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COLLECTIVE MANAGEMENT OF INTELLECTUAL PROPERTY RIGHTS

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Collective Management of Intellectual Property Rights

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Abstract: This paper proposes a common analysis for a large set of *multilateral* agreements that are used to collectively manage intellectual property in industries as different as biotechnologies or information technologies. It discusses how these agreements, based on existing intellectual property institutions, can encourage innovation either by facilitating technology transfers or by improving the organization of collective innovation processes. In the first part we explain how the collective management of intellectual property rights can be used to facilitate arm's length technology transfers. Its objective is then to facilitate the access to information about variety, to reduce negotiation costs and to optimize the management of prices. In the second part we explain how the collective management of intellectual property rights can be used to improve the innovation production processes by proposing a wide set of organizational structures ranging from centralized organizations that rely heavily on planning, to decentralized organizations that use incentives to motivate participants. As a conclusion, we highlight new challenges for competition policy generated by those tools.

Keywords : Intellectual property right, consortia, biotechnology, open source, software.

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1. Introduction

This paper proposes a common analysis for a large set of *multilateral* agreements that are used to collectively manage intellectual property in industries as different as biotechnologies or information technologies. It discusses how these agreements, based on existing intellectual property institutions, can encourage innovation either by facilitating technology transfers or by improving the organization of collective innovation processes.

Intellectual property institutions were developed to design a decentralized organization of R&D. Their efficiency can be explained by the following arguments (see Foray, 2004, for instance). First, they provide individual incentives to invest in R&D because they guarantee exclusivity on the use of the innovation. Moreover, when the private value of exclusivity is linked to the social value of the innovation, they provide incentives to invest in those R&D programmes that are the most valuable from society's point of view. Note here that legal exclusivity may not be the main source of incentives to innovate. Lead time, secret or complementary products or services may be superior to intellectual property rights to protect their intellectual assets (Teece, 1986; Cohen and al., 2000). In some case, the incentives to innovate may not be related to exclusivity at all, as illustrated by open source programmers (Bonaccorsi & Rossi, 2004). Second, they create a legal framework that facilitates bilateral or multilateral technology transfers between technology developers and technology users, which achieves gains in allocative efficiency. Users generally accept to pay for such transfers, which reinforces the incentive function of intellectual property rights. But technologies may also be transferred for free as, again (but not only), in the case of open source software. Still, even in this case, intellectual property rights may be used to define rules the user will have to comply with. Such rules can be particularly useful when many technology transfers take place within a group of technology developers, because they allow, *ex ante*, a clear definition of appropriate steps of the innovation process.

This article discusses how collective initiatives can improve the second function of intellectual property, e.g. the allocative one. Usual means to protect intellectual property (patents, copyright, plant breeders' rights, etc.) are imperfect and define different balances between the need to provide incentives to innovators and the need to guarantee the widest possible dissemination of knowledge and information. Their intensive use in recent years has raised some concerns that they may discourage innovation rather than encouraging it (see Heller and Heisenberg, 1998). Multilateral agreements based on standard intellectual property institutions and designed to supplement them can address many of these concerns. As we will

see, some facilitate the transfer of technology inputs between innovators and technology users; others allow a better organization of collective innovation.

In most high tech sectors, essential inputs and outputs are elements of knowledge protected by intellectual property rights. These rights can be of various forms and guaranteed either by copyright or by patents or, in the case of the agbiotech sector, by more specific rights such as plant breeders' rights. A common feature of these high tech sectors today is that intellectual property is characterized by complementarities. Consequently, the value of a piece of intellectual property is strongly contingent on the availability of other pieces. These complementarities can be technological. This is the case when any marketable innovation involves the combination of different independent inputs. The cumulative nature of the innovation process is another common feature. In high tech sectors, innovations are usually obtained by "standing on the shoulders of giants" (see Scotchmer, 1991), i.e. by building on many previous innovations obtained by a large number of previous innovators and which may all be protected by intellectual property rights.

A direct consequence of intellectual property complementarities and cumulative innovation is that there is a need for numerous transactions to aggregate pieces of intellectual property all throughout the production process. These transactions may be necessary to produce a marketable final good that exploits an innovation or even just to produce an intermediate good and not to block progress. Licensing is the basic tool used to trade intellectual property. The market for technology inputs that is needed in high tech sectors is therefore a market for licensing agreements. However, the functioning of such a market is hardly smooth and various frictions plague it. In a survey of 229 U.S. and Canadian firms, Razgaitis (2004) finds for instance that only 4% of licensable technologies end up in a license. In an empirical study of European patents, Gambardella and al. (2006) similarly find that small and large firms license respectively 26% and 9% of their patented technologies while they are actually willing to license 37% and 16%. Both Razgaitis (2004) and Gambardella and al. (2006) attribute such limited rates of success to various transaction costs.

One argument that reinforces the difficulties encountered in the market for licenses in high tech sectors is that of anti-commons developed by Heller and Heisenberg (1998). It is also called the "patent thicket" in the case of IP protected by patents (see Shapiro, 2001). The first aspect of the anti-commons problem is royalty stacking or, in economics terms, multiple marginalizations. All owners of a piece of intellectual property are monopolists that are going to exploit their market power by pricing above the marginal cost. When several pieces of

intellectual property are needed in a production process, this behaviour exerts a negative externality on the other owners involved by reducing the total quantity bought by the producer. In the extreme, an uncoordinated behaviour of multiple monopolists may lead producers to abandon their project. A second aspect of the anti-commons problem is the fear of hold-up. The surge in intellectual property protection makes it difficult for a firm to know precisely which areas of the technological landscape are protected and which are not. Therefore, when starting a new project, innovators may fear that they are actually infringing on some intellectual property rights and that, once they have made the initial investments, the owner of those rights will charge higher royalties than what they could have obtained with an ex ante negotiation. In some sectors this fear is so great that it may discourage innovators from launching their project. This second aspect likewise concerns the diverse inspection costs that must be incurred by an innovator before starting a project. Just to get a good picture of the technological landscape and its protected areas, and therefore to be able to avoid hold up, an innovator may need to spend huge amounts of money. Finally, a third aspect of the anti-commons problem is enforcement and litigation costs. Intellectual property is valuable only if it is correctly enforced and secures clear rights. With the multiplication of intellectual property protections, it becomes difficult for firms to anticipate correctly what is protected and what is not. Expenses linked to litigation procedures are tending to explode. To summarize the anti-commons argument in a nutshell, the generalization of intellectual property protection may in fine increase transaction costs in the technology market, where those transaction costs refer to costs linked to asymmetric and/or imperfect information and coordination or cooperation failures.

Technology input complementarities also have the consequence that the success of an innovative project may need the collaboration of many parties. In other words, successful innovative projects are often team projects, where each member of the team may be a firm or an individual. To manage those projects efficiently, it is generally necessary for parties to sign a binding contract ex ante, in order to minimize the impact of opportunistic behaviour on transaction costs. However, because of the very nature of innovative activity, such a contract is hardly complete and transaction costs may not disappear. In these circumstances, Intellectual Property Rights facilitate ex ante agreements between parties because they enrich the set of contractible variables. They may therefore alleviate moral hazards in team and hold-up problems, in the form of standard transaction costs plaguing team projects. However, IP is not a solution *per se*, only a building block that may be used to construct a solution.

Most notably in the biotech and information technology sectors, economic agents have tried to develop some collective initiatives to minimize the impact of all those kinds of transaction costs. These collective tools involve multilateral negotiations. They include patent pooling, open source licensing and clearing house mechanisms and are examples of what we call a collective management of Intellectual Property Rights. They are based on standard intellectual property rights and typically make extensive use of standard protections like patents or copyright. But they elaborate on these standard protections by proposing various forms of collective management.

In the following we draw on a series of examples to analyse the impact of those collective tools on technology transfers and on collective innovation. In the first part we explain how the collective management of intellectual property rights can be used to facilitate arm's length technology transfers. Its objective is then to facilitate the access to information about variety, to reduce negotiation costs and to optimize the management of prices. In the second part we explain how the collective management of intellectual property rights can be used to improve the innovation production processes by proposing a wide set of organizational structures ranging from centralized organizations that rely heavily on planning, to decentralized organizations that use incentives to motivate participants. As a conclusion, we highlight new challenges for competition policy generated by those tools.

2. Collective initiatives to facilitate technology transfers

The organization of research and the development of innovations rely on access to technology inputs that are individually protected by intellectual property rights. Such access is impeded by the difficulty of identifying the relevant technology inputs and defining the conditions of their use, in other words, it is impeded by transaction costs linked to informational problems. These problems are particularly acute when intellectual property rights are fragmented and innovations are combinatorial or cumulative. Of course the markets for technology are not the only ones plagued by transaction costs, and for a long time economic agents have developed solutions to cope with those costs. Traditional solutions typically involve bilateral negotiations and are therefore likely to emerge without any collective intervention. Vertical integration can be useful in solving multiple marginalization problems, because the consequences of monopoly pricing of the intermediate inputs are fully internalized by a vertically integrated firm. Specialized intermediaries can develop expertise in some

technological fields and sell their services to innovators. This is mainly what Intellectual Property brokers do. Similarly, cross-licensing agreements are often used to limit the legal costs of enforcement.

As regards technology transfers, however, other more collective initiatives have been developed to improve the allocation of technology inputs by creating networks that facilitate such transfers. Designed for a specific technological area (i.e. software, agbiotech, etc.) and for a given market structure (limited to public actors, private actors, a combination of public and private actors, etc.), each of these collective initiatives provides some responses to the following three impediments to efficient technology transfers: the difficulty of access to information, the heterogeneity of licensing terms, and the uncoordinated pricing policies for access to (and use of) innovations, in particular via royalty pricing.

2.1 Available technologies

In markets for technology inputs even more than in other markets, information is critical. On the one hand technologies are experience goods and must therefore be disclosed to potential buyers before any transaction is possible. On the other hand the disclosure of a non-rival technology can destroy its market value since the potential buyer can then appropriate the disclosed information without having to pay. The exclusivity conferred by intellectual property is a way to solve this paradox.

Yet exclusive IP rights and the associated disclosure of information may not be sufficient to ensure the proper functioning of markets for technologies. The private incentives to disclose strategic information through IP rights may not be aligned with the collectively beneficial objective of ensuring the existence of a transparent market for technologies (think about the phenomenon of “submarine patents” analysed for instance by Graham and Mowrey (2004)). Because it benefits all actors in the sector, transparency may have some public good features.

Thus it is often worthwhile complementing information provided by IP rights with other information regarding the number of available technological inputs, the characteristics of those inputs, the level of accessibility to them, or the missing inputs in the market. Providing such information allows for savings on costs related to requests for non-accessible technological inputs or for technological inputs diffused by means of incompatible licenses. Such information may also reduce the cost of transactions via the identification and diffusion of technological packages which then limit the multiple negotiations with the holders of

complementary technological inputs. It may limit the frequency of situations of multiple marginalizations.

Providing such information is the purpose of a number of collective initiatives in various sectors which do so by building networks of actors. We present two examples, namely "PIPRA" (for Public Intellectual Property Resources for Agriculture) in the ag-biotech industry³ and "SourceForge" in the software industry, to highlight different philosophies:

On PIPRA's website, one can read:

"The development of new crop varieties with biotechnology depends on access to multiple technologies which are often patented or otherwise protected by intellectual property rights (IPRs). Ownership of these rights is fragmented across many institutions in the public and private sectors, which makes it difficult to identify who holds which rights to which technologies, in which countries, and to establish whether or not a new crop variety is at risk of infringing on those rights. PIPRA is an initiative by universities, foundations and non-profit research institutions to make agricultural technologies more easily available for development and distribution of subsistence crops for humanitarian purposes in the developing world and specialty crops in the developed world." (source: PIPRA).

PIPRA is an initiative conducted by public actors to create a tool for the collective management of intellectual property rights in plant biotechnologies. Information disclosure is one of its core missions. Interestingly, this tool defines itself as a "Clearing House Mechanism" (CHM) while its objective is clearly not only to balance the payments between participants, neither publicly nor secretly. It is also more ambitious than simply organizing a business forum for research in the agbiotech sector (Zilberman and Graff, 2005).

SourceForge is presented in the following terms:

"SourceForge.net is the world's largest Open Source software development web site, hosting more than 100,000 projects and over 1,000,000 registered users with a centralized resource for managing projects, issues, communications, and code. SourceForge.net has the largest repository of Open Source code and applications available on the Internet, and hosts more Open Source development products than any other site or network worldwide. SourceForge.net provides a wide variety of services to projects we host, and to the Open Source community". (source: sourceforge.net)

³ PIPRA initiative is discussed in Kapczynski et al. (2005) and Holland-Moritz (2003).

Contrary to PIPRA, the distinction between public and private actors is absent in the SourceForge initiative. Here, the perimeter of action is defined through reference to the Open Source community, by implicit opposition to proprietary software actors. In what follows we adopt PIPRA's terminology and call these two similar initiatives Clearing House Mechanisms (CHMs).

In both CHMs the first objective is to centralize and manage information about technology inputs. This is achieved through the creation of databases and the definition of different levels of access to the databases. PIPRA makes efforts to develop databases of patented agricultural technologies, so that *"public-sector researchers can be informed about freedom to operate obstacles at the initiation of their research"* (source: PIPRA.org).

This requires providing the best information about the available technologies and their potential use. Such information may be especially useful to avoid the duplication of technologies that already exist and to obtain a license more easily. It is moreover a way to prevent innovators from being held up by patentees they had not identified before investing in R&D.

A second type of information concerns the accessibility of the technologies. Both initiatives provide information to clarify the type of license which covers the technology (exclusive or non-exclusive license, in the case of biotechnologies) and/or the type of license which covers the element according to the type of open source(spring) software (General Public license, BSD license, Mozilla Public License , etc. in the case of software).

This information reduces the risk of incompatibility between two modules protected by different licenses or the risk of by-passing elements which are covered by exclusive licenses. For instance, *"PIPRA will complement the data by developing a common database that provides an overview of IPR currently held by the public sector, including up-to-date information about licensing statuses"*. By doing so, it intends to limit the cost of transactions.

The information disclosure activity of those two initiatives is clearly subject to network externalities: the higher the number of participants in the initiatives, the more valuable the information that is provided. Accordingly, in their presentation SourceForge managers insist on the fact that it is the biggest project of its kind. PIPRA participants similarly inform their colleagues at their institutions and other public sector organizations, and request their comments and suggestions. They welcome participation by additional institutions from the

U.S. or from other countries to enlarge the perimeter of the market for technology inputs.

Lastly, the access to these two types of information makes it possible to identify complementarities or lacks of technology inputs:

PIPRA is exploring the possibility of identifying technology packages available to member institutions and to the private sector for commercial licensing or for designated humanitarian or other uses. *“Patent pools have been used effectively to expedite the development of more than 70 technologies with significant societal impact, including farm implements and digital videodisks.”* (source: PIPRA.org). Using the collective public IP asset database to make complementary sets of key technologies available should help public sector researchers to obtain freedom to operate in crop biotechnology and significantly reduce the transaction costs now associated with negotiating the large number of licenses required to develop a new crop variety (see Section 2.3.2.). Source Forge allows users to know which software is accessible or not. It also helps them to join a network to develop new software (the user thus becomes a developer). *“The Software map will help you quickly navigate around the thousands of projects hosted on SourceForge.net. To use the Software Map, simply click on one of the popular Topics displayed. Once you're browsing a particular topic, you'll be able to easily filter, sort and search your project list”* (Source Sourceforge.com)⁴.

The collective management of information conversely provides material to check the non-availability of some required technology. This absence in the network can have diverse consequences: encourage the development of future research, or encourage negotiations with actors outside the network (2.3.2.)⁵.

2.2 Licensing terms

The creation of a network of exchange for technology inputs is intended to limit the cost incurred in acquiring information on the existing technology options, their characteristics and their accessibility. This tool is also designed to limit the costs of negotiation. In this section

⁴ The bioforge initiative has the same goal, for example: “TransBacter is designed to be a work-around to the many patents covering *Agrobacterium* transformation and thus aims to overcome the current Intellectual Property restrictions to the commercialization of products created using bacteria-mediated gene transformation in plants.” Source: <http://www.bioforge.net>.

⁵ The choice will depend on the development cost of the missing element compared with the cost of access to that element outside the network. In this context, we can already note that in the case of copyrighted software it can be less expensive to develop a substitute even if the technology exists. By contrast, in the case of patented software or sequences of genes for which the cost of obtaining a substitute can be infinite, it will be necessary to opt for a license.

we discuss the reduction of negotiation costs by means of the standardization of licence agreements and the implementation of guidelines.

In the PIPRA project, information disclosure about licensing practices paves the way for a systematic exploration of public sector IP licensing policies and for identifying the “best practices” that will encourage the greatest commercial development of publicly funded research while at the same time ensuring the greatest social welfare benefits. Within the framework of PIPRA, there is a will to standardize the access rules inside the network, even if each university remains the owner of its innovation. The standardization occurs at the level of licences on technological packages. Moreover: *“At least initially, PIPRA will develop guidelines to assist in the management of intellectual property so that it may be available to serve a greater public benefit.”* (Source: PIPRA.org)⁶.

“Science Commons” is another initiative to limit negotiation costs. Science Commons proposes to harmonize licences and the clauses within licence contracts. It is interested in the dissemination of scientists’ publications, of biological material and of data. The objective is to promote effective use of digital networks to broaden access to all three types of information. As stated in the creative commons website: *“For example, some publishers of peer reviewed science journals are employing a new, open access business model where the authors grant the public a Creative Commons license in their articles. Creative Commons licenses make clear to the public the broad range of uses they may make of these articles”*. As in the case of open source software, the harmonization of licences makes it possible to quickly inform the user about his or her rights and duties without having to renegotiate each clause of the contract. The goal of open access is to broaden the dissemination of knowledge about the natural world to researchers and other readers who can put this knowledge to use. In the case of licensing, *“the science commons licensing project will explore standard licensing models to facilitate wider access to the material.”* This standardization is all the more necessary as biotechnological research is confronted with more and more intellectual property whereas it needs to use more and more technology

⁶ The problem of access through licensing agreements is quite new in the agricultural sector. Traditionally, seed sector innovations are protected by “Plant Breeders Rights” (PBR). This intellectual property right is similar to patents (exclusivity, duration) but leaves a free access – free of charge, automatic and without licence agreement – to the genetic diversity which composes the innovation. This free open access is operative as long as future innovations are not considered as an “essential derivation”⁶. An innovator protecting his/her varieties by PBR will still have incentives to spend money and time in R&D to innovate. This is because the time necessary to develop and market a substitutable innovation (10 years minimum) is sufficient to ensure a return on the investment. However, with the development of biotechnologies, seed-sector innovations are now patentable and numerous negotiations might be necessary even just to conduct research.

inputs. The harmonization of licence agreements, particularly of the Material Transfer Agreements (MTA), has reduced the costs related to negotiation and to the duration of negotiation. To convince users, Science Commons note that: *“One of your colleagues says that she’d be happy to send you her transposon insertion lines that saturate the right arm of chromosom 9; you’ll just need to have a MTA signed by your institution. Six month later, the terms of the agreement are still under negotiation, you have missed the field season, your grant has expired and there is now a better resource that is been developed and if you are starting negotiation now...”* This example shows the advantage of developing standardized licences, the scope of which is limited to the uses the applicant chooses (for profit or not for profit). This facilitates the access to protected innovations without hurting the owner’s rights. Moreover, Scientific Commons proposes the use of a standardized basic contract common to all the MTA, offered with a set of options: *“creating in effect an entire suite of legally binding, standard contractual terms that can be mixed and matched to create a customized agreement, tailored to fit the large variety of transfer situations”*.

Even in the Open Source world, license type proliferation is a real problem that generates legal uncertainty on the compatibility of software modules. About sixty different types of OSS licenses are currently on the shelves, among which three broad categories can be distinguished. First, “copyleft” or “viral” licenses – such as the famous General Public License (GPL) – require that any derivative product based on code protected by such licenses be protected under the same license. By contrast, so called “academic” licenses like the Berkeley Software Development (BSD) license are not viral. In other words, proprietary software can be derived from, or combined with, code licensed under a BSD license. Finally, a third category of licenses has an intermediate position between academic and copyleft licenses. Such licenses allow the use of open source code as building blocks to develop broader software, be it open source or proprietary.

This variety of licenses generates several types of incompatibility. First, software derived from “copyleft” code cannot be turned into proprietary software or licensed under any type of OSS license that is more restrictive than the initial license. Second, even licenses of the same type may not be compatible because they incorporate contradictory clauses. In that case it is not possible to aggregate pieces of code disseminated under such licenses. Finally, the aggregation of various pieces of code distributed under numerous different licenses is an important source of legal uncertainty for users of open source software, especially for firms. Therefore, the wide variety of open source licenses can represent an impediment to

innovation.

In this context, several organizations intervene as legal standardization bodies to promote the voluntary adoption of some particular types of license by open source software developers. The Open Source Initiative (OSI) brings together leaders of the open source community and aims to recommend safe licenses. In 2005 it created a commission to address the issue of license proliferation. One of its goals is to classify the OSI-Approved License in three categories, namely 'Preferred', 'Recommended but not preferred', and 'Not recommended' licenses. At the same time the OSI published a policy statement⁷ in which it proposed the addition of an eleventh criterion to obtain the OSI label for new licenses: the candidate license should be clearly written, simple, understandable and reusable by moving the names of specific individuals, projects or organizations into an accompanying attachment.

2.3. Prices

Multilateral agreements used to collectively manage intellectual property are also intended to influence the commercial relationships among members or between members and third parties, via pricing policies.

2.3.1. To facilitate access to technology inputs owned by members

Consider the problem of pricing to members or third parties, as illustrated by the example of golden rice. Golden rice is a technology developed to enrich rice in vitamin A. It is an innovation of particular importance for developing-country populations with a deficit in vitamin A and for whom rice is a staple food. Three genes were inserted in standard rice to develop the biosynthesis of beta-carotene. The development of that innovation requires the use of transformation vectors, gene promoters and resistance markers to antibiotics. All these technology inputs are necessary to exploit the innovation but they are all patented or covered by Material Transfer Agreements. Essential inputs represent more than 70 items controlled by a dozen rightholders (Kryder et al., 2000). Without an agreement between these holders, any market for golden rice is doomed, as along with any new research on it, since uncoordinated pricing strategies would lead to an unreasonably high level of royalties to be paid to

⁷ <http://opensource2.planetjava.org/docs/policy/licenseproliferation.php>

rightholders. This example illustrates problems linked to multiple marginalizations⁸.

In the previous sections we analysed the identification of complementarities and the creation of technological packages. This section deals with the tools used to distribute them. Networks built to facilitate the transfer of technology inputs (like CHMs) do not solve the multiple marginalization problems. In the case of golden rice, as well as in other important cases like MPEG or DVD formats, this problem was handled by the creation of a patent pool. A patent pool is a collective agreement between several patent holders to bundle the sale of their respective licenses. Patent pools benefit the licensees because they allow one-stop shopping and because the total royalty rate imposed for the licenses is maintained at a reasonable level. The licence on a patent pool internalizes the problem of multiple marginalizations.

This problem is also solved by some research consortia such as Génoplante. Génoplante is a French public/private consortium on plant genomics and on the development of innovation in the plant breeding sector (Assouline and Joly, 2001). Within this consortium, the royalties drawn from the licences on patents or on know-how are distributed between the partners according to their effective participation in the project. The participation of each partner – their weight in the creation of an innovation – is evaluated according to the information centralized in a “book of research” kept in each laboratory (time spent on the project, laboratory of origin of the biological material used, owner of the techniques, owner of the licences, etc.). In this institutional setting, the global price is maintained at a reasonable level, which may be negotiated *ex ante*, by the consortium, while the revenue-sharing rule might be renegotiated after each new innovation.

2.3.2. To facilitate bargaining with third parties

There are at least two cases in which bargaining with a third party is necessary: a member may need a technology input possessed by that third party, or may need the third party's expertise to commercialize its innovation.

In some cases members do not possess all technology inputs. The need for external technology inputs can exist for individual or collective research and the multilateral

⁸ The choice of the manager of the collective is of primary importance. Maurer 2006 shows that the failure of the Mutation Database initiative is related to the fact that: "deadlock occurred because most members could not afford the information costs needed to reach a decision." This situation is the resultant of a management which did not make it possible to reduce the costs of transaction for the partners.

agreements can be used to strengthen the bargaining position of members in relation to third parties. This reason was actually at the origin of the PIPRA clearing house mechanism. In the plant biotech sector Monsanto owned 14% of the patent and the three largest companies possessed more than 30%. In comparison, the largest public actor, the University of California, owned 1.7% of the patents. As a consequence, the bargaining power of any single public laboratory was not strong when negotiating with the largest private companies. Nevertheless, looking at public research as a whole, the public sector held 25 to 30% of the patents in plant biotechnologies (Graff and al. 2003). Hence, the weight of public research in plant biotechnology was not so small. PIPRA was initially an attempt to give public sector researchers a better bargaining position when negotiating licenses on privately owned patents.

Even if members possess all the technology inputs, they may need third-party expertise for the valorization of intellectual property. Here again, respective bargaining strength is important to determine the patterns of the licensing agreement. Still in the ag-biotech sector, the broad scope of the patents has had consequences on the use of licensing by public laboratories. Private firms generally require exclusive world licences to develop public patents, or granting an exclusive licence under these conditions would be economically and socially not very effective. With the strengthening the public sector bargaining position, via the creation of clearing house mechanisms, it has become possible for public labs to propose licenses limited to the research identified, in a given geographical area and for clearly defined durations.

3. Collective management of innovative projects

Efficient markets for technologies enable the identification, selection and aggregation of technology inputs that can be used to develop future innovations. Such projects may be undertaken by a single agent. But in some cases they involve several participants, which raises new collective management issues, especially regarding additional R&D investments and their results. Collective innovation projects may have various motives, from benefiting from network effects through the creation of an industry standard, to sharing and eventually reducing the cost of developing a technology that is needed by all. Our focus here is more on the practical organization of such projects than on their motives. In this part we compare and discuss how rules based on intellectual property rights can contribute to the collective handling of such projects, through institutions as different as research consortia, patent pools

or open source software.

3.1 Aggregating intellectual property rights

The aggregation of technology concerns three types of input protected by intellectual property rights, namely (i) existing inputs that have no substitutes, (ii) existing inputs that must be picked among a set of substitutes, and (iii) forthcoming technology inputs.

The problem of aggregating technology inputs is often considered from a technology market standpoint. In this perspective the questions deal with the selection and pricing of existing technology inputs. They lead to the distinction between those inputs that have substitutes and those that do not, for only the latter provide their owners with a market power. This is why antitrust law authorizes the creation of patent pools only for essential patents – that is, those that do not have any substitute. In that case coordinated pricing is a way to eliminate the double marginalization problem. By contrast, the inclusion of non-essential patents into the pool could allow their licensing at a non-competitive price.

Although this antitrust approach to technology aggregation makes sense, it does not take into account the complete scope of technology aggregation and its dynamic dimension (see Dequiedt and Versaevél, 2005). Today, most patent pools are set in a context of cooperative standard setting. As a result, only a part of the pooled essential patents were essential from the very beginning of the standard-setting process. The others initially had substitutes and were selected as key elements of the standard during the process. Such an ex post essentiality – meaning that the patent becomes essential only after it has been picked among various other possibilities – is not limited to IT patent pools. The patent pool backing the Golden Rice consortium, for instance, includes such patents. There was indeed a choice ex ante for the selection of patented promoters, while patents on gene sequences and insertion technologies were essential from the beginning. Open source projects similarly consist in aggregating copyrighted pieces of source code that are highly substitutable ex ante, but become essential once embedded in a broader software programme⁹.

Apart from existing technology inputs with or without substitutes, the processes of technology

⁹ Interestingly, the increasing number of software patents blurs the limits between patent-based and copyright-based collective innovation projects, thereby introducing essential patents into the latter. Standard-setting bodies such as the Internet Engineering Task Force or World Wide Web Consortium now face the need to take into account patents in their activity, while they were initially working with copyrighted software only. Besides, several open source licenses now include provisions that extend the copyleft to software patents.

aggregation also concern future innovations since technology standards or open source software evolve over time, thus requiring the integration of new technology inputs. For example, the MPEG-LA patent pool included more than 700 patents at the end of 2005, which is approximately four times more than when it was created. Many collective innovation projects aim primarily at investing in the development of new technologies in fields where few inputs are available at the beginning. This is for instance true in health genetics. Projects such as the Single Nucleotide Polymorphism¹⁰ or Haplotype Map (HapMap)¹¹ Consortia are principally forward-looking since they aim at creating new genomic data that can be used as a facility for future research. Whether evolving standards or research consortia are concerned, the problem of technology aggregation becomes a prospective one which can be anticipated through the ex ante definition of collective aggregation rules.

3.2. Organizing innovation through aggregation

There are several ways of managing the aggregation of technology inputs, each of which corresponds to a different organization of the collective innovation effort. In our view they can be ranked in relation to their degree of decentralization of future innovation efforts – the most decentralized being more reliant on intellectual property rights.

A first way of organizing the production of inputs for a collective technology consists in planning collectively and delegating the R&D effort. The centralization of decisions makes it possible to avoid the duplication of research lines and the costs related to a lack of coordination in patent races. However, it requires that a sufficiently complete contract can be designed so that the agents make efficient R&D investments. This is possible only if the global R&D effort can clearly be anticipated and divided among the innovators (Scotchmer, 2005). The principal can then delegate the innovation effort to one or several agents in order to achieve the most efficient investments. This organization has been adopted by the SNP and HapMap Consortia, as well as in the case of Génoplante in France (Section 2.3.). In both cases the members of the Consortia have collectively planned and shared the research effort. In the case of HapMap, a second stage of research has been organized in a slightly different

¹⁰ A Single Nucleotide Polymorphism or SNP is a DNA sequence variation occurring when a single nucleotide - A, T, C, or G - in the genome (or other shared sequence) differs between members of a species (or between paired chromosomes in an individual).

¹¹ “The International HapMap Project is a multi-country effort to identify and catalog genetic similarities and differences in human beings. Using the information in the HapMap, researchers will be able to find genes that affect health, disease, and individual responses to medications and environmental factors”. Source : <http://www.hapmap.org>

way. In order to improve the first version of the HapMap developed collectively, the National Institutes of Health and National Human Genome Research Institute have delegated the task of adding data to Perlegen Science Inc. as a result of a grant competition.

In many cases the R&D paths towards a particular innovation cannot be predicted correctly, so that R&D investments cannot efficiently be organized *ex ante*, in a centralized way. An alternative to the collective planning of innovation consists in aggregating technology inputs progressively, as they come up. This more flexible organization relies more heavily on intellectual property rights and on *ex post* forms of governance. Open source software and Information and Telecommunication industry standards provide various examples of this type of collective innovation. While the former mixes elements of centralization and decentralization, the latter rely more completely on a decentralized model of innovation.

There is a wide variety of open source software projects that can rely on different models of governance. Yet all of them follow a general pattern of organization that is specific to open source innovation. This organization is framed by concentric circles around a project leader that may be an individual or an institution like a firm, depending on the case. The smallest circle includes the key programmers who add the main pieces of code to the software. A second, wider circle includes less important programmers whose activity is principally to debug the software. A third, still wider circle encompasses users who identify bugs and report them to programmers in the inner circles. From our standpoint, the circles that matter are the first and, to a certain extent, the second one, since they comprise the programmers whose innovative work – the source code – will be aggregated into the software.

The pieces of technology are always protected by copyright. They may in addition be protected by patents when the main contributors work for firms, which is for instance the case with Linux. Whatever the intellectual property rights, the contributors do not receive any direct reward for their work. Rather, programmers have various types of indirect incentive to contribute to open source projects, from signalling their programming skills to future employers, to ideology or pushing a particular technology option (Lerner & Tirole, 2004). As stated by Benkler (2005), such incentives are sufficient when the technology is granular, because participants can make relatively small contributions that can easily be aggregated. In this context the processes of innovation and aggregation are very intricate and their coordination largely relies on the project leader. Basically, any programmer is free to propose an input that improves the software. The final say then comes to the leader who picks the best input to aggregate it into the program. With time, some programmers may specialize in

certain particular types of contribution and build a longer-term cooperation with the leader. The aggregation process is thus centralized but not planned ex ante: information on the need and supply of inputs is managed in real time.

The definition of cooperative industry standards in biotechnology or in information and communication technologies is still more decentralized. Here the technology inputs are generally protected by patents, which at the same time guarantee the incentives to innovate and constitute the main coordination tool for innovators. The fact that patents incorporated into standards are often remunerated, adds a direct incentive to the indirect ones of open source software. Given the relatively strong protection they provide, patents furthermore bind the set of possibilities for aggregating technology inputs into one given standard. They are therefore necessary bargaining chips to negotiate which inputs will be incorporated into the standard. Meanwhile, filed patents help contributors to coordinate their R&D investments as their filing and disclosure signal the fact that the corresponding innovation lead is legally blocked.

	Research consortium	Open source software	Cooperative standard
Individual incentives	No	Weak	Strong
Aggregation	Planned before innovation	Simultaneous with innovation	After innovation
Coordination	Formal hierarchy	Informal hierarchy	Decentralized

Note that even in that case patent owners may delegate an aggregation function to some central body. The MPEG-LA is for instance responsible for selecting the patents that will be added to the standard once it has been created. In a different context, one of the roles of the CAMBIA organization is to define technology platforms, including the best available technologies in order to facilitate their licensing as a package¹². Yet in both cases the role of the central body is limited to ex post aggregation.

¹² This initial BioForge prototype is an open source platform of biotechnology tools to allow scientists and other innovators in diverse locations to work together, and with those who can apply and use their research. It has been seeded with technology CAMBIA owns and is making available under [open source principles](#).

3.3 Defining rules for access

It is not possible to give a general explanation for why members of a collective innovation project agree to grant access to their results to third parties. We can nevertheless point out that intellectual property rights provide the legal basis that allows the design of any rules governing such access. These rules can be sorted into two categories: those that regulate the use of the collective technology, and those that control its evolution over time.

How the use of the technology is regulated primarily depends on the innovators' intention and, in some cases, on external regulations. Innovators may want to keep the benefit of their collective good for themselves. They will then use their intellectual property rights either to block the access to third parties or to control it through limited disclosure of information, restrictive licensing provisions or expensive licensing fees. Yet in many cases the access is made available to other agents, on a non-discriminatory basis. This may be the direct will of the innovators. The HapMap and SNP consortia intend, for instance, to grant a free access to their production to any outside user in order to promote research. Open and non-discriminatory access can also be mandatory, which is the case when competition authorities authorize the creation of a patent pool only on condition that access is not discriminatory. The extent to which industry standards are accessible to outside users mainly depends on whether their creators intend to diffuse the standard by attracting new users (Lerner & Tirole, 2005). Information disclosure is more important and licensing royalties are lower when the standard targets users other than its creators. In the case of open source software, the disclosure of the source code and the absence of royalties signal that a maximum diffusion is targeted.

Interestingly, access to an attractive collective technology can be used to obtain commitments from the users, which is a way to control the evolution of the collective technology over time. This is clearly illustrated by Open Source Software licenses that require users not to make profits with the software or, in some cases, to give any improvement of the code back to the community. In the first case the provision ensures that the principles set by the initial software developers will be followed by other users. Interestingly, it has been extended to patents in recent versions of open source licenses. In the draft GPL3.0 license, for instance, a proposed provision compels users of the software to use their own patent portfolio to defend other users of the open source software against any patent suit! We are then close to the objective of facilitating access to technology outside the project, as analysed in Section 2.3.2. In the second case, the grant-back provision is a way to extend the scope of the collective technology over time. Such viral clauses can also be found in industry standards such as the

MPEG or DVD technologies. If users of the standard file patents on improvements that are likely to impede or block the use of the standard in the future, they are compelled to license back these patents to the organization that manages the patent pool. Licenses thus guarantee the integrity of the collective technology over time.

4. Conclusion and possible extensions

This paper has analysed different tools for the collective management of intellectual property rights. Such tools include patent pools, clearing house mechanisms and standard-setting institutions, among others. We have argued that they are designed for two distinct purposes. First, they facilitate arm's length technology transfers in industries where the proliferation of essential innovations is a key feature. Second, they enable a decentralized yet coordinated management of R&D projects that involve a large number of actors in industries where cooperative R&D is commonplace.

Although the development of IP-based collective tools can be seen as a remedy to the drawbacks of intellectual property, our view is that this would be an understatement of their potential. Certainly the proliferation of intellectual property rights can generate "anticommons" tragedies, which IPR holders must avoid by finding ways to eliminate excesses or inefficiency in the way they exercise their own rights. Yet the point is that they frequently find a way to avoid or reduce it, and end up with solutions that outmatch this purely corrective goal. In this view, the collective handling of intellectual property rights allows the creation of original forms of organization, from the market for technologies based on collective supporting institutions, to collective innovation through decentralized co-competition. Although we have endeavoured to give a comprehensive and synthetic view of such institutions, we have also seen that they vary widely as regards the practical details of their functioning and implementation. This reflects the variety of technology fields in which they can take place – thereby illustrating the flexibility of IP-based collective tools.

Is this view too optimistic? Should we not worry about IP proliferation? IP proliferation would not be a problem if communities of IP users were able to organize so as to eliminate completely the negative effects of IP. Yet although collective institutions may be efficiency improving, nothing guarantees that they can perfectly compensate all deficiencies of the IP system. Therefore IP proliferation remains a problem. From a policy standpoint, this implies

deficiencies of the IP system should be prevented through a careful and effective enforcement of IP law.

From an economic research standpoint, it is also important to better understand how deficiencies of the IP system may affect the creation of collective institutions and their dynamics. In this respect, a problem deserving further research may be the dual inclusive/exclusive nature of collective forms of organization based on IPRs. Indeed, the various institutions we described in this paper may rally large coalitions of actors involved in a particular technology field, but not all the actors involved in this field. We have highlighted the power that the members of such institutions can leverage vis-à-vis outsiders, and the incentive that it may constitute for the latter to join the movement. This coalition feature raises potential governance and collusion issues, which deserve attention. Some research has been undertaken as regards standard-setting organizations, patent pools (Lerner & Tirole, 2004) or open source software (Hall & Gambardella, 2006). Things are much less clear in the case of other collective institutions, especially those supporting technology transfers.

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Bibliography

- Assouline, G., Joly, P.B., 2001. Rhône-Poulenc Agrochimie: An Uncertain Future. *AgBioForum*, vol. 4, n° 1, pages 26-33.
- Benkler, Y., 2002. Coase’s Penguin or, Linux and the Nature of the Firm. *Yale Law Journal*, 112:369.
- Bonaccorsi, A., Rossi, C., 2004. Why open source software can succeed?. *Research Policy* 32:1243–1258.

- Cohen, W., Nelson, R., Walsh, J., 2000. Protecting their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not). *NBER Working Paper No w. 7552*, 50 pp.
- Dequiedt, V., Versaevel, B., 2005. Patent pools and the dynamic incentives to R&D. *Working Papers 200412*, Grenoble Applied Economics Laboratory (GAEL), France, 20 pp.
- Foray, D., 2004. *The Economics of Knowledge*. MIT Press, 288 pp.
- Gambardella, A., Giuri, P., Luzzi, A., 2006. The Market for Patents in Europe. *LEM Working Paper*, 38 pp.
- Graff, G.,D., and al., 2003. The public-private structure of intellectual property ownership in agricultural biotechnology. *Nature biotechnology*, vol. 21, n°9, pp. 989-995.
- Graham, S., Mowrey, D., 2004. Submarines in Software? Continuations in US Software Patenting in the 1980s and the 1990s. *Economics of Innovation and New Technology*, 13(5), 443-456.
- Hall, B., Gambardella A., 2006. Proprietary versus Public Domain Licensing of Software and Research Products. *Research Policy*, 35: 875-892.
- Heller, M., Eisenberg, R., 1998. Can Patents Deter Innovation? The Anticommons in Biomedical Research. *Science*, 280: 698-701.
- Holland-Moritz, P., 2003. PIPRA to Manage Agricultural IP. *Genomics and Proteomics*, 3(7), 13.
- Kapczynski, A., Chaifetz, S., Katz, Z., Benkler, Y., 2005. Addressing Global Health Inequities: an Open Licensing Approach to University Innovations. *Berkeley Technology Law Journal*, 20(2), 1031-114.
- Lerner, J., Strojwas, M., Tirole J., 2005. The Design of Patent Pools: The Determinants of Licensing Rules. *IDEI Working Paper*, n.187, Toulouse, France, 26 pp.
- Lerner, J., Tirole, J., 2004. Efficient Patent Pools. *American Economic Review*, 94(3), 691-711.
- Kryder, R., Kowalski, S., Krattiger A., 2000. The Intellectual and Technical Property Components of Pro-Vitamin A Rice (Goldenrice): A freedom-to-operate review. Ithaca, New-York, ISAAA Briefs, n°20, pp. 74.
- Maurer, S. M., 2006. Inside the Anticommons: Academic scientists' struggle to build a

commercially self-supporting human mutations database, 1999–2001. *Research Policy*, Volume 35, Issue 6, Pages 839-853

Razgaitis, S., 2004. US/Canadian licensing in 2003: survey results. *Journal of the Licensing Executive Society* 34, 139-151.

Scotchmer, S., 1991. Standing on the Shoulders of Giants: Cumulative Research and the Patent Law. *Journal of Economic Perspective*, 5, 29-41.

Scotchmer, S., 2005. *Innovation and Incentives*. MIT Press, 356 pp.

Shapiro, C., 2001. Navigating the Patent Thicket: Cross-Licenses, Patent-Pools, and Standard-Setting. in Jaffe, A., Lerner, J., Stern, S. (Eds.), *Innovation Policy and the Economy*, 1, 119-150.

Teece, D., 1986. Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy. *Research Policy*, 15: 285-305.

Zilberman, D., Graff, G., 2005. IPR innovation and the evolution of biotechnology in developing countries, *Quarterly Journal of International Agriculture*. 3: 247-266