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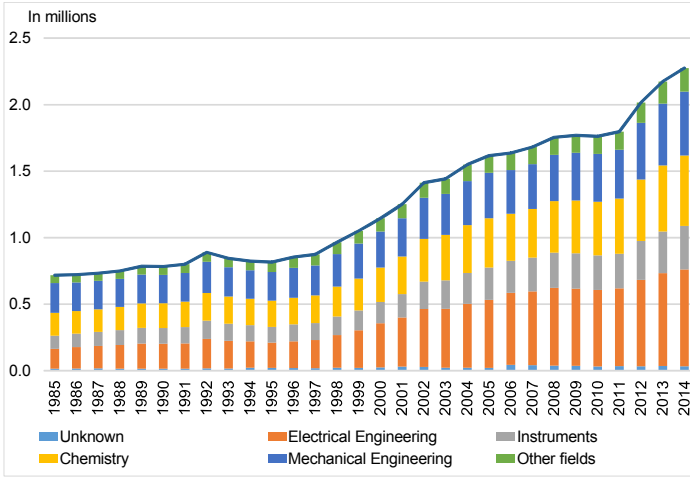
TRÉSOR-ECONOMICS

Patents and Technical Standardisation: how to balance Competition and Innovation?

- Patent systems were developed to spur innovation. Patents grant their owner a temporary monopoly on the use of the patented technology. Without a patent system (or other means of stimulating innovation), the inventor cannot fully capture the profits resulting from the innovation, and the devoted effort is insufficient. Consequently, patents encourage innovation in exchange for a temporary restriction on competition.
- Standards[1] are shared, written guidelines whose purpose is to harmonise the activity of market sectors such as the IT sector (4G, Wi-Fi, MP3, etc.) to increase efficiency. Standards can require the use of patent-protected technology. Patents that are critical for implementing standardised technology are thus named "standard-essential". In 2014, 140,000 active patents were declared standard-essential, compared with roughly 30,000 in 2000 (see Baron and Pohlmann[2], 2015).
- When patents are standard-essential, tensions between competition and incentives to innovation rise. As standards are intended to promote a technology over time, holders of standard-essential patents possess strong market power, which they can use to demand high licensing fees or exclude competitors from the market. This can hamper innovation, raise prices, and reduce overall well being. However, incentives to innovate and take part in the standardisation process must be kept in place. To balance the twin goals of competition and incentives to innovation, the licensing of standard-essential patents is governed by specific rules, defined by the various standard-setting organisations.
- Early in 2015, the IEEE (Institute of Electrical and Electronics Engineers), a US standard-setting organisation, decided to restrict the negotiating power of standard-essential patent holders by amending its intellectual property rules. However, empirical studies have failed to show that the current system of standard-essential patents licensing provides their holders with excessive negotiating power. The change prompted by the IEEE could thus deter innovation. Nevertheless, it is possible to improve the standardisation process and the valuation of standard-essential patents, particularly through measures that focus on patent quality, the effectiveness of legal procedures and the transparency of the standardisation process, among others.

Worldwide Patent Publications by Technology and Year of Publication



Source: WIPO (World Intellectual Property Organisation).

(1) The terms "standard" and "standardisation" are used in this document in their broadest sense, comprising standards created by officially recognised organisations and those developed by consortia and fora.

(2) Baron, J. and Pohlmann, T. (2015) "Mapping Standards to Patents using Databases of Declared Standard-Essential Patents and Systems of Technological Classification", Working Paper, *Searle Center on Law*, Regulation and Economic Growth.

MINISTÈRE DE L'ÉCONOMIE
ET DES FINANCES

1. The patent system provides incentives to innovation, but does not fully correct market failures related to intangible assets

1.1 What is a patent?

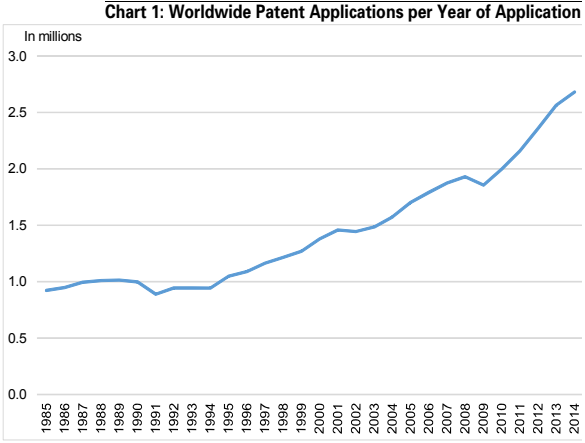
Patent systems came into being at the end of the 18th century, notably in the US[1] and France[2]. A patent "protects a technical innovation, i.e. a product or process which provides a new technical solution to a particular technical problem"[3]. It enables the owner to prohibit any form of commercial exploitation of the invention by a third party (use, production, import, etc.) for a limited period of time and within a given territory.

In addition to commercially exploiting the technology, the patent holder can realise its value through sales and licensing. Through licensing agreements, patent holders allow third parties the use of patents, usually in exchange for compensation which is freely determined by the parties and could comprise a flat fee plus royalties.

Alternatives to patents do exist, however, and their advantages and disadvantages are much debated in the economic literature. On the one hand, businesses sometimes use alternative methods of protection for their intellectual property, such as trade secrecy. Conversely, in some sectors, open innovation ecosystems may appear. On the other hand, governments have other means besides patents for promoting innovation. These include prizes[4] in the form of reward from the government or from a supranational body, in return for a commitment from the inventor to make the new product available at its marginal cost.

In 2014, 2.7 million patent applications were filed throughout the world (see Table 1), and 1.2 million patents were granted by patent offices. In France, patents are granted by the National Intellectual Property Institute (INPI). European patents provide for protection of inventions in the Member States of the European Patent Office (EPO).

Chart 1: Worldwide Patent Applications per Year of Application

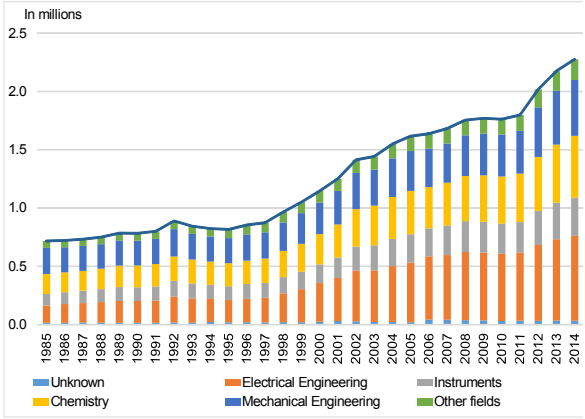


Source: WIPO.

Direct applications to a country or territory, and international applications through the PCT system then instructed in at least one member country (Patent Cooperation Treaty, authorising application for protection of a patent for an invention in several countries simultaneously, by filing an "international" patent application).

The rise in the number of patent applications is partly due to new developments in information and communication technology, where the products are complex: each new product or process consists of many components, themselves covered by several patents. The share of patents filed in the field of electrical engineering has increased by 10 percentage points, and accounted for nearly 40% of the overall increase in patent applications between 1985 and 2014 (see Chart 2).

Chart 2: Worldwide Patent Publications by Technology and Year of Publication



Source: WIPO.

1.2 Patents represent a financial incentive to innovation, but reduce competition

The patent system is designed to encourage innovation. According to Arrow (1962)[5], technological innovations are public goods, *i.e.* non-rival (its consumption by several agents does not result in loss of well being) and non-excludable (an agent cannot be deprived of access to such knowledge[6]). Absent a system of patents, the innovator cannot benefit from a return on investment, and the incentives to invest in innovation are reduced, even if such an investment is socially desirable. By legally limiting access to the innovation for a given period of time, patents incentivise inventors, enabling them to temporarily reap the economic benefits relative to their invention. At the end of this period (20 years for French and European patents), the monopoly is ended and the innovation enters into the public domain. In this way, patents promote the production of growth-enhancing innovations (dynamic efficiency), but also distort competition by granting monopoly market power during the period of protection (static inefficiency).

1.3 Patent transactions are subject to multiple market failures

Transactions involving intellectual property can be prone to various market failures which cannot be resolved by simply establishing a system of patents:

- These transactions are surrounded by a high degree of uncertainty. In fact, the vagaries of technology and trade

(1) Patent Act of 1790 (U.S. Patent Act).
(2) Brevet d'invention, 1791 (French Patent Act).
(3) Source: Institut national de la propriété intellectuelle (INPI) (French National Intellectual Property Institute).
(4) See Abramowicz, M.B. (2003), "Perfecting Patent Prizes", *Vanderbilt Law Review*, 56(1), pp. 115-236.
(5) Arrow, K. (1962), "Economic Welfare and the Allocation of Resources for Invention", *The Rate and Direction of Inventive Activity: Economic and Social Factors*, pp. 609-626, NBER (National Bureau of Economic Research).
(6) Trade secrecy with regard to an invention is always possible, but provides imperfect protection.

make the future value of the innovation uncertain. Moreover, the property rights defined by the patent are uncertain, as court decisions on the validity of patents are open to interpretation.

- In addition, these transactions are conducted under conditions of asymmetric information. For example, patent holders may be better informed on the value of the technology because they have tested it, or, conversely, the buyer may have a better knowledge of opportunities for applying the innovation, in which case the patent holder is likely to underestimate the value of its invention.
- Such uncertainties and asymmetric information can lead to opportunistic behaviour, which the buyers themselves may have anticipated[7], resulting in a phenomenon of adverse selection. To hedge against patent quality risks, buyers offer a low price,which does not encourage sellers of quality patents to enter a market in which only low-quality patents remain. Moreover, this phenomenon tends to be self-perpetuating.

All these types of market failures disrupt the functioning of the market for intellectual property assets, which can lower the number of transactions and eliminate profitable transactions, thus limiting the financial incentives to innovation that patents create. Furthermore, a rise in speculative behaviour can occur, with a large proportion of agents buying patents for other motives than the implementation of a technology (LeBas *et al.*[8], 2011).

1.4 The patent system can also lead to some adverse effects

The intrinsic complexity of products in the ICT sector amplifies market failures with regard to intellectual property assets. This is known as a patent thicket (Shapiro[9], 2001). In this case, it is highly likely that a product will contain technologies covered by patents held by multiple owners (fragmentation of rights). In extreme cases, the fragmentation of intellectual property rights among the various rightsholders can lead to a "tragedy of the anticommons" (Heller and Eisenberg[10], 1998), with each one having the right to exclude the others from accessing the technology, to the point that no one can exploit it.

The strategic interest in holding patents, even those of poor quality, is also enhanced, for the purpose of thwarting competitors or bolstering one's own position (patent race). The patent thicket situation leads to inefficiency: it can not only become a barrier to entry (by increasing transaction costs), but can also result in a phenomenon of "royalty stacking", *i.e.* exceedingly high royalties. In fact, fragmentation of intellectual property rights can present a problem of double marginalisation, as shown by Shapiro[11] (2001) after Cournot[12] (1838): a succession of monopolies leads to a higher price than the one set by a single monopoly. For example, in the case of a technology involving several patents, each patent holder determines a price without taking into account the negative impact on the demand adressed to other patent holders, to the point that the technology is not adopted (a case of prisoner's dilemma[13]).

1.5 Patents can lead to opportunistic behaviour that are detrimental to innovation or competition

Holding a patent can provide the owner with the ability to sue alleged infringers in order to prevent them from using an innovation, or in order to obtain compensation for its use.

This right can be used in an opportunistic fashion to harm competitors. For one thing, a business which is suspected of infringing a patent has already made specific investments toward the patented technology, which raises the cost of choosing a different technology. This gives patent holders market power during *ex-post* negotiations and enables them to initiate a holdup (Lemley and Shapiro[14], 2007), *i.e.* obtain an amount of licence which is unreasonable with respect to the value of the technology. For another thing, a patent holder can purposefully conceal its existence until the technology protected by its patent is adopted, and then subsequently reveal this information and demand a sizable fee. This is known as patent ambush.

The possibility of a holdup by itself can also be detrimental to innovation if certain businesses avoid introducing products for fear of a holdup, according to Shapiro (2001)[15] (see Box 1).

Legal proceedings contribute to the possibility of holdups, as they are costly and their outcome is unpredictable, given the uncertainty of the property rights defined by a patent. These uncertainties are now being exploited by patent trolls, entities which provide no goods or services and whose economic activity consists of buying patents, often those of dubious quality. Patent trolls provoke holdup situations by demanding unreasonable amounts of licence, with the intent to negotiate after the start of litigation a high royalty amount, although still lower than the cost of litigation. Such behaviour can curtail innovation (Pénin[16], 2012).

(7) This situation is often called a market for lemons (Akerlof, G. (1970), "The Market for 'Lemons': Quality Uncertainty and the Market Mechanism", *Quarterly Journal of Economics*, 84(3), pp. 488-500).
(8) Le Bas, C., Dupuis, J.-C. and Lawson, S. (2011), "Patent as Quasi-Financial Asset: Emergence, Forms and Economic Implication", *Revue d'Économie Industrielle*, 134(2).
(9) Shapiro, C. (2001), "Navigating the Patent Thicket: Cross Licenses, Patent Pools and Standard Setting", in Jaffe, A.B., Lerner, J. and Stern, S., *Innovation Policy and the Economy*, Vol. 1, MIT Press, pp. 119-150.
(10) Heller, M. A. and Eisenberg, R. S. (1998), "Can Patents Deter Innovation? The Anticommons in Biomedical Research", *Science* 280.5364, pp. 698-701.
(11) *Op. cit*.
(12) Cournot, A. (1838), "Recherches sur les principes mathématiques de la théorie des richesses"("Researches into the Mathematical Principles of the Theory of Wealth"), Hachette.
(13) Each patent holder has an interest in applying a high price; however, this is an inefficient strategy from the collective point of view, for it leads to demanding a prohibitively high aggregate price.
(14) Lemley, M. and Shapiro, C. (2007), "Patent Holdup and Royalty Stacking", *Texas Law Review*, Vol. 85, pp. 1990-2049.
(15) *Op. cit*.
(16) Pénin J. (2012), "Strategic uses of patents in market for technology: a story of fabless firms, brokers and trolls", *Journal of Economic Behavior & Organisation*, 84, pp. 633-641.

Similarly, the lack of incentives to challenge a potentially invalid patent facilitates holdups. Challenging the validity of a patent is very costly, whereas the advantages, such as a reduction in royalties, will benefit many companies, and thus are not fully obtained by the one initiating the proceedings. Consequently, there is a risk of underinvestment in such a challenge, and firms may prefer to pay for the licence of a non-legitimate patent. The importance of patents invalidation is illustrated by Galasso and Schankermann[17] (2015), who show that in decisions of the United States Court of Appeals for the Federal Circuit, which deals with high value patents, patent invalidation leads to a 50% increase in subsequent citations, *i.e.* applications citing the patent, for five years following the decision.

In contrast, companies which might adopt the technology also have market power, allowing them not to negotiate in good faith. In fact, according to Geradin[18] (2010), in case of infringement of their intellectual property, patent holders can either initiate costly and uncertain litigation or giving up on filing a suit. When the cost of litigation is high and the outcome uncertain, it can be more reasonable for the patent holder not to sue and consequently for the infringer not entering into licence. This is known as a reverse holdup, or holdout.

Box 1: Opportunistic behaviours in transactions involving intellectual property assets were illustrated, with potentially detrimental effects on innovation

The patent system spurs the production of innovations over the long term. Empirical studies tend to confirm that the patent system stimulates R&D and the production of knowledge (notably Lerner and Zhua[a], 2007; Arora *et al.*[b], 2008), even if some works have presented contradictory results in some sectors (Murray and Stern[c] (2007) in biotechnology, or Huang and Murray[d] (2007) and Williams[e] (2013) in genomics).

However, market failures surrounding patents, particularly patent thickets, strategic patenting and the fragmentation of intellectual property rights, can deter innovation, especially for smaller businesses. Bessen and Hunt[f] (2004) suggest that in sectors where strategic patenting is most common, an increase in patent protection has led to a decrease in R&D spending. The patent thicket phenomenon could be a barrier to entry: Hall *et al.*[g] (2013) show that the density of the patent thicket has a negative effect on the probability of entry into patenting in a sector – an effect all the more negative for SMEs. According to Cockburn *et al.*[h] (2010), fragmentation can penalise innovation in companies which report positive expenditures on in-licensing, especially as their patent portfolio is small, whereas companies that do not report in-licensing expenditures can benefit from fragmentation. Using data from Germany, Schwiebacher[i] (2013) shows that fragmentation of intellectual property rights reduces the propensity of entering into a licence agreement for companies with small patent portfolios. Nagaoka and Nishimura[j] (2014) qualify these results: they contend that the fragmentation of property rights might not have an effect on innovation.

a. Lerner, J. and Zhu, F. (2007), "What is the Impact of Software Patent Shifts? Evidence from Lotus v. Borland", *International Journal of Industrial Organization*, 25, pp. 511-529.
b. Arora, A., Ceccagnoli, M. and Cohen, W. (2008), "R&D and the Patent Premium", *International Journal of Industrial Organization*, 26, pp.1153- 1179.
c. Murray, F. and Stern S. (2007), "Do Formal Intellectual Property Rights Hinder the Free Flow of Scientific Knowledge? An Empirical Test of the Anti-Commons Hypothesis", *Journal of Economic Behavior and Organization*, 63, pp. 648-687.
d. Huang, K. and Murray, F. (2009), "Does Patent Strategy Shape the Long-Run Supply of Public Knowledge? Evidence from Human Genetics", *Academy of Management Journal*, 52(6), pp. 1193-1221.
e. Williams, H. (2013), "Intellectual Property Rights and Innovation: Evidence from the Human Genome", *Journal of Political Economy,* 121(1), pp. 1-27.
f. Bessen, J. and Hunt, R. (2004), "An Empirical Look at Software Patents", Federal Reserve Bank of Philadelphia, Working Paper 03-17.
g. Hall, B., Helmers, C., von Graevenitz, G. and Rosazza-Bondibene, C. (2013), "A Study of Patent Thickets", The Intellectual Property Office.
h. Cockburn, I.M., MacGarvie, M. J. and Mueller, E. (2010), "Patent Thickets, Licensing and Innovative Performance", *Industrial and Corporate Change*, 19(3), pp. 899-925.
i. Schwiebacher, F. (2013), "Does Fragmented or Heterogeneous IP Ownership Stifle Investments in Innovation?", ZEW *Discussion Paper* No. 13-096.
j. Nagaoka, S. and Nishimura, Y. (2014), "Complementarity, Fragmentation, and the Effects of Patent Thickets", *Research Institute of Economy, Trade and Industry.*

2. Standardisation can be a source of improved efficiency gains, but can also lead to inefficient behaviours

2.1 Standards are critical to the development of information and communication technology

Standardisation (see Box 2) consists of establishing technical norms, *i.e.* shared, written guidelines whose purpose is to harmonise the activity of a given sector. Some standards are designed to enable interoperability, ensuring that various operators or equipment (5G, Wi-Fi, Peritel, MP3, chargers for electric vehicles, etc.) and the networks they use can connect to each other.

For example, Wi-Fi technology, which enables wireless communication of various electronic information devices within a network by transmitting data between them (computer, tablet, printer and a wireless internet access point), consists of a set of protocols governed by the standards of IEEE 802.11, developed by the Institute of Electrical and Electronics Engineers (IEEE), a US standard-setting organisation. These standards define the speed and mode of transmission of the signals.

ICT products require a large number of standards. A smartphone uses Wi-Fi standards to connect to a network, 3/4/5G network standards for Internet access, NFC technology for the exchange of contact-free information, USB standards for connection to a computer, etc. A laptop computer presumably conforms to over 250 standards[19]. Each standard involves a large number of patents; among them, some are key for adoption of the standard (when there is no alternative technology

(17) Galasso, A. and Schankerman, M. (2015), "Patents and Cumulative Innovation: Causal Evidence from the Courts", *Quarterly Journal of Economics*, 130(1), pp. 317-369.
(18) Geradin, D. (2010), "Reverse Hold-ups: The (Often Ignored) Risks Faced by Innovators in Standardized Areas", in *The Pros and Cons of Standard Setting*, Swedish Competition Authority.
(19) Biddle, B., White, A. and Woods, S. (2010), "How Many Standards in a Laptop? (And Other Empirical Questions)", in 2010 ITU-T Kaleidoscope: Beyond the Internet?-Innovations for Future Networks and Services (pp. 1-7). IEEE.

compatible with the standard), and are referred to as "essential"[20]. The 3G standards (3GPP and 3GPP2) involve some 8,000 essential patents[21].

Box 2: **The functioning of standardisation in France, Europe and the world**

There are two levels of standards: *(i)* those drawn up by established organisations and *(ii)* those generated by consortia and fora.

i) Standards at this first level are decided by international governmental bodies: the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), the International Telecommunication Union (ITU); European organisations: European Committee for Standardization (CEN, Comité européen de normalisation), European Committee for Electrotechnical Standardization (CENELEC, Comité européen de normalisation électrotechnique), European Telecommunications Standards Institute (ETSI); or national organisations: French Standardization Association (AFNOR, Association française de normalisation) in France; German Institute for Standardization (DIN, Deutsches Institut für Normung e.V.) in Germany; the British Standards Institution (BSI) in the United Kingdom.

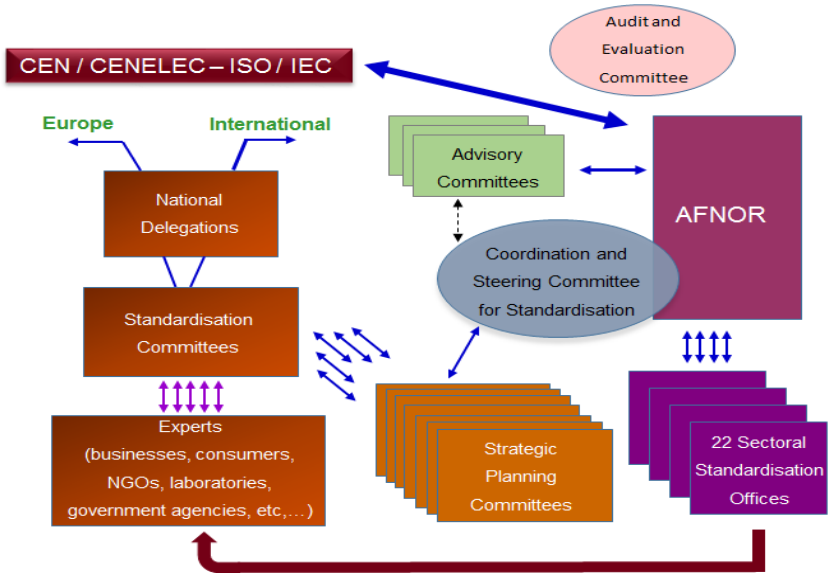
ii) A second level of standards emanates from private organisations acting within a limited sector of activity. This option is prevalent in the case of digital devices: the *Internet Engineering Task Force* (IETF) develops internet standards; the *Institute of Electrical and Electronics Engineers* (IEEE) develops standards necessary for local wired and wireless networks; the *World Wide Web Consortium* (W3C) develops standards ensuring the compatibility of web technologies; the *Organization for the Advancement of Structured Information Standards* (OASIS) develops standards which establish formats for open databases.

The following entities can participate in the development of standards broadly defined, according to the various standard setting organisations: businesses, research institutes and universities, consumers, regulatory agencies and governments.

In France, AFNOR determines the need for standardisation, after which the sectoral offices develop the standards by calling upon various contributors. AFNOR or a technical expert provides input in international fora (see Chart 3).

At the IEEE, the development of a standard evolves from the initiative of an entity (business, government, association, etc.) which sets up a technical working group, then recommends a standard which is put to a vote by all parties concerned. If the project obtains more than 75% of the votes, it is submitted for approval from the Review Committee, composed of IEEE board members and volunteer engineers, then to a final vote leading to its publication.

Chart 3: Organisation of the Standardisation System in France



Source: DGE, Sous-Direction de la qualité pour l'industrie et de la normalisation (Directorate General for Enterprise: Deputy Directorate for Quality in Industry and Standardisation).

2.2 Standardisation creates significant welfare gains in the economy but can generate costs when misused

Standards are responsible for substantial economic gains for both consumers and businesses. By facilitating compatibility between devices, standards generate positive network externalities: the value of a good increases when the network expands; an example is a telecommunications network (Katz and Shapiro[22], 1985). In addition, by concentrating production of goods on a limited variety, standards create economies of scale which reduce production costs (market size effect). Finally, compatibility between goods can strengthen competition on price.

However, if improperly used, standardisation can generate social costs. Standards leads to variety reduction, and this can be detrimental if consumers have a taste for variety (Farrell and Saloner[23], 1985; Auriol and Benaim[24], 2000). Standards

(20) In accordance with the rules of procedure of the European Telecommunications Standards Institute (ETSI), a patent is considered "essential" if it is not technically possible to manufacture a device which complies with a standard without infringing that patent.
(21) Goodman, D. J. and Myers, R. A. (2005), "3G Cellular Standards and Patents", IEEE.
(22) Katz, M. and Shapiro, C. (1985), "Network Externalities, Competition and Compatibility", *American Economic Review*, 75(3), pp. 424-440.
(23) Farrell, J. and Saloner, G. (1985), "Standardization, compatibility, and innovation", *The RAND Journal of Economics*, 16(1), pp.70-83.
(24) Auriol, E. and Benaim, M. (2000), "Standardization in Decentralized Economies", *American Economic Review*, 90(3), pp. 550-570.

can also be disadvantageous if they adopt a suboptimal technology, for example if the technology is not sufficiently mature at the time of choice (Cabral and Salant[25], 2014). This is the case for the QWERTY (or AZERTY) keyboards which persist for reasons of compatibility and user habit while alternatives such as the DVORAK (or BEPO) keyboards are technically more efficient.

2.3 Standards increase tensions between innovation and competition surrounding intellectual assets

By increasing the strategic interest in holding an essential patent, standards magnify the problems induced by the complexity of information and communication technology (patent thicket, patent race, royalty stacking and patent ambush; see section 1.5).

In particular, Kang and Bekkers[26] (2015) describe a strategy of just-in-time patenting, whereby some companies patent a low-quality technology just before a standardisation meeting, even when research is incomplete, or by using inventions of other participants, and then negotiate the patented technology into the standard.

In addition, standards can create market failures. As with all patents, standard-essential patents reduce competition with respect to the patented technology. But they also reduce it with alternative technologies designed for a similar function, both present and future, as the standard is intended to anchor a technology over time. Once the standard is adopted, the costs of switching to another technology increase due to network externalities: downstream firms (which implement in their products technologies covered by the standards) cannot unilaterally switch to another technology.

Consequently, standards confer additional market power on patent holders, which they can exploit *ex-post*, increasing the possibility of a patent holdup, by excluding competitors from the market or by demanding high royalties (Lemley and Shapiro[27], 2007).

Altogether, these opportunistic strategies within the context of standardisation create inefficiency, insofar as they contribute to a rise in the cost of standards for users, act as a barrier to entry and complicate the standardisation process.

3. 3. Essential patents licensing is governed by specific rules

3.1 The rules covering intellectual property must ensure the broad adoption of standardised technologies while preserving the incentive to innovate

The amount of revenue accruing to standard-essential patent holders must balance the broad diffusion of standards with the incentives to innovate. Technologies defined by standards aim to be widely disseminated and adopted, and should therefore remain appealing to their users. Accordingly, it is important to prevent patent holders from demanding exorbitant royalties (holdup) and thus hindering the dissemination of standardized technologies.

Standards should also be able to implement the most efficient innovative technologies possible. Thus, a breeding ground of firms offering innovative technologies is vital to the proper functioning of standardisation, which is only ensured if the incentives to innovate and participate in standardisation are sufficiently high.

To that end, standard setting organisations adopt intellectual property rules on the use of standard-essential intellectual property, which patent holders must adhere to if they participate in the standardisation process. These rules cover two aspects: the obligation to disclose the patents they hold prior to standardisation, in order to avoid patent ambush, and control over the conditions for granting licences, which can involve licensing obligations, the definition of rates and basis of remuneration, the possibilities of cross-licensing agreements (when two companies grant licences to each other for use of their respective technologies) as well as the capability to file for a court injunction to block infringement. These conditions can be summarized in general as the commitment to provide licences in reasonable and non-discriminatory conditions (the FRAND commitments: Fair, Reasonable and Non-Discriminatory). However, the rules vary considerably according to the standard setting organisations.

3.2 FRAND terms determine the conditions of bilateral negotiations

Licensing agreements are usually bilateral and confidential. However, contrary to non-essential patents, FRAND commitments grant the right to have royalties determined at a fair and reasonable level by a third jurisdiction to potential licensees. Thus, in case of dispute between the parties, the commitments to licence on FRAND terms are considered and interpreted by the court. By establishing an alternative to negotiations, these court decisions influence the conduct and outcome of the disputes.

The FRAND royalty rate is difficult to determine. In theory, the holder of a standard-essential patent should benefit only from the value of his technology relative to the best alternative solution, before its inclusion in the standard (incremental value of the technology independent of network externalities enabled by the standard, Swanson and Baumol[28], 2005).

Since the 1970s, American jurisprudence has adopted several methods for evaluating reasonable royalty amounts. In some cases, this amount is evaluated as resulting from a hypothetical negotiation, before the inclusion of the technology into the standard (notably in the case of *Microsoft vs. Motorola*, 2011). In these cases, the royalty is calculated on the basis of the price of the entire product (a telephone, in the case of *Microsoft vs. Motorola*, 2011), taking into account the value of the functionality that the patents contribute to (Wi-Fi and video coding) and the royalty rates determined in similar cases. In the absence of similar cases, a top-down approach has been used (notably in the case of *Innovatio IP Ventures*,

(25) Cabral, L. and Salant, D. (2014), "Evolving technologies and standards regulation", *International Journal of Industrial Organization*, 36, pp. 48-56.
(26) Kang, B. and Bekkers, R. (2015), "Just-in-time patents and the development of standards." *Research Policy*, 44(10) pp. 1948-1961.
(27) *Op. cit.*
(28) Swanson, D. G. and Baumol, W. J. (2005), "Reasonable and Nondiscriminatory (RAND) Royalties, Standards Selection, and Control of Market Power", *Antitrust Law Journal*, 73(1), pp. 1-58.

2013), in which the reasonable royalty amount is evaluated on the basis of the price of the component containing the infringed patent (here, a Wi-Fi chip), the contribution of the patent to the standard, and the contribution of the standard to the revenue generated by the component.

The legal framework in Europe regarding standard-essential patents has evolved in recent years. In particular, in the 2015 case of Huawei vs. ZTE regarding a patent held by Huawei linked to the 4G standard, the Court of Justice of the European Union (CJEU) clarifies the circumstances in which bringing an action for infringement constitutes an abuse of a dominant position. On the one hand the Advocate General[29] establishes that seeking an injunction does not constitute an abuse of dominant position as long as the patent holder is willing to negotiate, *i.e.* if he or she previously alerted the alleged infringer, if upon request of the alleged infringer the patent holder makes a specific, written offer for a licence on FRAND terms, and if the alleged infringer has not diligently responded to that offer in accordance with recognized commercial practices in the field and in good faith. On the other hand, the Advocate General also establishes the fact that, in such circumstances, bringing an action against infringement with a view to obtaining the compensation of the loss suffered does not necessarily constitute an abuse of a dominant position. This decision pursues a balance between the risks of holdup and holdout.

3.3 The IEEE has modified its rules governing FRAND terms, which could significantly reduce royalties to standard-essential patent holders

If royalties on standard-essential patents are too high, there can be detrimental effects on the adoption of standardised innovations, and it would be justified to take measures to reduce these royalties.

In March 2015, the IEEE (which established the Wi-Fi and Bluetooth standards), approved new intellectual property rules that restrict the negotiating power of patent holders.

On the one hand, the new IEEE rules restrict the capability of a standard-essential patent holder to file for an injunction against infringement. In negotiations for royalties, patent holders can acquire negotiating power through threat of an injunction; in the absence of this argument, their negotiating power is curtailed, since obtaining a favourable court decision becomes a much longer and more costly ordeal. Consequently, removing the possibility of requesting injunctions reduces the amount of the *ex-ante* negotiated licence (Sidak[30], 2008).

On the other hand, the new rules require that the royalty rate be calculated on the basis of the value of the smallest saleable unit incorporating the standard or the patent. For example, in the case of a patent on a technology included in the Wi-Fi standard, the smallest saleable component is a microchip, whose value is shared among the different patents involved. This method of valuation puts a cap on the royalty rate equal to the of the value of the smallest saleable unit. This does not allow for systematic valorisation of the economic value generated by standard-essential patents. In fact, this method excludes any value created by the complementarity between various technologies (Sidak[31], 2014) – for example, a smartphone and high speed mobile networks are complementary – or if the technology serves as a base for development of an innovation ecosystem. Furthermore, the final manufacturer selects the architecture of the components and can thus minimise the value of the smallest unit.

3.4 There is no empirical result establishing that the market power of patent holders is too high

If standard-essential patents holders were able to obtain an excessive share of the profit generated by standardised products (*i.e.* operate holdups), this would result, due to a decline in competition, in an increase in the price of those products and a decline in innovation, quality and consumer adoption. In this case, it would be justified to modify the rules concerning patent licensing.

Some studies suggest that standard-essential patents could account for a large part in the cost of products. Lemley and Shapiro[32] (2007) report that royalties for the 2G and 3G technologies represent between 15 and 30% of the price of a smartphone[33]. Armstrong *et al.*[34] (2014) suggest that royalties for licences in incorporated standards account for $120 of a $400 smartphone (30%). Data from these studies are nevertheless open to criticism since they refer to the royalties published by the firms; actual licence agreements are generally confidential. The data also reflect cross-licensing agreements at face value, whereas one or more parties could tend to exaggerate, for example to enhance a negotiation position or a reputation. These amounts are therefore skewed upwards (Layne-Farrar[35], 2014).

Galetovic *et al.*[36] (2015) compare on US data changes in the price of products dependent on standard-essential patents with those of products depending very little on such patents. By analysing the effects of a court decision which diminished the power of standard-essential patent holders (*eBay Inc. vs. MercExchange LLC*, in 2006), they determine that prices

(29) CJEU Press Release No. 88/15.

(30) Sidak, G. (2008), "Holdup, Royalty Stacking, and the Presumption of Injunctive Relief for Patent Infringement: A Reply to Lemley and Shapiro," *Minnesota Law Review*, 92(3), pp. 714-748.

(31) Sidak, G. (2014), "The Proper Royalty Base for Patent Damages", *Journal of Competition Law and Economics*, 10 (4), pp. 989-1037.

(32) *Op. cit.*

(33) The study draws on the following estimates : Bekkers and West (2006), reporting an amount of 20 % for firms which do not hold patents, according to PA Consulting (2002); Thelander (2005) with 22.5% for WCDMA technology and 15-20% for GSM technology. Bekkers, R. and West, J. (2006), "The Effect of Strategic Patenting on Cumulative Innovation in UMTS Standardization" *Dynamics of Institutions and Markets in Europe, Working Paper* No. 9. PA Consulting (2002), Press Release dated 11 September 2002. Thelander, M. (2005), "The IPR Shell Game", *Signals Ahead.*

(34) Armstrong, A., Mueller, J. J. and Syrett, T. D. (2014), "The Smartphone Royalty Stack: Surveying Royalty Demands for the Components within Modern Smartphones", *mimeo.*

(35) Layne-Farrar, A. (2014), "Intellectual Property and Standard Setting", OECD, DAF/COMP/WD 84.

(36) Galetovic, A., Haber, S. and Levine, R. (2015), "An Empirical Examination of Patent Hold-up", *Journal of Competition Law & Economics*, 11 (3), pp. 549-578.

always decrease more rapidly in essential patent-intensive industries than in other industries, before and after the court decision. This does not lead to conclude that there was a holdup that would have reduced innovation prior to 2006.

Finally, in the ICT field, all other things being equal, inclusion of patented technologies in a standard would have a positive effect on the follow-on progress in the standard (Baron *et al.*[37], 2016). This effect would diminish with the fragmentation of intellectual property rights. However, the inclusion of essential patents would delay the total replacement of the standards.

* * *

In the absence of empirical results attributing excessive market power to standard-essential patent holders, a modification of intellectual property rules resulting in a significant reduction in remuneration to those patent holders could be detrimental to innovation, to standardisation and consequently to consumers. The economic literature proposes several alternative approaches to curtail opportunistic behaviour associated with standard-essential intellectual property.

First, the functioning of standardisation can be improved through an upgrade in the quality of the patents issued by patent offices in general, since patent quality varies depending on the office. The work of de Rassenfosse *et al.*[38] (2016) illustrate variations in the quality of patents issued by various offices. An improvement in patent quality would reduce the number of long and costly legal proceedings, although it would increase the cost of obtaining a patent. Indeed, the increase in quality could entail stricter requirements for research by applicants on the state of the art, for example, or it could involve introducing a category of "super patents" associated with heightened obligations relative to state-of-the-art and prior research. Such patents would benefit from a stronger presumption of validity by the courts.

Second, standardisation could benefit from maximum upstream transparency concerning patented technology inclusion, as well as the actual essentiality of declared standard essential patent. Improvement in information lowers the risk of holdups for firms having made specific investments toward implementing standards without knowing the contents in patents.

Third, the costs of resolving dispute on intellectual property can be lowered by resorting to alternative to court procedures, particularly mediation.

Finally, some economists (Lerner and Tirole[39], 2015, notably) have suggested that taking into account the cost of patents in the choice of standards would lead to an optimal selection of technologies. However, as the authors admit, these works are exploratory, and their hypotheses accordingly simplifying (particularly by not taking into account market uncertainties or the changing nature of standards).

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(37) Baron J., Pohlmann T. and Blind K. (2016), "Essential Patents and Standard Dynamics", *Research Policy*, 45(9), pp. 1762-1773.
(38) de Rassenfosse G., Jaffe A. B. and Webster E. (2016), "Low-Quality Patents in the Eye of the Beholder: Evidence from Multiple Examiners", *Working Paper NBER* No. 22244.
(39) Lerner J. and Tirole J. (2015), "Standard-Essential Patents", *Journal of Political Economy*, 123(3) pp. 547-586.

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