive purposes[2]. "Knowledge capital" (see fig 2) refers to the accumulated knowledge of one or several linked firms (embedded in the individuals – know-how – machines, technologies and routines of the enterprise) which is continuously enriched by information flows and which is used in the production process or more globally in the value creation process. Thus, it is a dynamic concept – a process – that defines the knowledge accumulated by one or several firms and continuously enriched and combined in different ways, and eventually used or commercialized. This productive aim – the creation of value – is the main characteristic which turns knowledge into 'capital'.

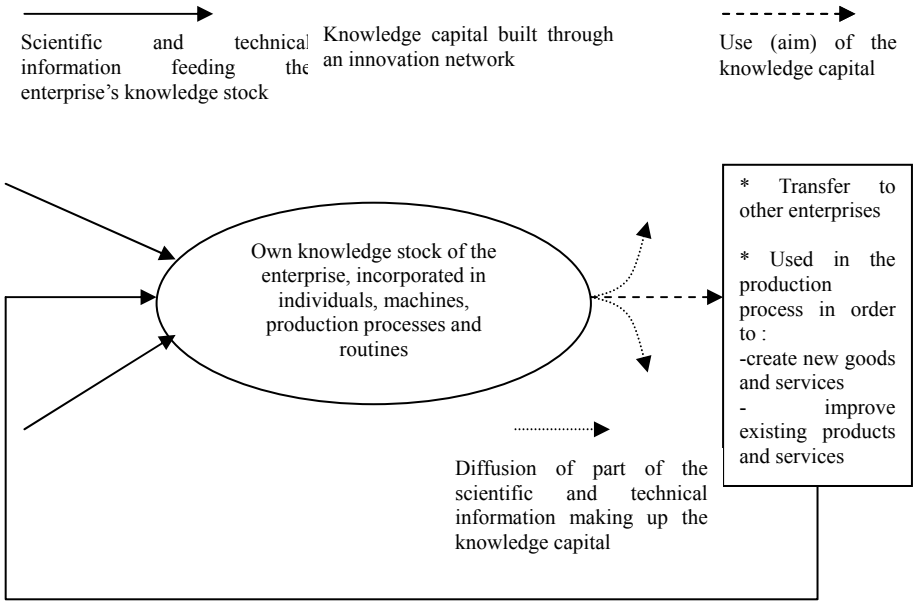

Figure 2 The 'Knowledge Capital' (38)

A firm may use its "knowledge capital" in a value creation process by i) simply selling this knowledge base to another enterprise (e.g. the selling of a computer program). Thus, the "knowledge capital" (embodied in the software) is transferred to another enterprise which can use it in its production process; ii) using this "knowledge capital" in its own production process. In this case, the 'knowledge

[1] The Coase theorem means that negotiation lead to an effective allocation of resources when property rights are clearly defined and when there is no other obstacle to the transaction.

[2] Theoretically, the notion of "knowledge capital" is based on the definitions and/or on the economic developments of three key concepts/notions: knowledge, firm and capital [38]

capital' can be considered as a means to produce or to improve goods and services and as a tool for reducing its production process completion time.

The formation of the enterprise's "knowledge capital" implies the gathering of different types of inputs, i.e. human resources (researchers, engineers), tangible resources (machines, tools) and intangible ones (patents, software, information). The enterprise has to produce and appropriate scientific and technical knowledge in order to expand the knowledge base it has already accumulated. Different means are used by the enterprise, which we can call for one part in-house means (investment and management of human resources, R&D and tangible and intangible resources), and for the other part external means [on the growing importance of external means of protection , see 3]. External means can be divided in two categories: equity relations (for example joint venture) and non equity relations (contracts with firms and other institutions and more informal contacts). (see table 1)

Table 1 Means of Formation of the Firm's "Knowledge Capital"

In-house means	**External Means**
- Investment in Human Resources - Investment in and management of R&D and means of production (tangible and intangible)	*Equity relations*: - joint venture - purchase of innovative enterprise *Non equity relations*: - Contracts with other firms (including licensing) - Contracts with institutions: e.g. university research labs (including licensing and hiring of short term researchers) - More informal contacts

Currently the constitution of knowledge capital shows distinctive characteristics. A first characteristic is the growing interest of firms for the various steps of R&D, notably the most basic ones. Given the strong competitive context based on technological performance and 'permanent innovation' [21], enterprises always try to develop and increase their knowledge base; they focus on their core activities and try to develop their competencies within these activities. Moreover, they are more and more interested not only in applied research but in basic research as well, which is one of the explanations of the interactive character of the innovation process [31].

The second characteristics of R&D activities and thus of the constitution of Knowledge capital is globalization. If R&D has long been regarded as a case of non globalization [54], the studies conducted in the 1990s show that the globalization of RD is gaining ground, whatever the focus of specific studies: in terms of foreign-based laboratories [6, 23, 41, 42], in terms of patents and technological flows [51], and in terms of R&D partnerships [4, 28]. The 2005 issue of the *World Invest Report* also reports a sharp increase in R&D globalization, which however mostly concerns the most applied parts of the R&D process [72]. The aims of the globalisation of R&D activities are mainly to lower R&D costs, attract local scientists, adapt to the needs and regulatory requirements of local markets and attract local scientific talent [53].

Finally, the third characteristic is that firms more and more develop their knowledge base thanks to the innovation network into which they are involved. The issue of networks is now considered as a challenge in the economics of innovation, which starts 'from the recognition that innovation and industry are highly affected by the interaction of heterogeneous actors with different knowledge, competencies and specialization, with relationship that may range from competitive to cooperative, from formal to informal, from market to non market' [43, p.15). The link between innovation and networks which has been made theoretically and empirically [55], shows that after relying on states' investments and on their own competencies, big firms rely more and more on external means of formation of the knowledge capital.

The increase in R&D partnerships and alliances is a first illustration of that trend. Alliances and partnerships may be used whether in exploitation strategies (refinement and extension of existing technologies) or in exploration strategies (exploration of a new technological field) [45].

Innovative start-ups also play an important role in networked enterprise. When they are not taken over by bigger firms, start-ups are often linked by contract with them which usually take part in their funding (through corporate ventures) [34]. In this strategy, the large corporation does not bear alone the risk inherent in the development of new technology, and shares it with its partner (here, the start-up). This strategy has been largely used during the 1990s by big American firms to enrich their knowledge base [71, pp. 425-463].

National or international outsourcing is another way to reduce the cost of technological development (and hence a strategy to increase profitability) and also results in the expansion of networks. It is very often used in the software industry (software design outsourced to Bangalore – India, for example). Innovation activities can be fully outsourced to another institution, being and enterprise or a research lab for example. The relationship between firms and universities and public research labs have been allowed by law in the US since the early 1980s (notably the Bayh Dole Act) – and was further adopted by many countries – thus facilitating the signature of contracts as well as technology transfers between enterprises and universities and more informal contacts between enterprises staff and scholars [29, 50, 35].

This strategy of collective constitution of the knowledge capital can be seen in high tech sectors as in apparently more traditional ones. The case of the Lafarge Group can illustrate this: its research centre is located at L'Isle d'Asbeau, next to Lyon, and is in 2000, the first world research centre, in terms of employees and budget in the field of building material. It also cooperates with other enterprises (Bouygues and Rhone Poulenc, and then Rodhia since 1994) and with research Labs (Polytechniques, INSA Lyon and Toulouse, Universities of Berkeley, Princeton, Massachussets institute of Boston US, of Laval and Sherbrooke Canada and Polytechnique of Lausanne) [5].The evolution of IBM from a hardware manufacturing company to a global service provider has depended on a strong evolution of its collaborative network that has taken part to the adaptation of its knowledge capital. In the case of IBM, the network - and the characteristics of the relationships within the network - has been used to facilitate to the strategic positioning of the firm [19]. It is also through the constitution of a network of partnerships, linking small and big companies, universities and research centres that Monsanto achieved in the 1970s-1980s its strategic shift from chemistry to vegetal biotechnology [30].

The purpose of all these strategies is to reduce the cost, risk and length of technical progress and hence increase the short term return on investment in the scientific and technical fields. This purpose is all the more important that the complexity of technological development increases, which implies a collective process to be able to innovate quicker and with less risks. Due to the profitability imperative, the big enterprise develops external means of formation of the knowledge base, which are both less risky and less costly. This does not mean, however, that the firm does not make in-house investment any more, as this kind of investment is crucial to understanding and absorbing the scientific and technical development achieved by other institutions on their own base [59, 16]. This trend shows that the formation of the "knowledge capital" is built collectively, i.e. several institutions (big or small enterprises, research laboratories…) take part in its formation.

The collective constitution of the knowledge capital thus implies that the role of IPRs in the coordination within the networked enterprise and between the central firm and its partners (networks of firms). This is shown by the sharp increase of licence agreements in the past decade: in a recent survey of firms in OECD countries, approximately 60% of respondents indicated that they had experiences an increase in both inward and outward patent licensing over the past decade and more than 70% expected inward licensing to increase further in the next 5 years [61][1]. Whereas some empirical studies show the importance of property rights protection over transaction cost considerations in the decision to outsource [27], according to us, IPRs also have also a role in the reduction of transaction costs in collaborative strategies (including outsourcing). As a matter of fact, IPRs clarify the relationships between the co-contractors (coordination), and thus, by reducing transaction costs, give incentives to the collective building of knowledge capital, by protecting the tangible and intangible elements that constitute it.

Moreover, the temporary monopoly conferred by industrial property rights gives the possibility to go to courts in case of infringement. IPRs thus secure merchant relations and give an incentive to joint investment efforts and to the internal transfer of technology. Within the firm, IPRs are a tool used by firms to replace the control based on the ownership of tangible assets by a control based on the ownership of intangible assets.

Finally, IPRs give a value to R&D investments, in a context where profitability has become an imperative. Filing and holding patents transform potential inventions in valuable assets, which can give confidence to investors and shareholders concerning the profitability of the firm's investments.

[1] The types of IPRs agreement may depend on the type of commitment between the partners. Whereas licence agreements may be used in exploitation strategies which involve important exchange of information, exploration strategies may rely on lower commitment (as shown by Dittrich et al [19] in the case of IBM), notably at the beginning of the project (trade secrets could be used first – however, if from exploration strategies are generated new technologies, these ones would surely result in shared patents or cross licences).

However, IPRs are not always considered as efficient tools of protection. For instance, patents diffuse too much information and are costly (direct and indirect costs). Copyright protection implies the capacity to make the proof to be the first creator, etc. To reduce the limits of IPRs, enterprises use joint tools of protection; in other words, they built portfolio of protection tools, notably associating lead time to traditional IPRs protection tools [40, 17]. This leads us to the offensive role of IPRs within innovation networks.

4 The Offensive Role of IPRs: Leadership within Innovation Networks

4.1 Patent Pools as a Solution to Patent Thicket

The innovation strategies of networked firms lead to a blurred distinction between the networked enterprise and the innovation network to which it belongs. As a matter of fact the constitution of the knowledge capital implies contractual relations between the central firm and units and partners. The partners may be small and medium enterprises specialized in technological fields but they may also be big enterprises and competitors of the networked firm as a whole. These kinds of alliances are meant to share the cost of development of new products and processes and to reduce the conception needed time. These alliances often lead to an important number of patents that can be owned separately by the different partners or be shared. Whatever the solution chosen, the development of a new technique lead to an important number of patent, a 'patent thicket' in the words of C. Shapiro [66] that can block the use or even the final production by a subcontractor that would have to sign too many and costly licences. The number of infringement and litigation thus also increases. These situations have been become much more common with the growing number of very restricted patents delivered notably by the USPTO since the 1980s [26]. A good example of the blocking impact of a patent thicket in the biotechnology sector is the case of the Golden Rice, this variety of rice produced through genetic engineering to biosynthesize beta-carotene, a precursor of pro-vitamin A in the edible parts of rice. While created at the university of Zurich, the golden rice uses technological means protected by patents. Its exploitation needed to negotiate licences with more than 70 patent owners [30].

Some legal solutions are proposed to conciliate the incentives to innovate and the dissemination of knowledge, such as compulsory licensing, non exclusive licences, modifying the duration and the breadth of patents [53, 64]. But another type of solution to these restrictions has been found in the way firms manage their industrial property rights. Some studies have shown that building patent pools that are current in the definition of collective standards, could be a solution to the blocking of knowledge or could prevent litigation [13, 66, 12, 64]. According to C. Shapiro, 'Virtually, every patent licence [and by extension cross licences and patent pools, bl] can be viewed as a settlement of a patent dispute' [66, p. 392]. This was for example the solution chosen to solve the problem of the exploitation of the Golden Rice, case to which we referred above [9].

A patent pool can be defined as 'an agreement between two or more patent owners to license one or more of their patents to another or third party', or more precisely as 'the aggregation of intellectual property rights which are the subject of cross-licensing, whether they are transferred directly by patentee to licensee or through some medium, such as a joint venture, set up specifically to administer the patent pool' [13, p.4]. Patent pooling is not new, as shown by the cases of the Manufacturer's Association formed in 1914 and the radio broadcast pool undertaken by RCA in 1920 [64, pp.174-176]. This practice was often regarded as a threat for competition (notably in the US under antitrust laws), but in the two cases mentioned above, the US navy supported the patent pools for defence purposes.

In fact, two cases may be distinguished: when patent pools, or cross licences concern technology substitutes, they are considered as part of a strategy of cartelization (C. Shapiro [66, p.139] gives the example of the laser eye surgery attempted by summit technology Inc and VisX Inc). In these cases, patent pooling can encourage the development of monopolistic behaviours (such as high prices, imposition of "invalid" technologies, technology malthusianism). When patent pools concern complementary pieces, they may be considered positively, as a solution to resolve blocking situations (the famous cases of MPEG 2 video compression technology, DVD standard and DVD video are often cited in the literature). The strong link between cartelization and patent agreements justifies according to C. Shapiro the development of antitrust limits to patent settlements, based on the consumer benefit of such agreements [67].

In the same time, since the beginning of the 1980s, discussions have gained ground on the positive impacts of patent pooling, and led to the *Antitrust guidelines for the licensing of intellectual property* in 1995 (issued by the US Department of Justice and the Federal Trade Commission) which recognises that

'patent pools can have significant pro-competitive effects' [13, p.6). According to this guideline, an intellectual property policy is pro-competitive when it integrates complementary technologies, reduces transaction costs, clears blocking positions, avoids costly infringement litigation and promotes the dissemination of knowledge.

The same report states that the benefits of such a strategy are the elimination of problems caused by blocking patents, the increase in the disclosure of information between patent pool members, the reduction of licensing transaction costs and the distribution of risk: 'Like an insurance policy, a patent pool can provide incentive to further innovation by enabling its members to share the risks associated with research and development. The pooling of patents can increase the likelihood that a company will recover some, if not all, of its costs of research and development efforts' [13, p.9]. The latter argument also shows that the patent pooling strategy, which is gaining ground in new technology sectors (like biotechnology and ICT, in the latter case see [65]) is driven by the same profitability imperative which also explained the development of external means of formation of the 'knowledge capital'.

4.2 Patent Pools and the Construction of a Hierarchy within an Innovation Network

Patent pooling is often studied in relation to its pro-competitive effects (cf. coordination role within the network of firms) but we would like to put forward that it also plays an important role in the definition of the place of the firm within its network. As a matter of fact, patent pooling, even in the case when complementary technologies are involved, supports the idea of a growing private and oligopolistic appropriation of the 'knowledge capital'. Even if the formation of "knowledge capital" depends on interdependent relations between increasing numbers of institutions (big firms, small concerns, research labs, etc.), only a few firms appropriate the return of their investment, thanks to the patents they own separately and/or collectively and that they licence to each other. The other members of the innovation network (the users: clients, suppliers, subcontractors, tec.) are not the owners of the technology, have to pay a licence fee to use the technology and/or to produce the products and services that derive from this technology. And this is true, even if they have participated, in more or less easily observable ways (competencies, consulting, informal exchanges of information…) in the constitution of the knowledge capital from which the licenced technology (or set of technology) emerges. What is important here is that the practice of patent pooling, notably resulting from ex-ante cooperation processes, contributes to define the place of firms (their hierarchy) within the networks (see figure 3). The members of the patents pool, that is the ones which own the separate or shared patents, are the leaders of the networks. Thanks to the power conferred by the ownership of intellectual property rights, they build entry barriers protecting the highest level of networks (the leaders). These protected leaders can also keep their advance over competitors, by reinvesting the rents they receive from the commercialisation of licences in R&D processes meant to develop the next generation of technology [33]. This strategy clearly shows the offensive role of Intellectual Property Rights within innovation networks.

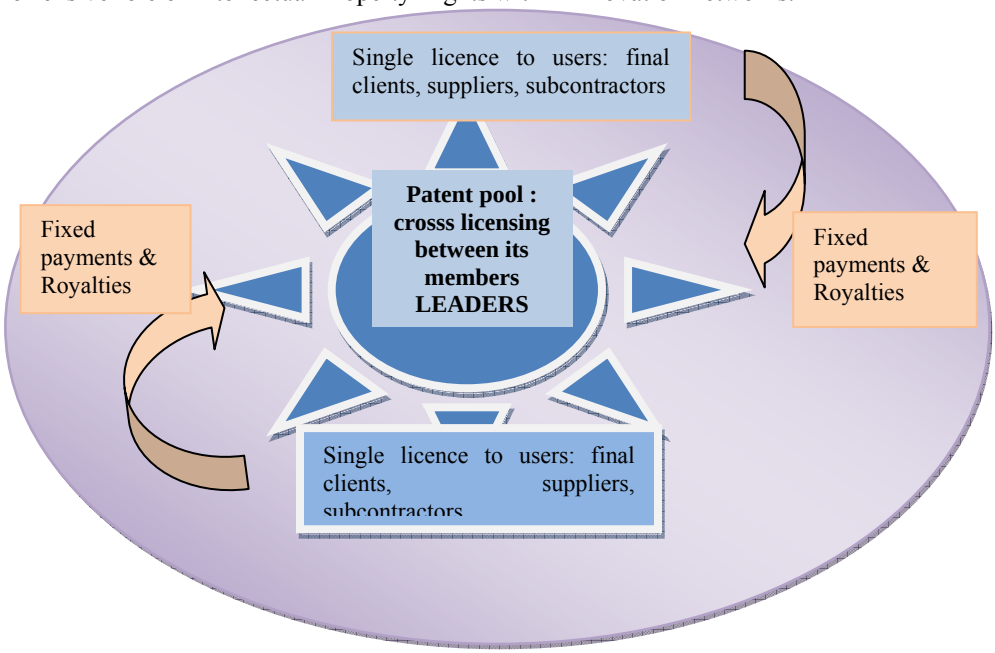

Figure 3 Patent pool and Hierarchy within a Network

5 Conclusion

To sum up, we can say that IPRs' role in economics is clearly linked with importance of networks for the firm itself and for its innovation strategy. The whole value chain is thus networked, vertically and horizontally. The roles played by IPRs in the networked enterprise an in innovation networks are summed up in table 2.Applying this analysis empirically to some particular networks will be the next step of this work.

Table 2 Role of IPRs in the Networked Enterprise and in Innovation Networks

Role	Explanation
Coordination role	*Reduction of transaction costs within the networked enterprise and within the networks of firms (patent pools) *Solution to patent disputes (licences, patent pools) *reputation within innovation networks (trademark)
Defensive/ incentive role	*Protection of the socialized Knowledge capital *Incentives to the diffusion of technology and to the investment in the constitution of the "Knowledge capital" *IPRs give a value to R&D investment (secure the shareholders)
Offensive role	*Definition of the place of the enterprise within the innovation network *Oligopolistic appropriation of knowledge capital and construction of barriers to competitors *Lead time

To conclude, we can put forward that the reasons of the evolution of IPRs laws at the international levels are closely linked to the need of IPRs by firms. As firms are more and more open to their environment, constituting global networks at each step of the value chain, they need tools to improve their coordination and provide their own knowledge base with wider and stronger protection. The recent trend towards extending patentability to new fields and closer to the scientific border can be regarded as an answer to this growing need for protection (the global protection given by the TRIPs agreement also favours their appropriation strategies) [26, 36]. Back in the 1980s, in a context of decreasing competitiveness and serious challenge by Japanese enterprises, the US made substantial changes in the IPR, and notably in the fields of biotechnologies and information and communication technologies (ICT), i.e. the embryonic technologies of the time. Software programs were traditionally protected through copyright (this was explained by the fact that, as they are composed of mathematical algorithms, they were excluded from patentability, just like natural laws, scientific theories, natural phenomena, abstract ideas, formulae and methods). However in the US, a case law led to the patentability of computer programs (*Diamond v. Diehr*, 1981). Computer program patentability ensued from the explanation that a computer program represents an invention (in terms of process) and from the fact that it produces a useful, concrete and tangible result. The patentability of computer programs paved the way for the possibility to patent business models (*Street Bank v. Signature*, 1988). In Europe, even though the legal context is not clear, many software patents have been granted. The origin of the extension of patentability to living organisms can also be found in the US, and was based on the argument that a living being produced by a non-natural process (apart from human beings) is eligible for patent. Then patentability was extended to recombinant DNA (1980), to transgenic animals (the "onconmouse patent" in 1988) and to human gene and research tools (DNA sequences). In Europe, a 1998 directive specified the patentability of genes and of partial gene sequences.

Moreover, the scope of industrial property rights was widened at the end of the 1990s, with the Trade related industrial property rights (TRIPs). This agreement allows patentability in all technological fields and harmonises the protection period covered by patents - 20 years. This agreement is managed by WIPO and WTO, and any infringement to this agreement can lead to commercial sanctions. Thus, it creates a favourable context for the global diffusion –Within the networked enterprise and/or within innovation networks, of patented technology [46]. All of these institutional changes evidence a greater need for protection, requested by firms themselves. This greater coordination and appropriation need can be linked to what we have called the profitability imperative. Global corporations have to innovate in order to be competitive. The complexity, but also the rapid pace of technological progress ('permanent innovation') leads to the increase in the cost, in the complexity and hence in the risk of the innovation process, which has nonetheless to be reduced if firms want to keep their precious investors. To reduce the cost, the risk and the length of the innovation process, firms rely on their own capabilities but also on the resources offered by their networks. However, being more open to their environment, they

become more vulnerable, all the more so when appropriability regimes are different in the countries they are active in. That is why corporate lobbying is a major explanatory element of the evolution of IPRs laws, as reported by J. Rifkin or S.K. Sell in the case of the TRIPs agreement [58, 60].

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