Are patent pools a way to help patent owners enforcing their rights?

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Abstract

This paper explores empirically the interplay between patent pooling and litigations using data on 1564 essential U.S. patents belonging to 8 different pools and a control database with patents having the same characteristics. We investigate two main questions. We first assess whether the introduction in a pool fosters the patents' enforcement. Our analysis makes it possible to highlight various factors that help patent pool members enforcing their Intellectual Property Rights. We find a positive effect of the pools' size, as measured by the number of members, on litigations. We argue that this effect could be due to a transmission of information between members and thus increase the likelihood that the infringement is detected by the patent owner. We emphasize and discuss other factors that impact the incentives to litigate, after introduction, such as the size of the firm and whether the patent holder is vertically integrated or not. Secondly, we underline that the patent introduction into a pool, by reducing the uncertainty on the patent essentiality, facilitate the 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. Patent pools are often considered as a good way to reduce or avoid the "patent thicket" problem[2]. The patent thicket problem appears in economic sectors with a high density of patents and more generally in areas of complex technologies such as telecommunications. Patent pools could help to reduce this problem by reducing the number of licenses that a company wishing to use a new technology must sign.

The economic literature underlines two main economic benefits of patent pools. By reducing the number of licenses for a potential licensee, they help to reduce the overall transaction costs. They also eliminate or reduce the double marginalization problem[3]. Shapiro (2001) adapted the double marginalization concept to Intellectual Property, indicating that the total amount of royalties claimed by the owners of complementary patents, due to a lack of coordination, will be too high. 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.

On the other hand, these organizations can also have perverse economic effects. The main problem highlighted by the literature is the introduction in the pool of substitutable patents (Lerner & Tirole, 2004) thereby reducing competition on the royalty level of these patents. Kato (2004) stresses that, under certain conditions, patent pools constituted of substitutable patents can also enhance the consumer welfare. In order to avoid potential perverse economic effects, Lerner and Tirole (2004) indicate that a pool should be formed only of complementary patents and also allow patent owners to license their patents independently. This compulsory individual licensing rule should eliminate pools constituted of substitutable patents making them unstable. Brenner (2008) deepens the analysis of the compulsory individual licensing rule underlining that this rule is efficient only if the patent does not have strong competition (substitute) outside the pool.

The main difficulty faced by the 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 advantages of the opportunity to charge higher royalties for their patents by not participating to the pool (Aoki & Nagaoka, 2004). If the pool does

[2] Shapiro (2001) defines the patent thicket as: "a dense web of overlapping intellectual property rights that a company must hack its way through in order to actually commercialize new technology"
[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".

not necessarily allow maximizing the licensing revenues, the patent holders may have additional incentives. Delcamp (2010) opens this field of research underlining that one advantage of the pool for patent owners could be to increase the patents' value.

The purpose of this paper is to analyze more precisely what could be a strong incentive for patent holders to introduce their patents in pools namely the usefulness of these organizations to help patent owners enforcing their intellectual property rights. Indeed, this aspect is often mentioned by professionals, such as patent holders or pool administrators, but is not studied in the economic literature. As far as we know, nobody has ever questioned the possible link between the patent introduction in the pool and the incentives to litigate. For instance, it is possible to imagine that a pool patent because of its higher quality (Delcamp, 2010) is more litigated than a non pool patent. It is also plausible that the patent introduction into the pool changes the incentives for a patent holder to litigate.

In order to analyze these hypotheses, we use a database of 1564 U.S. patents in 8 pools. We use the litigation database created by the Stanford Law School which contains data on more than 100,000 intellectual property cases. We link these data on 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 to help patent holders enforcing their rights. We also highlight that the concentration of patents in the pool has an important role. Thus, a pool with a large number of members but also a large number of patents is less effective to help patent owners enforcing their rights. We provide evidences suggesting that this phenomenon comes from a mutual observation between pool members. We also emphasize that the size and the structure of the firm, vertically integrated or not, have an impact on incentives to litigate. Finally, we stress that the patent introduction in a pool facilitate the dispute resolution by settlement. This result is in line with the theoretical literature on the subject (Bessen and Meurer, 2006). Indeed, the patent introduction in a pool reduces the uncertainty on the outcome of the dispute. The patent enjoys, in this case, a presumption of essentiality to the standard and the plaintiff only has to prove that its patent is legally valid.

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

the impact of the patent introduction into a pool on the outcome of the case. Section 6 presents the empirical results.

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

The creation of a standard can be defined as the creation of a common and documented repository to harmonize the activities of a technological sector. Standardization can be conducted by formal (such as standard developing organizations) or informal (such as consortia) standardization bodies. Pools are created to help the dissemination of technology by allowing user to sign only a single license for several patents. A patent holder may choose to bring or not its patent to the pool. In practice, patent holders have little incentives to participate to the pool because there is a free riding possibility (taking advantage of the pools' creation by charging higher royalties without participating to it). The pools are constituted by patent holders or by pool administrators such as MPEG LA or Sisvel whose principal business is the creation and administration of pools.

A patent has to be essential, to the standard, to be introduced in a pool. The exact definition of essentiality is still subject to debates and there are different interpretations of it (Gilbert, 2009). In this paper, and because the exact definition is of little importance for this research, we will use the technical essentiality definition that considered as essential any patent that has no close substitutes or substitutes so inferior that makes them very distant alternatives. Nonetheless, it is difficult to precisely identify all the essential patents related to a technology. All pool patents are essential but all essential patents are not in the pool. Indeed, a vast majority of essential patents are not included in a pool mainly due to the lack of incentives for patent holders to participate.

Pools usually have third party experts that assess the essentiality of the patents before inclusion. If the patent is considered as essential, it can be included in the pool. The third party expert usually establishes a patent essentiality report precising to which part of the standard the patent is essential[4]. One of our main hypotheses in this paper is that this essentiality evaluation by a patent expert reduces the uncertainty on the outcome of the dispute and thus facilitates the resolution by settlement.

[4] The essentiality reports are available online for the DVD 6C pool or all pools managed by MPEG LA.

Simcoe, Graham and Feldman (2009) study the effect of patent disclosure in Standard Setting Organizations (hereafter SSOs) on the number of litigations. They show that patents disclosed in SSOs are more litigated than other patents with the same characteristics. They highlight that this effect is more important for small than big firms. In this article we work on pool patents consisting of patents declared as essential and essential patents not disclosed. The overlap between patents disclosed as essential in an SSO and real essential patents introduced in a pool is quite small. This striking fact can be explained by two main points. The first one is that no evaluation of the patent essentially is made before disclosure in an SSO and then many patents disclosed are not essential in reality[5]. Moreover, some very large firms particularly active in the standardization field do not participate to patent pools (e.g. Qualcomm). Furthermore, 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.

A patent infringement can be defined 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. Patents can generally be enforced by a civil lawsuits[6] 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 that at least one of the patent claims is violated. But, 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“.

One of the major constraints, for a patent owner that would like to enforce its right, is the possibility for an accused infringer to challenge the validity of the patent. Indeed, in the United States for instance, the civil courts that consider the case can and often declare the patent invalid. A patent can be declared invalid if at least one of the patentability requirements is not filled. These requirements vary by country but the main one such as utility, non obviousness or novelty apply almost everywhere.

[5] 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)
[6] Such as in the United States

Nevertheless, all patent infringements do not reach the judicial step. Indeed, many conflicts are resolved by a bargaining between the possible infringer and the patent holder. One of the main question studied by economists working on patent litigation is to understand why some patent holders choose to bring their case to the court and do not settle before trial. The first obvious answer is that the patent holder and the possible infringer have different expectations on the outcome of the case[7]. The economic literature (Meurer, 1989 ; Yildiz 2004 ; Nalebuff 1987 ; Lanjouw and Lerner 1998; Priest and Klein, 1984 ; Cooter and Rubinfeld, 1989) also underlines 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 being held :

- 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 work on 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 work on the demand side using the number of forward cites to control for a demand increase after the patent introduction in a pool. We underline the effect of the patent introduction 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[8]. The data were collected early 2010. These eight pools relate to Information and Communication Technologies and are the only I.C.T. pools that make their data publicly accessible. Some patents are included in several pools. We treat each of these patents, in different pools, as different observations.

[7] For instance the patent holder believes that the patent is infringed and the potential infringer disagree

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

Using Internet Archives[9] we obtain the list of pool patents at different date over time. Comparing successive patent lists allow us to identify the date of the patent first appearance on the list. We call it the date of introduction. Of course, there may be some discrepancies between this date of introduction and the real date of the patents' introduction in the pool[10]. We do not think this is a major problem because the updates are regular. We complete this database with data on the nature and structure of the firm[11]. We match the 1564 US patents in our sample with the NBER database and thus obtain a full range of information on the patents[12]. We complete the dataset using the website of the European Patent Office[13]. We thus only concentrate on U.S. patents because we do not have litigation data for other countries. Nonetheless, this choice is consistent for pool patents because the U.S. patents are usually the first patent of the family to be included (Baron & Delcamp, 2010). Figure 1 presents the distribution of U.S. patents per pool. We can see on Figure 1 the preponderant number of U.S. patents in the DVD6C patent pool. We check that our results are robust excluding the DVD pools (results available in appendix 6).

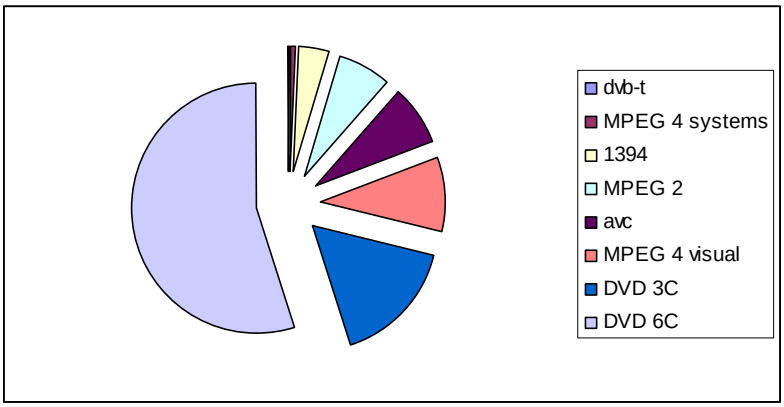

Figure 1. Number of patents / Pool

Based on this pool database, we create a control database with patents presenting the same characteristics[14] and the same type of information than our pool database. Previous papers have demonstrated the link between these characteristics and the number of

[9] www.archive.org
[10] due for instance to a late update of the websites
[11] size of the patent portfolio, number of employees, number of patents already included in the pool, vertical integration
[12] 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
[13] www.espacenet.com
[14] application year and type of assignee

patent litigations. Then, we match our databases to the Stanford IP litigation database[15] 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. This lack of historical data could create a truncation problem for patents granted before 2000 and introduced in a pool around this year. To control for this potential bias, we also run our regressions on patents granted after or in 2000 and for which we have all the history. The results are presented in appendix 3 and are quite similar to the results presented in the paper[16]. Table 1 summarizes the main information for pool and non pool patents.

	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 we can see in table 1, pool patents are more likely to be litigated than non pool patents. Indeed, pool patents have a likelihood of litigation around 8% against less than 1% for non pool patents. The other interesting information in this table is that there is also 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…).

The first step of our paper is a descriptive analysis of litigations in our sample. In order to do so, we conduct regressions on the likelihood to be litigated and the number of litigations with indicators of patent quality as explanatory variables. We therefore revisit already existing results on our sample. The results are presented in appendix 1 and are consistent with previous findings on the subject (Lanjouw & Schankerman, 2004 ; Lerner, 2009 ; Simcoe Graham & Feldman, 2009). We confirm that patents more cited are more likely to be litigated. All our indicators of patent quality (the number of forward cites, the number of claims and the generality of the patent) are also linked to the number of

[15] www.lexmachina.org

[16] In order not to reduce our sample and as the truncation problem does not seem important, we presented the results for our entire sample in the body of the paper.

litigations for a patent. These results confirm the previous findings on the subject but using a new database on litigations (Stanford IP litigation database). These first results are reassuring on the method and the data contained in the database.
In the next part, we present some descriptive findings on the link between patents pools and litigations.

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

This parts' aim is to give some descriptive findings on the interactions between patent pooling and litigations. There are many questions to address. We will treat each of them successively.

We first investigate if pools are mostly created to end patent disputes. Indeed, some authors (Shapiro, 2003) believe that the creation of a patent pool is a way to end a dispute related to intellectual property. In this case, we should have, before the pools' creation, a high number of litigations between pool members. We will analyze this question on the first subsection. Another question is: Why are pool patents more litigated? Indeed, we highlight in the precedent section that pool patents have a higher likelihood to be litigated. There are two ways to explain a potential difference between pool and non pool patents, we present and investigate these explanations on the second subsection.

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

A first interrogation on the link between litigations and pools is whether patent pools are used to resolve previous disputes among patent holders. For example, Shapiro (2003) asserts that : « Patent pools are another form of settling patent disputes ». He takes the exemple of the pool, involving patents for laser eye surgery, formed by Summit Technologies and Visx. Each of these firms claimed that it held essential patents and sued each other for infringement. The pool, called Pillar Point Partners, was created to end the dispute and was finally forced to dissolve by the Federal Trade Commission. In order to answer this question, we carefully analyze litigations on the pool founding patents. In this case, a founding patent is defined as a patent which is included in a pool since its creation. In our pool sample, we have 13 patents that are at the same time litigated and founding patent of a pool. The detail is presented in Table 2.

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

Table 2. Number 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. It appears that the assumption that patent pools are created to end litigations between patent holders is not verified.

Of course, this does not mean that this hypothesis is wrong but only that given the data we have we can reject it. It is for instance possible that pools are created to end conflicts that have not yet reached the litigation stage and which are thus not present in our database.

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

On the precedent section, we highlight that pool patents have a higher likelihood to be litigated. There are two main workable explanations for a potential difference in litigations between pool and non pool patents. The first one is that pool patents are more litigated because of their intrinsic quality. The point beyond this idea would be that due to the pool selection, pool patents do not have the same quality than non pool patents having the same characteristics[17]. In this case, it would be normal that pool patents have a higher number of litigations but it would not come from any ex-post pool effect. This explanation is plausible because, as explained in the second section, pools carry a selection of the patents. Moreover, there are, within technological classes to which belongs our sample, many sleeping patents. This could therefore justify an important difference of intrinsic quality between pool and non pool patents (see Delcamp, 2010).

In order to test this first explanation, we create a control database (presented in the data subsection) with patents having the same year of application and type of assignee. Indeed, previous papers highlight that both these variables have an impact on the patent number of litigations. Then, we perform a comparison of the two samples by performing

[17] Technological class and assignee type

the same (cross-sectional) regression than in the previous section with a dummy variable for pool patents but adding indicators of patent quality as explanatory variables to control for possible different characteristics. We add a column with a rare event logit model in order to take into account the small amount of patents introduced in patent pools, in the real population, compared to our sample. Indeed, econometric studies (Prentyce and Pyke, 1979; Scott and Wild, 1997) underline 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)[18]. The results are presented in table 3. They confirm our previous descriptive statistic findings. Pool patents have a higher likelihood to be involved in litigation and have a higher number of litigations than non pool patents having the same characteristics.

	Probit litigated	**Logit litigated**	**Rare event Logit litigated**	**Poisson number Litigations**	**Negative binomial number Litigations**	**Tobit number Litigations**
Pool	1.59555***	3.51032***	3.33546***	2.55484***	3.12215***	18.89406***
	(0.248)	(0.635)	(0.629)	(0.825)	(0.417)	(3.179)
Log(allnscites)	-0.05665	-0.13409	-0.13541	-0.04913	0.01686	-0.58943
	(0.071)	(0.125)	(0.124)	(0.114)	(0.155)	(0.867)
Log(claims)	0.16344*	0.27786	0.27102	0.71462***	0.30456	2.71844**
	(0.091)	(0.173)	(0.171)	(0.223)	(0.207)	(1.070)
Generality index	-0.46128**	-0.85349**	-0.84491**	1.08397**	1.60788***	-1.79965
	(0.200)	(0.353)	(0.350)	(0.443)	(0.593)	(2.731)
Control Grant Year	Y	Y	Y	Y	Y	Y
_cons	-10.07664	-32.25241	-28.59257	160.13597*	358.27254***	320.9736
	(39.608)	(71.626)	(71.064)	(93.378)	(137.963)	(531.047)
Number of obs	758	758	758	758	758	758
Chi2	55.00	39.64		28.45	225.05	93.42
Prob > chi2	0	0		0	0	0
Pseudo R2	0.1902	0.1920		0.2211		0.0914
Zero observation						673
Non zero observation						85

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

[18] The *relogit* command. Stata programs available at : http://www.jstatsoft.org/v08/i02

This result requires further analysis to understand and identify the sources of this pool effect. To answer this question, it is interesting to have a look at the distribution of litigations over time.

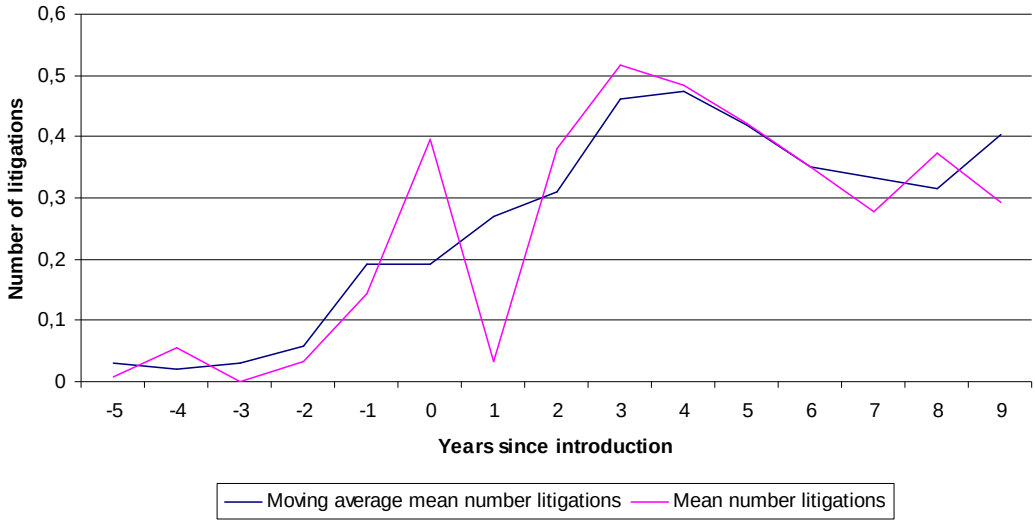

Figure 2. Mean number litigations / introduction in the pool

As we can see on figure 2, the number of litigations increases strongly after the patent introduction in a pool. This mean also appears to reach a peak three or four years after introduction and then declined. It is also interesting to note that the rise in litigations is almost immediate or even precede the introduction for a few months. This could be explained by our data collection process for which there may be some discrepancies between the date of patent introduction in the pool and the update of the pools' website. Table 3 and figure 2 seems to confirm that our second explanation, the pool has an ex-post effect on the number of litigations is verified.

The result on this introduction effect can be explained in two ways. The first one is that the pool creation has an impact on the demand side by increasing the opportunities for the patent owner to licence its patent (Delcamp, 2010). The second one is that patent pools are a way for patent holders to remain informed of potential infringement and thus have an impact on the likelihood that the offense is detected. The following part will be dedicated to the presentation of our theoretical framework and hypotheses on the introduction effect but also on the impact of the patent introduction into a pool on the outcome of the dispute.

5. Theoretical framework

This part presents our theoretical framework and hypotheses. We have two different sets of hypotheses. The first one applies on the introduction effect; why are pool patents more litigated after introduction into a pool. The second one is dedicated to the analysis of the outcomes of the cases; why does the patent essentiality evaluation should have an impact on the outcome of the case.

5.1 Theory and hypotheses on the introduction effect

In this part, all our hypotheses are based on the assumption that the patent holder is plaintiff in the case. A first explanation for the introduction effect could be that the number of litigations rises because the patent introduction in the pool increases the market size of the patent. To control for this effect we will use as an explanatory variable the number of forward cites that changes over time and allow to take into account this demand side effect (Simcoe, Graham and Feldman, 2009).

If we control, for this demand side effect, our main hypothesis is that the pool has an impact on the level of information. As confirmed by many pool patent holders, one of the main advantage of a pool would be to help enforce its patents. Indeed, after introduction in the pool, the patent holder remains informed (by other pool members) about technologies that could infringe its patents. The patent holder level of information increases and he can therefore more easily enforce his rights.

Hypothesis 1: The introduction effect is due to a higher level of information of pool members on possible infringement. Thus, controlling for the demand side effect, the introduction effect should remain positive.

It is interesting to note that there may be several axioms of this hypothesis. The first one would be that pool members voluntarily exchange information about the violation of intellectual property rights. The second one, less restrictive, would be that patent holders remains informed by the action of other pool members even if there is no voluntary exchange of information, for instance because they can observe each other. In order to capture this effect, we created a variable that interact the disclosure effect to the number of other patent holders in the pool at the time of patent introduction. In order to

disentangle between the two axioms presented, we created another interaction variable that interact the disclosure effect to the number of other patent holders and the number of patents in the pool at the time of patent introduction. Thus, if our second axiom is right, the parameter for the first interaction variable should be positive (the higher the number of pool members, the higher the introduction effect) and the second parameter negative (this effect is compensated by the number of patents in the pool which makes it more difficult to observe the actions of other members).

Hypothesis 2: The introduction effect, explained by a higher level of information, results from a voluntarily exchange of information or a mutual observation.

We also have several hypotheses on the structure and status of the firm that could explain a change in the level of incentives after the patent introduction in the pool.

On the size of the firm, there are several complementary effects that can affect the incentives for a patent holder to litigate after the patents' introduction in the pool. First of all, Simcoe, Graham and Feldman (2009) show that the level of litigations increases more sharply for small firms after the patents' disclosure in a Standard Setting Organization. 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 side, 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 to capture 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. We thus create a control variable p*ortfolio_size* to capture this learning curve effect. To describe these reputation and learning curve effects, the size of the firm patent portfolio is more important than the size of the firm measured by the number of employees. In this paper, we will therefore test our hypothesis with the size of the firm measured by the size of the patent portfolio. We also run the regressions with the size of the firm measured by the number of employees. The results are quite similar whatever the variable used[19].

[19] Results with the number of employees available on request

Another effect that could have an impact on incentives to litigate is the risk of counter infringement. This counter infringement threat is often stressed by the patent holders[20]. Consequently, a firm that can be counter attacked could have fewer incentives to litigate. In order to capture this counter infringement risk, we created a variable *vertical_integration* for companies that are both licensors and licensees of the pool. Indeed, a firm that is vertically integrated (also licensee) can be more easily threatened. This lack of counter infringement risk is for instance often underline for non practising entities that can not be threatened on the downstream market and are thus more inclined to litigate.

Hypothesis 3: The introduction effect varies according to the size, structure and status of the firm within the pool.

To summarize, we can say that the patent introduction in a pool can have two different impacts. The first one on the patent holder level of information. The second one on the level of incentives of the patent holders. If these hypotheses are verified, we should thus observe a positive introduction effect for pool patents controlling for the demand side effect. We should also be able to disentangle between the two axioms underlying this hypothesis using data on the pool number of members and number of patents. If our hypothesis on the level of incentives is true, the introduction effect should vary according to the firm status in the pool. In order to capture these different effects, we created interaction variables that capture the patent introduction in the pool and the variables : *pool_size, firm_size, ppprior, patent_portfolio. firm_size_vertical integration.* The graph available in appendix 2 emphasizes the difference in the intensity of the introduction effect by firm size, pool size and nature of the firm.

5.2 Theory and hypotheses on the outcomes of the disputes

Our main question, in this part, is to understand why the patent introduction in a pool could have an impact on the outcome of the dispute. We will first present a general model of patent disputes (Bessen and Meurer, 2006) that will help us to understand what can be the effect of the patent introduction into a pool on the outcome of the case.

[20] On this counter infringement risk, one of the pool administrator interviewed said: "Also there is a possibility that filing of an infringement action against company A may cause a serious problem, such as a counter patent infringement action against the company, that may cause a bigger damage to the member company."

The Bessen and Meurer (2006) model is a setting of patent disputes with early-stage patent and investments for development by a potential infringer and the patent holder. In the first stage of the game, the first firm chooses a level of investment, P1, in patent « refinement ». In this model, the invention is considered as exogenous and the inventor chooses a level of protection that impacts the likelihood of suing and winning the case of patent infringement. In the second stage of the game, both firms choose the level of investment for development, x1 and x2. This choice is considered simultaneous. The model assumes a constant marginal and average cost of development, δ_i. In the last stage of the game, the firms decide whether to enter a license agreement or to litigate (filing a lawsuit).

In this model, it is assumed that the firms hold symmetric information during the game. Between the second and the third stages, the firms can observe the probability α that the patent holder win the case against the infringer. Before that, the two firms know that α is distributed over [0,1] following the distribution function $F(\alpha; P1, x2)$. This model assumes that P1 and x2 influence the distribution α. In the stage three, there are possible different outcomes :

- Firm 2 observes α and decides to abandon its newly adopted technology. This situation is called « deterrence ». In this case, Firm 1 gets a monopoly payoff, M(xl), and firm 2 gets zero.

- Firm 2 does not abandon the technology, but firm 1 decides not to assert its patent. This choice is called « acquiescence ». In this case, the two firms get dupoly profits Dl(x1) and D2(x2).

- Firm 2 does not abandon the technology and Firm 1 decides to assert its patents. The firms bargain to a settlement. In this case, the payoffs are a Nash bargaining solutions, S1 and S2.

- Firm 2 does not abandon the technology and Firm 1 decides to assert its patents. The firms bargain but do not reach a settlement. In this case, the firms litigate with payoffs L1(a, x1) and L2(a, x2). The patent holder may sue because it obtains benefits such as a reputation for toughness, or an enhanced value for the successfully litigated patent.

The authors find a sub game perfect Nash Equilibrium by backward induction of the game. There are four possible solutions that are presented in the figure below. Vi represents the third stage profit for firm I, then a stronger α increases the profit of firm 1 and decreases the profit of firm 2.

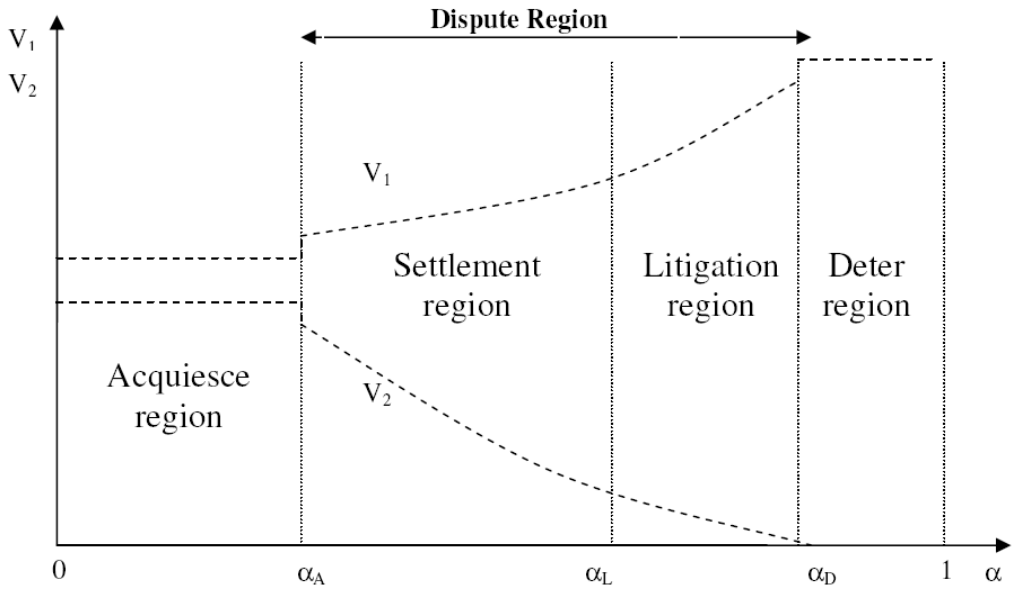

Figure 3. Dispute region

This model allows testing various implications. Many of them were analyzed in a subsequent paper, Bessen and Meurer (2005). We will only discuss the implications that could be analyzed using our data on pool patents.

This model is very useful to analyze the effect of the vagueness of the patent rights. In fact, Bessen and Meurer argue that the distribution of trial outcome probabilities is affected by the endogenous choices of the firms but also by a variety of exogenous factors such as policy changes in antitrust rules or patent law. They assert that the changes that increase the clarity of patent rights should engender a reduction in lawsuits while more uncertainty increases the probability of litigation. In this paper, we will test an hypothesis that is derived directly from this model: the patent introduction in a pool should have an impact on the equilibrium settlement/litigation and thus increase the number of disputes that are ended with a settlement. This assumption is quite logical, given the model presented above. Indeed, in case of litigation, the court has to answer two questions: Is the patent valid and is the patent infringed?

A patent that is introduced in a pool is reviewed by an external expert that evaluates its essentiality. Thus, the pool patents are necessarily essential to the technology and the introduction gives a presumption of essentiality to the patent. This presumption of essentiality gives at least a partial answer to the question: is the patent infringed? Therefore, the essentiality evaluation by a third party expert should decrease the level of uncertainty on the outcome of the dispute (the essentiality of the patent does not have to be assessed again if the patent is accepted in a pool).

Hypothesis 4: 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 increases the likelihood of settlement.

6. Empirical results

This section presents the main empirical results on the hypotheses presented 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 have a look at the litigations in which the patent holder is plaintiff, consistent with our hypotheses. The cases in which the patent holder is defendant are very rare after the patent introduction in the pool and the results remain robust when we have the same analysis for the overall sample as shown in appendix 4.

As we explain in the precedent section, we have two main hypotheses on the introduction effect: the changes in the level of information and in the level of incentives. In order to do so, the best way to work is to use a panel database with fixed effect count models grouped on patents (in order to only capture the change controlling for other variables such as the intrinsic quality). This fixed effect approach is confirmed by the test results presented in appendix 8 (table 13). 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. The main problem of this method is that it is performed only on the groups that have an introduction effect variable that equals 1.

	Fixed effect logit litigated	Fixed effect logit litigated	Fixed effect logit litigated	Fixed effect logit litigated	Fixed effect poisson	Fixed effect poisson	Fixed effect poisson	Fixed effect poisson
				Firm size assessed by the number of patents				
Introduction effect	1.71975** (0.761)	3.70276** (1.648)	10.84063** (4.487)	13.77389** (5.412)	3.49540*** (0.987)	13.63207*** (3.359)	21.65224*** (5.51)	21.95810*** (5.441)
Number_other_member Introduction	-0.00485 (0.040)	0.02056 (0.044)	0.10603* (0.058)	0.14533** (0.066)	0.02380 (0.020)	0.16737*** (0.037)	-0.03254 (0.089)	-0.02372 (0.088)
Number_other_member2 Introduction							0.01179*** (0.004)	0.01150*** (0.004)
Number_othermembers_ numberpatents_Introduction			-0.00054** (0.000)	-0.00067*** (0.000)		-0.00077*** (0.000)	-0.00148*** (0 .000)	-0.00149*** (0.001)
PPprior_introduction		-1.58017 (1.510	-0.58744 (1.560)	-3.25562* (1.688)	-1.30864** (0.660)	-0.27678 (0.681)	-0.58256 (0.702	-1.51384** (0.698)
Portfolio_size_introduction		0.00011 (0.000)	0.00038* (0.000)	0.00031 (0.000)	0.00011** (0.000)	0.00056*** (0.000)	-0.00185 (0.001)	-0.00172 (0.001)
Portfolio_size2_introduction							1.275e-07* (7.21e-09)	1.218e-07* (7.07e-08)
Portfolio_size_Vertical Integration_introduction		-0.00002* (0.000)	-0.00009** (0.000)	-0.00012** (0.000)	-0.00002** (8.68e-06)	-0.00012*** (0.000)	-0.00013*** (0.000)	-0.00013*** (0.000)
Cites N-1				0.79004*** (0.230)				-1.63263*** (0.344)
Calendar year effect	0.00749 (0.026)	0.00068 (0.026)	0.00012 (0.027)	-0.10397*** (0.032)	0.01932 (0.012)	0.02058* (0.012)	0.02055 (0.013)	-0.00782 (0.012)
Number of obs	**1037**	**1003**	**1003**	**1003**	**1003**	**1003**	**1003**	**1003**

*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

Our first hypothesis, that the introduction effect is due to the level of information of the patent holder is verified. Indeed, controlling for the demand side effect, the introduction effect is positive and significant meaning that, for the same patent, the likelihood and the number of litigations increase after introduction in a pool.

The results on the number of members and the number of patents in the pool suggest that this effect is due to a mutual observation between members and not a voluntarily exchange of information (hypothesis 2). In fact, the interaction variable between the introduction effect and the number of other members in the pool is positive and significant. This means that, ceteris paribus, the pools that have a higher number of members are more efficient helping patent holders to enforce their rights. If we accept the assumption that the number of pool members is directly linked to the level of information of the patent holder, this result is perfectly normal. The negative and significant parameter between this interaction variable and the number of patents in the pool at the time of introduction confirms that at least a part of this result is due to mutual observation and not to a voluntarily exchange of information between patent holders. Of course, there is a chance that this variable captures only a nonlinear relationship for the *number_othermember_introduction* variable. To control this effect, we added in the last column an interaction variable between the number of other members in the pool squared and the introduction effect. The introduction of this new variable does not change the previous results meaning that these results do not come from a misspecification.

On the incentives, the reputation effect is confirmed by our results; smaller firms (firms that have fewer patents in the pool) pay more attention to their toughness reputation and thus litigate more than firms holding an important number of patents in the pool. The learning curve effect is also verified because the parameter of the control variable *portfolio_size* is positive and significant. These two results are consistent with previous empirical works on the subject such as Simcoe, Graham and Feldman (2009) that underline the importance of the reputation effect for small firms and Lerner (1995) that highlights the learning curve effect.

On the risk of counter infringement, the parameter for the variable *Portfolio_size_VerticalIntegration_introduction* is negative and significant meaning that, controlling for the size of the firm, vertically integrated firms attack less than pure research firms. Thus, our hypothesis on the risk of counter infringement is also confirmed by the results in Table 4; the incentives to litigate are negatively affected by being also licensee of

the pool. As far as we know, this is the first time that the effect of the counter infringement risk is clearly empirically underlined.

This part was dedicated to the empirical results on the introduction effect. All our main hypotheses seems to be verified by the findings. The next part will be dedicated to the empirical results on the outcomes of the disputes.

6.2 Results on the outcomes of the disputes

The aim of this part is to test our hypothesis that the patent introduction in a pool has an impact on the equilibrium settlement/ litigation. First of all, we will present some graphical evidences on the hypothesis tested. For recall, our hypothesis is that 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. Figure 4 presents the outcomes of the disputes for pool and non pool patents:

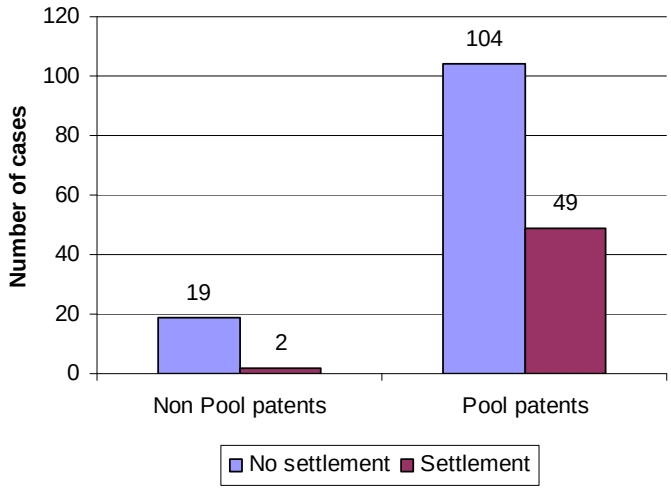

Figure 4. Settlement for pool and non pool patents

Figure 4 suggests that the likelihood that the case ends with a settlement is higher when patents are pool patents. Of course, this difference could be due to intrinsic differences between pool and non pool patents that could foster settlements to end disputes. These descriptive results are consistent with our theory presented above that the patent introduction decreases the level of uncertainty and thus changes the equilibrium settlement/litigation. We will confirm this result using econometrics methods.

In order to test this hypothesis, and due to the small number of observations, we first run a cross section regression with the likelihood that the dispute is ended by settlement as the explained variable. This regression is run on all the litigated patents of our sample. We control for the age and quality[21] of the patents. The control database is constituted of patents having the same assignee and technological class. Finally, we also use dummies to control for a possible Court fixed effect. Indeed, we could argue that the level of uncertainty vary according to the court (some outcome are easier to predict) and that the disputes are not resolved by the same jurisdiction. For the same reasons than in section 4.2, we also run a rare event logit regression to control the stability of our results. The results are presented in the following table :

	Probit Settlement	**Probit Settlement**	**Probit Settlement**	**Logit Settlement**	**Logit Settlement**	**Logit Settlement**	**Rare event Logit Settlement**
Presence Pool	0.84220*** (0.393)	1.01342** (0.466)	1.18009** (0.477)	1.54096* (0.808)	1.53102* (0.829)	1.94542** (0.857)	1.27912* (0.689)
Log_allnscites		-0.31326** (0.138)	-0.39839** (0.197)		-0.52062** (0.258)	-0.68908* (0.369)	-0.53349 (0.333)
Generality			-0.59606 (0.532)			-0.97056 (0.891)	-0.36077 (0.781)
Control Grant Year	Y	Y	Y	Y	Y	Y	Y
Dummy Court		Y	Y		Y	Y	Y
_cons	-1.30917*** (0.379)	-34.17209 (73.420)	24.80475 (93.617)	-103.06138 (89.262)	-20.46234 (137.416)	58.58852 (170.438)	-3.54719 (112.722)
Number of observations	174	144	144	136	123	136	105
Wald chi2	4.57	23.97	13.17	12.18	15.11	12.18	
Prob > chi2	0.0325	0.0012	0.1061	0.0582	0.0346	0.0582	
Pseudo R2	0.0257	0.0012	0.1038	0.0747	0.0968	0.0747	

*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

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

Table 5 confirms our previous descriptive findings. Everything else equal, pool patents have a higher likelihood to be involved in a dispute that is ended 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 the 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. In this case, we have to choose between a fixed and a random effect model. It could be argued that, as in the previous section, the best method is a fixed effect model. Nevertheless, the nature of the data changed and random effects also could be justified. We chose a random effect model due to the results of the tests presented in appendix 8 (Table 14). We control for the calendar year of the litigation, the quality and age of the patent. The results are presented in appendix 7 because of the small number of observations. They confirm our previous findings, the likelihood that a dispute is ended by settlement increase after the patent introduction into a pool.

6.3 Robustness tests

Our regressions on the introduction effect are based 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. Of course, our assumptions are based on the fact that the patent holder is plaintiff and the previous results are based only on the cases in which the patent holder is plaintiff. We also present in appendix 4 (Table 8) the results for the overall sample. The results are very close of those presented in Table 4. As explain in the data section, we control the robustness of our results excluding the DVD pools (results available in appendix 6).

Our results could also be impacted by a truncation in the data. Indeed, we only have data on litigations that were filed after 2000. To take into account this point, we run the same regressions on patents that were filed after or in 2000. The results are presented in the appendix 3 (Table 7) and are close to the results presented in table 4.

It is clear that these results 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 are presented in appendix 5. The results could also be sensitive to the

age of the patent at the time of litigation (patents could be introduced in the pool at different age). To overcome this difficulty, we run the same regression with interaction variables between the introduction effects and the age of the patent at the time of litigation. These results are presented in appendix 5 (Table 10) and summarize our results. It also allows us to confirm the robustness of our findings. The results are even more significant using dummies and controlling for the age of the patent than in Table 4.

Our results could be driven by the patent litigation history. Indeed, it could be argued that patents, which already have a high number of litigations, have a higher likelihood to be litigated in the future. To take into account this effect, we run the regression with a dummy variable *already_litigated* that equals 1 for all observations after the first litigation. The results are presented in appendix 5 (Table 10). Even if the parameter for this new variable is positive and significant, patents that already have a high number of litigations are more likely to be litigated again, our previous results remain robust. For all the regressions presented above, we also test that our results are robust to a fixed effect negative binomial model instead of a fixed effect Poisson model. The results are available on request.

Finally, as explained in the precedent subsection, we also use a panel approach to underline the result on the outcomes of the disputes. These random effect model results are presented in appendix 7 and confirm the results of the cross section model.

CONCLUSION

This paper analyzes the interplay between patent pools and litigations. We show that pool patents are more litigated than patents not included in a pool presenting the same characteristics. This result could have two explanations: pool patents are more litigated before introduction or the patent introduction 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. This result could be explained by the greater ease, enjoyed by the patent holder after introduction, to detect a potential infringement.

We advance results showing that this explanation seems to be verified for our sample, such as the pool ex-post effect is higher for pools with a greater number of members. Using the patents' concentration in the pool, we argue that this effect should be due to mutual observation rather than an exchange of information.

Finally, we underline that the patent introduction into a pool has an impact on the outcome of the litigation facilitating the resolution by settlement. Using the Bessen and Meurer (2006) model on patent litigation, this result can be easily explained by a change in the expectations of the parties. Indeed, these expectations are closer, for the same patent, after than before introduction and this due to the patent essentiality evaluation run by the pool.

These results are important and could help to understand the creation and stability of patent pools. Indeed, the theoretical literature on the subject underlines the free-riding problem and the difficulty of maintaining stable this kind of organizations. This paper, by highlighting that patent holders could have other incentives that those discussed in the literature, help to fill in at least partially this lack of knowledge on patent holders' incentives to participate to these organizations.

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Appendix 1 : Descriptive regressions litigations

	Probit litigated	Poisson number_litigations	Probit litigated	Poisson number_litigations
Log(forward cites)	0.12118* (0.062)	0.32537* (0.137)	0.19459** (0.073)	0.35354** (0.135)
Generality	0.14038 (0.175)	2.00399*** (0.401)	-0.16067 (0.230)	1.92154*** (0.498)
log(claims)	N/A	N/A	0.19664 (0.107)	0.63336* (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***	-3.432***	-2.779***	-5.262***
Number of obs	1060	1491	608	758
Wald chi2	99.49	16994.16	100.35	11367.88
Prob > chi2	0	0	0	0
Pseudo R2	0.1877	0.3266	0.2596	0.3589

*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

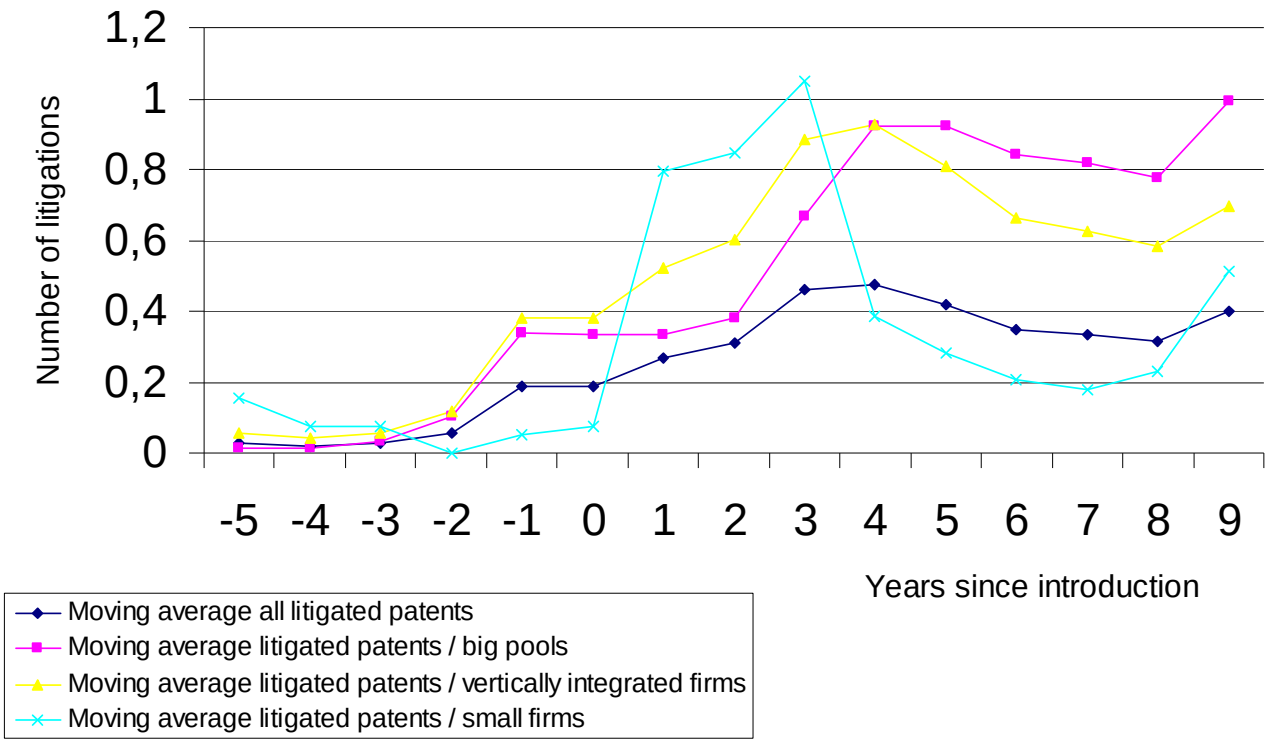

Figure 5. Introduction effect by pool and firm size

Appendix 3 : Results for patents granted after or in 2000

	Fixed effect logit litigated	Fixed effect logit litigated	Fixed effect poisson	Fixed effect poisson
		Size of the patent portfolio		
Introduction effect	11.15359** (4.751)	12.56818** (5.046)	14.00882*** (3.887)	15.00070*** (3.866)
Number_other_member Introduction	0.08146 (0.123)	0.11631 (0.126)	0.21282*** (0.631)	0.23171*** (0.064)
Number_othermembers_ numberpatents_Introduction	-0.00052** (0.000)	-0.00057** (0.000)	-0.00074*** (0.000)	-0.00078*** (0.000)
PPprior_introduction	0.10627 (4.295)	1.43219 (5.116)	-2.57095* (1.931)	-2.58399 (2.049)
Portfolio_size_introduction	0.00056* (0.000)	. 0.00046 (0.000)	0.00118*** (0.000)	0.00119*** (0.000)
Portfolio_size2_introduction	-7.265e-09 (1.26e-08)	-5.371e-09 (9.91e-09)	-1.889e-08** (8.76e-09)	-1.881e-08** (8.72e-09)
Portfolio_size_Vertical Integration_introduction	-0.00009** (0.000)	-0.00010** (0.000)	-0.00013*** (0.000)	-0.00013*** (0.000)
Cites N-1		0.48499** (0.233)		0.39924*** (0.124)
Calendar year effect	-0.13771** (0.057)	-0.26212*** (0.073)	-0.12479*** (0.025)	-0.20730*** (0.029)
Number of obs	**425**	**357**	**425**	**357**
*Legend: * p<0.10; ** p<0.05; *** p<0.01. Standard errors in parentheses*				

Table 7. Regressions results fixed effect panel, patents granted after or in 2000

Appendix 4 : Results for the overall sample

	Fixed effect logit litigated / year	Fixed effect logit litigated / year	Fixed effect logit litigated/ year	Fixed effect logit litigated/ year	Fixed effect poisson Litigations	Fixed effect poisson Litigations	Fixed effect poisson Litigations
				Firm size assessed by the number of patents			
Introduction effect	1.54765** (0.728)	3.91103** (1.666)	7.36690** (3.085)	8.74541** (3.731)	3.91983*** (0.997)	10.70365*** (2.785)	14.95564*** (4.302)
Number_other_member Introduction	0.00410 (0.039)	0.02708 (0.043)	0.05896 (0.048)	0.06495 (0.053)	0.03124 (0.020)	0.12621*** (0.032)	-0.04563 (0.088)
Number_other_member2 Introduction							0.00636** (0.003)
Number_othermembers_ numberpatents_Introduction			-0.00029** (0.000)	-0.00030* (0.001)		-0.00055*** (0.000)	-0.00065*** (0.000)
PPprior_introduction		-2.22683 (1.449)	-1.54347 (1.461)	-3.59714** (1.615)	-1.67489** (0.639)	-0.96166 (0.646)	-2.02418*** (0.662)
Portfolio_size_introduction		0.00010 (0.000)	0.00034* (0.000)	0.00035 (0.001)	0.00010* (0.000)	0.00067*** (0.000)	0.00113*** (0.000)
Portfolio_size2_introduction							-1.720e-08* (9.88e-09)
Portfolio_size_Vertical Integration_introduction		-0.00003* (0.000)	-0.00006* (0.000)	-0.00007* (0.000)	-0.00003** (8.52e-06)	-0.00010*** (0.000)	-0.00013*** (0.000)
Cites N-1				0.83050*** (0.231)			-1.31093*** (0.216)
Calendar year effect	0.00383 (0.025)	-0.00076 (0.026)	-0.00118 (0.026)	-0.10973*** (0.032)	0.01624 (0.012)	0.01768 (0.011)	-0.01716 (0.012)
Number of obs	**1122**	**1088**	**1088**	**1087**	**1088**	**1088**	**1088**

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

Table 8. Regressions results fixed effect litigated, overall sample

Appendix 5 : Results using dummies and controlling for the age of the patent

	Fixed effect logit litigated	Fixed effect logit litigated	Fixed effect poisson litigations	Fixed effect poisson litigations
Introduction effect	1.98244**	2.31237***	1.69388***	1.92227***
	(0.798)	(0.836)	(0.450)	(0.456)
Big_pool_Introduction	0.56502	0.65551	0.74237**	0.71377**
	(0.566)	(0.636)	(0.304)	(0.319)
Big_portfolio_Introduction	-0.78082	-1.15314	-0.29686	-0.69637
	(0.862)	(0.957)	(0.482)	(0.515)
PPprior_introduction	-2.65837*	-4.64015***	-1.83428***	-2.82617***
	(1.426)	(1.584)	(0.611)	(0.585)
Cites N-1		0.85453***		0.87594***
		(0.239)		(0.150)
Calendar year effect	0.012664	-0.09595***	0.03129***	-0.05399***
	(0.025)	(0.031)	(0.012)	(0.014)
Number of obs	**1122**	**1121**	**1122**	**1121**

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

Table 9. Regressions results fixed effect litigated, dummies

	Fixed effect logit litigated	Fixed effect logit litigated	Fixed effect logit litigated	Fixed effect poisson litigations	Fixed effect poisson litigations	Fixed effect poisson litigations
Introduction effect	1.57606*** (0.393)	2.81182*** (0.747)	1.57593*** (0.428)	1.81464*** (0.222)	1.90941*** (0.222)	1.54087*** (0.222)
Big_pool_Introduction* Patent Age	0.08957** (0.042)	0.03727 (0.076)	0.08651* (0.050)	0.12787*** (0.024)	0.11969*** (0.025)	0.10854*** (0.026)
Big_portfolio_Introduction* Patent Age	-0.08674* (0.050)	-0.18456** (0.087)	-0.11743** (0.058)	-0.08667*** (0.027)	-0.09352*** (0.029)	-0.12072*** (0.030)
PPprior_introduction* Patent Age	-0.25050** (0.102)	-0.39427*** (0.142)	-0.38260*** (0.0120)	-0.19552*** (0.040)	-0.228855*** (0.039)	-0.21091*** (0.039)
Cites N-1		-1.01148*** (0.358)	0.82462*** (0.233)		-1.30150*** (0.217)	0.79987*** (0.143)
Dummy_already_litigated			0.02419 (0.292)			0.24937* (0.133)
Calendar year effect	0.04437 (0.043)	0.06252 (0.071)	-0.03319 (0.048)	0.02898 (0.025)	0.00581 (0.026)	-0.02361 (0.026)
Number of obs	**1037**	**828**	**1036**	**1037**	**1037**	**1036**

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

Table 10. Regressions results fixed effect litigated, dummies and patent age

Appendix 6 : Results excluding DVD 3C and DVD 6C pools

	Fixed effect logit litigated	**Fixed effect logit litigated**	**Fixed effect poisson litigations**	**Fixed effect poisson litigations**
	Results excluding DVD 3C		*Results excluding DVD 6C*	
Introduction effect	1.58233*** (0.421)	1.57593* (0.428)	2.37226*** (0.712)	2.36112*** (0.721)
Big_pool_Introduction* Patent Age	0.08651* (0.050)	0.08651* (0.050)	-0.03283 (0.056)	-0.03320 (0.056)
Big_portfolio_Introduction* Patent Age	-0.11731** (0.058)	-0.11743** (0.058)	-0.18665** (0.081)	-0.18628** (0.081)
PPprior_introduction* Patent Age	-0.38362*** (0.119)	-0.38260*** (0.120)	-0.25925** (0.118)	-0.25746** (0.119)
Cites N-1	0.82546*** (0.232)	0.82462*** (0.233)	1.11446** (0.443)	1.11254** (0.443)
Dummy_already_litigated		0.02419 (0.292)		0.03182 (0.344)
Calendar year effect	-0.03183 (0.045)	-0.03319 (0.048)	0.17188** (0.076)	0.16997** (0.079)
Number of obs	**1036**	**1036**	**798**	**798**

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

Table 11. Regressions results fixed effect litigated, excluding DVD pools

Appendix 7 : 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
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*

Table 12. Regressions results random effect settlement

Appendix 8 : 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 13. 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 14. Results panel outcomes