Are patent pools a way to help patent owners enforce their rights?[1]

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Abstract

This paper explores empirically the interplay between patent pooling and litigations using data on 1,564 United States patents belonging to eight different pools and to a control database with patents having the same characteristics. We investigate two main questions. We first assess whether the entry in a pool fosters the patents' enforcement. Our analysis makes it possible to highlight various factors that help patent pool members enforce their Intellectual Property Rights. We find that the pools' size, as measured by the number of members, has a positive effect on litigations. We argue that this effect could be due to a transmission of information between members and, thus, increases the likelihood that the patent owner will detect the infringement. We emphasize and discuss such other factors that affect the incentives to litigate as the size of the firm and whether the patent holder is vertically integrated. Second, we underscore that the patent inclusion in a pool, by reducing the uncertainty on the patent essentiality, facilitates dispute resolution by settlement.

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A patent pool is an agreement between patent owners in order to grant a single license for several patents. The economic literature underlines two main economic benefits of patent pools: a) by reducing the number of licenses for a potential licensee they help to reduce the overall transaction costs, and b) they eliminate or reduce the double marginalization problem.[3] In adapting the double marginalization concept to intellectual property, Shapiro (2001) indicates that the total amount of royalties that owners of complementary patents claim will be too high due to a lack of coordination. In the case of a standardized technology, this lack of coordination between owners of complementary patents could reduce the standards' diffusion. Patent pools, by allowing patent owners to coordinate their behaviors on royalties, may reduce or avoid this multiple marginalization problem.

In contrast to these benefits, these organizations can also have negative economic effects. The main problem highlighted in the literature is the introduction of substitutable patents into the pool thereby reducing competition on the royalty level of these patents.[4] In order to reduce these potential negative effects, Lerner and Tirole (2004) indicate that a pool should be both formed only of complementary patents and allow patent owners to license their patents independently. This compulsory individual licensing rule should eliminate pools constituted of substitutable patents, making them unstable.[5]

The main difficulty faced by patent pools, in practice, is to create sufficient incentives for patent owners of essential patents to participate. Indeed, patent holders have strong incentives to free ride by taking advantage of the opportunity to charge higher royalties for their patents by not participating to the pool (Aoki and Nagaoka, 2004). If the pool does not necessarily allow for the maximization of licensing revenues, the patent holders may have additional incentives. Delcamp (2012) opens this field of research by underlining that one advantage of the pool for patent owners could be to increase their patents' value.

The purpose of this paper is to analyze more precisely the usefulness of these organizations in helping patent owners enforce their intellectual property rights. This could act as a strong incentive for patent holders to use patent pools.[6] As far as could be ascertained, nobody has ever questioned empirically the possible link between patent pools and litigations. For instance, it is possible to imagine that, because of its higher quality (Delcamp, 2012), a pool patent would be subject to more litigation than a non-pool patent. It is also plausible to suggest that the patent's introduction into the pool changes the incentives for a patent holder to litigate.

[3] The double marginalization problem was first defined by Cournot (1838) as: "the exercise of market power at successive vertical layers in a supply chain".
[4] Kato (2004) stresses that, under certain conditions, patent pools constituted of substitutable patents can also enhance consumer welfare. In order to avoid potentially perverse economic effects,
[5] Brenner (2008) deepens the analysis of the compulsory individual licensing rule by underlining that this rule is efficient only if the patent does not have strong competition (substitutes) outside the pool.
[6] Practitioners, such as patent holders or pool administrators, often mention this aspect, but it has not been studied in the literature.

In order to analyze these hypotheses, we use a database of 1,564 U.S. patents in 8 pools and a litigation database created by the Stanford Law School. We link these data on patents and litigations to data on the nature and structure of firms and patent pools. We show that pools with a higher number of members are more effective in helping patent holders enforce their rights. We also emphasize that the size and the structure of the firm, vertically integrated or not, have an impact on the incentives to litigate. Finally, we stress that the patent's introduction into a pool facilitates dispute resolution by settlement. This result is in line with the theoretical literature on the subject. Indeed, the patent's introduction into a pool reduces uncertainty regarding the outcome of the dispute. In this case, the patent enjoys a presumption of essentiality to the standard and the plaintiff only has to prove that his patent is legally valid.

The remainder of this paper is organized as follows. Section 2 presents some stylized facts on the subject of patent pools and patent litigations. Section 3 explains the collection process of the data. Section 4 provides some descriptive findings. Section 5 introduces our theoretical framework on the link between patent pools and litigations. Section 6 presents the empirical results.

2. What is a standardization process, an essential patent and an infringement?

Stylized facts on essential patents and the standardization process

One may define the creation of a standard as the creation of a common and documented repository to harmonize the activities of a technological sector. Either formal (such as standard developing organizations) or informal (such as consortia) standardization bodies may conduct standardization. The creation of pools helps the dissemination of technology by allowing users to sign only a single license for several patents[7]. A patent holder may choose whether to bring its patent to the pool or not. In practice, patent holders have few incentives to participate due to the possibility of free-riding (taking advantage of the pools' creation by charging higher royalties without participating in it).

A patent has to be essential to the standard to be included in a pool. Nonetheless, it is difficult to identify precisely all the essential patents related to a technology. All pool patents are essential, but all essential patents are not in the pool. A vast majority of essential patents are not included in a pool probably due to the lack of incentives for patent holders to participate.

Pools usually have third-party experts that assess the essentiality of the patent before inclusion. If this expert considers the patent essential, it can be included in the pool. The third-party expert usually

[7] Patent-holders or such pool administrators as MPEG LA or Sisvel, whose principal business is the creation and administration of pools, comprise patent pools.

establishes a patent essentiality report identifying the part of the standard to which the patent proves essential[8]. One of our main hypotheses in this paper tests whether this essentiality evaluation by a patent expert reduces the uncertainty on the outcome of the dispute and, thus, facilitates the resolution by settlement.

Simcoe, Graham, and Feldman (2009) study the effect of patent disclosure in Standard Setting Organizations (SSOs) on the number of litigations. In this paper, we analyze pool patents consisting of not only patents declared essential but also essential patents not disclosed in an SSO. There is a strikingly small overlap between patents disclosed as essential in an SSO and real essential patents included in a pool.[9] This small overlap can be explained in two ways. First, the evaluators do not typically assess patent essentiality before disclosure in an SSO and, subsequently, many patents disclosed turn out not to be truly essential in reality.[10] Moreover, some very large firms particularly active in the standardization field do not participate to patent pools (e.g., Qualcomm). In addition, the pool functioning rules (essentiality evaluation, patent holders discussion on royalties…) should have an impact on litigations that the patent disclosure in an SSO does not have. Thus, although we use a similar method, we analyze a different underlying effect than that analyzed by Simcoe, Graham, and Feldman (2009).

Stylized facts on patent infringement

One can define a patent infringement as the use and/or production of an invention or a technology, for which someone owns a patent, without obtaining permission from the patent holder. In most countries, patent holders generally can enforce patents via civil lawsuits[11] but some countries also have criminal procedures against infringement. In the case of a civil lawsuit, the patent holder will seek monetary compensation and the infringer can be liable for all or part of profits made from the use of the infringing technology as well as damages to compensate any harm suffered by the patent holder. In order to prove the infringement, the patent holder has to show a violation of at least one of the patent claims.[12]

A patent owner that would like to enforce its rights faces a major constraint when an accused infringer attempts to challenge the validity of the patent. Indeed, in the United States, the civil courts that consider these cases can—and often do—declare the patent invalid. The courts can declare a patent

[8] The essentiality reports are available online for all the pools managed by MPEG LA.
[9] See for instance, Delcamp (2012)
[10] For instance, the essentiality evaluation of Fairfield Resources on patents declared as essential to LTE and SAE emphasizes that around 50% of the families declared contain no essential or probably essential patent (see http://www.frlicense.com/LTE%20Final%20Report.pdf)
[11] Such as in the United States
[12] However, in many states, the accused infringer can be liable for patent infringement even though the technology does not fit exactly in the field of a patent claim due to the "doctrine of equivalents."

invalid if at least one of the patentability requirements has not been fulfilled. Although these requirements vary by country, such core requirements as utility, non-obviousness, or novelty apply almost everywhere.

All patent infringements do not reach the level of judicial decision. Indeed, many conflicts are resolved by a bargaining between the possible infringer and the patent holder. The economic literature on the subject identifies many reasons that could justify the refusal of a settlement by one of the parties. The first obvious answer: the patent holder and the possible infringer have different expectations on the outcome of the case. The economic literature (Meurer, 1989; Yildiz, 2004; Nalebuff, 1987; Lanjouw & Lerner, 1998; Priest & Klein, 1984; Cooter & Rubinfeld, 1989) also highlights two other reasons that could justify this choice, hidden information and positive litigation externalities. Lerner (2009) summarizes four points that increase the probability of a trial occurring:

- The likelihood that the offence is detected by the potential plaintiff;
- The size of the stakes under dispute;
- The uncertainty about the outcome of the controversy between the two parties;
- The costs of settlement relative to that of trial.

In this paper, we address each of these points. In particular, we show that a pool with a higher number of members increases the likelihood that the offense is detected by the potential plaintiff. We also illustrate the demand side using the number of forward cites to control for a demand increase after the patent's introduction in a pool. We underline the effect of the patent entry in the pool on the uncertainty about the outcome of the controversy. We carefully analyze the impact of the structure and the size of the patent holder on the incentives to litigate.

3. Data

We use a database of 8 patent pools: DVD3C, DVD6C, MPEG2, MPEG4 Systems, MPEG4 Visuals, AVC H/264, IEEE 1394 and DVB-T. We retrieve the patent numbers and the name of patent holders from the lists available on the websites of the pools.[13] These eight pools relate to Information and Communication Technologies (I.C.T.) and are the only I.C.T. pools that make their data publicly accessible.

Using Internet Archives,[14] we obtain the list of pool patents at different dates over time. Comparing successive patent lists allow us to identify the date of the patent's first appearance on the list. We call it the "date of introduction." Of course, there may be some discrepancies between this date of

[13] www.mpegla.com (MPEG2, MPEG4 Systems, MPEG4 Systems, AVC, IEEE 1394), www.dvd6cla.com (DVD6C), www.sisvel.com (dvb-t)
[14] www.archive.org

introduction and the real date of the patents' introduction in the pool.[15] This is not a major issue in our analysis because the updates occur on a regular basis. We complete this database with data on the nature and structure of the firms[16] and match the 1,564 U.S. patents in our sample with the National Bureau of Economic Research (NBER) database to obtain a full range of information on the patents.[17] Therefore, we concentrate solely on U.S. patents because we do not have litigation data for other countries. Nonetheless, this choice remains consistent working on pool patents because U.S. patents tend to be the first patent of the family included in a pool (Baron & Delcamp, 2012). Figure 1 presents the distribution of U.S. patents per pool. Figure 1 highlights the preponderant number of U.S. patents in the DVD 6C patent pool. Accordingly, we check that our results are robust when excluding the DVD pools.[18]

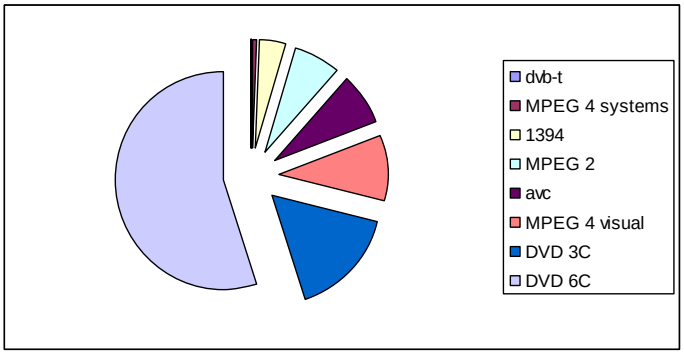

Figure 1. Number of patents / pool

Based on this pool database, we created a one to one match control database with patents presenting the same characteristics[19] and the same type of information as in our pool database. Previous papers have demonstrated the link between these characteristics and the number of patent litigations. Next, we matched our databases to the Stanford IP litigation database[20] in order to obtain the number of litigations per patent. This database contains data on more than 100,000 intellectual property cases filed from January 2000 to the present. The lack of historical data pre-2000 could create a truncation problem for those patents granted before 2000. To control for this potential bias, we also run our regressions on patents granted during or after 2000 and for which we have all the history.[21] Table 1 summarizes the main information for pool and non-pool patents.

[15] Due, for instance, to a late update of the websites.
[16] Size of the patent portfolio, number of employees, number of patents already included in the pool, vertical integration
[17] The number of claims, forward and backward cites (forward cites count the number of times a patent is cited by ulterior patents, backward cites count the number of previous patents cited by a patent), patent generality, technological class, grant and application year
[18] See the subsection dedicated to the robustness checks.
[19] The joint distribution of application year and assignee type is the same
[20] www.lexmachina.org
[21] See the subsection dedicated to the robustness checks. Since the truncation problem does not seem significant, in order not to reduce our sample, we presented the results for our entire sample in the body of the paper.

	Patent pool sample	Non Patent Pool sample
Likelihood litigated	0.08	0.01
Mean number litigations / year	0.04	0.00
Mean cites	23.10	14.58
Mean forward cites	18.58	13.20
Number of claims	14.67	13.63
Mean family size	30.34	22.61
Generality index	0.33	0.31
Application Year	1997.82	1997.80
Age since grant	9.94	9.96

Table 1. Samples presentation

As Table 1 details, pool patents are more likely to be litigated than non-pool patents. Indeed, pool patents have an 8% likelihood of litigation versus 1% for non-pool patents. Of note, this table also illustrates a significant difference between our samples on the traditional indicators of patents' quality (total number of cites, number of forward cites, number of claims, family size…).

In the next section, we provide a descriptive analysis of the litigations in our sample. In order to do so, we conduct regressions on the likelihood of litigation and the number of litigations with indicators of patent quality as explanatory variables. We, therefore, revisit already existing results on our sample. The results, presented in Appendix 1, remain consistent with previous findings on the subject (Lanjouw & Schankerman, 2004; Lerner, 2009; Simcoe, Graham & Feldman, 2009). We confirm that the more-cited patents have a higher likelihood of litigation. All our indicators of patent quality (the number of forward cites, the number of claims, and the generality of the patent) link to the number of litigations for a patent.

In the next section, we present some descriptive findings on the links between patents pools and litigations.

4. Descriptive findings on the link between patent pools and litigations

This section offers some descriptive findings on the interaction between patent pooling and litigations. We must address many questions, and, as such, we will treat each of them successively.

We first investigate whether pools are created, in larger part, to end patent disputes. Indeed, some authors (Shapiro, 2003) believe that the creation of a patent pool provides a way to end a dispute related to intellectual property. In this case, we should see a high number of litigations between pool members before the pools' creation. We will analyse this question in the first subsection. Next, we examine the question, "Why are pool patents more litigated?" Indeed, we highlight in the precedent section that pool patents have a higher likelihood of litigation. There are two ways to explain a

potential difference between pool and non-pool patents; we present and investigate these explanations in the second subsection.

4.1 Are patent pools a way to end intellectual property disputes?

A first review of the link between litigations and pools brings up the issue of whether patent holders use patent pools to resolve previous disputes among themselves. For example, Shapiro (2003) asserts that: "Patent pools are another form of settling patent disputes." He uses the example of the pool involving patents for laser eye surgery formed by Summit Technologies and Visa. Each of these firms claimed that it held essential patents and both sued each other for infringement. The creation of the pool Pillar Point Partners was designed to end the dispute; however, the Federal Trade Commission finally forced it to dissolve. In order to answer this question, we carefully analyze litigations on the pools' founding patents. In this case, we define a founding patent as a patent included in a pool as of its creation[22]. In our pool sample, 13 patents are—at the same time—litigated and founding patent of a pool. Table 2 presents this detail.

Pool	**Freq.**	**Date of pool creation**
DVD 6C	4	1999
MPEG 4 systems	1	2003
Avc	8	2005
Total	**13**	

Table 2. Number of litigations / founding patents

In our litigation database, we carefully analyse each of the litigations that take place before the pools' creation. None of these litigations has opposed the patent holder and a future member of the pool. Given the data we have, we must reject the hypothesis that patent pools are a way to settle patent disputes. Nevertheless, it remains possible that pools are created to end conflicts that have not yet reached the litigation stage and which, therefore, do not appear in our database.

4.2 Are pool patents more litigated because they are of higher quality or is litigation due to a pool ex post effect?

In the precedent section, we highlight that pool patents have a higher likelihood of being litigated. Two explanations support a potential difference in litigations between pool and non-pool patents. The first explanation contends that pool patents are more litigated because of their intrinsic quality. Indeed, the empirical literature on the subject (Lanjouw & Schankerman, 2004; Lerner, 2009; Simcoe, Graham & Feldman, 2009) underlines the link between patent quality and the likelihood of litigation.

[22] For the dates of pool creation, see Geary B. (2009). Patent pools in high-tech industries. Intellectual Asset Management

There could be significant differences in terms of quality between pool and non pool patents having the same characteristics. In this case, it would be normal that pool patents have a higher number of litigations, but this difference would not come from any pool effect *per se*. This explanation is plausible because, as explained in the second section, pools carry a selection of the patents. Moreover, the technological classes to which our sample belongs hold many sleeping patents. This could, therefore, justify an important difference of intrinsic quality between pool and non-pool patents as underlined by Delcamp (2012).

In order to test this first explanation, we create a control database with patents having the same joint distribution of application year and assignee type.[23] Next, we compare the two samples by performing the same (cross-sectional) regression as in the previous section, using a dummy variable for pool patents but adding indicators of patent quality as control variables.

We add a column (5) with a rare event logit model in order to account for the small amount of patents introduced in pools in the real population as compared to our sample. Indeed, econometric studies (Prentyce & Pyke, 1979; Scott & Wild, 1997) point out that, if the proportion of positive results in the sample is not comparable to the proportion of positive results in the real population, then logistic regression yields biased estimates. To control for this overestimation of the population of patents introduced in pools, we use the method of King and Zeng (2001) implemented in Stata by Tomz, King, and Zeng (2003).[24] Table 3 presents the results. They confirm our previous descriptive-statistic findings. Pool patents have a higher likelihood of being involved in litigation and have a higher number of litigations than non-pool patents having the same characteristics.

[23] Previous papers highlight that both these variables have an impact on the patent number of litigations.
[24] The *relogit* command. Stata programs available at : http://www.jstatsoft.org/v08/i02

	(1) Logit		(2) Poisson		(3) Negative binomial		(4) Tobit	(5) RE Logit
	DV= Dummy litigation		DV= Number of cases					DV= Dummy litigation
	Coef.	Marg. effect	Coef.	Marg. effect	Coef.	Marg. Effect	Coef.	Coef.
Pool	3.510*** (0.635)	0.196*** (0.022)	2.555*** (0.825)	0.843*** (0.168)	3.122*** (0.417)	1.061*** (0.203)	18.894*** (3.179)	3.335*** (0.630)
Log_ Cites	-0.134 (0.125)	-0.006 (0.005)	-0.049 (0.114)	-0.013 (0.031)	0.017 (0.155)	0.004 (0.038)	-0.589 (0.867)	-0.135 (0.125)
Log_ Claims	0.278 (0.173)	0 .012 (0.008)	0.715*** (0.223)	0.193*** (0.072)	0.305 (0.207)	0.076 (0.043)	2.718** (1.070)	0.271 (0.172)
Genindex	-0.853** (0.353)	-0.037* (0.016)	1.084** (0.443)	0.292 (0.187)	1.608*** (0.593)	0.401 (0.247)	-1.799 (2.731)	-0.845* (0.351)
Control Grant Year	Y	Y	Y	Y	Y	Y	Y	Y
_cons	-32.252 (71.626)		160.136* (93.378)		358.27*** (137.963)		320.974 (531.047)	-28.593 (71.064)
Obs.	758		758		758		758	758
Chi2	39.64		28.4		225.05		93.42	
Prob> chi2	0		0		0		0	
Pseudo R2	0.1920		0.2211				0.0914	
Log lik.	-214.95		-1237.46		-452.21		-464.57	
Zero obs.							673	
Non zero							85	

*Legend: * p<0.10; ** p<0.05; *** p<0.01. Robust standard errors in parentheses. Control database comprised of patents having the same application year and assignee type.*

Table 3. Regressions results cross section litigated, pool and non-pool patents

This difference in the likelihood to be litigated between pool and non pool patents requires further analysis to understand and identify the sources of this discrepancy. To address this, Figure 2 presenting the distribution of litigations over time offers interesting information.

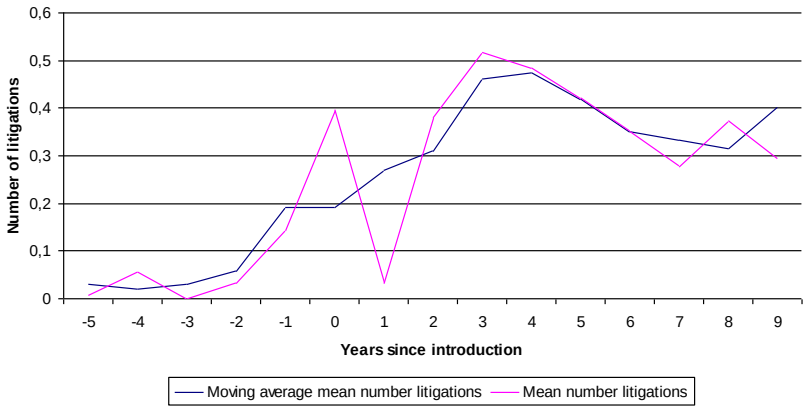

Figure 2. Mean number litigations / introduction in the pool

As Figure 2 illustrates, the number of litigations increases strongly after the introduction of the patent in the pool. This number also appears peaking three or four years after introduction and then decline. Note that the rise in litigations is almost immediate or even precedes the introduction by a few months. Our data collection process may create some discrepancies between the date of patent introduction in the pool and the update of the pools' website, which could explain this discrepancy. Table 3 and Figure 2 both seem to confirm our second explanation; the pool has an *ex post* effect on the number of litigations.

One can explain this *ex post* effect in two ways. First, the pool creation affects the demand side by increasing the opportunities for the patent owner to licence its patent (Delcamp, 2012). Second, the patent pool has an impact on the patent holder incentives to litigate after the patent inclusion in a pool. This next section presents our theoretical framework and hypotheses on this introduction effect.

5. Theoretical framework

This part presents our theoretical framework and the hypotheses that could explain the introduction effect presented in the precedent section. In this part, we base all our hypotheses on the assumption that the patent holder is plaintiff in the case.

5.1 Theory and hypotheses on the introduction effect

One explanation for the introduction effect could be that the number of litigations rises because the patent's inclusion in the pool increases the market size of the patent. To control for this effect, we will use the number of forward cites, that changes over time and allow taking into account this demand side effect (Simcoe, Graham, & Feldman, 2009), as control variable. Thus, if the pool has an effect different from the one on the market size, the introduction effect should remain positive even if we control for the number of cites.

Hypothesis 1: The increase in the likelihood to be litigated after inclusion in a pool could be explained by an impact on the market size of the patent or by a pool effect per se

Controlling the market size of the patent, we have two main hypotheses that could explain a pool effect *per se*. The first one is that the pool has an impact on the patent holder level of information. As confirmed by many pool members and administrators, patent enforcement assistance is one of the main advantages of a pool. Indeed, after introduction in the pool, other members help inform the patent holder about technologies that could infringe its patents. The patent-holder's level of information increases, and it can, therefore, more easily enforce its rights. If this hypothesis is confirmed, the introduction effect should vary according to the number of patent holders in the pool as a higher number of members would engender a higher level of information. In order to capture this potential effect, we create a variable that interacts the disclosure effect with the number of other patent holders in the pool at the time of patent introduction.

Hypothesis 2: The introduction effect can be explained by a higher level of information and thus the size of this effect should vary according to the number of pool members

Our second main hypothesis is that the introduction effect has an impact on the patent holder expectations on the outcome of the dispute and thus on its equilibrium settlement/litigation. Lerner (2009) or Bessen and Meurer (2006) point out the importance of the uncertainty about the outcome of the controversy on the equilibrium settlement/litigation.[25] Our second hypothesis is directly derived from this literature: the patent introduction in a pool, by reducing the uncertainty on the outcome of the case, should have an impact on the patent holder expectations on the outcome of the dispute and thus have an effect on its equilibrium settlement/litigation. This assumption is based on the fact that when a patent is included in a pool, it has to be reviewed by an external expert that evaluates its essentiality. This essentiality evaluation by a third party expert should gives a presumption of essentiality to the patent and thus decreases the level of uncertainty on the outcome of the dispute. Therefore, if the patent dispute ends in a court, there is a presumption of essentiality for pool patents that do not benefit to other patents.[26]

Hypothesis 3: The patent essentiality evaluation by an expert, at the time of introduction, decreases the level of uncertainty on the outcome of the dispute and thus has an impact on the patent holder equilibrium settlement/litigation

[25] These two papers follow the same direction, the closer the expectations on the outcome of the controversy, the higher the likelihood that the case is settled

[26] Patents that are disclosed in an SSO do not have to be assessed by a third party expert and thus do not benefit from this presumption of essentiality.

5.2 Other parameters that could have an impact on the introduction effect

The introduction effect could also be nuanced by different parameters concerning the structure and status of the firm. These parameters should affect the patent holders' incentives to litigate and, thus, also affect the size of the introduction effect. These hypotheses have been tested in previous research; this part aims simply to test these classical assumptions within a pool framework (using variables obtained through the firms' participation to the pool).

Regarding the size of the firm, several complementary effects can affect the litigation incentives for a patent holder. First, Simcoe, Graham, and Feldman (2009) show that the level of litigations increases more sharply for small firms after the patents' disclosure in an SSO. This could be due to a reputation externality effect, and it would, therefore, not be surprising that the reputation for "thougness" is more important for small than large firms. On the other hand, big firms could have more incentives to litigate because of lower litigation costs due to "learning-curve" effects (Lerner, 1995).

In order to capture this reputation effect, we create two variables. The first one (*ppprior*) represents the number of patents already held by the patent holder in the pool and should allow capturing the reputation effect. At the same time, we have to control for the overall size of the firm patent portfolio due to the learning-curve effect. To do so, we create a control variable, *portfolio_size*, to capture this learning-curve effect.

The graph in Appendix 2 emphasizes the differences in the intensity of the introduction effect according to the firm size, the pool size, and the nature of the firm.

6. Empirical results

This section presents the main empirical results on the hypotheses described above. We present, in the first subsection, the results on the introduction effect and, in a second subsection, the results on the outcomes of the disputes.

6.1 Results on the introduction effect

In this subsection, we only examine the litigations in which the patent holder is plaintiff, consistent with our hypotheses. The cases in which the patent holder is a defendant rarely occur after the patent introduction in the pool, and the results remain robust when we have the same analysis for the overall sample.

In order to test the hypotheses presented in the preceding section, the best method is using a panel database with fixed-effects models grouped on patents. The test results presented in Appendix 4 (Table 7) confirm this fixed-effect approach. We introduce a dummy variable *(introduction_effect)* that equals 1 for all observations after introduction in a pool. We control for a timing trend (in litigations) using a fourth-order polynomial in calendar years and for a demand increase following the patent introduction in the pool through the number of forward cites at year N-1.[27] As patent litigation history could have an impact on future litigation (patents, which already have a high number of litigations, have a higher likelihood of being litigated in the future) we run the regression with a dummy variable *already_litigated* that equals 1 for all observations after the first litigation.

[27] This method was developed by Simcoe, Graham and Feldman in their 2009 paper

	(1) Fixed effect poisson	(2) Fixed effect poisson	(3) Fixed effect poisson	(4) Fixed effect poisson	(5) Fixed effect poisson	(6) Fixed effect logit
	DV= Number of cases with the patent holder as plaintiff					DV= Litigation dummy
Introduction effect	2.082***	1.033**	1.407***	1.356**		1.846**
	(0.211)	(0.473)	(0.539)	(0.542)		(0.924)
Big_pool_Introduction		0.004**	0.004**	0.004**		0.002
		(0.001)	(0.001)	(0.02)		(0.003)
Introduction effect DVD6C					1.446***	
					(0.456)	
Introduction effect MPEG2					3.336***	
					(0.595)	
Introduction effect MPEG4 Systems					16.469	
					(12.645)	
Introduction effect MPEG4 Visual					3.371***	
					(0.660)	
Introduction effect DVB-T					14.112	
					(13.608)	
Introduction effect AVC					3.376***	
					(0.655)	
Big_portfolio_Introduction			-0.361	-0.381	-0.838	-0.620
			(0.492)	(0.492)	(0.534)	(0.884)
PPprior_introduction			-2.899***	-2.780***	-2.227***	-3.713**
			(0.647)	(0.655)	(0.660)	(1.495)
Cites N-1	-1.260***	-1.257***	-1.320***	-1.311***	-1.317***	-0.970***
	(0.215)	(0.215)	(0.217)	(0.217)	(0.217)	(0.290)
Dummy_already_litigated				0.179	0.202	-0.181
				(0.132)	(0.132)	(0.289)
Big_pool		-0.005*	-0.003	-0.003		0.001
		(0.002)	(0.003)	(0.003)		(0.005)
Calendar year effect	-0.018	-0.016	-0.009	-0.020	-0.021	-0.015
	(0.012)	(0.013)	(0.013)	(0.015)	(0.016)	(0.031)
Dummy patent pools	Y	Y	Y	Y	Y	Y
Chi2	151.23	146.32	166.50	166.50	155.49	79.05
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Log lik.	-1082.10	-1079.34	-1068.07	-1068.07	-1061.18	-292.87
Number of obs	1122	1122	1122	1122	1122	1122

*Legend: * p<0.10; ** p<0.05; *** p<0.01. Standard errors in parentheses*

Table 4. Regressions results fixed effect litigated, patent holder as plaintiff

The findings verify our first hypothesis, there is a pool effect *per se* which is independant of the effect of the pool on the market size of the patent. Indeed, controlling for the demand side effect, the introduction effect is positive meaning that, for the same patent, the likelihood of litigation and the number of litigations increase after introduction in a pool.

The results on the number of members suggest that this effect is explained, at least partially, by a higher level of information for pool members. Indeed, the positive and statistically significant coefficient of the variable *big_pool_introduction* indicates that the size of the introduction effect is higher for pools that have a higher number of members.

On the parameters linked to the status and structure of the firm that could have an impact on the incentives to litigate and thus on the introduction effect, we can underline several findings. First of all, our results confirm the reputation effect; as shown by the coefficient of the variable ppprior_introduction, firms that have fewer patents in the pool pay more attention to their reputation for toughness and, thus, litigate more than firms holding an important number of patents in the pool. However, firms that have a bigger patent portfolio do not seem to be more likely to trigger litigations than firms having a small number of patents in portfolio as the coefficient for the variable *big_portfolio* is not significant.

This section reviewed the empirical results on the introduction effect and the findings appear to verify our main hypotheses. The next section addresses the empirical results on the outcomes of the disputes.

6.2 Results on the outcomes of the disputes

This section tests our hypothesis that the introduction of a patent in a pool affects the equilibrium settlement/litigation. Our hypothesis seeks to test whether the expectations on the outcomes of the disputes are different before and after introduction in a pool. If our hypothesis is verified, the number of disputes ended by settlement should be higher after than before the patent introduction in a pool.

In order to test this hypothesis, we first run a cross section regression with, as dependant variable, the likelihood that the dispute is ended by settlement. Due to the small number of observations, we use a cross-section approach. We run this regression on all the litigated patents of our sample. We control for the age and quality[28] of the patents. The control database is comprised of patents having the same joint distribution of assignee type and technological class. Last, we also use dummies to control for a possible court-fixed effect. For the same reasons as in section 4.2, we also run a rare event logit regression to control the stability of our results. Table 5 presents the results:

[28] Using the number of forward cites and the generality index

	(1) Probit		(2) Probit		(3) Logit	
	DV= Settlement dummy					
	Coef.	Marg. effect	Coef.	Marg. effect	Coef.	Marg. effect
Presence Pool	1.302* (0.557)	0.288*** (0.064)	1.493* (0.584)	0.281 (0.056)	2.591* (1.212)	0.270*** (0.059)
Log_ Cites	-0.292 (0.154)	-0.099 (0.052)	-0.399 (0.219)	-0.127 (0.069)	-0.681 (0.409)	-.0126 (0.075)
Generality			-0.241 (0.488)	-0.077 (0.156)	-0.342 (0.817)	-0.063 (0.152)
Control Grant Year	Y	Y	Y	Y	Y	Y
Dummy Court	Y	Y	Y	Y	Y	Y
_cons	-32.539 (70.170)		-7.103 (82.514)		1.017 (145.70)	
Obs.	139		139		139	
Wald chi2	21.20		17.04		14.89	
Prob > chi2	0.0035		0.0297		0.0614	
Pseudo R2	0.1275		0.1180		0.1162	
Log lik.	-76.363		-58.798		-58.923	

*Legend: * p<0.10; ** p<0.05; *** p<0.01. Robust standard errors in parentheses. Control database constituted with patents having the same application year and assignee type.*

Table 5. Regressions results cross section settlement, pool and non-pool patents

Everything else equal, pool patents seem to have a higher likelihood to be involved in a dispute that will end with a settlement. These findings take into account the possible intrinsic differences between pool and non-pool patents, controlling for the number of forward cites, and patent generality. These results corroborate our fourth hypothesis: the patent essentiality evaluation decreases the level of uncertainty on the outcome of the dispute and, thus, increases the likelihood of settlement.

Due to the nature of our observations, the best econometric method to use, to emphasize this result, is a panel approach.[29] Because of the small number of observations, we present the results using a panel approach in appendix (3). These results confirm our previous findings that the likelihood of a dispute ending by settlement increases after the patent's introduction into a pool.

[29] Due to the results of the tests presented in Appendix 4 (Table 8), we chose a random-effect model. We control for the calendar year of the litigation, the quality of, and the age of the patent.

6.3 Robustness tests

We base our regressions on the introduction effect on a fixed-effect Poisson model with a dependant variable that is the number of litigations (for a patent) per year or a fixed effect Logit model on the likelihood for a patent to be litigated in the year. In the body of this paper, we present the results for cases in which the patent holder is plaintiff. We also run the regressions for the overall sample. The results closely follow those presented in Table 4.

A truncation in the data may affect our findings. Indeed, we only have data on litigations filed after 2000. To take this effect into account, we run the same regressions on patents filed in or after 2000. The results closely follow the results presented in Table 4.

Our results clearly are sensitive to the unit of the variables. To avoid this problem, we run the same regressions using dummies to disentangle between small and large firms and pools. The results may also be sensitive to the age of the patent at the time of litigation (patents could be introduced in the pool at different ages). To overcome this difficulty, we run the same regression with interaction variables between the introduction effect and the age of the patent at the time of litigation. The results are even more significant using dummies and controlling for the age of the patent than in Table 4.

Conclusion

This paper analyzes the interplay between patent pools and litigations. We show that pool patents are more litigated than patents presenting the same characteristics but not included in a pool. This result could have two explanations: first, pool patents are more litigated before introduction or, second, the introduction of a patent into a pool increases the number of litigations. We demonstrate that the patent introduction into a pool greatly increases the number of litigations (or the likelihood that the patent is litigated) with the patent holder as plaintiff. One could explain this result by the greater ease a patent holder has to detect a potential infringement after introduction. We present results that appear to verify this explanation for our sample. For example, the pool *ex post* effect is higher for pools with a greater number of members.

We also demonstrate that the patent introduction into a pool has an impact on the outcome of the litigation by facilitating the resolution via settlement. Using the literature on patent litigations (Lerner, 2009; Bessen & Meurer, 2006), one can easily explain this result by a change in the expectations of the parties. These expectations are closer, for the same patent, after introduction than before introduction; this due to the patent essentiality evaluation run by the pool.

These results help to understand the creation and stability of patent pools. Indeed, the theoretical literature on the subject emphasizes the free-riding problem and the difficulty of maintaining the stability of this type of organization. This paper, by highlighting that patent holders could have other incentives that those discussed in the literature, help fill in, at least in part, this lack of knowledge regarding patent holders' incentives to participate in these agreements.

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Appendix 1 : Descriptive regressions litigations

	(1) Probit	(2) Probit	(3) Poisson	(4) Poisson
	DV= Litigation dummy		DV= Number of cases	
Log(forward cites)	0.12118*	0.19459**	0.32537*	0.35354**
	(0.062)	(0.073)	(0.137)	(0.135)
Generality	0.14038	-0.16067	2.00399***	1.92154***
	(0.175)	(0.230)	(0.401)	(0.498)
log(claims)		0.19664		0.63336*
		(0.107)		(0.253)
Control Assignee dummy	Y	Y	Y	Y
Control Technological class dummy	Y	Y	Y	Y
Control Grant Year	Y	Y	Y	Y
_cons	-2.168***	-2.779***	-3.432***	-5.262***
Number of obs	1060	608	1491	758

*Legend: * p<0.05; ** p<0.01; *** p<0.001. Robust standard errors in parentheses.*

Table 6. Regressions results cross section litigated, patent quality

Appendix 2 : The introduction effect by size and structure of firms and pools

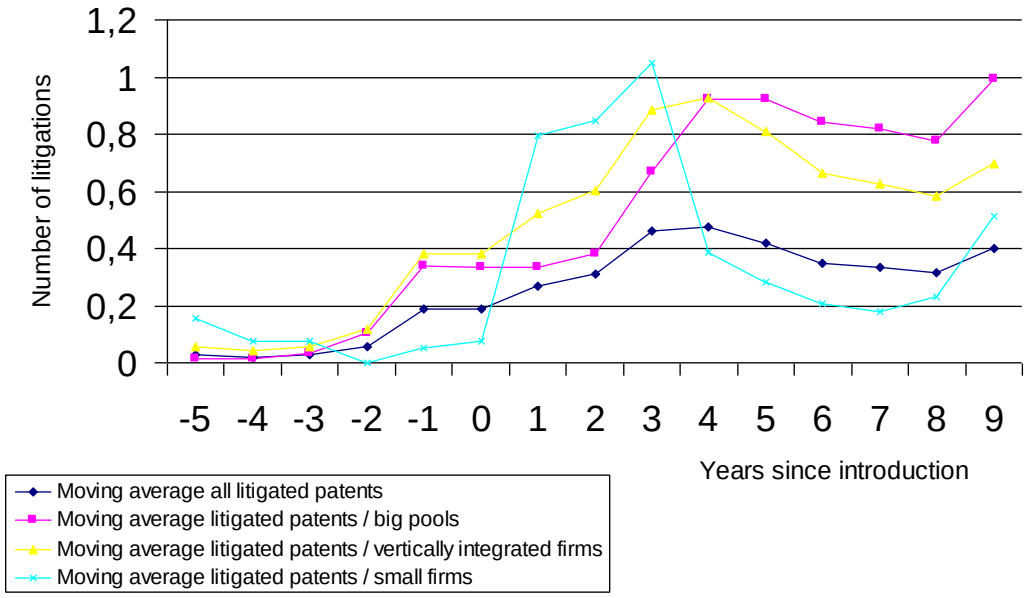

Figure 4. Introduction effect by pool and firm size

Appendix 3 : Settlement results using a panel approach

	Random effect logit settlement	**Random effect logit settlement**	**Random effect logit settlement**	**Random effect poisson Number settlements**	**Random effect poisson Number settlements**	**Random effect poisson Number settlements**
	DV= Settlement dummy			DV= Number of settlements		
Introduction effect	2.14909 (1.514)	1.85074 (1.365)	3.53464* (1.962)	2.16671** (0.995)	2.16705** (0.993)	2.04548** (0.998)
Log_Allnscites		-0.00411 (0.006)	-0.00020 (0.009)		-0.00306 (0.006)	-0.00341 (0.005)
Control Grant Year			Y			Y
Calendar year effect	-0.26980 (0.186)	-0.17185 (0.161)	-0.31725 (0.240)	-0.30775*** (0.097)	-0.29055*** (0.096)	-0.27926*** (0.097)
Number of obs	**113**	**108**	**108**	**113**	**108**	**108**

*Legend: * p<0.10; ** p<0.05; *** p<0.01. Standard errors in parentheses*

Appendix 4 : Test results fixed/random effects

F Test Fixed Effect		Breusch and Pagan Lagrangian multiplier test random effects	
F :	1.8	Chi2 :	2.51
Prob > F :	0.0156	Prob > chi2 :	0.1131

Table 7. Results panel litigations

F Test Fixed Effect		Breusch and Pagan Lagrangian multiplier test random effects	
F :	0.89	Chi2 :	2.56
Prob > F :	0.6562	Prob > chi2 :	0.1094

Table 8. Results panel outcomes