

# Collective Management of Intellectual Property Rights

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## 1. Introduction

This paper proposes a common analysis for a large set of multilateral agreements that are used to manage collectively intellectual property in such different industries as biotechnologies or information technologies. It discusses how these agreements, which elaborate on existing intellectual property institutions, could encourage innovation either by enhancing the efficiency of the market for technologies, or by improving the governance of the innovation processes.

Intellectual property institutions were developed to design a decentralized organization of R&D. Their efficiency can be explained by the following three 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 R&D programs that are the most valuable from the society point of view. Second, they create a market for technologies by giving the right to sign licensing contracts with other parties. Therefore, trade can be used ex post to achieve gains in allocative efficiency. Finally, they also open the possibility for cooperation in R&D, because they allow, ex ante, a clear definition of appropriable outputs of the R&D process.

Usual means to protect intellectual property (patents, copyright, plant breeders rights, ...) are imperfect and define different balances between the need to provide incentives to innovators

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and the need to guarantee the widest possible diffusion of knowledge and information. Their intensive use in recent years raised some concerns that they may discourage innovation rather than encourage it (see Heller and Heisenberg, 1998). In the sequel, we show how limits and perverse effects of intellectual property institutions can be circumvented, in many cases, by multilateral agreements that elaborate on standard intellectual property institutions and try to supplement them in order to facilitate the functioning of a market for technology inputs as well as the management of collective innovative projects.

In most high tech sectors, essential inputs and outputs are pieces of knowledge protected by intellectual property rights. These rights can be of various forms and guaranteed either by copyright, patents or, in the case of the agbiotech sector more specific rights such as, plant breeders rights. By now, a common feature of those high tech sectors is that intellectual property is characterized by complementarities. Consequently the value of a piece of intellectual property is highly dependent on the fact that other pieces are available. These complementarities can be technological. This is the case when any marketable innovation involves the combination of different independent inputs. There, they are mainly exogenous to the definition of intellectual property rights. They can also be legal. This is the case when property rights have been awarded in such a way that any use of a piece of intellectual property necessarily infringes on another piece. Such a situation arises for instance with mutually blocking patents. There, complementarities are partially endogenous to the process of definition of property rights. 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 elaborating on many previous innovations obtained by an important 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 along 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 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 different frictions plague it.

One argument that explains the difficulties encountered on the market for licenses in high tech

sectors is that of anti-commons developed by Heller and Heisenberg (1998). It is also called “patent thicket” in the case of IP protected by patents (see Shapiro, 2001). The first aspect of the anti-commons problem is that of royalty stacking or, in economics terms, that of multiple marginalizations. Each owner of a piece of intellectual property is a monopolist that is going to exploit his 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 the producer to abandon his project. A second aspect of the anti-commons problem is that of the fear of hold-up. The surge in intellectual property protection makes 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, an innovator may fear that he is actually infringing on some intellectual property rights and that, once he made the initial investments, the owner of those rights will ask higher royalties than what he could have obtained with an ex ante negotiation. In some sectors, this fear is so important that it may discourage the innovator to start the project. Similarly, this second aspect concerns also the diverse inspection costs that must be incurred by an innovator before starting a project. Just to have a good image 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 that of 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 explode. To summarize the anti-commons argument in a nutshell, the generalization of intellectual property protection may in fine increase the transaction costs on the market for technology, where those transaction costs refer to costs linked to asymmetric and/or imperfect information and coordination or cooperation failures.

Technology input complementarities have also 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 efficiently those projects, it is generally necessary that parties sign ex ante a binding contract, in order to minimize the impact of opportunistic behavior 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 it enriches the set of contractible variables. It may therefore alleviate moral hazard in team and hold-up problems which are standard transaction costs that plague team projects. However, IP is not per se a solution, but only a building block that may be used to construct a solution.

Most notably in the biotech and information technologies 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 an extensive use of standard protections like patents or copyright. But they elaborate on these standard protections by proposing some various forms of collective management.

In the following we analyse through a series of examples the impact of those collective tools on the functioning of the markets for technology inputs as well as their impact on the efficiency of the innovation production processes. In a first part we explain how the collective management of intellectual property rights can be used to facilitate transactions on the market for technology. Its objective is then to facilitate the access to information about variety, to reduce negotiation costs and to optimize the management of prices. In a 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 that range 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 raised by those tools.

## **2. Collective initiatives to shape markets for technology**

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 to identify the relevant technology inputs and to define the conditions of their use, i.e. 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 with transaction costs and economic agents have developed for a long time 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 to solve 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 an expertise about some technological landscape 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.

In the context of markets for technology, however, other more collective initiatives have been developed and try to improve the allocation of technology inputs by creating networks that smooth the functioning of markets for technologies. Designed for a specific technological area (i.e. software, agbiotech,...) and for a given market structure (limited to public actors, to private actors, to a combination of public and private actors,...), each of these collective initiatives provides some responses to the following three impediments to well-functioning markets for technologies: the difficulty of access to information, the high level of negotiation costs, the uncoordinated pricing policies for access to (and use of) innovations, in particular via royalty pricing.

## **2.1. Access to information**

On markets for technology inputs even more than on 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 a correct functioning of markets for technologies. Indeed, 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 for instance about the phenomenon of “submarine patents”). Because it benefits all actors in the sector, transparency may possess 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 these inputs, the level of accessibility to these inputs, or the missing inputs on the market. Providing such information allows to save on costs related to requests for non accessible technological inputs or for technological inputs diffused by the means of incompatible licenses. Such information may also reduce the cost of transactions by the identification and the 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. Those initiatives intend to do so by building networks of actors. We present two examples, namely "PIPRA" (for Public Intellectual Property Resources for Agriculture) in the ag-biotech industry 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 what rights to what technologies, in which countries, and to establish whether or not a new crop variety is at risk of infringing 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 in its core missions. Interestingly, this tool names itself a "Clearing House Mechanism" (CHM) while its objective is clearly not only to balance the payments between participants neither publicly nor secretly. Its objective is also more ambitious than simply organizing a business forum for research in the agbiotech sector.

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)

Contrary to PIPRA, the distinction between public and private actors is absent in the SourceForge initiative. Here, the perimeter of action is defined through the reference to the Open Source community, by implicit opposition to proprietary software actors. In the sequel, we follow 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 goal is achieved through the creation of databases and the definition of different levels of access to the databases. For example, 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 especially be useful to avoid the duplication of technologies that do already exist, by facilitating the getting of a license. 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 not exclusive license, in the case of biotechnologies) and / or the type of license which covers the element according to the type of software open source(Spring) (General Public license, BSD license, Mozilla Public License , ..., 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, SourceForge managers are insisting in their presentation on the fact that it is the biggest project of that type. Similarly, PIPRA participants are informing their colleagues at their institutions and at other public sector organizations, and are soliciting 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 in 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 specific 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 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 each user to know which software is accessible or not. It also helps him integrate a network to develop new softwares (the user becoming 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).

The collective management of information finally 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.)<sup>4</sup>.

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<sup>4</sup> 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 substitute can be infinite, it will be necessary to opt for a license.

## 2.2 To lower negotiation costs

The creation of a network of exchange for technology inputs has vocation to limit the cost incurred to reach information on the existing technology options, their characteristics and their accessibility. This tool has also vocation to limit the costs of negotiation. In this section we discuss the reduction of the cost of negotiations by means of standardization of the licence agreements and implementation of guidelines.

Indeed, in the PIPRA project, the information disclosure activity about licensing practices paves the way for a systematic exploration of public sector IP licensing policies and for the seeking of “best practices” that will encourage the greatest commercial development of publicly funded research while at the same time ensure 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)<sup>5</sup>

“Science Commons” is another initiative to limit negotiation costs. Science Commons proposes to harmonize the licences and the clauses inside the licence contracts. It is interested in the diffusion of the scientists publication, the diffusion of biological material and the diffusion of data. The objective is to promote effective use of digital networks to broaden access to all three types of informations. In the creative commons website we can read: *“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”* (see annex 1). As in the case of the open source software, the harmonization of the licences makes it possible to quickly inform the user about his rights and his 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

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<sup>5</sup> 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 much as future innovations are not considered as an “essential derivation”<sup>5</sup>. An innovator protecting his varieties by PBR, will still have incentives to spend money and time in R&D to innovate because the time necessary to develop and bring to the market a substitutable innovation (10 years minimum) is sufficient to ensure a return on investment to the initial innovator. However, with the development of biotechnologies, seed sector innovations are now patentable and numerous negotiations might be necessary even just to conduct research.

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 inputs. The harmonization of licence agreements, particularly of the Material transfer agreements (MTA), has reduced the costs related to the negotiation and 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 negociation, you have missed the field season, your grant has expired and there is now a better resources that is been developed and if you are starting negotiation now...”* This example shows the interest of developing standardized licences which scope is limited to the uses the applicant wants to make (for profit or not for profit). This facilitates the access to protected innovations without hurting the owner’s rights. Moreover Scientific Commons proposes to use a standardized basic contract common to all the MTA and to propose in parallel a set of options: *“creating in effect an entire suite of legally binding, standard contractual terms that can be mixed and match to create a customized agreement, tailored to fit the large variety of transfer situations.*

In the Open Source world, license type proliferation is a real problem that generates legal uncertainty on the compatibility of software modules. 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 purpose of the Open Source Initiative (OSI) is to recommend safe license. Yet even OSI has validated an increasing number of licenses (nearly 60 different licences are approved ). Therefore OSI formed in 2005 a commission to address the issue of license proliferation. One of its goals is to classify the OSI-Approved License in three categories : Preferred, Recommended but not preferred, Not recommended. As the same time the OSI published a policy statement<sup>6</sup> in which it proposes the adjunction 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 organisations into an accompanying attachment.

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<sup>6</sup> <http://opensource2.planetjava.org/docs/policy/licenseproliferation.php>

## 2.3. To manage access and use prices

Multilateral agreements used to manage collectively intellectual property also try 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 basic 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 of rightholders (Kryder et al., 2000). Without an agreement between these holders, any market for golden rice is condemned as well as any new research on it. Indeed, uncoordinated pricing strategies would lead to an unreasonably high level of royalties to be paid to rightholders. This example illustrates problems linked to multiple marginalizations.

In the previous sections, we analyse the identification of complementarities and the creation of technological packages. This section deals with the tools used to diffuse them. Networks built to smooth the functioning of the market for technology inputs (like CHMs) do not solve the multiple marginalization problem. 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. 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 – his weight in the creation of an innovation- is evaluated according to the information centralized in a “book of research” held in each laboratory (time spent on the project, laboratory of origin of the biological material used, owner of the techniques, owner of the licences, ...). 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 ; a member may need the third party’s expertise to commercialize its innovation.

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

\* To facilitate the development of members’ innovations by third parties: 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 are important to determine the patterns of the licensing agreement. Still in the ag-biotech sector, the broad extent of the patents had consequences on the use of licencing by

public laboratories<sup>7</sup>. Private firms generally required world exclusive licences to develop public patents. With the strengthening the public sector bargaining position via the creation of clearing house mechanisms, it became possible for public labs to propose licenses limited to the research identified, on 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 for given projects. Such projects may be undertaken by a single agent. But in some cases they involve several participants, which raises new collective management issues regarding especially additional R&D investments and their results. Collective innovation projects may be motivated by various motives, from benefiting of 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 project than on their motives. We indeed compare and discuss in this part how rules based on intellectual property rights can contribute to the collective handling of such projects, through as various institutions as research consortia, patent pools or open source software.

#### **3.1 Aggregating intellectual property rights**

The aggregation of technology concerns three types of inputs 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 market of technologies 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

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<sup>7</sup> Trommetter (2005) proposes that to yield an exclusive licence under these conditions would be economically and socially not very effective, but what is the capacity of negotiation of a laboratory vis-a-vis companies that know often better the perimeters of the research laboratories than the laboratories themselves.

substitutes and those that do not. Indeed only the latter provide a market power to their owners. 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 Versaevel, 2005). Today, most patent pools take place in a context of cooperative standard setting. As a result only a part of the essential patents that are pooled were essential since the very beginning of the standard setting process. The other ones 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 since 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 into a broader software program<sup>8</sup>

Besides existing technology inputs with or without substitutes, the processes of technology aggregation also concerns future innovations. Indeed technology standards or open source software evolve over time, which requires the integration of new technology inputs. As an example, the MPEG-LA patent pool included more than 700 patents in end 2005, which is approximately four times more than when it was created. Besides, 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 SNP or HapMap Consortia are principally forward looking since they aim at creating new genomic data that can be used as a facility for future research. Be it for evolving

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<sup>8</sup> 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.

standards and for research consortia, 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 ranged in function of their degree of decentralization of the 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 permits 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 undertake efficient R&D investments. This is possible only if the goal of the R&D effort can be identified and specified very precisely ex ante (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 and also in the case of génoplatte 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 way. In order to improve the first version of the HapMap that had been developed collectively, the NIH and National Human Genome Research Institute have delegated the task of adding data to Perlegen as a result of a grant competition.

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 right 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 are a large 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 organisation is framed by circles around a project leader that can be an individual or an institution like a firm, depending on the cases. A first narrow 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 one, 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. But they may moreover 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 incentives to contribute to open source projects, from signalling one's programming skills to future employers, to ideology, to pushing a technology that one masters in a program that will be widely diffused (Lerner & Tirole, 2004). As stated by Benkler (2005) such incentives are sufficient when the technology is granular, because participants can make relative small contributions that can be aggregated easily. 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 can specialize in some particular types of contributions 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 principal coordination tool for innovators. Indeed patents incorporated into standards are often remunerated, which adds a direct incentive to the indirect ones that feature open source software. Given the relative strong protection they confer, patents furthermore bind the set of possibilities for aggregating technology inputs into one given standard. Therefore they are 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 charged to pick 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 package. Yet in both cases the role of the central body is limited to ex post aggregation.

### 3.3 Defining rules for access

It is not possible to give a general explanation for the reasons why members of a collective innovation project accept to grant access to their result to third parties. Yet one can underline that intellectual property rights provide the legal basis that allows the design of rules governing such access. These rules can be sorted out in 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 principally depends on the intent of the innovators, and in some cases on external regulations. Innovators may want to keep the benefit of their collective good for themselves. Then they will use their intellectual property rights either to block the access to third parties, or to limit it through limited disclosure of information, restrictive licensing provisions or expensive licensing fees. Yet in many cases the access is let open to other agents, on a non-discriminatory basis. This can 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 principally depends on whether their creators intend to diffuse the standard by attracting new users (Lerner & Tirole, 2005). Indeed information disclosure is more important and licensing royalties are lower when the standard targets other users than its creators. In the case of open source software, the disclosure of source code and the absence of royalties signal that a maximum diffusion is targeted.

Interestingly, the 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 especially illustrated by Open Source Software licenses that require users not to make profits with the software or, in some cases, to give back any improvement of the code 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 analyzed in section 2.3.2. In 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.

#### 4. Conclusion

This paper analysed different tools for the collective management of intellectual property rights. Such tools include patent pools, clearing house mechanisms or standard setting institutions among others. We argued that they are designed for two distinct purposes. First, they help smoothing the functioning of the market for licensing agreements in industries where the proliferation of essential innovations is a key feature. Second, they facilitate the management of R&D projects that involve an important number of actors in industries where cooperative R&D is commonplace.

As such, the development of those tools seems to be more precisely an answer to the specificities of technology in different industries rather than an answer to intrinsic weaknesses of intellectual property legal protection. It is an illustration of the flexibility of intellectual property rights which provide the basis for more or less complex contractual arrangements.

Because it involves some kind of cooperation between otherwise competing actors, the collective management of intellectual property rights may raise relatively new issues for competition policy. If patent pools have a long history and are by now quite well understood and controlled by competition authorities, things are not so clear for the other collective institutions. Actually, there might be two different types of concerns.

First, consumers may be harmed by a collective management of intellectual property rights if it restricts competition by innovations. There we face a situation similar to that of institutions for the collective management of copyright which can control the prices to end users.

Second, other innovators may be harmed by the excessive bargaining power of members of the collective institution. These institutions might be used to evict potential entrants or competitors on the final market.

These concerns certainly deserve much attention by competition authorities.

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