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The Antitrust/IPRs Interface in the EU : Towards the Suppression of Innovation ?

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Abstract :

Empirical evidence suggests that the software industries are shifting toward a more patent-intensive approach to the protection of their intellectual property. On its face, this evidence has given rise to two sets of complaints. The first is that a lot of "bad" patents are being issued. The second is that the pendulum has swung too far : after decades when patents did not afford inventors and companies enough protection, they now offer too much. The aim of this paper is therefore to demonstrate that that IP laws and antitrust are heading for a collision. To do so, we provide an assessment of the main consequences for innovation and competition of extending patent protection beyond current levels for computer-related inventions, and in particular, we examine the market power interaction arising from network effects and IP protection.

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1. Introduction

Not too many years ago, the courts regularly characterised intellectual property as an evil exception to the antitrust laws and regularly spoke of "patent monopolies". Today it is generally recognised that both the antitrust and intellectual property laws promote innovation and competition[1]. Intellectual property is now treated by antitrust authorities like other forms of property and the current climate of opinion is heavily weighted towards the proposition that strong and broad patent rights[2] are conducive to economic progress

Yet this today's conventional wisdom was not always so definitely in favour of strong patent protection (see Machlup, 1958; Mazzoleni and Nelson, 1998) and recently there has been a wide-ranging discussion of the appropriate scope of IP protection, particularly in the context of network industries, increased appreciation of the sequential nature of innovation, and the growth of the information-based economy (see Gilbert and Shapiro, 1990; Klemperer, 1990). Indeed, concerns about possible anti-competitive uses of intellectual property have been reinforced by perceptions that the scope of IPRs may, in some circumstances, be over-broad, or at least that trends are at work that may eventually result in over-broad protection of such rights. In addition to the widely-cited situation of network industries, the point has been made that, to the extent that technological progress depends on cumulative innovations ("standing on the shoulders of giants") as opposed to discontinuous breakthroughs, it may be best promoted through relatively narrow forms of protection (Scotchmer, 1991).

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[1] As the U.S. Department of Justice and FTC Antitrust Guidelines for the licensing of Intellectual Property (hereinafter 1995 IP Guidelines) emphasise, both serve, and are interpreted by U.S. Courts and enforcers to further "*the common purpose of promoting innovation and enhancing consumer welfare. The IP laws provide incentives for innovation and its dissemination and commercialisation by establishing enforceable property rights for the creators of new and useful products, more efficient processes and original works of expression. ...The antitrust laws promote innovation and consumer welfare by prohibiting certain actions that may harm competition with respect to either existing ways or new ways of serving consumers*", §1.0 citing *Atari Games Corp. v. Nintendo of America*, 897 F.2d 1572, 1576 (Fed. Cir. 1990).

[2] Patent scope or patent breadth refers to the size of the region of technology space from which a patentee may exclude others from operating.

This paper is aimed at casting light on this debate and we argue that, even if the balancing to be sought is nothing new, the controversies at the intersection of antitrust and intellectual property law nonetheless remain perplexing and more importantly that IP laws and antitrust are heading for a collision. That is partly because the value of knowledge has grown relative to other assets. But also because new kinds of patents are being awarded, in areas that might have been thought unpatentable in the past, such as computer software, genetic engineering and Internet business methods[3]. The rush of new patents has given rise to two sets of complaints; the first is that a lot of "bad" patents are being issued[4]. The second is that the pendulum has swung too far : after decades when patents did not afford inventors and companies enough protection, they now offer too much.

In other words, while a consensus has emerged that innovation is the main driver of economic growth, we are witnessing somewhat of a backlash against the patent system as it is currently operating and are facing the danger that the patent system impose an unnecessary drag on innovation by creating significant transaction costs for those seeking to commercialise new technology based on multiple patents, overlapping rights, and hold-up problems[5]. The tensions in this balancing exercise are important in a knowledge-based economy and were addressed by Stiglitz (1995) :

"*We often talk about how important patents are to promote innovation, because without patents, people don't appropriate the returns to their innovation activity, and I certainly very strongly subscribe to that (...). On the other hand, some people jump from that to the conclusion that the broader the patent rights are, the better it is for innovation, and that isn't always correct, because we have an innovation system in which one innovation builds on another. If you get monopoly rights down at the bottom, you may stifle competition that uses those patents later on, and so ... the breadth and utilisation of patent rights can be used not only to stifle competition, but also [can] have adverse effects in the long run on innovation. We have to strike a balance*"[6].

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[3] Software patents granted to protect programming techniques were very few ten years ago and were mainly used by large industrial corporations to protect, for example, computerised oil exploration techniques. The reason for the exclusion of programs for computers *as such* is that, like discoveries, scientific theories, mathematical methods and presentations of information, they are not of a technical nature. Patentability requires a specific technical application.

[4] Patents risk being "bad" if there is inadequate prior art surveyed (see Merges 1999 on patent quality).

[5] It is the specificity of assets together with imperfect contracting that lies at the core of the hold-up problem. Concerns about these problems may lead to inefficiencies as firms fearing that their investments will leave them vulnerable, refuse to make the efficient investments.

[6] Testimony of J.E. Stiglitz before the FTC Hearings on Global and Innovation-Based Competition, October 12, 1995 at p. 24-25, see FTC Staff Report, chapter 6, p. 6.

As such, the modern computer software industry[7] is clearly an example of an industry in which the returns to innovators' investment, and in many cases market structure, are heavily influenced by the ownership of intellectual property. But interestingly, some of the most innovative industries, software, semiconductors to take a few examples, have historically had weak patent protection. However, empirical evidence suggests that the personal computer software industry is now shifting toward a more patent-intensive approach to the protection of its intellectual property, as the largest firms increase their patent propensities, both absolutely and as a share of the total patenting in the US (see Kortum and Lerner, 1999). On its face, this evidence of more intensive use of formal intellectual property protection by established firms could be taken to mean that these firms are using software patents to erect barriers to entry, as the strengthening of patent rights could increase the risk that one holder of property rights can effectively exclude or block another from using the technology embodied in the patent. Eventually, there are increasing signs of, and concerns over, IPRs counteracting their purpose and hampering technological progress and entrepreneurship, especially among small firms.

Clearly, these concerns form the basis for a reform of the patent system[8] (see Merges, 1999; NRC, 2000) and are now pushing the European Commission to re-examine its patent system[9].

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[7] The computer software industry of the 1990s differs sharply from the software industry of the 1960, most notably in the growth of mass markets for so-called packaged software, see Graham & Mowery (2000) for an analysis of this point. The authors show that these differences are reflected in the growing importance of formal protection of intellectual property. See also Cohen & al. (1997), Kortum & Lerner (1998 and 1999) and Hall & Ham (1999) for an analysis of the more intensive use of formal IP protection.

[8] To explain why a reform of the patent system is necessary, some authors argue that European software industry is way behind the US industry in its awareness of the possibilities for it for patents. This puts it to a serious disadvantage. What if the United States has one system and the EU another ? Can they coexist ? Shapiro & Varian (1999) argue that knowledge intensive industries have been with us for a long time. If they are right, coexistence is possible. Intra EU IP law was different for many years even in knowledge intensive industries. EU firms could patent in the US but not in the EU. And the US could exercise patent rights here. Experience is (cf. paper by Lerner, 2001) that different patent systems have coexisted in the world. Some authors like Foray (1994) even argue that if diversity in National Innovation Systems is needed for overall innovativeness, then diversity in national IPRs is also needed. But if it is so, could there not be a coexistence between open and closed software ? Shapiro and Varian (1999) say that firms have an interest to optimise the use of IPR, not to maximise its protective power. Open licensing is often a profitable strategy, so can we not rely on firms act wisely in this respect ? Why should the fact that some firms choose a tight patenting strategy prevent others from open sourcing ? But *a contrario*, international harmonisation of the IPR system is highly desirable regarding their key aspects, such as ground for priority (first to file versus first to invent) due to the costs that are otherwise incurred in and around innovative work.

[9] Pressure for the removal of the exception for computer programs is mainly "cosmetic" and to remove confusion. After the Board of Appeal decisions (T935/97 and T1173/97), it is clear that inventions embodied in a computer program can be protected by the European patent system by claiming (i)-a computer system performing the functional steps of the program that embodies the invention; (ii)-a process or method of operating a computer system to perform the functional steps of the program to execute the invention and (iii)-a computer program for operating a computer system to perform the functional steps of the program to execute the invention as long as the invention provides a technical contribution which has to be identified in the claims. It is the requirement for technical contribution for the invention that separates the US from the EU.

Under the patent laws of the Member States and the European Patent Convention, programs for computers are not regarded as inventions and, therefore, are expressly excluded from patentability[10]. Under the future Directive on the patentability of computer programs, inventions relating to computer programs which are new, which involve an inventive step and are susceptible of industrial application, should be patentable. In such a context, the purpose of this paper is not to attempt to determine the optimal level of protection (this as been the focus of much of the patent design literature and is still a point of considerable debate) but rather to focus, as does the traditional literature (see Merges, 1990), on the capacity of patents to block competitors, or put in another way to look at the question of when does business conduct move from a legitimate assertion of IPRs to a use that may constitute an antitrust violation. More precisely, the aim of this paper is to provide an assessment of the main consequences for innovation and competition of extending patent protection beyond current levels to new types of inventions on firms characterised by systems- and network effects, cumulative innovation, rapid technological change, and multiple owners of overlapping property rights.

In order to cast light on this debate, we will proceed as follows. In *Section 2* we will review the static models that underline the traditional justification for patents. We show that, in reality, the question of how strong a patent should be, or whether a patent should be granted at all, no longer turns on an analysis of a trade-off between the positive effects on inventing of stronger patents, and the restrictions in use of technology associated with a regime of strong patents. Rather a good part of the argument is about whether the long run net effect on inventing of strong broad patents is positive or negative. Then in *Section 3* we turn to the empirical evidence that might bear on these theories and we show that in the last two decades, increasing attention has been paid to the strategic use of IP. In particular, there is clear evidence that, a "shot gun" approach develops on patenting. In the software industry, for example, the patent system is creating a "patent thicket"[11], an overlapping set of patent rights requiring that those seeking to commercialise new technology obtain licences from multiple patentees, thus increasing the risk of "hold-up", namely the danger that new products will inadvertently infringe on patents issued after these products were designed. In *Section 4,* we discuss the effects of the extension of patentability to new types of inventions. We show, in particular, that patent portfolio races currently observed in the software industry are different

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[10] This exception, however, applies only to the extent that patents would relate to computer programs *as such*. Based on these legal provisions, the jurisprudence has held that an invention which uses a computer program is, in principle, patentable.

[11] Cf. the expression by Shapiro (2000).

from the models envisioned by the classic patent races literature. Then, in *Section 5,* we discuss the complementary and cumulative character of software patents and examine the market power interaction arising from network effects and IP protection. These points are crucial as they require attention to the possibility of blocking patents and dominance via *de facto* standardisation. Finally, in *Section 6*, we refer to the fact that investment decisions are having to be made in the presence of great uncertainty over when and whether a competitor holds a key patent and over whether the firm could face a detrimental suit. On its face, this evidence could stop firms from continuing on the innovation path and stimulate know-how secret. Under these circumstances, it is fair to ask whether the pendulum has swung to far in the direction of strong patent rights.

2. Patents as appropriability mechanisms

Intellectual property policy traditionally focuses on how Intellectual Property Rights (IPRs) can stimulate innovation by increasing an innovator's ability to appropriate the fruits of its labour. The economic rationale for the patent system is that, on account of the appropriable nature of inventions, it is necessary to grant patents so as to provide an incentive to invent. This increase in incentives is then balanced against static pricing distortions that may arise when IPRs lead to market power in product markets, and dynamic distortions that may arise if an innovator does not efficiently license to other parties who could otherwise build on its innovations (see O'Donoghue, Scotchmer & Thisse, 1998).

The patent system has long been recognised as an important policy instrument used to promote innovation and technological progress. Two fundamental mechanisms underpin the patent system. First, an inventor discloses to the public a "novel", "useful", and "non obvious" invention. In return, the holder of the legal right can prevent (or exclude) others from making, using, or selling the patented product or process for a fixed period of time. The rules of the patent game may differ from country to country (e.g. whether rights are granted to the first inventor or the first to file the patent application), but the underlying principle remains the same. By providing exclusionary rights for some period of time and a more conducive environment in which to recoup R&D investments, the patent system aims to encourage inventors to direct more of their resources toward R&D than would otherwise be the case.

However, "*an economic review of the patent system*" by Machlup in 1958 recounts a long history of doubts about the patent system. Suffice it to say here, that often strong patents are not necessary to induce invention and that the entail significant economic costs[12]. Where property rights are weak, Teece (1986) observes, firms may respond with a number of strategies. They can, for example, acquire complementary assets that may become specific to a product. Ownership of these assets thus serve as an appropriability mechanism that stands as an alternative to strong IPRs. From this perspective, an endogenous shift toward stronger property rights changes the appropriability mechanism. Appropriability strategies involving the acquisition of complementary assets might be abandoned in favor of reliance on property rights. Several authors, such as Dasgupta & Stiglitz (1980) and Gilbert & Newbery (1982), have also recognised that the "prize" nature of patents leads to a socially wasteful duplication of efforts. Indeed, the patent system sets up a race, which can cause firms to devote more resources to speeding up their discoveries than would be justified by a benefit/cost test[13]. Granting the winning firm long-term exclusive rights merely because they were slightly faster than others to make a discovery could well create more monopoly power than was necessary to elicit the innovative effort, and slow down future invention as well (see Mortensen, 1982).

In fact, economists tend to be slightly uneasy about the patent system on account of its ability to stifle competition, and in particular whether the patent holder receives more in monopoly rents than the patented product or process has added to total welfare[14]. Does this mean that intellectual property can never be the foundation of a monopoly ? A number of recent FTC actions involving IPRs help make the point. An important issue is whether a monopolist can use its power to deprive others of their IPRs. A closely related question is whether a company can violate the antitrust law simply by refusing to license its patents, or by refusing to sell patented items, to its rivals.

A long standing literature in the innovation and economics literatures has established however, that the effectiveness of patents varies greatly across industries and technological

[12] The amount of RD that is "best" is not known, so one can never be certain whether a cutback in R&D helps or harms welfare (See Rapp (1995) about the "socially optimal" amount of R&D).

[13] There has been substantial discussion in the economic literature of patent races in which effort is duplicated and therefore wasted (see Kitch, 1977, p. 278). The patent race is often modelled as a winner-takes-all game (Reinganum, 1989). The winner of the race obtains a patent and the associated monopoly profits while the loser gets nothing at all. The solution of such game is often characterised by an over-investment, from a social point of view, in R&D, at industry level.

[14] It means that firms choose technologies whose variance is stronger than what is socially optimal, i.e. that the risk linked to these technologies is higher. Even if a deadweight loss results, however, it is possible that social welfare will be higher than it was in the absence of intellectual property. For example, if an inventor patents an invention that can substitute for a much more expensive input, social welfare may be greater in comparison with the *statu quo ante* even if the inventor charges a monopoly price for the invention (see Dam, 1994).

areas[15]. Empirical analysis of the patent system is, at best, ambiguous as to the importance of this effectiveness, except in certain specific industries such as pharmaceuticals or chemicals (see Levin & al., 1987, p. 783). Despite the fact that patents do not provide strong innovation incentives, except for the industries cited above, many inventions are in fact patented. The proportion of inventions patented is in most industries positively related to firm size. Large firms make more use of patent protection than small firms (see Mansfield, 1986; Cohen & al., 2000). Adding to this point, Lerner (1995) shows that small firms are far more likely to "opt out" of the patent system entirely and rely more heavily on formal trade secret mechanisms to protect their inventions. It is so because in some industries, trade secrets are more appropriate to protect innovation (for example, if technology progresses rapidly and patent procedures take too much time) or reverse engineering is so costly that patent protection is not worthwhile (Mansfield, 1986).

Traditionally, the most important reasons for patenting product innovations are to prevent copying and often extend beyond directly profiting from a patented innovation through either its commercialisation or licensing. In particular, one of the most prominent motive for patenting includes the prevention of rivals from patenting a related innovation (i.e. patent blocking), followed by the use of patents in negotiations and the prevention of infringement suits, i.e. that some firms may patent for defensive reasons (i.e. in anticipation of future requests from larger firms or competitors for royalty payments). So as underlined by the Carnegie-Mellon results (1996), the primary motivation for patenting in many industries may not be directly related to protecting investments in R&D. In particular, some studies suggest that stronger patent rights have simply enabled firms with large legal departments to extract rents from and deter entry by other firms in the industry. These firms are engaging in "patent mining", trying to get the most out of their patents by asserting them more aggressively than ever against possible infringing firms. This point is also stressed by Lanjouw and Lerner (1997) who find evidence that large firms may use preliminary injunctions as a form of predation against smaller firms with limited financial resources.

Last but not least, if the market value of firms is strongly related to it knowledge assets, and patent measures contain information above and beyond that conveyed by the usual R&D measures, Lanjouw (1994) shows that the value associated with patents differs across firms, simply because of the "true" value of patents often is not revealed until such rights are held

[15]If at first, IPRs have led innovators or at least patenters to get bigger incentives to do R&D, one observes today a massive industrial consolidation as these firms try to internalise transaction costs.

valid by the courts, a process that places a disproportionate burden on poorly capitalised firms. This point is confirmed by Lerner (1995) who finds evidence that patents with broader claims tend to be of greater value, and shows that the actual scope of a patent is not established until the patent is litigated, as the interpretation of a patent's claims is an issue of law for the courts to decide[16].

3. The impact of changes in the US environment

Several important changes took place in the US legal environment during the early 1980s that collectively broadened and strengthened the rights conferred on US patent owners and hence the economic value of patents. New antitrust policies have reversed an antipathy to licensing that had long given strength to antitrust defences against patent infringement actions (Lanjouw, 1994; Barton, 1997 and 1998; Jaffe, 1999)[17]. Not only are patents enforced more strongly, but their claims may now be very broad with some patent claims apparently designed to cover an entire area of research and even basic research. This is clearly the case in biotechnology and in the software industry where the growing importance of formal IP is obvious.

In this context, the 1980 Supreme Court decision *Dawson Chemical Co.*[18] ushered in a series of court rulings that were more favourable to patent owners[19]. For example, in *SCM Corp. v.*

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[16] See *Markman v. Westview Instrument*, 116 S. Ct. 1384, 1837, (1996).
The few empirical studies of patent value conducted in the past 35 years indicate that most patents, whether licensed or held exclusively, have little value. While the average value of patent protection varies greatly across industries, there are very few "million dollar patents" in any industry. See Schankerman (1998), p.94.

[17] Antitrust law generally focuses on attaining competitive market conditions, not particular outcomes, whereas intellectual property focuses on achieving the proper mix of incentives and access so as to attain the optimal level of investment in R&D. Put in another way, while antitrust law assumes that deterring monopoly will lead to the attainment of economic efficiency, intellectual property law assumes that efficiency will be achieved only if the social planner correctly estimates the proper mix of incentives and access to go into the formulation of IPRs (see Dumont & Holmes, 1999 for a discussion on this point).

[18] *Dawson Chemical Co. v. Rohm & Haas*, 448 US 176, 221

[19] The U.S. Court of Appeals for the Federal Circuit was cited as the major force behind stronger, broader patent rights. The Federal Circuit increasingly has tended to uphold broad patents and make them less vulnerable to attack, thereby increasing a patent's value (see Merz & Pace, 1994).

Landmark court decisions have made new areas of technology patentable. In the cases of *Diamond v. Diehr* (450 U.S. 175) and *Diamond v. Bradley* (450 U.S. 381), both decided in 1981, the Supreme adopted a more favourable posture toward software patents and Court stated that software algorithms were patentable. Both the courts and the Patent and Trademark Office have supported this policy, strengthening patent protection for software (see Samuelson, 1990 and Merges, 1996 on this point). The culmination of this extension of patent protection for software was the *State Street Bank* decision (1998) [*State Street Bank & Trust Co. V; Signature Financial Group Inc.*, 149 F.3d 1368 (Fed. Circ. 1999)] and the AT&T decision [*AT&T v. Excel Communications, Inc.*, 172 F.3d 1352 (Fed. Cir. 1999)] which extended patent protection into "business

Xerox Corp.[20], the District Court ruled that it was lawful to acquire patents, even if those rights were acquired with the intent of dominating a market should the product prove to be successful[21]. But most important, business's attitudes to patents have also been changing. Indeed preliminary evidence suggests that the pro-patent shift in the 1980s in the USA has altered the patent strategies of firms, notably software firms, but in ways that go beyond the classic incentives provided of the patent system. In this context, the computer software industry provides an interesting example to observe the transition from a relatively open intellectual property regime to one in which formal protection, especially patents, figures prominently; and in particular, how the strength of patent rights affects the way firms structure their contracts and relationships with other firms for technology transfers.

On the one hand, stronger patent rights may have facilitated "specialisation" in the software industry and may well have supported a market for know-how or technology exchange with either suppliers or customers (Arora, 1995; Merges, 1996 and 1999). The surge in patents relative to R&D spending may indeed reflect important managerial changes, but in how firms manage the R&D output, not necessarily the R&D input side of the innovation system, i.e. changes in the management of R&D that lead to increases in R&D productivity and a shift to more applied activities that has increased the yield of patentable discoveries. Thus, the existing volume of patent filling appears to reflect a "deeper reach" into an existing pool of inventions rather than a shift in R&D activities *per se*. Putting it differently, the extension of patentability to new types of inventions (and the exclusionary rights that such patents entail) may have increase the incentives of firms to patent for reasons other than the traditional incentives provided by the patent system (Merges & Nelson, 1990; Mazzoleni & Nelson,

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methods". These two cases specifically held that business methods are patentable subject matter, and that a method does not need to specifically involve any type of physical transformation in order to be patentable. In particular, the Court of Appeals for the Federal Circuit held in both cases that as long as the inventions can be shown to be new, useful, and non-obvious, and if they yield a useful, concrete, and tangible result, the inventions should be patentable.

[20] *SCM Corp. v. Xerox Corp* (645 F.2d 1195, 1206, 2d Cir. 1981).

[21] Cf. the recent antitrust brought against Intel Corporation by the FTC (*Intergraph Corp. V. Intel Corp.* 3F. Supp. 2d. 1255, 1998 and *re Intel Corp.* Docket N° 9288, FTC filed June 8, 1998; the complaint is available at http://www.ftc.gov/os/1998/9806/intelfin.cmp.htm). It may represent a swing of the pendulum away from the pro-patent US legal environment. A pivotal issue here is whether Intel had the right to refuse its competitors licenses to key patents owned by Intel or whether Intel's intellectual property is an "essential facility" for these companies given Intel's dominance in the microprocessor market. The possibility that a "facility" consisting in whole or in part of IP may be viewed as "essential" highlights two sources of tensions : on the one hand, the tension between antitrust and IP law with respect to a monopolist's rights to engage in exclusionary practices; on the other hand, the tension within the IP law itself, between the need to provide exclusive rights so as to preserve the incentives to create, and the need to insure access so as to facilitate the creation of new products. On this matter, IP law, however does make an effort to insure access through various restrictions on the duration and scope of subject matter and through the various doctrines, such as the fair use, functionality, and experimental use doctrines. But since the whole of having a patent is to confer upon the patentee the right to exclude others, it is difficult to see how the patent and antitrust laws could be in sharper contrast.

1997; Cohen & al., 1997). On the other hand, this shift is not solely explained by a move toward more applied R&D. Such a positive effect is countered by a socially inefficient process whereby firms amass vast patent portfolios simply as "legal bargaining software"[22], i.e. that many firms increased their propensity to patent in response to an increasing threat of "hold up" when they are sued for infringement.

The threat of "hold-up" has increased because patents are more likely to be upheld and because the nature of innovation in this industry has become more complex and depends on technological inputs from more actors. As stressed by Scotchmer (1991, pp. 29-30), "*most economics literature on patenting and patent races has looked at innovations in isolation...but the cumulative nature of research poses problems...the challenge is to reward early innovators fully for the technological foundation they provide to later innovators, but to reward later innovators adequately for the improvements...as well*".

Indeed, notwithstanding the potential costs associated with winner-takes-all markets, when innovation is both complementary[23], in the sense that each potential innovator takes a somewhat research line (and thereby enhances the overall probability that a particular goal is reached within a given time), and cumulative (or sequential) in nature, in the sense of a long string of successive products, each improving on prior generations[24], IP protection held by early generation innovators may forestall competition from later generation innovators (see Besen & Maskin, 2000, p. 2). Overbroad initial patents are a disincentive for rivals to pursue follow-on innovation, thereby making new entry more difficult and stifling competition[25]. Thus the issuance of broad patents may intensify two problems related to incremental and

[22] Cf. the analogy with the expression "legal bargaining chip" developed by Hall & Ham, 1999, p.4.
According to Graham & Mowery (2000) it seems likely that software patents are being used for strategic purposes, such as cross-licensing or blocking other firms' innovations, as well as for protection of their IPs (Cohen & al., 1998; Hall & Ham, 1999).

[23] See Jaffe (1999) on the empirical evidence of innovative complementaries. See Green & Scotchmer (1995) and Scotchmer (1996) on the theoretical implications of sequential innovation.

[24] This is sometimes called a "quality ladder". It is worth noting that on a quality ladder, each innovator will typically be in the position of both licensor and licensee, since he will build on previous protected products, and also provide a foundation for future ones. As stressed by Scotchmer (1999, p. 1) "*cumulativeness makes it especially difficult to turn social value into private value. This is particularly true when future innovations are improved versions of previous innovations. In that case, there may be too little incentive to provide the earlier products. A solution is to give broad protection to the earlier innovator so that licensing is necessary*". However heavy burdens to license can have the symmetric problem of stifling second-generation products instead of first-generation products. It is worth noting that two types of follow-on innovation are possible : first, where innovation occurs along a natural technological trajectory; and second, where there is not a natural progression but a second inventor could take the fundamental invention in a totally new direction.

[25] On the other hand, Chang (1995) and Matutes and al. (1996) have argued that broad patents may be necessary to provide enough incentives to generate the initial innovations, which are pre-requisites for follow-on innovations.

follow-on research. First, inventors face increasing liability for infringement, which in turn reduces incentives for, and the feasibility of incremental and follow-on research. To avoid such liability, inventors must negotiate licence and royalty agreements with the holders of the relevant patents, which can be difficult. Second, anti-competitive practices can occur.

More precisely, the distortion can take two forms, a standard static distortion as a result of the firm's residual market power, as well as a dynamic distortion created by insufficient incentives to engage in either the initial or the derivative innovative activity. Indeed, the innovation process in many network industries is cumulative, meaning that IP rights for early innovators may block the production of or impose costs upon later innovation that builds on earlier technology. This is also called the "IP assembly problem" : products and services become more multi-technological. At the same time, technologies become more multi-product also. It means, therefore, that the strength of the IP rights of later-generation innovators is in inverse proportion to the strength of the IP rights granted to standard-setters. In other words, the ability of entrants to successfully introduce follow-on products depends on their ability to incorporate first-generation technology into their own products. Where innovation is distributed among multiple firms over time, the key question is not whether to allocate IP rights but how to allocate IP rights across different generations of innovators so as to preserve the momentum of the innovative process (see Merges & Nelson, 1990; Green & Scotchmer, 1995). In fact, in an environment subject to network effects, the allocation of IP among generations of technology should be designed to maximise incentives to innovate across each generation (see Scotchmer, 1991).

The trend towards the knowledge-based economy signals a further weakening of old "market failure" arguments in guiding public action in the field of innovation policy. Rather a Schumpeterian perspective on technological change recognising the intrinsic differences in nature of the accumulation process across sectors and industries appears more and more warranted. The main issue is how to make the IPR system better fit different industries, as well as different emerging technologies. Tailoring of the IPR system to fit the situation in different industries has been suggested from time to time (see Thurow, 1997, for a recent example) but has traditionally been done only to a limited extent. But in reality, there is a real need to scrap the American one-size-fits-all system and replace it with one that responds to the investments that an invention represent. Patents should come in different shapes and sizes. The trouble with the law is that it does not differentiate between the incentives needed to invest in different kinds of technologies and we are just beginning to see how patterns of post-grant transaction affect the economic impact of various property rights entitlements.

Last but not least, the literature on patent protection of cumulative technology initially focused on the breadth of patent protection (Kitch, 1977; Merges and Nelson, 1990)[26]. This literature, however, fails to distinguish between products that infringed the claims of the initial innovations, which are technically equivalent or inferior, but perhaps novel in another dimension, and those that were technologically superior. In reality, this distinction is important because it is the breadth of an initial innovation's claims over superior technologies that is important in the division of surplus between the first and second generation innovators for cumulative technologies[27].

Since the second-generation product is facilitated by the first product, the social value of the first product includes the expected value of the second product. Patent infringing forces licensing which is a vehicle to transfer profit. The Nordhaus trade-off between deadweight loss and incentives to innovate re-appears in another guise : if the firms are prevented from consolidating their property rights in an *ex ante* agreement, the second generation product might be lost (and hence the first generation investment also becomes less profitable), but if the investment takes place, consumers will get the products at lower prices[28].

In network industries, technological advance is often enabled by multiple proprietary technologies. Consequently, second-generation innovators must license multiple initial technologies and firms have recently voiced concerns over the increasing costs of licensing the technologies necessary to operate in high-tech industries, as such costs can stifle R&D. Adding to this point, Heller and Eisenberg (1998) argue that the dispersion of IPRs makes it costly to assemble the necessary rights. Indeed, the various technologies that a firm must

[26] Early work in the law literature by Kitch (1977) argued that basic innovation should be granted broad patent protection in order to spur subsequent innovation. Merges and Nelson (1990) took the opposite view, namely arguing that broad protection could stifle latter competition.

[27] O'Donaghue, Scotchmer and Thisse (1998) refined the concept of patents scope, distinguishing between *leading breadth* and *lagging breadth*. Lagging breadth specifies the set of products which require no further innovation that infringe the patent, while leading breadth specifies the set of products that are technologically superior that infringe the patent. Whether a derivative innovation infringes the initial innovation and is patentable, will in turn effect the division of the surplus between the initial and derivative innovators and the incentives for innovation at each stage.

[28] If one defines patent breadth as the minimum improvement required to avoid infringing a prior patent and one assumes that the quality of a second product is uncertain, then the patent breath becomes a proxy for the probability that the second product will infringe the first patent *ex post*. Green and Scotchmer (1995) show that by controlling this probability, patent breadth controls the expected licensing fees that a second innovator will face *ex post*, and thus the terms on which he will make an *ex ante* agreement to share the proceeds of his research. It is worth noting that small breadth erodes a patentholder's profit in two ways : it reduces the time until better product enters the market, since a small quality improvement can be achieved in less time, and conditional on entry, leads to less difference between the patented product and its replacement, so the firms in the market earn less profit. The erosion of profit with narrow breath can reduce the incentive to invest.

license are complementary inputs. As a result the terms of each licensing contract can effect the revenues that all other firms receive from the licensee and strong patent rights for a sequential innovator can then weaken the rights and incentives to innovate of subsequent innovators, whose inventions, even if patentable, are made to infringe prior patents. By establishing these bargaining positions, intellectual property thus determines how the flow of profit is divided among sequential innovators.

4. The effects of the extension of patentability to new types of invention

In an attempt to determine the effects of the extension of patentability to new types of inventions, it is worth examining two recent studies by Cohen & al. (1997 and 2000). The authors show that US manufacturing firms in most industries rely more heavily on lead time and secrecy to recoup their research and development than they do on legal mechanisms such as patents. But surprisingly, this reported decline in the effectiveness of patents has coincided with a recent and unprecedented surge in the number of patents applied for and granted to firms (Kortum & Lerner, 1997).

This study also shows that the patent portfolio races observes in most US industries are different from the models envisioned by the classic patent races literature (Reinganum, 1989; O'Donoghue, 1998). Indeed, it appears that although patents still perform their traditional function of safeguarding against outright theft and infringement of these firms' invention, this classical role of patent seems to be dominated by a broader or "strategic" use of patents as "legal bargaining software", that enable the firms to avoid being excluded in a particular field of use, to obtain more favourable terms to their licensing agreements, to safeguard against costly patent litigation, or to gain access to external technologies on more favourable terms of trade (e.g. Parr & Sullivan, 1996; Cohen & al., 1997). As stressed by Cohen & al. (1997, p. 17) "*The picture that emerges from [the] results is that the prevention of imitation is only one of several reasons for patenting. The motive of blocking as well as the prominent motives of the prevention of suits and use in negotiations suggest that patents are used more broadly than simply to protect the returns to a specific innovation*".

Have patents simply become more important "bargaining software" to firms in their efforts to craft favourable licensing deals and to keep potential litigants at bay, as it is suggested by Cohen & al. ? And how does the use of patents vary among firms in the same industry, i.e. among small and large software enterprises ? This is not to say that patents do not serve some of their traditional function of safeguarding against outright theft of patented ideas. But rather, this traditional for obtaining patents for several of these firms to be dwarfed by broader motives[29].

First of all, it appears that software firms do not rely on patents to profit from innovation or appropriate returns from R&D, but patent rights are still of critical importance to firms in this industry (Christie, 1994). A patent policy implicitly assumes that inventions are rare and precious, since only in those circumstances is it beneficial. But in reality, the software industry does not have a shortage of innovation. Indeed software development has not be able to keep up with research; moreover, in the software industry, independent reinvention is common place and inventions are comparatively unimportant. The prevalence of independent reinvention negates the usual purpose of patents. Patents are intended to encourage inventions and, above all, the disclosure of inventions. If a technique will be reinvented frequently, there is no need to encourage more people to invent it. Much software invention comes from programmers solving problems while developing software, not from projects whose specific purpose is to make inventions and obtain patents; and these solutions are likely to be reinvented frequently as other programmers tackle similar problems. In other words, these innovations are byproducts of software developments. By reducing the number of programmers engaged in software development, software patents could actually impede innovation.

In reality, firms generally rely on mechanisms other than patents to profit from innovation. Because of the short product life cycles in the software industry and the fact that competitive advantage is largely driven by lead time, design complexity, patents are a relatively ineffective means by which to profit from innovations, at least for current generation products. However, the long-term value of these patents can be quite high if future generations of products build on the patented technology, this technology becomes widely used by other firms, and alternative methods are difficult or prohibitively costly to adopt (Scotchmer, 1991).

Another point to keep in mind is that it is difficult for firms to rely on a single patent or set of patents to entirely exclude rivals from a given product line. The maze of patents identified in a software product has been identified as one of the reasons that patents are especially valuable to software firms as "bargaining software". A single firm rarely owns all the rights

[29]Patents are not just about defence. They are also crucial to building companies' capital values. Licensing patents help build the market for a particular technology and boost the revenues from licensing.

(either based on its own patents or licensing agreements) to technologies embodied in a new product. Consequently, it is important to have assets with which to trade in the event that other patent owners assert their rights against the firm. The situation is such that, according to some industry representatives, firms occasionally find patents so difficult to value that some cross-licensing negotiations are conducted using patent counts as the unit of currency[30].

Overbroad patent protection may increase the need for cross-licensing arrangements and thereby increase the competitive dangers associated with patent pooling (see FTC Report, 1996, chapter 8). When competitors control patents that include legitimate conflicting claims, so that each patent holder is blocked from bringing a superior, non-infringing product to the market, the courts consistently have allowed cross-allowed, even when the cross-licences incorporated agreements on price or where the combination of blocking patents had dominant or even monopoly power. Under this view, where incremental research is important, but the patents are broad and basic, cross-licensing is potentially anti-competitive and may choke future innovation. As pointed out by Barton (1997), extensive cross-licensing among a closed group in an industry, where group members share large amounts of information, and at times even future improvements, may decrease research incentives and raise substantial entry barriers, because new entrants must invest more heavily to develop technology that can compete with the sum of the cross-licensed technology[31].

Moreover, there is clear evidence that a "shot-gun" approach develops on patenting, implying a more aggressive use of IPRs by large firms with "deep pockets". By acting as an entry barrier, patents can be economically effective even if they are legally invalid. Indeed, patents are valued as important strategic assets and some firms amass large portfolios of patents in order to obtain the rights to infringe patents held by external parties and to improve their leverage in negotiations with other patent owners. These large patent owners increased their charges for rights to infringe their patents during this period and more actively sought royalty payments from smaller firms. This means that stronger patent rights increased the ability of some firms to secure incomes from licensing rights to patents on more favourable terms. This can not be compared to a race to patent, i.e. a race to win rights to some standalone technological prize, but rather to a race to secure the right to exclude others before being excluded themselves (cf. the literature on raising rival's cost theory by Salop & Scheffman,

[30] Heller & Eisenberg (1998) point out the problem related to what they call the "tragedy of the anti-commons". This "tragedy" arises when there are multiple gatekeepers, each of whom must grant permission before a resource can be used. In that case, the resource is likely to be under-used and innovation might be stifled.

[31] Cross-licensing of patents served as the primary method of cartelisation in the '20s and '30s.

1983). Several participants at the FTC hearings (1996) confirmed this point and contended that a deliberate intention to slow down competitive entry motivated much of the litigation.

Clearly, to the extent that this practice is widespread, there is a considerable incentive to apply for patents on minor innovations that have non intrinsic value. As a matter of fact, the private value of innovating on a quality ladder arises mostly from becoming the incumbent firm. Since it takes time and money to achieve a large improvement, a firm would prefer to become the incumbent by patenting a small improvement rather than a large one. If the second product infringes the prior patent and is itself patentable, then the two firms could end up with blocking patents *ex post*, which would give the second innovator as much bargaining power as the first patentholder[32]. But, the recent surge in patenting in the software industry may not be welfare-enhancing if firms are compelled to apply for patents of modest significance purely for defensive motives. As stressed by Graham & Mowery (2000), increased patenting activity in technology-intensive industries may reflect a zero-sum competitive game among firms that does not enhance social welfare, rather than improved innovative performance.

Putting it differently, this means that profits could be eroded quickly by the outflow of royalties payments to a disparate array of owners of software patent rights. Thus, the need to take out "defensive" patents is likely to be detrimental to the overall profitability of the software industry as resources are already being diverted away from developing software and towards building up defensive patents portfolios. But at a more micro-economic level, with the strengthening of US patent rights, the expected benefits of owning US patents for firms, especially larger ones (for offensive and defensive reasons) could begin to outweigh their expected costs.

In an industry where the pace of technology is rapid, innovation is cumulative, and ownership of the technologies used in production is fragmented across a diverse set of actors (Merges & Nelson, 1990; Scotchmer, 1991 and 1996), the strengthening of EU patent rights could then increase the risk that one holder of property rights can effectively exclude or block another from using the technology embodied in the patent[33]. Such a situation might be explained by

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[32] Denicolo (1997) further explores whether the second product should be patentable as well as infringing and asks how patentability affects the timing of innovation.

[33] *"Cohen and his co-authors suggest that the reconciliation of the jump in patenting and the lack of increase in perceived effectiveness may lie in the multiple ways that firms use patents. In particular, their survey show that, in addition to protecting the returns to specific inventions, firms use patents to block products of their competitors, as bargaining chips in cross-licensing negotiations, and to prevent or defend against infringement suits. It is possible that respondents did not consider these benefits of patents when answering the question about*

the fact that the standards of patentability have been lowered, especially the standard that an invention must be "non obvious" in order to be eligible for a patent award. In principle, patent portfolio racing is not an inevitable outcome of strengthening patent right in cumulative technological areas. If patent rights were strictly awarded to inventors of non-obvious, useful and novel inventions, then it should become increasingly difficult to obtain a patent when a thicket of prior art exists, and the number of successful applications should fall[34].

But one should also keep in mind that stronger patents rights are important for firms as an imperfect but quantifiable measure of technology that enable technology-based trades to be made in external markets, both in financial markets, notably for SMEs in attracting venture capital funds[35] and securing proprietary rights in niche markets and with suppliers and owners of complementary technologies. Indeed the primary vertical role of patenting for SMEs appears to be in securing capital from private investors in the start-up phase. At the same time, it is less clear that ownership of strong patent rights is important to firms in licensing their technologies or in managing their vertical relationships with suppliers of manufacturing services.

So, *in fine,* the effects of stronger patent rights on the intensity with which firms patent remains unclear (e.g. Lerner, 1995; Lanjouw & Schankerman, 1997; Kortum & Lerner, 1997; Cohen & al., 1997). By deciding whether a patent is valid or whether another party has infringed on the patent owner's rights, courts play a pivotal role in determining the strength (and hence, the value) of patent rights[36]. Indeed, bad software patents become valuable for their nuisance value as the financial risk/reward ratio decreases.

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the effectiveness of patents in protecting the returns to innovations. More fundamentally, firms using patents for these purposes are engaging to a significant extent in a zero- or negative-sum game. If all firms do more blocking, accumulating of bargaining chips, and patenting to fend off infringement suits, it could easily be the case that, in the end, none of them has succeeded in increasing their returns to innovation. Under this hypothesis, what has happened is that everyone is patenting more because the private, marginal return to patenting is high, but firm's actions largely offset each other so that the perceived value of patents overall is no higher", Jaffe, 1999.

[34] see Van Dijk, 1994 on the concept of novelty.

[35] One major economic role for patents lies in the strategic possibility of "reserving processes" rather than products, particularly in industries such as biotechnology, to serve as an asset for raising finance for future research.

[36] Cf. case *Polaroid v. Kodak*

5. Compatibility and intellectual property in network industries

The aim of this section is not to argue that the nature of the software industry makes it an inappropriate subject for the granting of patents, but rather to stress the key features of the software industry and raise a number of difficult and important issues regarding compatibility and customer switching costs in the context of interpreting the scope of IP protection for the software industry. Indeed, account must be taken of some economic characteristics of the industry in order to define precisely what scope of protection is appropriate. All these elements have important implications for the efficient form and extend of intellectual property protection, as the basic question is whether IPRs could lead to excessive protection in the presence of network effects[37].

Understanding the basic principles that underlie network effects and IP is essential to exploring how this interaction impacts market structures and the exercise of market power, as well as why the interaction poses important trade-offs for antitrust policymakers[38]. An important consequence of network effects is that certain "arbitrary" features of a technology underlying the network can become critically important to customers, i.e. agreeing on a standard technology for the network may be far more important to users than the performance of the technology itself. In economic terms, standardisation is the result of demand-side technology specific economies of scale. These demand-side network externalities (as well as powerful supply-side economies of scale) may have a significant impact on competitive dynamics and market evolution, particularly when consumers also incur switching costs in replacing one technology with another (moving to another network) (see Klemperer, 1995).

Indeed, many software have the property that the greater the number of users on the system, the more valuable it is to an individual user and the more users want to adopt it. This positive feedback is known as a network effect. With positive feedback the strong get stronger and the weak get weaker. Market adoption dynamics in positive feedback markets tend to evolve along the lines of an S-curve, with the initial adoption period being flat (while the market winner is in doubt). Once an apparent market winner emerges, the adoption rates takes off dramatically continuing until market saturation. In other words, popularity in positive feedback markets is the ultimate metric of success. Big networks tend to grow bigger, while

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[37] The courts have recognised the presence of network effects for personal computer operating system software (cf. *Apple Computer v. Microsoft Corp.*, 717 F. Supp. 1431).

smaller networks shrink. Eventually, the winner takes all. Those expected to win in the market do win because second place or third place is tantamount to last place. The end result in a world of increasing returns may be the leading product's becoming dominant and thus, the tendency of the market is towards monopolisation (see David, 1985). Thus, network effects can constitute a significant barrier to entry and lead to a collective lock-in in an established technology (Sheremata, 1997). Products that can achieve lock-in will benefit from the switching costs that preclude customers from switching over to competing (even perhaps superior) solutions. In other words, the market may be subject to excess inertia to a particular technology, and products that get a user to commit time, knowledge and/or resources to them are likely to continue to be used even in the face of superior products given the cost of switching to alternative products.

One problem is that, if network theory predicts that the optimal number of providers in a given market is one, then there is nothing obviously wrong, from an antitrust perspective, with being that one. A related point is that even if it is possible for network effects to allow technological inferior competitor to prevail, it is not clear that antitrust authorities or courts are well-positioned to as which standards are technologically superior and which have achieved their market share due to inefficient tipping; nor are they well suited to perform regulatory function of setting prices

Another characteristic of the software industry is that information goods have a rather unusual structure of costs. Information is costly to produce but cheap to reproduce. The economic rule that parallels this theme is that while fixed costs of production are large (mainly for leader products), variable costs of reproduction are near zero and capacity restraints are absent. This translates to a lot of latitude in coming up with pricing models and corresponding versions of a product to create both the maximum revenue opportunities and establish the largest number of members of the product's network of users (see Shapiro and Varian, 1999). But at the same time, given the low cost of reproduction, it stands to reason that the patent system represents an enormous cost to the software industry. Indeed, the cost of patents is proportional to the development cost, because it is the amount of stuff that you actually put in your product that determines how many different patents may be involved.

The cost of developing a software package also depends on the stock of technologies that are technically and legally available to today's developers. A software product is of no use in

[38] The key theoretical contributions in this field are Katz & Shapiro (1985); Farrell & Saloner (1985); David (1985); Arthur (1989). See also the Journal of Economic Perspective, Spring 1994, vol. 8 for a symposium issue on lock-in (i.e. "herding").

itself, but only when working in conjunction with other complementary products as part of a system. In the absence of compatibility, markets may tip (Farrell & Saloner, 1985, 1992). For this reason, the leading supplier for software in a given category has incentives to prevent others from offering compatible products. Often these disputes implicate Internet Protocol (IP). Planned obsolescence in the software industry thus revolves around intergenerational compatibility. If the interfaces that control interoperability with other programs are subject to broad IP protection, the firm controlling the interface could exclude competitors not only in its own market but also in neighbouring markets (leveraging). Indeed broad scope could thwart efforts to enhance operability, which would in turn impair the growth of computer networks, the anticipated source of substantial innovation in the near term. Patenting of software interface specifications could then permit an inefficient extension of market power to complementary software and alter improvements. Thus, allocating strong IPRs to the inventor of a standard may reduce incentives for future innovators to maintain backwards-compatibility with the existing standard or even to innovate at all. Software market dynamics could then turn arbitrary choices into compelling choices, and switching cost could confer monopoly power even absent real innovation (Katz & Shapiro, 1985, 1998). Accordingly, how IPRs are allocated between different generations of innovators will be particularly important in shaping R&D incentives in network industries. The form of IP expropriation is thus important in designing an effective remedy (e.g. licensing v. forfeiture)[39].

IPRs by precluding competitors from offering users products compatible with those supplied by the incumbent, could impose significant efficiency costs. To begin with, the standard allocative efficiency loss will be greater than is conventionally the case, because the higher price the incumbent can charge imposes welfare losses not only on marginal users but through foregone network effects, on infra-marginal consumers as well. Additionally, there may be dynamic efficiency loses as products that are superior on the merits may take longer to displace less meritorious products, if they can displace them at all. From these observations flows an argument that IP protection should be weaker for products in which network effects predominate (see Farrell, 1995).

With respect to initial standard setting, the promise of strong IPRs and the prospect of a market tipping to a single technology may lead several firms to race to set a technology standard for a particular industry and to secure IP protection of that technology from competition (see Gandal, 1995; Lemley, 1996). Indeed the need for intercommunication

[39] As such, the Borland remedy, agreeing to forgo key IP claims in exchange for merger approval, is instructive. See Competitive Impact Statement, *U.S. v. Borland International Inc.*, 56 fed. Reg. 56, 096, 56, 100 (1991), final judgement, 1992-1 Trade Cass. (CCH).

favours a certain standardisation of the products so that the presence of network effects means that it may actually be profitable to engage in predation because once the rival has been put at a sufficient disadvantage in terms of actual and anticipated installed base, it may be impossible for that firm to compete effectively in the future (Farrell, 1989). This means that software patents have a negative impact on standardisation. Indeed, it is possible to use patents to get a monopoly on the use of a business method or an electronic commerce method by patenting as such its implementation in a program for computers. As a result, there are some concerns when an IPR provides a mechanism of control over a standard adopted by a standard committee[40]. If the specifications and technology that embody a standard are the protected IPRs of one party, then it can unilaterally block other suppliers from producing compatible products. This does not mean that innovators should be denied rights to software that has these properties, but that one has to be careful in granting patents since when software programs achieve the status of *a de facto* standard, patent protection allows the possibility of leveraging the monopoly into complementary hardware and software (Farrell & Saloner, 1992).

It also seems that market may be biased against open systems. This is because in network markets proprietary systems may have a strategic advantage unrelated to efficiency. Proprietary systems can more easily engage in penetration pricing than can open systems, whose many sponsors must somehow agree who will bear what portion of the early period sacrifice in profits, and who are unable to recoup the losses through higher prices in face of the onslaught of new entrants. If markets are biased against open systems, that bias should not be exacerbated.

Last but not least, particular software product can be sold to a particular customer at most once. If it is to be sold to that customer again, it must be enhanced with new features and functionality. The inevitable conclusion is that, even if the software industry approaches maturity, any software company that does not produce new and innovative products will simply run out of customers (Shapiro & Varian, 1999). Thus, the industry will remain

[40] One of the most famous cases of standardized intellectual properties is *Dell Computer Corp*. (File N° 931-0087 (consent agreement accepted for public comment, FTC November 2, 1995, 60 Fed. Reg. 57870; the agreement was accepted by the FTC with slight modifications, 62 Fed. Reg. 4767, 1997). The case implicated not only the patent-antitrust interface, but the role of antitrust in private, voluntary standard-setting activities as well. The complaint alleged a restriction of competition in the personal computer industry and an abuse of a private standard setting process by threatening to exercise previously undisclosed patent rights. In this case, the FTC's order suggests that by participating in standard-setting, a firm assumes the duty to disclose on participants all relevant intellectual property. This is particularly interesting in light of concerns about first-mover advantages, networks and switching costs.

innovative whether or not software patents exist. As a result, the need for a patent system to encourage innovation in mature industries doesn't seem to apply to the software industry.

6. The ability of patents to exclude competitors.

In most industries patents searches are fairly easy to perform and provide fairly solid results. In contrast, the nature of software means that much of it is very abstract, so it is hard to classify these technologies; as a result, searches are unreliable and in any case too expensive to use for software projects; moreover there is a combinatorial explosion of potential patent coverage which removes any kind of certainty about what is patented and what is not. All of which makes it difficult to assess whether patent claims are novel and non-obvious. In short, because of their broad coverage and complexity software patents introduce far more uncertainty than do their non-software cousins. And uncertainty is bad for business as uncertainty makes it difficult to decide the best strategy to pursue. Investments decisions are having to be made in the presence of great uncertainty over whether a competitor holds a key patent covering the technology being considered. Thus there is considerable uncertainty over when and whether the firm would face a detrimental suit itself

As a result, it is now difficult or impossible to produce new products in the software industry without violating numerous patents. Because software is largely free from physical constraints, complexity has grown to the current state where a major computer program can comprise anywhere from 100,000 to 10 million lines of code. In most industries, a product will involve technologies covered by just a few patents. In the software industry, a product can contain thousand of inventions, any of which might be patented. The number and scope of basic software patents lead to a pattern of mutual infringement. Indeed, there are so many new patentable programming techniques emerging everyday in the software industry that it is really impossible to keep up to date. As a consequence any large software package is likely to infringe dozens of software patents held by large companies and most companies are now forced to apply for software patents for defensive purposes.

The prospect of litigation itself is enough to stop enterprises, especially small ones from continuing on the innovation path (Lanjouw & al., 1997). SMEs, in particular, do not have the necessary cross-licensing agreements covering broad usage and generally do not have the necessary resources to do a thorough search of competing patents. Because it is quite expensive to file a patent and enforce it, small software companies can not either really benefit from patent protection on software (Mansfield, 1986).

Moreover, there are also numerous problems in dealing with software patents within the patent office, notably a problem of "submarine patents", i.e. an excessive period of pendency - typically 2 years. This time period is unacceptably slow in comparison to the rate at which software technology advances. In some cases, applicants have allegedly purposely delayed their applications in order to wait for the market to "mature" so as to maximise the value of their patents, and to let them make improvements before others are appraised of their basic patent. These tactics can distort the returns to patent holders, frustrate the disclosure of patented inventions, which is a basic *quid pro quo* for patent protection under the patent system, and lead to unnecessary duplication of effort (Lanjouw, 1994).

As if complexity and abstraction were not enough, the software industry is developing much faster than other industries. The rate of product generational change in the software industry is far higher than that of other industries. The presence of patents that last for 17 years is therefore extremely alarming. Ironically, the rapid pace of technological change and short product life cycles that characterise the software industry appear to increase rather than to diminish these firms' incentives to patent. If product life cycles were longer, firms would need to think more carefully about whether competitors would benefit from the information disclosed in the patent application and would perhaps protect a broader range of inventions with trade secrecy instead.

Thus, on one hand, short product life cycles tend to undermine the ability of firms in this industry to rely exclusively on patents to profit from inventions on a given generation of products (Scotchmer, 1991). On the other hand, because patent rights extend across generations of products and technologies and invention in this field is highly cumulative, patents may nonetheless be valuable in negotiations with other patent owners. Within this context, the rapid product life cycles that characterise this industry may contribute to an aggressive patenting strategy : by obtaining a patent, the firm purchases an option to exclude others from using its patented invention (a potentially valuable asset in negotiations with other patent owners or with users of the technology), while ensuring the firm's freedom to design and manufacture products using technologies that it developed. At the same time, the firm is able to secure this legal right to exclude without disclosing information that world jeopardise the firm's competitive advantage[41].

Imagine now that you own a software patent and want to find if your competitor is infringing it. If your competitor publishes its software as binary code, you will have to decompile it which is illegal. In certain countries, using an illegal approach to prove something makes the proof void. Because decompiling a software is mostly illegal[42], how can one discovers legally if a competitor is infringing on a software patent ? Such a situation may lead people to keep their source code secret, although it would be much more efficient for all users and programmers to be able to modify the source code and eventually to learn from the source code, therefore slowing down the diffusion of programming know-how. In reality, many software makers are currently refrained to publish open source software because they are scared to be sued for infringing on a software patent. Instead of stimulating know-how sharing, software patents seem to stimulate know-how secret which is exactly the opposite of their historical goals.

Conclusion : Is the case for stronger, broader patents persuasive ?

As regulators struggle to apply antitrust laws in dynamics, high-technology industries marked by significant levels of concentration and technological standardisation, the antitrust challenges raised by the interaction of network effects and intellectual property protection have become ever more salient. Policy-makers have come to recognise that observed competitive outcomes often result from subtle interactions between different sources of market power. This is especially true in high-tech industries, where the exercise of market power depends on the continuous development and diffusion of new products and technologies. Among other factors, the ability to sustain market power in network industries critically depends upon the strength and distribution of IPRs and the dynamics of technological standard setting.

[41] Different aspects of software can be protected simultaneously by patents, copyrights, and trade secrets, which one could characterise as the peculiar "triple treat" of software (see FTC Report, 1996).

[42] Decompiling a software is forbidden in Europe and in the USA. It is legal in Japan except for US software. Nevertheless, in Europe, it is possible to decompile a software but only for interoperability purpose. Moreover, thanks to what is called the "opposition" system, whereby, after a patent has been issued, the competition has a statutory right to oppose it, patents are often overturned. Proponents of this system maintain that it helps to weed out bad patents.

The interaction between these sources of market power can have dramatic competitive implications. In environment like the software industry, which exhibit both network effects and strong IP protection, there exists the significant possibility that a firm can create a closed standard[43] and thereby achieve a monopoly, notwithstanding the fact that alternative and perhaps superior technologies are available or could be readily developed. Standing alone, IPRs allow an innovator to exclude other firms from using protected technology, but cannot forestall the introduction of competing products based on alternate technologies. Independently, network effects may drive the market to converge on a single technological standard in which several firms can participate. When the two sources of market power interact, rather than moving towards a single technological standard in which several firms may participate, the market may tip to a single supplier, the owner of the intellectual property underlying the standard. In other words, a single firm's ability to exercise market power may be magnified by the interaction of IP and network effects.

Looking at the patent system as it is currently operating, it is obvious that the pendulum has swung too far : after decades when patents did not afford inventors and companies enough protection, they now offer too much. As a result, we are now facing the danger that the patent system impose an unnecessary drag on innovation by creating significant transaction costs for those seeking to commercialise new technology based on multiple patents, overlapping rights, and hold-up problems. The U.S. Supreme Court foresaw the danger in 1882, when ruling on the matter of boat-propeller technology : "*such an indiscriminate creation of exclusive privileges tend rather to obstruct than to stimulate innovation. It creates a class of speculative schemers who make it their business to match the advancing wave of improvement, and gather its foam in the form of patented monopolies, which enables them to lay a heavy tax on the industry of the country, without contributing anything to the real advancement of the arts*". If this view is correct, one should be very hesitant about extending the scope of patents even if this were justifiable in an ideally functioning system until we can be confident that the alleged deficiencies in the US system would not be reproduced here.

[43] See Shapiro, C. (1996) "*IPRs...often determine whether a network can be kept proprietary or not*", Antitrust in network industries, Remark before the American Law Institute and the American Bar Association, Jan. 25.

BIBLIOGRAPHY

Arora, A., 1995, Licensing Tacit Knowledge : Intellectual Property Rights and the Market for Know How, *Economics of Innovation and New Technology* 4, pp. 41-51.

Arthur, B., 1989, Competing technologies, Increasing returns and Lock-in by Historical Events, *The Economic Journal* 99, pp. 116-131.

Barton, J.H., 1997, Patents and Antitrust : A Rethinking in Light of Patent Breadth and Sequential Innovation, *Antitrust Law Journal* 65.

Barton, J.H., 1998, Paradigms of Intellectual Property/Competition Balances in the Information Sector, *OECD Report*, DAFFE/CLP (98) 18, pp. 295-303.

Besen, J. & Maskin, E., 2000, Sequential Innovation, Patents, and Imitation, *Working Paper* 00-01, January, Massachusetts Institute of Technology, Department of Economics.

Chang, H.F., 1995, Patent Scope, Antitrust Policy, and Cumulative Innovation, *Rand Journal of Economics* 26.

Christie, A., 1994, Designing Appropriate Protection for Computer Programs, *European Intellectual Property Review* 11, pp. 486-493.

Cohen, W.M., R.R. Nelson and J. Walsh, 1996, A First Look at the Results of the 1994 Carnegie-Mellon Survey of Industrial R&D in the United States, *Unpublished Manuscript*, February 28th.

Cohen, W.M., R.R. Nelson and J. Walsh, 1997, Appropriability Conditions and Why Firms Patent and Why They Do Not in the American Manufacturing Sector, *Unpublished Manuscript*, Carnegie-Mellon University. Paper presented at the Conference on New Science and Technology Indicators for the Knowledge-Based Economy, OECD, June 24th.

Cohen, W.M., R.R. Nelson and J. Walsh, 2000, Protecting Their Intellectual Assets : Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not), *NBER Working Paper* N°W7552, February.

Dam, K.W., 1994, The Economics Underpinnings of Patent Law, *Journal of Legal Studies* 23, pp. 247-263.

Dasgupta, P. & J.E. Stiglitz, 1980, Uncertainty, Industrial Structure, and the Speed of R&D, *The Bell Journal of Economics* 11, pp. 1-28.

David, P., 1985, Clio and the Economics of QWERTY, *The American Economic Review*, Proceedings 75, pp. 332-337.

Denicolo, V., 1997, Patent Policy with a Finite Sequence of Patent Races, *Mimeo*, Department of Economics, University of Bologna.

Dumont, B. & P. Holmes, 1999, The Breadth of Intellectual Property Rights and their Interface with Competition Law and Policy : Divergent Path to the Same goal, *Paper* presented at the International Conference "Innovation, Appropriation Strategies and Economic Policy", November 19, 32p. Forthcoming in *Economics of Innovation and New Technology*, 2001.

Farrell, J., 1989, Standardization and Intellectual Property, *Jurimetrics Journal*, Fall, pp. 35-50.

Farrell, J., 1995, Arguments for Weaker Intellectual Property Protection in Network Industries, *Standardview* 3, pp. 46-49.

Farrell, J. and G. Saloner, 1985, Network Externalities, Competition and Compatibility, *The American Economic Review* 75.

Farrell, J. and G. Saloner, 1992, Converters, Compatibility, and the Control of Interfaces, *The Journal of Industrial Economics*, March, XL (1), pp. 9-34.

Foray, D., 1994, Production and Distribution of Knowledge in the New Systems of Innovation : The Role of IPRs, *Paper* presented at the Conference : IPRs and Global Competition, Science Center for Social Research, Berlin, April.

Gandal, N., 1995, Competing Compatibility Standards and Network Externalities in the PC Software Market, *Review of Economics and Statistics*, November.

Gilbert, R.J. and D.M. Newbery, 1982, Preemptive Patenting and the Persistence of Monopoly, *The American Economic Review* 75, pp. 514-526.

Gilbert, R.J. & C. Shapiro, 1990, Optimal Patent Length and Breadth, *The Rand Journal of Economics* 21, pp. 106-112.

Graham, S. and D.C. Mowery, 2000, Intellectual Property Protection in the Software Industry, *Working Paper*, 49p., Haas school of Business, University of California at Berkeley.

Green, J. and S. Scotchmer, 1995, On the division of Profit in Sequential Innovation, *The Rand Journal of Economics* 26, pp. 20-33.

Hall, B.H. and R.M. Ham, 1999, The Patent Paradox Revisited : Determinants of Patenting in the US Semiconductor Industry, 1980-94, *Revised version of a Paper* for presentation at the January 1999 NBER " Patent and Innovation " Conference in Santa Barbara, CA, 44 p.

Heller, M.A. and R.S. Eisenberg, 1998, Can Patents Deter Innovation ? The Anticommons in Biomedical Research ? *Science* 280, May, pp. 698-701.

Jaffe, A.B., 1999, The US Patent System in Transition : Policy Innovation and the Innovation Process, *NBER Working Paper* #7280, 60p, August, available at http://www.nber.org/papers/w7280

Katz, M.L. and C. Shapiro, 1985, Technology Adoption in the Presence of Network Externalities, *Journal of Political Economy* 94, pp. 822-841.

Katz, M.L. and C. Shapiro, 1998, Antitrust in Software Markets, *Paper* prepared for presentation at the Progress and Freedom Foundation Conference, Competition, Convergence and the Microsoft Monopoly, February 5, 56 p.

Kitch, E.W., 1977, The Nature and Functions of the Patent System, *Journal of Law and Economics* 20, pp. 265-290.

Klemperer, P., 1990, How Broad should the Scope of Patent Protection Be ? *The Rand Journal of Economics* 21, pp. 113-130.

Klemperer, P., 1995, Competition When Consumers Have Switching Costs : An Overview, *Review of Economic Studies* 62.

Kortum, S. and L. Lerner, 1997, Stronger Protection or Technological Revolution : What is Behind the Recent Surge in Patenting ?, *Carnegie Rochester Conference Series on Public Policy* 48, pp. 247-304.

Kortum, S. and L. Lerner, 1999, What is Behind the Recent Surge in Patenting ?, *Research Policy* 28, pp. 1-28.

Lanjouw, J.O., 1994, Economic Consequences of a Changing Litigation Environment : The Case of Patents, *NBER Working Paper* N° 4835, August.

Lanjouw, J.O. and J. Lerner, 1997, Preliminary Injunctive Relief : Theory and Evidence from Patent Litigation, *Harvard Business School Working Paper* N° 96-068, and *NBER Working Paper* N° 5689.

Lanjouw, J.O. and M. Schankerman, 1997, Stylized Facts of Patent Litigation : Value, Scope and Ownership, *Working Paper* N°6297, NBER, December, 40p.

Lemley, M.A., 1996, Antitrust and the Internet Standardization Problem, *Connecticut Law Review* 28, pp. 1041-1057.

Lerner, J., 1995, Patenting in the Shadow of Competitors, *Journal of Law and Economics*, October, pp. 463-495.

Lerner, J., 2001, 150 years of Patent Protection, *Economics of Innovation and New Technology* (forthcoming).

Levin, R.C.; A. Klevorick; R. Nelson and S. Winter, 1987, Appropriating the Returns from Industrial R&D, *Brookings Papers on Economic Activity*, N° 3, pp. 783-820.

Machlup, F. (1958), An Economic Review of the Patent System, *Study* of the Subcommittee on Patents, Trademarks and Copyrights of the Committee on the Judiciary U.S. Senate, 85th Congress, Washington DC, Government Printing Office.

Mansfield, E., 1986, Patents and Innovation, *Management Science* 32, pp. 173-181.

Matutes, C., P. Regineau and K. Rockett, 1996, Optimal Patent Design and Diffusion of Innovation, *Rand Journal of Economics* 27.

Mazzoleni, R. and R.R. Nelson, 1998, The Benefits and Costs of Strong Patent Protection : A Contribution to the Current Debate, *Research Policy* 27, pp. 273-284.

Merges, R., 1994, Intellectual Property Rights and Bargaining Breakdown : The Case of Blocking Patents, *Tennessee Law Review* 75.

Merges, R., 1996, A Comparative Look at Intellectual Property Rights and the software industry, in Mowery, D.C. ed., The international Computer Software industry: A Comparative Study of Industry Evolution and structure, New York : Oxford University press.

Merges, R., 1999, As Many as Six Impossible Patents Before Breakfast : Property Rights for Business Concepts and Patent System Reform, *Berkeley Technology Law Journal* 14, pp. 578-615.

Merges, R. and R. Nelson, 1990, On The Complex Economics of Patent Scope, *Columbia Law Review* 84, N° 5, pp. 839-916.

Merz, J.F and N.M. Pace, 1994, Trends in Patent Litigation : The Apparent Influence of Strengthened Patents Attributable to the Court of Appeals for the Federal Circuit, *Journal of Patents and Trademark*, August (cited in the FTC Report, 1996).

Mortensen, D.T., 1982, Property Rights and Efficiency in Mating, Racing and Related Games, *American Economic Review* 72, pp. 968-979.

Mowery and Rosenberg, 1998, Paths of Innovation : Technological Change in 20th Century America

National Research Council (NRC), 2000, Committee on Intellectual Property Rights and the Emerging Information Infrastructure, The Digital Dilemma : Intellectual Property in the Information Age, Washington D.C. : National Academy Press.

O'Donoghue, T., 1998, A Patentability Requirement for Sequential Innovation, *The Rand Journal of Economics* 29, N°4, pp. 654-679.

O'Donoghue, T., S. Scotchmer and J-F. Thisse, 1998, Patent Breadth, Patent Life, and the Pace of Technical Progress, *Journal of Economics & Management Strategy,* Spring 7, N° 1, pp. 1-32.

Parr, R.L. and P.H. Sullivan, 1996, Technology Licensing : Corporate Strategies for Maximizing Value, New York : John Wiley & Sons, Inc.

Rapp, R.T., 1995, The Misapplication of the Innovation Market Approach to Merger Analysis, *Antitrust Law Journal* 64.

Reinganum, J.F., 1989, The Timing of Innovation : Research Development and Diffusion, in R. Schmalensee & R.D. Willig, eds., The Handbook of Industrial Organization, New York : North Holland.

Salop, S. and D.T. Scheffman, 1983, Raising Rivals' Cost, *The American Economic Review* 73, May, pp. 267-271.

Schankerman, M., 1998, How Valuable is Patent Protection ? Estimates by Technology Field Using Patent Renewal Data, *The Rand Journal of Economics* 29, pp. 77-107.

Scotchmer, S., 1991, Standing on the Shoulders of Giants : Cumulative Innovation and the Patent Law, *Journal of Economic Perspectives* 5, N° 1, pp. 29-41.

Scotchmer, S., 1996, Protecting Early Innovators : Should Second-Generation Products Be Patentable ?, *The Rand Journal of Economics* 27, pp. 322-331.

Scotchmer, S., 1999, Cumulative Innovation in Theory and Practice, *Unpublished Manuscript*, University of California, Berkeley.

Shapiro, C., 2000, Navigating the Patent Thicket: Cross-Licenses, Patent Pools, and Standard-Setting, *Paper* presented at the NBER conference "*Innovation Policy and the economy*", April 12, 32p.

Shapiro, C. and H.R Varian, 1999, Information Rules: A Strategic Guide to the Network Economy, Cambridge, Mass.: Harvard Business School Press, 324p.

Sheremata, W., 1997, Barriers to Innovation : A Monopoly, Networks Externalities, and the Speed of Innovation, *The Antitrust Bulletin* 42, pp. 937-996.

Teece, D.J., 1986, Profiting from Technological Innovation : Implications for Licencing, Integration and Public Policy, *Research Policy* 15, pp. 285-307.

Thurow, L.C., 1997, Needed: A New System of IPRs, *Harvard Business Review*, pp. 95-103.

U.S. Department of Justice (DoJ) and Federal Trade Commission (FTC), 1995, Antitrust Guidelines for Licensing of Intellectual Property, Government Printing Office.

Van Dijk, T., 1994, The Limits of Patent Protection : Essays on the Economics of Intellectual Property Rights, *PhD Thesis*, 195p., Maastricht University.