The strategies of patent introduction into patent pools[1]

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Abstract:
This article explores the impact of patent pools on patenting strategies. We conduct an empirical analysis of 1,337 U.S. patents introduced into 7 important pools. This analysis highlights differences in the characteristics of patents introduced by entrants and incumbent pool members. We prove that incumbent members are able to include narrower, more incremental and less significant patents than outsiders. These findings could be explained both by bargaining power and information asymmetry. We find in particular that, as measured by a new indicator, experienced pool members file patents that are more focused on the criteria of essentiality practiced by the pool.

JEL Code: L24, O32, O34

Keywords: patent pool, patenting strategy, patent quality, patent breadth

1. Introduction

Patent pools are agreements between different patent holders to offer joint licenses for a bundle of patents. There have been patent pools since the early 19th Century, but since the successful launch of the MPEG2[4] and DVD patent pools in 1997 and 1999, pools have evolved with impressive speed. Today, patent pools are a phenomenon of increasing and undeniable importance in Information and Communication Technologies (ICT). Modern mobile phones, DVD or mp3 players, receivers for digital TV—all these high tech consumer goods use technology licensed from patent pools. The value of products produced under pool licenses and sold on the US market exceeds US $100 billion annually in 2004 (Clarkson, 2004).

Given the importance of patent pools, empirical analysis of the effects of pools on firm strategies is surprisingly scarce. This article analyzes the impact of pool creation on patenting strategies of pool members and outsiders. We investigate how patent pools affect the propensity to patent and the technological focus of firm R&D. We are thereby able to assess whether pools mitigate the effects of patent thickets or rather increase the adverse effects of strategic patenting on cumulative innovation.

We focus on patent pools in the field of technological standardization. While there have recently been important efforts to create patent pools in the fields of biotechnology and pharmaceuticals, most important patent pools are still related to technological standards. The importance of patent pools in ICT results from the fact that technological standards incorporate an increasing number of technologies protected by patents (Shapiro, 2001). Patent pools can play a beneficial role in standardized technologies. First, by bundling patents, they reduce the transaction costs by cutting down the number of licenses needed to comply with the standard. Second, pools reduce the

[4] MPEG2 is a data compression technology of moving pictures used in digital television, Internet streaming, DVDs among other uses.

multiple marginalization problem[5]. This problem arises when different firms have market power over complementary inputs (such as different patents necessary for complying with the same standard), and the firms fix prices independently of each other.

While there has been a fruitful stream of research on the impact of pools on downstream markets (e.g. Gilbert, 2004; Lerner & Tirole, 2004), much less attention has been spent on their potential upstream effects on innovation and patenting strategies. For instance, there is to date no empirical analysis of the patenting strategies of pool members and of companies wishing to join. The purpose of this paper is to fill this gap and to analyze the patterns of patent introduction into ICT patent pools, using data from major contemporary patent pools. We analyze the impact of pool membership on the technological characteristics of patents that are introduced. For instance, we compare the breadth and technological focus of patents introduced by incumbent pool members with those introduced by outsiders. We have produced a unique dataset on the timing of patent introduction into several of the most important pools that currently exist. Furthermore, we make use of technical documents to construct a novel indicator for the technological focus of a patent on the technology underlying the pool.

We highlight patterns of patent introduction providing sufficient evidence for an effect of pool membership on patenting strategies. We find that insiders introduce narrower and more incremental patents. We argue that this high propensity to patent allows these firms to capture an important part of the royalty income of the pool. These findings could indicate that insiders benefit from stronger bargaining power or better access to information than outsiders. We find arguments and empirical evidence especially for the latter explanation. Indeed, pool insiders and firms with a longstanding experience in a patent pool file patents that are more focused on the technology

[5] This problem was first analyzed by Cournot (1838) as "the exercise of market power at successive vertical layers in a supply chain".

licensed out through the pool. While these findings provide evidence for opportunistic patent files induced by patent pool membership, we also find that patent pool membership increases the technological significance of patents controlling for patent breadth and generality.

The remainder of this paper is organized as follows. Section 2 presents a review of the economic literature on pools. Section 3 discusses main institutional features of contemporary ICT pools. Section 4 presents a quick overview of the novelty and interest of our data to establish new findings. Section 5 presents our main results on the differences between patents introduced into pools by firms according to their membership and experience in the pool. Section 6 highlights the importance of information asymmetry to understand how patents of different characteristics can be included. Our conclusion in section 7 discusses the implications of our findings for pool design and policy.

2. Theoretical background and empirical literature on patent pools

There is now a broad theoretical literature assessing the effects of patent pools on royalty rates and downstream markets (see for instance Gallini 2010, Gilbert & Katz 2006, Kato 2004). This literature generally stresses a positive welfare effect: patent pools have the potential to reduce the overall royalty rate by mitigating royalty stacking and transaction costs. But, in spite of their undeniable advantages, pools also have drawbacks. The main threat is the possibility that firms could use the pool for anticompetitive behaviors (Carlson, 1999). The literature particularly emphasizes the risk of introduction of substitutable patents, which would undermine competition between technologies (Gilbert, 2004; Lerner & Tirole, 2004).

There is also a smaller and more recent strand in the theoretical literature on the effects of patent pools on innovation incentives. Lerner and Tirole (2004) find that patent pools can induce socially wasteful excess innovation. LLanes and Trento (2010) also find that patent pools increase incentives to innovate, but in their model this increase is efficient, as it corrects for the negative effects of patents on sequential innovation. Dequiedt and Versaevel (2007) find a positive effect of prospective pool creation on innovation and patent files, as a patent is assumed to be more valuable to its owner when included into a pool. The recent empirical literature provides several justifications for this assumption. For instance, Delcamp (2010-1) shows that one advantage of the pool may be to increase the value of patents included. In another paper (Delcamp, 2010-2), the author shows that pools help patent holders enforcing their rights by increasing their level of information on possible infringement of the technology. Dequiedt and Versaevel (2007) nevertheless assume that companies willing to join an existing pool have to bargain their entry with incumbent pool members who extract the value added by the pool from the entrants. Their model thus predicts patent races until the launch of the pool, whereas innovation and patent files are on a low level during the existence of the patent pool.

Lampe and Moser (2010) verify this pattern of patent files empirically for the sewing machines patent pool in the 19th century. The number of patent applications both by pool members and outsiders was high before the creation of the pool, and dropped on a low level after pool creation. Nevertheless, the patent race in view of the pool creation did not yield significant technological progress on the technologies covered by the patent pool. Therefore, Lampe and Moser (2010) argue that the patent pool induced strategic patent files rather than innovation investments. Baron and Pohlmann (2010) find a similar result for contemporary ICT patent pools. They find that patent pools have a strong positive effect on the number of patents declared essential to the underlying standard in the periods before pool creation. This race of patent declaration does not induce an increase in standardization activity.

By contrast to the predictions of Dequiedt and Versaevel (2007) and the finding of Lampe and Moser (2010), Baron and Pohlmann (2010) find that patent pools have a positive and significant effect on patent declarations even after the pool is created. They argue that pool members continue to have stronger patenting incentives after patent pool creation than in the absence of a patent pool. This explanation is corroborated by descriptive results in Baron and Delcamp (2010). This description of the current patent pool landscape in ICT standardization reveals that generally more than half of the patents included into patent pools have been introduced after the pool creation. This result is confirmed for U.S. patents in our sample as it is shown in figure 2, appendix 1. Initial pool members account for the large majority of these late patent introductions. The descriptive analysis of patent pools provides furthermore further support for the suspicion that the strong patenting activity by pool members after patent pool creation does not reflect an increase in innovation investment. Indeed, Baron and Delcamp (2010) show that the scope and the technological significance of patents introduced into the pool strongly decreases over time.

Nagaoka (2009) provides a further analysis of the development and growth of patent pools over time. In order to do so, he examines three technological standards in information technology. The author underlines that the number of essential patents within pools increases significantly after the standard definition. He identifies three reasons to explain this increase over time: patents cover a number of different technology fields, there exists R&D competition and a firm can expand its patent portfolio by using continuation and other practices based on the priority dates of its earlier filed patent applications. He finds strong evidence for the hypothesis of a strategic increase of patent portfolios, as around 40% of the essential US patents for MPEG2 and DVD standards have been obtained by using these applications. The author also focuses on whether a firm already member of a pool can obtain more essential patents, using these practices. He concludes that firms with pioneering patents tend to have a smaller number of essential patents obtained through continuations.

Thus, there is evidence on an effect of patent pools on opportunistic patent strategies. These strategies induced by patent pools could increase the number of technologically insignificant or unnecessary patents on a standard. Gilbert (2009) argues that inclusion of such unnecessary patents into a patent pool should not lead to higher royalty rates and not represent a threat to consumer welfare. On the other hand, opportunistic patents reduce the return on technologically significant patents, as they dilute their share in the pool. Thereby they could reduce incentives to innovate and stifle the technological development of the standard.

Furthermore, opportunistic patent files potentially reduce the stability of patent pools and induce holders of valuable patents to refrain from joining the pool. For instance, Layne Farrar and Lerner (2010) find that holders of high quality patents are less inclined to join patent pools that redistribute royalty income according to the number of patents in the pool. In practice, the stability of patent pools is an important problem and many patent pools fail to emerge or to include all

relevant patent holders. Indeed, Aoki and Nagaoka (2004) highlighted that patent holders have strong incentives not to participate to the pool. They thus can benefit from higher licensing fees for their patents due to the pools' creation. Llanes and Trento (2010) show that the incentives to stay outside a pool are particularly strong for downstream inventors. The effects of opportunistic patenting on the attractiveness of patent pools are therefore potentially severe.

The theoretical and empirical literature thus discusses possible causes and implications of the impact of patent pools on patenting strategies. In particular, there is evidence for an increased patent propensity. The theoretical analysis of the impact of pools on patent strategies highlights the different incentives of pool members and outsiders. Nevertheless, there is no direct empirical analysis of how patenting strategies are affected by patent pools. The aim of the present study is to fill this gap.

3. Stylized facts

In order to analyze the effects of patent pools on the incentives of pool members and outsiders to file and introduce patents, it is important to present two main features of the institutional setting of contemporary patent pools. These features are the rules on revenue sharing between patent pool members and rules governing the inclusion of patents into pools.

Revenue-sharing rules

Not all patent pools collect royalties. For example, the Bluetooth pool has a royalty-free licensing rule. In this case, introduction of patents into the pools is driven by non-monetary incentives, such as encouraging the implementation of the standard or access to the licensees' technology. However, all pools that collect royalties have rules on how these royalties are shared between members. There is no legal requirement stipulating a certain form of royalty sharing. Therefore

members are free to agree on whatever rules they want. Layne-Farrar and Lerner (2010) identify two main types of sharing rules: numeric proportional rules and value added rules. Both rules provide important incentives to firms for increasing their share of patents in the pool.

The numeric proportional rule consists of dividing earnings based on the number of essential patents in the pool. All the pools administered by MPEG LA[6] use this revenue sharing rule (Layne-Farrar & Lerner, 2010). A variant of this rule is the revenue sharing rule of the MPEG 2 patent pool in which the calculation of the number of essential patents is weighted by country. The numeric proportional rule has a direct impact on the incentives to introduce large number of patents because each new patent increases the percentage of revenue allocated to its holder.

The value added rule exists in several variants. The first possibility is a negotiation that determines what share of revenue each contributor receives. The second possibility is a royalty sharing rule based on determinants such as the age of the patents, the number of claims, the number of times the patents are infringed, and the part of the standard these patents are essential for. In this case, the number of patents taken into account for the calculation of the share of revenue is weighted by some indicators of patent quality. One example of an application of the value added rule is the DVD 6C patent pool (Layne-Farrar & Lerner, 2010).

Even though the value added rule weights the number of patents by some indicators of patent quality, it still provides incentives to firms to increase their share of patents in the pool, even if the additions are of lower quality. The business review letter[7] of the DVD6C pool states: "The formula that will determine the royalty allocation is based on how many of each Licensor's 'essential'

[6] MPEG Licensing Association is one of the currently most important pool administrators (together with Via Licensing and Sisvel). There are currently 8 patent pools administered by MPEG LA, including very important pools such as MPEG2. See Baron and Delcamp (2010) for a description of the business model of a pool administrator.
[7] Available at http://www.justice.gov/atr/public/busreview/2485.htm

patents are infringed. Thus, although the formula weights the patent count with other factors, each Licensor will benefit monetarily from the exclusion of other Licensors' non-'essential' patents and accordingly has a strong incentive to encourage the expert to review other Licensors' patents critically, and to bring to the expert's attention any patents that have ceased to be 'essential.' ".

As all pools take the number of patents into account for determining the royalty shares of the members, it is straightforward why companies have incentives to introduce a high number of patents. On the other hand, it also becomes apparent that such strategies meet the resistance of other pool members, whose share in the pool would be diluted by opportunistic patents. It is the aim of our investigation to analyze how different firms manage to expand their share on the expense of others. As a further step, it is necessary to analyze how the rules of patent pools shape the incentives and possibilities of strategic inputs.

The rules governing inclusion of patents into patent pools

In order to qualify for introduction into a pool, a patent has to be "essential" to the underlying standard. In order to ensure the essentiality of the patents, and thus the compliance of patents with the criteria adopted by the pool, patent pools usually have a third party evaluator (or expert, as the DVD6C pool letter states) that establishes essentiality reports[8]. The evaluator's work is to analyze the patent and to declare whether this patent is "essential" according to the criteria of essentiality defined by this particular pool. There are several points to highlight on this essentiality criteria.

First, the criteria of essentiality are not always exactly the same and may be endogenous: the definition of patent essentiality is a subject of debate, but two mains interpretations emerge from the literature and the decisions of competition authorities (Gilbert, 2009). The first one focuses on technical essentiality, meaning that there is no technological alternative to a patent. A second,

[8] An example of a summary essentiality report is included in Appendix 3

broader definition includes criteria of economic feasibility. In this definition, patents are essential not because there is no technological alternative, but because the available technological alternative(s) is so costly that it is impossible to implement the standard in a way that is competitively priced without using the patent. In practice, pools have some discretion in defining their criteria of essentiality[9]. It is thus imaginable that the pool members choose the criteria of essentiality bearing in mind which criteria would best fit their patent portfolio. Furthermore, not all pools force members to consult the expert[10]. Finally, it is difficult to ascertain to what degree pool members can influence the outcome of the patent evaluation. Patent evaluators are appointed by the pool administrator and paid by the patent holders. In several cases of litigation, licensees have accused patent evaluators of being overly lax in their evaluation of allegedly essential patents.[11]

Most importantly, the criteria of the essentiality evaluation do not take into account the patent breadth or generality. Essential patents can still be of low technological or economic value. For instance, owners of an essential technology can often choose to protect it by one large or several narrow patents. Each of the numerous narrow patents may still be necessarily infringed by any implementation of the standard and therefore each separately complies with the criteria establishing essentiality in the respective pool.

We have thus discussed that essentiality evaluation by patent pool experts does not rule out the possibility of opportunistic patent introductions into pools. While the safeguards should be

[9] For instance, the MPEG 2 pool uses the technical essentiality criteria whereas the DVD 6C pool uses the economic feasibility criteria.

[10] For instance, the MPEG 2 pool stipulates: "The licensors are bound by the expert's opinion. However, they need not consult the expert if they agree unanimously in good faith that a submitted patent is an essential patent or that a portfolio patent is not essential"

[11] This claim is raised as patent misuse defence in many patent infringement cases, e.g. by disc replicator ODS in its litigation MPEGLA over the MPEG2 patent pool; Landgericht Düsseldorf Urteil vom 30. November 2006, Az. 4b O 346/05; V. b) cc);

efficient in ruling out that substitutable or unrelated patents are included into the pool, the essentiality evaluation has no impact on the propensity to file patents on essential technology. For instance, holders of standard-essential technology can increase their number of patents by filing a high number of narrow patents, or by filing patents not only on fundamental, but also on very incremental inventions related to the standard. We will explicitly address these hypotheses in the remainder of this article.

4. Methodology

Even though some commentators suggest that pools may increase the number of low quality patents, to date no reliable evidence has been gathered. If the number and quality of essential patents is endogenous to pools, this does not necessarily imply that patents in pools are on average of lower quality than other patents. Besides the potentially negative incentive effect, one expects pools to have a positive selection effect: Patents essential to technological standards are generally found to be of higher quality than other patents, because Standard Setting Organizations (SSOs) tend to select the best technologies. As patents included in pools are by force of law required to be essential, included patents are expected to be of higher quality than the average patent. Delcamp (2010-1) finds evidence on this link between essentiality and quality of patents in pools.

The most straightforward way of assessing the patent introduction strategies would be to compare for each standard and each year which patents are introduced into the pool and which patents are not. Unfortunately, it is impossible to reliably identify those patents covering the same technology as the pool that are not included in the pool. Recently, databases of patents declared essential to SSOs have been used for these purposes (Layne-Farrar & Lerner, 2010), but the overlap between patents declared as essential and essential patents is small. For instance, many patents declared to

be essential by their owner can be determined as not essential by an external evaluator[12], and there is no guarantee that all essential patents are correctly declared. This indicates that patent declaration databases do not reliably account for all relevant patents, which makes it impossible to distinguish between patents not presented to the pool by their owner and patents refused by the pool's patent evaluator.

Therefore, we concentrate on patents that have effectively been included into a pool and analyze patent quality with respect to the owners of the patent and the timing of their introduction. In particular, we analyze the effects of pools on patenting strategies by comparing patents introduced by firms that are already pool members and by outsiders. Furthermore, we compare patent introductions according to the experience of the firm in the pool, to the share of pool patents it holds, and to vertical integration. We label a firm as vertically integrated when it is licensor and licensee of the same patent pool.

Data

We have produced a unique database of 7 patent pools: DVD6C, MPEG2, MPEG4 Systems, MPEG4 Visuals, AVC H/264, IEEE 1394 and DVB-T[13]. These 7 major pools capture a big share of the commercial importance of patent pools in ICT. Restricting the analysis on ICT patent pools has the advantage that the institutional setting of the pools is very similar. As the first patent pools have undergone a rigorous and time-consuming screening by competition authorities, all later pools adopted an institutional framework sufficiently similar to the arrangements that had already been cleared as non-infringing.

[12] For instance, the essentiality evaluation of Fairfield Resources on patents declared as essential to LTE and SAE underlines that around 50% of the families declared contain no essential or probably essential patent (see http://www.frlicense.com/LTE%20Final%20Report.pdf)

[13] DVD6C is one of the two patent pools licensing out patents essential for DVD specifications, MPEG2, MPEG4 Systems, MPEG4 Visuals and AVC H/264are patent pools including essential patents for coding standards issued by the Moving Pictures Expert Group, the IEEE 1394 patent pool covers wireless communication technology, and DVB-T is a patent pool for patents on Digital Video Broadcasting technology.

The seven patent pools provide us with 8,046 patent observations. A few patents are included in several pools; for our purpose the same patent in different pools is treated as a separate patent observation each time it appears. Furthermore patents sometimes change the designation by which they are identified on patent lists (from application number to grant number) or are dropped (by expiry or retrieval of the holder). For these reasons the number of patent observations is higher than the number of patents currently included in the seven pools (8,046 observations for around 5,000 patents).

We retrieved the patent numbers and the name of patent holders from the lists available on the websites of the pools[14]. Using Internet Archives,[15] we checked when the patent first appeared on the list of pool patents. Patent pool managers regularly update the lists of pool patents on their websites. Like any other information on the site, these data are stored in Internet Archives. Comparing current lists with previous ones allows identifying the date when a patent is first listed as part of the pool. We call this the date of input. As the updating of sites may experience some delay or the update be retrieved from the Archives after some delay, the date we identify as date of input may differ from the actual date of introduction by as much as a couple of months. Nevertheless, our method reliably identifies the order in which patents are introduced into pools.

In order to compare only what is comparable; we restrict our analysis to the U.S. patents in our sample[16]. We match the 1,337 US patents with the National Bureau of Economic Research (NBER) database. By doing this, we obtain a full range of information on the patents, and especially the number of claims, forward and backward cites (forward cites count the number of

[14] www.mpegla.com (MPEG2, MPEG4 Systems, AVC, IEEE 1394), www.dvd6cla.com (DVD6C), www.sisvel.com (dvb-t)
[15] www.archive.org
[16] The U.S. patent is usually the first patent of a family to be introduced in a pool (Baron & Delcamp, 2010) and is also usually the patent upon which the essentiality evaluation is based

times a patent is cited by ulterior patents, backward cites count the number of previous patents cited by a patent), patent generality, technological class, and grant and application year. In order to deal with truncation problems and missing observations, we completed the dataset using the web service of the European Patent Office[17]. Using these databases, we also retrieve the size of the patent family. The patent family is defined as the group of patents sharing the same priority number.

We collect four important dates for each patent: application date, grant date, date of pool creation and date of introduction into the pool. From these dates are drawn our age variables. Patent age is the difference between today and the grant date, and Input age is the age of the pool at the time a patent was introduced, defined as the difference between date of input and pool creation date.

Indicators

The main purpose of our paper is to analyze the impact of pools on the patenting strategies of the members. We are especially interested in assessing the effects of pools on patent propensity. Two patent indicators are particularly relevant for analyzing patent propensity. First, we use the number of claims, which is a common indicator of the patent breadth (Merges & Nelson 1990, Klemperer 1990). If due to higher patent propensity a holder of a technology decides to file more patents on the same number of inventions, this should be reflected in the fact that his patents are narrower, and therefore have fewer claims. Indeed, it is difficult to increase the number of valid claims on a technological invention, as the claim is a unit of legal significance that is difficult to manipulate, because it will be used to assess the validity and the possible infringement in case of litigation. On the other hand, it is possible to increase the number of patents by reducing the number of claims per patent (Merges & Nelson 1990). The second indicator for the patent propensity of technology holders we use is the generality index. Patent generality is defined as the dispersion of prior art

[17] www.espacenet.com

over technology classes. If a patent cites prior art that is technologically very heterogeneous, it is more likely to protect a fundamental invention. By contrast, if a patent cites only prior art that is technologically very close, it is more likely to protect an incremental invention (Trajtenberg & al., 1997). Finally, we also use the family size to assess the value of a patent. Family size is a common indicator of patent private value (Putnam, 1996) as the costs of filing increase with the number of countries in which the innovation is protected.

In a next step, we want to analyze the technological focus of the patents filed by pool members. Indeed, if pools induce companies to file more patents with the only objective of introducing them into a pool, these strategies should be reflected by the fact that the patents of these companies are more focused on the technology covered by the pool. The generality index and other traditional patent indicators (such as the originality index) are unable to capture the relationship between a patent and a very precise technology such as a standard. Therefore we construct a novel indicator for the focus of a patent on a standard. This standard is based upon the breadth of the essentiality claim. As discussed earlier, the patent essentiality reports indicate the standard sections for which each patent is essential. Summaries of the essentiality reports carried through by independent patent experts are available on the pools' websites. These summaries indicate the sections and subsections of the standard document for which the respective patent is essential. We count these sections and subsections and correct by the median of patents in the same pool (respectively in the same licensing program for pools with several distinct licensing programs). Estimating the effects of patent pools on the breadth of the essentiality claim and controlling for the breadth and generality of the patent itself should give a good indication of the patent's focus on the standard underlying the pool.

Finally, we are also interested in analyzing the effect of pool membership on the technological significance of the patents filed by pool members. The most frequently used indicator of technological significance is the number of forward cites, which has been repeatedly found to

indicate the value of the patent and the significance of the underlying technology (Harhoff & al. 1997, Hall, Jaffe & Trajtenberg 2001, Giummo 2003). Layne-Farrar and Lerner (2010) and Rysman and Simcoe (2008) use forward number of cites to analyze the quality of patents incorporated into standards and patent pools. Economists have thought about a potential bias resulting from citations a patent receives from patents of the same patent holder[18]. To exclude any bias and in line with most empirical research on patent quality, we exclude citations received by patents owned by the same firm.

A list of all the variables used in this paper with some descriptive statistics can be found in Appendix 2.

5. The impact of pool membership on patenting strategies

Hypotheses

The aim of this part is to examine if a pool creation changes firms' patenting strategies. For instance, we will analyze whether a patent pool induces firms to increase their patent propensity. As discussed, a higher propensity allows firms to reap more important shares of the pool royalty income. This strategy makes sense only when some firms are able to increase their patent propensity at the expense of others. For instance, we expect that insiders are more able to introduce numerous patents of low significance than outsiders. In order to address this hypothesis, we analyze differences in the characteristics of patents introduced by incumbent pool members and outsiders.

We can also refine the analysis and have a closer look at the patents' characteristics depending on the firm status and position within the pool. If pool membership has an impact on firms' patenting

[18] Hall et al. (2001)

strategies, we expect that this effect is stronger for firms that have been in the pool for a longer time and that own more important shares of the patents in the pool.

A further hypothesis is that the patenting strategies could change if the firm is at the same time licensor and licensee (vertically integrated) of the pool. Licensees bear the cost of a higher patent propensity when it increases overall licensing costs or when it dissuades holders of significant essential patents from joining the pool. More generally, it has been found that the main motivation for manufacturing firms to join patent pools is to clear blocking positions and to facilitate access to technologies. This position could mitigate the incentives for a patent owner to increase the number of patents when he is at the same time a licensee of the pool.

Hypothesis 1: The characteristics of patents included should vary according to whether the patent holder is member of the pool, whether it is also licensee or held an important number of patents.

We will test the hypothesis of an increased patent propensity using three different patent characteristics. First, an increased patent propensity should result in narrower patents. Indeed, an essential technology can be protected by one or many essential patents. Patent holders have incentives to divide an essential technology in many essential patents if the sharing rules of royalties are at least partly based on the number of patents (cf. section 3). Furthermore, we expect that a high patent propensity leads firms to patent also very incremental inventions. We therefore expect that the patent generality decreases on average.

But at the same time, all the patents in the pool should have the same private value for the patent holder. In fact, after introduction into a pool, every patent gives a right to the same share of

royalties (or almost the same if the pool adopted the value added rule). Thus, we should not observe any difference in the family size of the patent.

Hypothesis 2: The patent private value should be equal whatever the firm status with respect to the pool

Moreover, we also investigate if there are differences in the technological significance of the patents. We thus look if the number of forward cites differs according to the status of the patent owner. As patent citations are an exogenous indicator and can not result from a deliberate strategy by the owner, we present the results in the next section.

Results

We successively test our hypotheses regarding the number of claims, the generality and the family size of the patents. We run Poisson estimations on each indicator. We control for patent age, the time of patent introduction and for pool fixed effects. The results are presented in the following table (negative binomial results can be presented on request and go in the same direction).

	Number claims	Number claims	Generality	Generality	Family size	Family size
Outsiders	0.37528***	0.21096**	0.61934***	0.41313***	-0.16081	-0.38395
	(0,067)	(0,103)	(0,081)	(0,115)	(0,197)	(0,421)
PPprior		-0.202041		-0.93253*		0.00905*
		(0,270)		(0,502)		(0,005)
Seniority		0.00450**		0.00299		0.55282**
		(0,002)		(0,004)		(0,256)
Vertical Integration		-0.14928		-0.04930		-0.36693
		(0,116)		(0,162)		(0,263)
Patent Age	0.01811	0.02098**	-0.06992***	-0.06788***	0.20054***	0.20757***
	(0,011)	(0,010)	(0,011)	(0,011)	(0,034)	(0,037)
Age input	-0.00178	-0.00365**	-0.00869***	-0.01046***	-0.01460***	-0.01806***
	(0,001)	(0,002)	(0,002)	(0,003)	(0,005)	(0,006)
Dummy Pools	Y	Y	Y	Y	Y	Y
Dummy Application year	Y	Y	Y	Y	Y	Y
_cons	-33.9089	-38.979*	138.437***	134.6002***	-397.4718***	-411.9019***
	(22,263)	(20,943)	(22,918)	(22,849)	(67,657)	(73,613)
Observations	1208	1208	707	707	698	698

*Regressions with robust standard errors in parentheses. Legend: * p<0.05; ** p<0.01; *** p<0.001.*

Table 1. Patent characteristics according to the status of the patent holder

Table 1 highlights two important results. First of all, we can underline that the pools grow by including over time increasingly narrow and incremental patents. We furthermore confirm Hypothesis 1 that patents brought by outsiders are broader and more general than patents brought by insiders. This result is verified for both the number of claims and the generality of the patent. Both findings concur that patent pools induce a higher patent propensity especially among pool members. Nevertheless, we do not find any significant incidence of vertical integration. Firms that are licensees of the pool do not introduce patents that are significantly different from patents introduced by other firms. Hypothesis 2 is also verified. Patents introduced by insiders or outsiders at the same time into the same pool do not differ in their family size. Patents brought by outsiders are thus less focused and more general, but of the same private commercial value than insider patents. This finding indicates that the opportunistic patenting strategies of pool members are

profitable, as they allow achieving the same private value with a smaller and therefore arguably less expensive technological contribution.

This finding nevertheless calls for further investigation. If pool members introduce increasingly narrow and incremental patents into the pool, why would the other members accept these patents? Indeed, each introduction of new patent changes the repartition of royalties. Thus patent pool members should be particularly cautious when accepting new patent introductions. Yet, we have just shown that pool members are able to introduce numerous narrow and incremental patents. A further point is that if filing narrower and more incremental patents allows holders of essential technology increasing their share in the pool, it is not straightforward why outsiders would introduce less patents with broader claims and on more general inventions.

Furthermore, also a more detailed comparison of patents introduced by different types of insiders raises further need for investigation. On the one hand, pool members that hold bigger shares of the patents in the pools introduce even more incremental patents than the other pool members. On the other hand, companies that have been pool members for a long time introduce patents that are broader than the patents introduced by other pool members. Their patents also seem to have a significantly higher private value than patents introduced by other companies, as indicated by the bigger patent families. These results suggest that the experience of a company in a patent pool has an effect that does not necessarily go into the same direction as pool membership as such or as the share of the firm's patents in the pool.

The next section will thus investigate how being pool member affects a company's capacity to increase the number of patents and thus the share in royalty rates. In particular, we will analyze how the experience and the share of a firm in a patent pool affect the technological focus and significance of its patents.

6. Why do the characteristics of inputs differ according to the status of the patent holder?

Hypotheses

In the previous part we have seen that pool membership has an impact on firms' patenting strategies. Pool members are filing patents that are narrower and more incremental. This result is in line with earlier findings that pools induce a higher patent propensity around a technological standard (Baron & Pohlmann, 2010). There remains however an important issue to clarify. The fact that we find firm characteristics to be correlated with patent characteristics could be explained by two different sets of arguments. The first argues that some firms are able to introduce patents of different characteristics, narrower and less general, to the pool because they have greater bargaining power. These firms can induce a pool to accept a patent that it would have rejected if it was submitted by a firm with less bargaining power. The other argument would be that pool members present patents that at given patent scope and generality are more important for the standard and for the successive technological development. According to the first argument, pool membership thus induces a change in patent strategy because it improves the firm's bargaining power with respect to the patent pool. According to the second argument, pool membership induces a change in patent strategy because it improves the firm's capacity to file patents that are essential for technological standards or for successive research by other firms.

The greater ability of insiders to introduce less general and narrower patents could be explained by bargaining power. Patent pool administrators and patent evaluators are paid by pool members. It is reasonable to argue that they maximize the welfare of the pool members. Patents presented by outsiders are therefore only accepted if the value they add to the pool more than compensates pool members for the decrease of their share in pool income. Patents introduced by pool members modify shares of individual pool members, but do not reduce the number of joint shares of all

members. Patents submitted by insiders should thus be accepted as soon as they add some value to the pool. Pool administrators could have a further incentive to reject patents presented by companies that are not yet pool members: accepting such patents means that their holders become pool members. If the pool increases, joint decision making becomes costlier and the risk of non-cooperative strategies increases. For both these reasons, at given patent quality and technological significance, a patent pool administrator could be expected to be more inclined to accept patents presented by pool members. This could explain our finding that outsiders introduce patents that are broader and less incremental on average.

By contrast to pool insiders, vertically integrated firms (in this context we mean patent holders that are also licensees of the same pool) may have weaker bargaining power. Licensees of a pool have an additional incentive to become pool members: being member of the pool allows them to participate in fixing the price of the license. Vertically integrated firms fix lower royalty rates in order to reduce their downstream production costs. For the other pool members, this shift away from the income-maximizing royalty rate is an additional cost. They will thus accept patents submitted by their licensees only if the value they add to the pool at least compensates for this cost. We can also reasonably argue that the number of patents a patent holder already detained in the pool has an impact on its bargaining power. Thus firms with a higher number of patents in the pool should, if this bargaining power hypothesis is verified, be able to introduce patents of different characteristics.

Hypothesis 3: Pool members are able to introduce patents of different characteristics to the pool because they have greater bargaining power. They thus voluntarily increase their patenting propensity which leads to narrower and less general patents.

But there is another explanation that is alternative or complementary to the theory of bargaining power. This second explanation states that the acceptance of the patent by the pool is determined by the patent's essentiality and thus by the focus of the patent on the standard. Indeed, some firms could be more able to introduce patents of different characteristics into the pool not because they have stronger bargaining power, but rather because they are able to file patents that qualify for the pool at lower level of innovation efforts. According to this hypothesis, pool members thus introduce patents that at given patent generality and scope have a blocking power over broader parts of the standard and constitute prior art for a broader stream of successive research.

Hypothesis 4: Pool members are able to introduce patents of different characteristics because they present patents that are more focused on the standard

In order to disentangle between these two explanations, we will have a closer look at the significance of the patents for the standard and for successive research. The significance of an essential patent for the standard can be conceived as the share of the standard that necessarily relies upon the patent. We therefore retrieve from the essentiality reports (cf. section 3) of the pools the number of standard sections to which the patent is essential. We will use this number of standard sections as the first explained variable. The significance of a patent for successive research is generally measured by the number of times a patent is cited by successive patents. We therefore use the number of forward citations as second explained variable. The explanatory variables include characteristics of the firm with respect to the pool, such as a dummy for pool membership, the number of patents in the pool, the seniority in the pool or a dummy for vertical integration (is the firm at the same time licensor and licensee of the pool). In a second step, we include the patent characteristics, and for instance the generality and the scope of the patent, as control variables. Indeed, if our precedent hypotheses are verified, we should find that the scope of essentiality (sections of the standard infringing the patent) and significance for successive research

(forward citations) vary according to the position of the firm with respect to the pool characteristics controlling for these patent characteristics. While we expect that broader and more general patents are generally more important for the standard and for successive research, we argue that pool membership increases the patent's importance at given scope and generality.

Results

We run successively Poisson estimates on each indicator (negative binomial results can be presented on request and go in the same direction).

	Standard sections	Standard sections	Standard sections	Standard sections	Number of cites	Number of cites	Number of cites
Outsiders	-0.36522*** (0,076)	-0.24924* (0,140)	-0.51218*** (0,151)	-0.48328*** (0,179)	0.27648** (0.103)	0.10993 (0.134)	-0.0178 (0.143)
PPprior			0.57614** (0,252)	0.042703 (0,338)		0.51005 (0.400)	0.17114 (0.421)
Seniority			0.00468** (0,002)	0.00518** (0,002)		0.01277*** (0.003)	0.00830** (0.003)
Vertical Integration			-0.03187 (0,099)	0.07104 (0,109)		-0.60012*** (0.177)	-0.20189 (0.146)
Patent Age	-0.10380*** (0,009)	-0.07762*** (0,017)	-0.10042*** (0,009)	-0.07014*** (0,017)	-0.10590*** (0.011)	-0.10319*** (0.012)	-0.07435*** (0.012)
age_input	0.03702*** (0,002)	0.03752*** (0,002)	0.03590*** (0,002)	0.03580*** (0,002)	-0.00809*** (0.002)	-0.01441*** (0.003)	-0.00785** (0.003)
Generality		-0.11545 (0,205)		-0.05897 (0,206)			0.47846*** (0.134)
Number claims		-0.00335 (0,003)		-0.00382 (0,003)			0.00928*** (0.002)
Dummy Pools	Y	Y	Y	Y	Y	Y	Y
Dummy Application year	Y	Y	Y	Y	Y	Y	Y
_cons	211.2717*** (19,438)	158.8029*** (33,205)	204.5776*** (19,690)	143.8985*** (35,700)	214.4111*** (22.723)	209.6948*** (22.905)	151.4187*** (24.636)
Observations	1164	685	685	685	1229	1229	700

*Regressions with robust standard errors in parentheses. Legend: * p<0.05; ** p<0.01; *** p<0.001.*

Table 2. Patent focus and technological significance according to the status of the holder

Table 2 presents the results of our estimation of standard sections infringing the essential patents. We find broad support for the theory of information asymmetry. Indeed, firms that are already pool members introduce patents that are essential to much broader parts of the standard, even though patents presented by these firms are narrower and more incremental. Their patents are thus much more focused on the technology included into the standard. This result holds true controlling for patent characteristics or not. Furthermore, there are more concrete indications for a learning process. Indeed, the more time a company has been member of a pool, the broader are the parts of the standard covered by their patents (and the stronger is the focus of the patents on the standard). Firms that have a better understanding of the functioning of a pool are more able to produce patents that are more focused on the standard and that better meet the expectations of the pools' experts. We also can highlight that among all patents, i.e. those introduced by pool members and outsiders, the essentiality claim is broader the later the patent is introduced. It has already been found in the literature that firms adjust their patents in order to match technological standards (Köhler & al., 2009). In the drafting of patent claims, firms try to cover as many standard sections as possible. We now observe that pool members learn more quickly than outsider firms how to adjust their patents to the underlying standard, which could explain that they are able to introduce a higher number of narrow and incremental patents into the pool.

At the same time, the bargaining power theory does not seem to be verified. Indeed, all our explained variables that capture possible differences in firms' bargaining power (*ppprior* and *vertical_integration*) are not significant when controlling for patent characteristics. To conclude, we can thus say that our results allow disentangling between the two hypotheses. While, the information asymmetry seems to be confirmed by our results, the bargaining power theory does not seem realistic in light of the results on our sample.

Table 2 presents the same estimation on the number of forward citations. We can highlight that in contrast to our findings on standard sections, the number of forward citations significantly decreases when a patent is introduced late into a pool (Baron & Delcamp, 2010). This is probably due to the fact that patents are increasingly focused on the underlying standard, and therefore decreasingly relevant for research in the broader technological field. We also can underline that patents presented by pool members are less cited than patents presented by outsiders. This result was to be expected, taking into account the fact that pool members introduce narrower and more incremental patents. Nevertheless, controlling for patent scope and generality, patents presented by pool members are not less cited than patents presented by outsiders. To the contrary, the more time a company has been in a pool, the more its patents are cited at given scope and generality. We therefore conclude that pool membership increases firms' ability to file patents that are eventually found to be relevant for successive research. This further corroborates the hypothesis of a learning effect of pool membership.

7. Policy discussion and conclusion

This paper explores empirically the introduction of patents into pools. One of the main challenges for this investigation is that we do not have precise information on the selection process and cannot observe patents rejected by pool evaluators. To circumvent this problem, we compare patents included into the pool and investigate whether the characteristics of these patents vary according to the time of introduction or the status of the patent holder with respect to the pool.

First of all, we emphasize that firms that are already pool members introduce patents that are narrower and less general. The longer a company has been member to the pool, and the bigger the share of pool patents it owns, the narrower and the more incremental are the patents it introduces. We also produce evidence that the patenting strategies of these companies are more focused on the

standard underlying the pool. It is thus reasonable to assume that these narrow and incremental patents are filed with the only objective to be included into the pool. On the one hand, these strategies of opportunistic patenting have an impact on the redistribution of royalty revenue inside the pool. On the other hand, our results do not necessarily imply that the consumer welfare will be affected. In fact, as the price of the pool license does generally not increase with the number of patents in the pool, these strategic inputs should not have any direct impact on the consumer. For instance Gilbert (2009) argues that if a patent pool contains at least one essential good quality patent, the introduction of trivial or non-essential patents does not increase royalty rates or deteriorate consumer welfare.

Nevertheless, consumers could be affected indirectly if pools are not able to attract the holders of good quality patents. Indeed, in this case, pools would not be able to reduce the multiple marginalization problem and consumers would have to bear the costs of licensing successive monopolies on complementary patents. This point has already been stressed in previous articles (Layne-Farrar & Lerner, 2010). Furthermore, on the long run, consumer welfare is reduced if pools reduce or skew innovation incentives. Indeed, by diluting the returns on significant patents, opportunistic patent strategies around patent pools also affect the return on innovation and thus the incentive to innovate. Moreover, this type of strategy is not socially optimal for patent holders. Indeed, if all patent holders adopt the same opportunistic behaviour and add patents in the same proportion, the revenue share of each of them should not evolve (because all members adopt the same behaviour) but the administrative costs of patenting rise without yielding additional innovation. For all these reasons, the opportunistic patent strategies we observe have the potential to seriously reduce the main interest of pools, which is to reduce the social costs of patent thickets. Indeed, we show that pools can even aggravate problems related to patent thickets.

In spite of these concerns, we also highlight a valuable learning effect for pool members. Firms that have been member of the pool for a longer time are more able to file patents that are technologically significant for subsequent research, controlling for the narrowness and generality of the patent. This is one of the first results underlining the importance of patent pools as a way to coordinate and orientate research. It thus gives credit to the assumption that these organizations not only have an effect on the royalty level but also and more fundamentally on the underlying innovation. This function is often claimed by the pool administrators. For instance, Sisvel ensures on its website[19] that one of its mission is to: "promote and guide innovation, and assist its partners in the development of intellectual property assets with market potential;"

These empirical results are important because they show how to strike a balance between patent pools' positive and negative effects on the underlying technology. As a negative effect, we can stress the incentive of pool members to file narrow patents and thus potentially increase the patent thicket problem. As a positive effect, we can underline that pools also are able to orientate innovation on fields that are technologically significant for subsequent research. Given the pros and cons highlighted above, we think that these results should be borne in mind especially by two groups: professionals responsible for the creation or administration of patent pools, and by public authorities.

Many important pools are in the process or about to be in the process of being created. An example is in the pharmaceutical sector where pools are promoted as a means to improve access to treatments against some of the major epidemics[20]. For this reason, the implications of the empirical results discussed here are particularly important.

[19] http://www.sisvel.com/english/aboutus/technicalexpertise, 07/12/2010
[20] For example, a pool was created to group the essential patents useful to struggle against AIDS. Information is available at: http://www.essentialinventions.org/

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Appendix 1: Descriptive findings

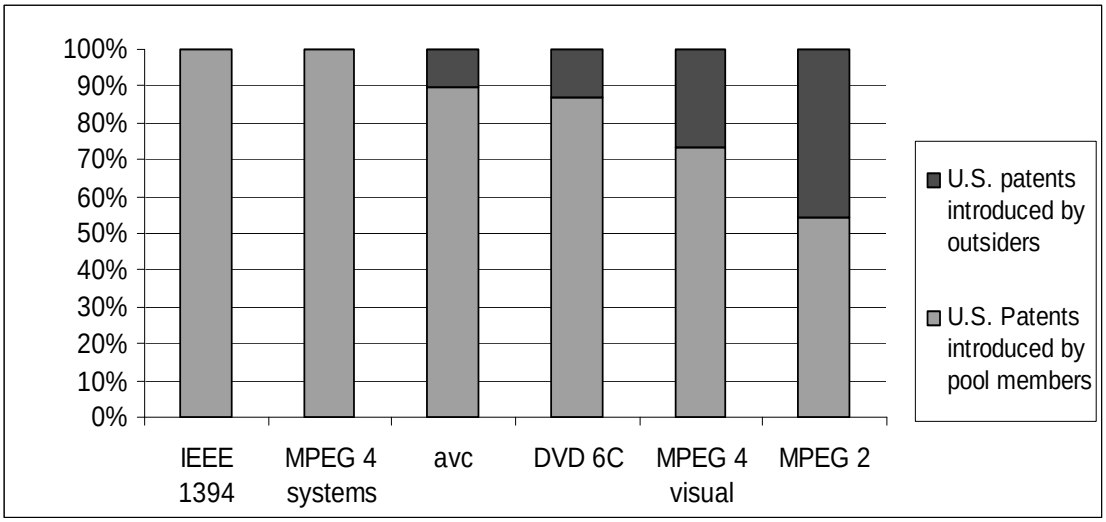


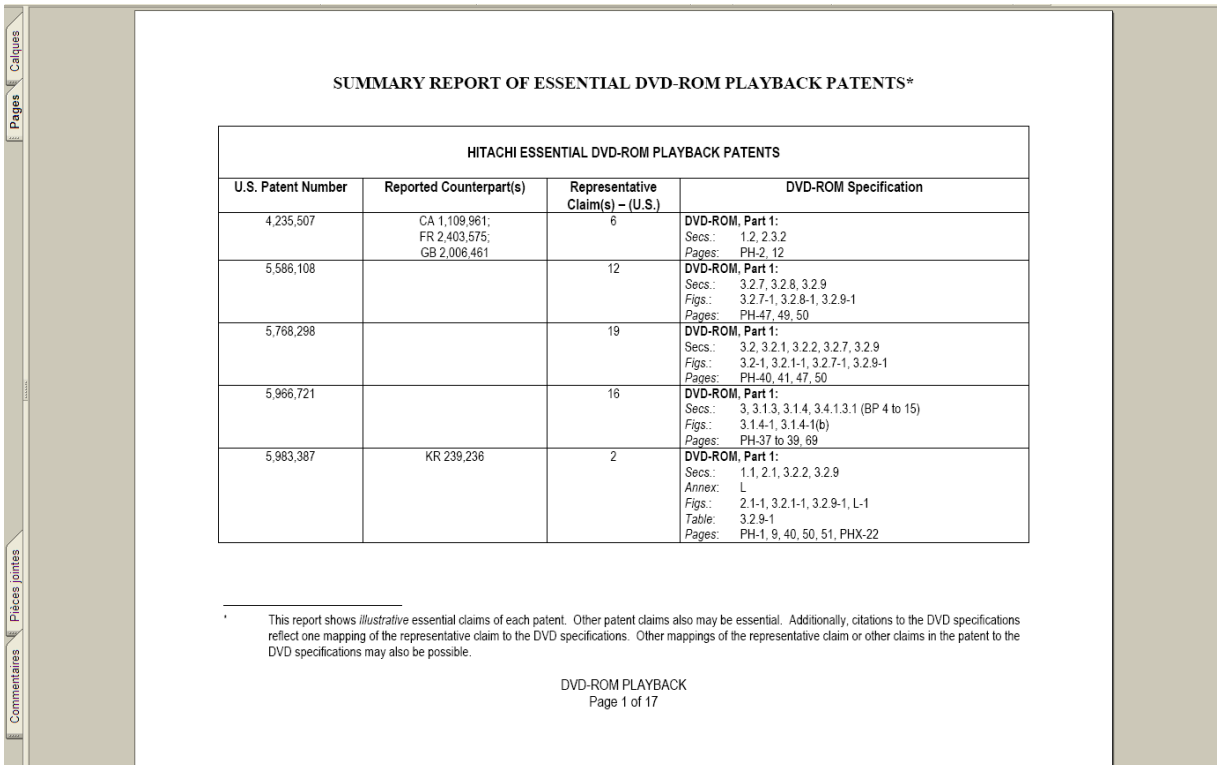
Figure 1: Introduction of U.S. patents insiders/outsiders

Appendix 2: Summary statistics

Variable	*Description*	*Mean*	*Std. Deviation*	*Min*	*Max*
Variables regarding patent					
Appyear	Year patent applied for	1998.226	3.959	1981	2006
Gyear	Year patent granted	2000.418	4.021	1983	2006
Nclass	U.S. patent technology class (3 digit)				
Allnscites	Total cites flow (truncation corrected) from other companies	17.916	29.404	0	251.334
Genindex	Generality of the patent (NBER U.S. database)	0.331	0.366	0	1
Claims	Number of claims for the patent	4.939	9.606	1	99
Family_size	Family size for the patent calculated from espacenet	30.371	83.237	1	700
External_cites	Cites received from patent not in the pool	20.5383	30.02179	0	270.467
Internal_cites	Cites received from patent not in the pool	2.567	6.579	0	88
Year_ disclosure_SSO	Disclosure year of the patent in the SSO	1998.821	3.601	1993	2007
Variables regarding the timing					
Age_input	Age of the input calculated from the pool creation date (in months)	40.261	29.522	0	139
Age_at_input	Patent age at the input date (in years)	5.441	2.919	0.199	19.25
Number_input	Chronological number of input into this pool	2.690	2.268	0	11
Age_at_creation	Age of the patent at the pool creation date (in years)	4.431	3.696	- 3.90	20.5
Variables regarding firms					
Ppprior	Number of patents previously in the pool held by the firm (Number of patents previously held by the firm in the pool / Number of patents previously in the pool)	0.136	0.141	0	0.7
Corpsize	Size of the company (based on ranking in Fortune 500 and Global2000 index)	0.001	0.002	0.001	.042
Patent_portfolio	Size of the company patent portfolio (2009 U.S. patent application * number of patents espacenet)	10637.84	13956.52	0	50932

Variables regarding the patent essentiality					
Sections	Number of standard sections for which the patent is cited	4.236	2.913	1	24
Subsections	Number of standard subsections for which the patent is cited	13.884	10.839	1	88
Sections corrected	Number of standard sections for which the patent is cited / median number of standard sections	1.411	0.945	.25	8.733
Subsections corrected	Number of standard subsections for which the patent is cited / median number of standard subsections	1.411	0.945	.25	8.733
Focus_standard	Number of claims / Number of sections corrected	3.523	3.140	0.021	24

Appendix 3: Example of essentiality report for DVD 6C essential patents



SUMMARY REPORT OF ESSENTIAL DVD-ROM PLAYBACK PATENTS*

HITACHI ESSENTIAL DVD-ROM PLAYBACK PATENTS			
U.S. Patent Number	**Reported Counterpart(s)**	**Representative Claim(s) – (U.S.)**	**DVD-ROM Specification**
4,235,507	CA 1,109,961; FR 2,403,575; GB 2,006,461	6	**DVD-ROM, Part 1:** *Secs.:* 1.2, 2.3.2 *Pages:* PH-2, 12
5,586,108		12	**DVD-ROM, Part 1:** *Secs.:* 3.2.7, 3.2.8, 3.2.9 *Figs.:* 3.2.7-1, 3.2.8-1, 3.2.9-1 *Pages:* PH-47, 49, 50
5,768,298		19	**DVD-ROM, Part 1:** Secs.: 3.2, 3.2.1, 3.2.2, 3.2.7, 3.2.9 *Figs.:* 3.2-1, 3.2.1-1, 3.2.7-1, 3.2.9-1 *Pages:* PH-40, 41, 47, 50
5,966,721		16	**DVD-ROM, Part 1:** *Secs.:* 3, 3.1.3, 3.1.4, 3.4.1.3.1 (BP 4 to 15) *Figs.:* 3.1.4-1, 3.1.4-1(b) *Pages:* PH-37 to 39, 69
5,983,387	KR 239,236	2	**DVD-ROM, Part 1:** *Secs.:* 1.1, 2.1, 3.2.2, 3.2.9 *Annex:* L *Figs.:* 2.1-1, 3.2.1-1, 3.2.9-1, L-1 *Table:* 3.2.9-1 *Pages:* PH-1, 9, 40, 50, 51, PHX-22

* This report shows *illustrative* essential claims of each patent. Other patent claims also may be essential. Additionally, citations to the DVD specifications reflect one mapping of the representative claim to the DVD specifications. Other mappings of the representative claim or other claims in the patent to the DVD specifications may also be possible.

DVD-ROM PLAYBACK
Page 1 of 17