

**THE LINK BETWEEN DAMAGES AND PATENT VALUE  
IN THE FRENCH JUDICIAL SYSTEM**

*Béatrice Dumont*

*University Paris 13 CEPN-CNRS & College of Europe*

\*\*\*\*\**First draft*\*\*\*\*\*

\*\*\*\**please do not quote*\*\*\*\*

**Abstract** : This paper presents an empirical analysis of the link between damages and patent value, based on information from suits filed during the period from 2008 to 2013 at the French district courts. Our results show that patent damage awards attributed by French judges are significantly linked to patent quality as assessed from a statistical point of view but this link is imperfect.

**Keywords** : Patent value, Patent infringement, Litigation

**JEL classification** : K41, O31

## 1. Introduction

In a technology-based economy, many firms recognize that patents, and intellectual property rights (IPRs) in general, are their most valuable assets. However, patents only have commercial value if they can be used to protect a profit stream by excluding others from making, using, or selling whatever is covered by the patent's claims. This implies that one of the conditions for patents to have value is that they are (correctly) enforced. In return, this means that in order to enforce rights, one has to go through litigation to a court judgment or a settlement agreement.

From an economic point of view, not only the probability of litigation is of interest for a patent owner but also the costs associated with it<sup>1</sup> and the expected awards granted to the winning party. However, most studies show that litigation is expensive, stressful, and rarely meets the expectation of either party seeking the intervention or assistance of the court. The prospect of a paltry result obtained at the end of a long and expensive trial can also make the infringement action much less effective for litigants and may even discourage some. Indeed, in theory damages serve both as compensation to the rightholder for the economic detriment that results from an infringement, and as a deterrent to would-be infringers. In practice, patent damage awards may be under-estimated. Indeed some of the profit or other economic benefit of an infringement often remains with the infringer as damages calculations can be difficult to quantify precisely, even after the rightholder has brought a successful civil case. As a result, the low level of patent damages is sometimes considered as an incentive to counterfeit and a penalty for enforcing patent rights<sup>2</sup>.

The need for legislators, judges and lawyers to improve the quality and efficiency of patent litigation in their jurisdiction but also the pressure created by forum shopping is behind the new IP Enforcement Directive in France by the 29 October 2007 Act<sup>3</sup> on the fight against

---

<sup>1</sup> The costs of litigation as such are quite notable, but the opportunity costs and business costs arising from patent litigation could be even higher. The latter include, for instance, foregone revenues resulting from a partial company standstill due to the uncertainty about a case outcome or even an interim injunction.

<sup>2</sup> Conversely, in some countries, patent damages are considered to be excessive and to lead to a tax on innovation.

<sup>3</sup> These new provisions transpose into French law the EU Directive N°2004/48/EC of 29 April 2004 on the enforcement of intellectual property rights, which tries to better fight counterfeiting by harmonizing the rules and making more dissuasive sanctions. However, the Rome II Regulation on the law applicable to non-contractual

counterfeiting which tries to bring improvements to the French system of compensation. At stake is the attractiveness and efficiency<sup>4</sup> of the French judicial system. Indeed, contrary to the United States, there is no punitive damage in France or in the EU and no consideration of infringer's profits. According to the principle of civil liability, patent infringement damages consist solely of compensatory damages. The limitation of compensation to the injury suffered but only the prejudice duly justified and the difficulties and proven evaluation involved have been identified as the main causes of the low amount awarded by the French courts (Triet, 2000). The new propositions offer applicants the choice of valuation method, which may correspond either to a calculation of the economic consequences of counterfeiting or as a lump sum that cannot be less than the amount of royalties which would have been due if the infringer had requested authorization to use the patent to which he has violated. However, the Rome II Regulation on the law applicable to non-contractual obligations, provides that the non compensatory damages, such as punitive damages or exemplary damages are contrary to Community public policy<sup>5</sup>.

In this paper, we concentrate on one aspect of patent litigation, namely duration of proceedings in France. Indeed, till recently, due to case management policy, France seemed to be left out of the running by quickest jurisdictions. The analysis of the French system is of special interest because, compared to the U.S., and to a lesser extent to the German and British systems, it works with relatively low costs. From an economic point of view, duration is at least as relevant for the firms as the risk of their patents to become involved in litigation. We thus postulate that patent litigation duration deserves more attention as the costs of litigation are highly driven by the duration of a suit. In the same way, we postulate that damage awards are a key variable to understand the strategic use of patents. Our aim is therefore to examine whether damage awards received by patent owners correctly reflect the value of (generated by) patents as characterized/assessed by economists or econometricians and thus compensate for the opportunity cost of the litigation. In short, to which extent do judges perceive the economic value (as defined by the economic literature) of a patent ? For

---

obligations, provides that the non compensatory damages, such as punitive damages or exemplary damages are contrary to Community public policy (recital 32 of regulation (EC) N°864/2007 of 11 July 2007 on the law applicable to non contractual obligations, OJ L 199, 31.07.2007, PP. 40-49.

<sup>4</sup> By efficiency of justice, we refer to the time periods for trials and the quality of the responses to cases.

<sup>5</sup> Recital 32 of regulation (EC) N°864/2007 of 11 July 2007 on the law applicable to non contractual obligations, OJ L 199, 31.07.2007, PP. 40-49.

that purpose, a proxy measure of the unobserved quality/value of patents is required. Indeed, econometric literature stresses the role of different patent metrics. A factor model (Lanjouw Schankerman 2004) is therefore used as a shortcut for more sophisticated and/or costly methods that deals with multiple patent metrics to address the problem of assessing the value of patents.

As previously outlined, a litigation suit before a district court is the last and most costly alternative to enforce a patent right. The most crucial argument in favor of the decision to file a suit is the expected value of the dispute. This value depends mainly on the value of the patented innovation but also on the characteristics of the parties and technological and economic conditions involved. It is expected that the probability of litigation will be higher for more valuable patents (Lanjouw and Schankerman, 2003; Harhoff and Reitzig, 2004). We therefore focus on those litigated patents for which a ruling on merits was given and for which damages are supposed to compensate a loss of value that normally accrues to the patent owner. Only, rulings on the merits in the case of a plaintiff win are considered (see Appendix). Because of a possible selection bias, we estimate a two step Heckman model.

This paper is organized as follows: in section 2, we outline the French litigation procedure. In section 3, we sketch an econometric model intended to test whether damages received by the plaintiff, if any, are in line with an objective measure of the quality of the patents involved in the case. Section 4 contains a description of the database. Empirical results for France are presented in section 5. The results obtained are discussed in section 6.

## **2. The French patent litigation procedure**

A patent can be subject to litigation before a French district court if it is valid in France. The original application may have been filed at the French patent office (INPI), as a Patent Cooperation Treaty (PCT) patent or at the European Patent Office (EPO), with France as a designated state in the latter cases. One of the main characteristics of the French judicial system as regards patents lies undoubtedly in the fact that in France the same court deal with patent validity and infringement at the same time. The courts of general jurisdiction deal with the patent litigation from the beginning to the end. The same court thus deals with the claim

for infringement and the possible counterclaim for patent revocation raised by the defendant<sup>6</sup>, which avoids a slowing down of the proceedings, since the court should never stay its proceedings for waiting a decision upon the validity.

The claims for infringement constitute the main part of the cases filed before the French courts: the claims for non infringement are very rare and the rest of the cases (agreements, claims for property, invention of employees) constitutes only about 20 % of the cases in first instance. In France all the infringement cases approximately follow the same course to the judgment.

(i)-To commence proceedings, a plaintiff makes a bailiff serve a writ of summons on the opponent party. The writ of summons is an act, which means the proceedings commencement, and includes the plaintiff's claims, which can generally be formulated relatively summarily. There is no discovery or disclosure but search and seizure is widely available. In the case a search and seizure is carried out<sup>7</sup>, the writ of summons has to be served within two weeks after the search and seizure; should he fails to do so, the actual search and seizure will be declared invalid<sup>8</sup>. However a case is not submitted to the court by the service of the writ of summons. For this purpose, once the writ of summons is served, afterwards the plaintiff has to register it in the cause list before the court office.

(ii)-Afterwards the parties communicate their argumentation in the written pleadings. Contrary to the procedure in some countries, the French judges are not aware of the case's exhibits before the oral hearing<sup>9</sup>. Pleadings are based on written evidence only. No legal text limits the number of successive written pleadings communications, nor requires to raise all the legal grounds simultaneously. In practice three or four written pleadings are communicated. The judge managing the case, who controls the course of the case, sets the time limits (generally three to five months) to file the written pleadings as a function of

---

<sup>6</sup> The patentee sometimes invokes unfair competition acts, which are distinct from the infringement but which are related thereto (as an example the reproduction of the product's appearance or package or the hiring away of employees). Under the ordinary rules of French procedure these claims would fall within the jurisdiction of the commercial courts composed of elected tradesmen and not of professional judges. In order to avoid that the patentee has to institute two claims at the same time against the same defendant before two distinct courts, Article L. 615-19 of the French Intellectual Property Code grants the exclusive jurisdiction to the 10 specialized courts to deal with the claims involving a patent infringement and a related question of unfair competition.

<sup>7</sup> In the high majority of the cases a claim for infringement instituted in France is preceded by a search and seizure, which enables to obtain the elements to prove the infringement rapidly and efficiently.

<sup>8</sup> The description part of the minutes remaining valid.

<sup>9</sup> The oral hearing is rarely more than an afternoon, only for attorneys' presentations, no witnesses, no experts.

several factors<sup>10</sup>, namely the case's complexity notably but the patent cases are not generally considered as the simplest ones, and the judge orders the closing when the case seems to him ready to be heard. The burden of proof is incumbent on the plaintiff for infringement. In French law the infringing acts can be proved by any means.

(iii)-The Court in its judgment, generally handed down a few weeks after the hearing can order an expert report<sup>11</sup>. After the result of the expert report the final decision is handed down; it can be accompanied with a provisional enforcement and includes almost always provisions about the litigation costs. The provisional enforcement of a judgment means that the party, which wins its case, can have this judgment enforce against the opponent party, even if the latter lodges an appeal. The judge sets a provisional award and appoints an expert for gathering the elements necessary for the calculation of damages. This means that damages are separate hearing after liability determined. Compensation is based on damages only. There is no account of profits possible. If the patentee does not work his patent : damages amount to a lost royalty while if the patentee/licensee work the patent, damages amount to lost profit (number of sales lost by the plaintiff x the incremental profit margin per unit of the plaintiff). Compensation is based on a combination of lost profit and lost royalty when the patentee/licensee work the patent but would not have made the sales of the infringer but for the infringement. Any other proven damages can be compensated: springboard affect, moratorium, lost profit on ancillary products, etc...the judge can also impose ancillary remedies, like publications. Counterclaims for abusive proceedings may also be raised.

Judgment in first instance are generally appealable. The appeal procedure in France constitutes a full re-hearing *de novo* of the case as to the facts and to the points of law. The appeal procedure suspends the enforcement of the first instance judgment except for provisional measures and unless otherwise decided. Exchange of pleadings and exhibits are similar to procedure before the first instance Court. There is the possibility of bringing additional exhibits, including additional prior art. Decisions in first instance can be upheld, partially confirmed or reversed.

The judgment handed down by the Cour d'Appel (second instance courts), can be appealable before the Cour de Cassation (Supreme Court of Appeal). The proceeding before

---

<sup>10</sup> Since 2007, the number of pleadings is usually limited to 2 for each party.

<sup>11</sup> Rarely in France an expert report is ordered on the merits of the dispute. As regards damages calculation, resorting to an expert report is on the contrary almost systematic.

the Cour de Cassation does not suspend the enforcement of the Court of Appeal decision. The French Cour de Cassation practices a review of the judgment of the Cour d'Appel remitted to it as to the points of law only. There are three possibilities : (i)-The appeal is held non admissible because it lacks interest. (ii)-The appeal is admissible but dismissed : the decision of the Court of appeal is final. (iii)-The appeal is admissible and (partially) admitted. The decision of the Court of appeal is quashed and the case is remanded to another Court of appeal to be decided *de novo* again.

Finally, litigation costs are composed of the lawyer's fees, on the one hand, and of various costs, on the other hand, which, in the practice, include essentially the fees of the bailiff and the expert, that are set according to a rate or a scale (Article 700). The involvement of the court is entirely free.

As already outlined, we concentrate in this paper on the outcomes of the decisions handed down by the Tribunal of First Instance of Paris in the 483 infringement cases for which a judgment on merits was rendered between 2008 and 2013 and which related to 673 patents (some cases involving more several patents and some patents being involved in more than one case)<sup>12</sup>. We more particularly look at the solution given to the case as regards infringement cases (*i*-patent held invalid (LOSS), *ii*-patent held valid but the claim for infringement dismissed (LOSS), *iii*-patent held valid and the claim for infringement accepted (WIN)). We then look at the sums awarded in patent infringement damages, i.e. damages awarded as a fixed sum without expert investigations, final amount of the damages awarded in light of an expert report and the sums allocated pursuant to Article 700 of the French Code of civil Procedure.

### **3- The econometric model**

The econometric model is intended to test whether damages received by the plaintiff, if any, are in line with an objective measure of the quality of the patents involved in the case. High quality patents or portfolio of patents are defined in a broad sense as protecting invention with a high technological and economic potential. The degree of quality is not observed and has to be inferred from patent metrics. We use a latent factor model to compute an estimate of the

---

<sup>12</sup> The reported number of litigation cases slightly underestimates the actual number of case because it is based on cases for which all information was available.

overall quality index of each litigation case. These estimates are then used as explanatory variables of the level of damages decided by the judge. Nevertheless, as damages are decided only for a subset of the cases studied, a potential selection bias has to be dealt with.

### *3.1-The factor model*

We are interested in computing a quality index  $y_i$  of the portfolio of  $N_i$  patents involved in each litigation case  $i$  of our dataset of  $I$  litigation cases. We could think of this quality index as an aggregate of the quality indexes of the  $N_i$  patents but the problem is twofolds.

First, the quality of each particular patent is not directly observed as such but has to be inferred from multiple patent metrics such as family size, claims, forward citations, backward citations at the assignment date. Among the different approaches developed by the econometric literature on patent quality and patent value to circumvent this problem, the factor model is most specifically appealing given our needs and constraints. To our knowledge, it has been first applied by Lanjouw and Schankerman (2004) and more recently by Squicciarini, Dernis and Criscuolo (2013). The key idea is that we observe multiple patent metrics that may be explained by some observed contextual variables (cohort or technology field for instance) and by a common unobserved factor that captures the quality of the patent. Estimating the common factor model and inverting the relation thanks to Bayes' theorem enable any econometrician to provide an estimate of the quality index. As the paper by Squicciarini, Dernis and Criscuolo (2013) stresses, one of the advantages of the method is that it can easily be implemented to a large set of patents and is more cost effective than survey methods (see e.g. Harhoff, Narin, Scherer and Vopel, 1999; Gambardella, Harhoff and Verspagen, 2008). Contrary to renewal methods that focus on an assessment of the monetary value of patents, the quality index estimated by factor models does not refer, at least directly, to an economic value but rather to the technological importance of the patented invention. Nevertheless, renewal methods rely on strong assumptions as regards the behaviour of patent holders whereas the factor model is based on a more intuitive and robust statistical intuition.

Second, we are interested in estimating a quality index of the litigation case rather than of each patent involved in the case. This is why we choose to aggregate patent metrics and to



apply the factor model to these aggregates instead of applying the factor model to each model and then aggregate the different patent-level quality indexes. By doing so, we expect to minimize the role of unobserved heterogeneity at the patent level and to better tackle the role of unobserved heterogeneity of the cases. Accordingly, the factor model for a litigation case  $i$  may be written as

$$x_i^c = \gamma_0 + \sum_{k=1}^K \gamma_k z_i^k + \lambda_c y_i + \varepsilon_i^c \quad \forall c \in \{1, \dots, C\} \quad (1.a)$$

$x_i^c$  denotes the average characteristic or patent metric  $c$  (with  $c \in \{1, \dots, C\}$ ) over all patents involved in the litigation case  $i$ . The  $z_i^k$  (with  $k \in \{1, \dots, K\}$ ) are observed variables common to all characteristics and specific to the case that help to control for differences between technology fields or between cohorts. The unobserved factor  $y_i$  is common to all characteristics  $c \in \{1, \dots, C\}$  but different for each case. Therefore, it is referred to as the latent common factor or latent common determinant of the different characteristics of the case. Unobserved cases and characteristic-specific heterogeneity is captured by the error term  $\varepsilon_i^c$  which is assumed to be independently drawn from a  $N(0, \sigma_c)$  distribution. The expression (1.a) may be equivalently written in the following matrix form

$$\underset{\{C,1\}}{X_i} = \underset{\{C,K\}\{K,1\}}{Z_i} \underset{\{C,1\}}{\Gamma} + \underset{\{C,1\}}{\Lambda} y_i + \underset{\{C,1\}}{E_i} \quad (1.b)$$

where capitals are used to denote the vectors of scalars appearing in (1.a). Factor models can be estimated by maximum likelihood. For this purpose, the unobserved common factor  $y_i$  is assumed to follow an *ex ante*  $N(0, 1)$  distribution. The normalization of the standard deviation to 1 follows on from the impossibility to identify it separately from parameters  $\lambda_c$ . In spite of this normalization, identifying the parameters  $\lambda_c$  remains an unobvious task. An iterative method (Bartholomew and Knott, 1999) can be implemented. Once the model has been estimated by this iterative method, Bayes' theorem is then used to compute the *ex post* (normal) distribution of the common latent factor for each case. Accordingly, the common factor for litigation case  $i$  has expected value.

$$E \left[ y_i / \underset{\{C,1\}}{X_i} \right] = \underset{\{1,C\}}{\Lambda'} \left( \underset{\{C,1\}\{1,C\}}{\Lambda} \underset{\{C,C\}}{\Lambda'} + \underset{\{C,C\}}{\Psi} \right)^{-1} \left( \underset{\{C,1\}}{X_i} - \underset{\{C,k\}\{C,1\}}{Z_i} \underset{\{C,1\}}{\Gamma} \right) \quad (2.a)$$

and variance

$$\text{Var} \begin{bmatrix} y_i / \\ X_i \\ \{C,1\} \end{bmatrix} = \left( \mathbf{1} + \begin{matrix} \Lambda' \\ \{1,C\} \end{matrix} \begin{matrix} \Psi^{-1} \\ \{C,C\} \end{matrix} \begin{matrix} \Lambda \\ \{C,1\} \end{matrix} \right)^{-1} \quad (2.b)$$

where

$$\Psi_{\{C,C\}} = \begin{pmatrix} \sigma_1 & 0 & \cdots & \cdots & 0 \\ 0 & \ddots & & & \vdots \\ \vdots & & \sigma_c & & \vdots \\ \vdots & & & \ddots & 0 \\ 0 & \cdots & \cdots & 0 & \sigma_c \end{pmatrix} \quad (2.c)$$

The expected quality for a case  $i$  given by expression (2) is a linear expression of the observed characteristics and thus differs from litigation case to another one whereas the variance given by (3) is similar for all cases. An important consequence is that the estimated latent quality does not generate heterocedasticity when it is introduced has a regressor in other equations. This is precisely what we do when we attempt to test whether the judge bases her decisions as regards damages on an objective measure of the quality of patents involved in the case.

### ***3.2-The damage model with potential selection bias***

A simple but potentially misleading way to test whether damages  $v_i$  received by the plaintiff in the litigation case  $i$  are correctly explained by the estimate  $\hat{y}_i$  of the latent quality index obtained with expression (2.a) consists in regressing  $v_i$  on  $\hat{y}_i$  and some other observed variables  $z_i^m$  (with  $m \in \{1, \dots, M\}$ ) that are introduced to control for other sources of heterogeneity in observed damages (more specifically trial duration). Accordingly, the damage equation to be estimated could be

$$v_i = \alpha_0 + \sum_{m=1}^M \alpha_m z_i^m + \beta \hat{y}_i + \omega_i \quad (3)$$

where  $\omega_i$  is a i.i.d random term draw form a  $N(0, \varphi)$  probability distribution that captures unobserved heterogeneity in damages. A positive and statistically significant  $\beta$  is expected if damages are more or less linked to the latent quality index. Nevertheless, as stressed in the

description of the French litigation procedure developed in section 2, damages are decided by the judge only for cases judged on the merit and won by the patent holder. Hence, we are not able to estimate equation (3) on the whole set of cases for which data have been collected but only on the subset  $\Omega \subset \{1, \dots, I\}$  of cases judged on the merit and won by the plaintiff. A selection bias problem may then arise if unobserved factors that influence the decision as regards the level of damages are correlated with unobserved factors that influence the fact that the case is judged on the merit and won by the plaintiff. The two outcomes (damages on the one hand and the fact that the case is judged on the merit and won by the plaintiff on the other hand) may for instance depend on the fact that patents involved in the case have been applied for in a defensive or an offensive view. Indeed, to our knowledge, standard patent metrics are not able to capture how IPRs are used by patent holders and what they are aimed at.

The potential selection bias is typically dealt with Heckman's 1979 two- steps estimation method (sometime referred to as the « Heckit » model). In a first step, the probability  $Pr_i$  that a litigation case  $i$  is judged on the merit and won by the patent holder is estimated, on the whole set of the  $I$  litigation cases, with a Probit model.

$$Pr_i = \Pr[h_i > 0] \quad i \in \{1, \dots, I\} \quad (4.a)$$

with

$$h_i = \delta_0 + \sum_{n=1}^N \delta_n u_i^n + \rho \hat{y}_i + \theta_i \quad (4.b)$$

The  $u_i^n$  (with  $n \in \{1, \dots, N\}$ ) are observed determinants of the issue of the case that may include some of the regressors  $z_i^m$  that also explain the level of damages. For their part, the  $\theta_i^n$  (with  $n \in \{1, \dots, N\}$ ) are random terms with a  $N(0, 1)$  distribution that capture unobserved sources of heterogeneity affecting the issue of the case. In a second step, the following modified damage equation is estimated by OLS

$$v_i = \alpha_0 + \sum_{m=1}^M \alpha_m z_i^m + \beta \hat{y}_i + \mu \hat{M}_i + \omega_i \quad i \in \Omega \quad (5.a)$$

with

$$\hat{M}_i = \frac{\phi(\hat{h}_i)}{1 - \Phi(\hat{h}_i)} \quad (5.b)$$

where  $\phi(h)$  is the partial density function of the  $N(0, 1)$  distribution and  $\Phi(h)$  its cumulative density function. Both function are evaluated at the estimated value of the latent variable of the Probit model defined in (4.b) to obtain the estimated inverse Mill ratio  $\hat{M}_i$ . The coefficient  $\mu$  in (5.a) is the covariance of the random terms  $\theta_i$  and  $\omega_i$  for cases  $i \in \Omega$ . Thus, if and only the unobserved factors  $\theta_i$  in the damage equation are not correlated with the unobserved factors influencing the fact that the case is judged on the merit and won by the plaintiff, then the damage equation (5.a) of the « Heckit » model reduces to the simple econometric model defined by equation (3). Otherwise, the term  $\mu \hat{M}_i$  generates a specification bias in the basic model (3) and the associated estimated value of  $\beta$  is potentially biased and unreliable. It is thus crucial to correctly address this potential bias with the « Heckit » model in order to test whether damages received by the plaintiff are in line with the estimated quality of patents involved in the litigation case.

#### 4-The dataset

Our empirical analysis of the French system of intellectual property rights using detailed data of enforcement suits handled at the French district Courts employs a hand collected data set of 483 patent infringement suits encompassing 673 patents<sup>13</sup>. The suits were filed at the district court in Paris from 2008 to 2013. The choice of 2008 as a starting date corresponds to the implementation of the Enforcement Directive in France by the 29 October 2007 Act. One of the consequences of this directive is the concentration of patent litigation cases. All cases are now handled by a limited number of courts and since 1 November 2009 by the court of first instance of Paris only, both in first instance and in appeal. This concentration of patent litigation is supposed to enhance the quality of patent case law since all decisions are issued by specialist judges and to increase legal security since it is no longer possible for a plaintiff to choose a court with less experienced judges for a « weak » case.

---

<sup>13</sup> France is the 4th country in the world for patent litigation, after the USA, China and Germany. This represents a litigation rate of less than one patent for every 1,000 patents per year.

Another consequence is that this transposition law is supposed to bring improvement to the French system of compensation.

Our hand collected data set contains summaries of first instance final decisions of *inter partes* patent infringement cases by calendar and matches them with patent characteristics. The point of focus is solely on patent cases terminating by court judgments and for which there was a ruling on merits. Judgments not considering the merits of case are not taken into consideration. Indeed, the trial can take on an important role in the information exchange process and the (potentially *ex-ante* diverging) information sets of different parties converge.

A large set of party information, information about the infringement action and facts about the course of the case are taken into account.

Three kinds of data have been collected : (i) data on patents' characteristics, (ii)-data on firms' characteristics and (iii)-data on litigation procedure and outcome.

(i)-Data on patent' characteristics extracted from the database *Patstat*©, such as the nature of the patent invoked (FR, EP, PCT), the filing and granting dates, the priority date and country, the family size, the number of renewal years, the number and nationality of inventors, the number of (dependent) claims, the number of (self) forwards/backwards citations, the technical field, survival of an opposition procedure, whether a license was granted and a transmission of property took place.

(ii)-Complementary data on firms' characteristics were added using the *Datastream*© database such as the nationality of the claimants and defendants, their status (companies, individuals, institutions), firm size measured by the number of employees if appropriate. Industry codes according to the European NACE classification were added as well as, whether the defendant or claimant is the patent holder or a licensee, the number of previous trials in which they were involved, the patent stock at the date of the assignment and whether they filed for bankruptcy and R&D spending. One of the underlying hypothesis here is that the more R&D a firm spend, the more it may increase its risk of infringement given that the firm cannot feasibly determine all possible patents it may need to avoid. In the same way, the firms' technological closeness is supposed to increase the probability of a suit. Variables correlated with the value of the patent, such as the number of citations made and received, the size of the patent family, the portfolio size, the number of claims, and the path of seeking patent protection within the French and European market were included. Control variables

such as earlier opposition procedures and the path of seeking protection were also included. Merging these data with the litigation data gives us a more detailed picture of the corporations involved.

(iii)-Data on litigation procedure and outcome of the litigation suits were extracted from the files in court archives. The Court of first instance of Paris was asked for access to its written case records. There is a wide range of different legal arguments treated in the three chambers : disputes over general contracts, license suits and IPR cases including patents, utility patents, copyright and trademarks. We discarded all suits regarding disputes over license contracts, legal arguments about compensation of employees' inventions, and other cases with patents and utility patents involved but where no infringement took place. After this second screening, 379 cases were left within the sample. The correspondence of the parties, including the statement of claims and the response of the defendant was checked. This process yielded information about the requested claims and the arguments of the parties. The court decisions and rulings revealed the outcome and the costs of the cases. The information extracted from the written case files was divided into three main categories : the proceedings of the suit, the parties, and the patent at issue. The first category covers a brief description of the stages of the infringement case. It includes the nature of the legal issues raised (counterfeiting, employees' invention, claim for a license agreement, contracted dispute, property claim, unfair competition, patent/claim nullity, ...), the nature of the counter-claim. It also includes the dates of filing, the oral hearing and the ruling, as well as whether a search and seizure (S&S) was conducted, the dates of the S&S order and the date of the S&S. The nature of the decision was also precised, i.e. a judgment (not) ruling on the merits of the case (withdrawal, stay of proceedings); Finally, all case files reported the outcomes of the decision (patent held invalid ("loss"), patent valid and infringed ("win"), patent valid and not infringed, unfair competition), whether an expert was appointed, the amount of civil damages awarded and ancillary sanctions imposed (prohibition, destruction, seizure measures, publication (cost), art. 700 NCPC). Cost figures were also collected. Additionally, paid damages were added to the costs. The second category covers the names and the locations of the parties involved in the trial. The third category covers information on the patents, such as the age of the patent at time of filing as well as the field of technology.

In order to complete the information about the patents involved in the disputes, data from the French patent office (INPI) and the European Patent Office (OEB) were added. Information

on application dates, granting dates, IPC classifications and the applicants and inventors are available from the database EPOLINE. All bibliographic data such as the fee payments, oppositions and their results, changes of the patentee, and the lapsing of the patent in the public domain, information about backward and forward citations / were extracted by searching the database / are viewable in this file.

## **5-Estimation results**

For the implementation of the latent factor model, eight characteristics of patents involved in the litigation cases have been considered. They correspond to standard patent metrics that are generally expected to capture the technological or economic value of patents. Several of them have been found to significantly impact the stated monetary value of patents in surveys (Harhoff, Narin, Scherer and Vopel, 1999; Gambardella, Harhoff and Verspagen, 2008) and/or have already been used in previous works that applied the latent factor model to assess the quality of patents (Lanjouw and Schankerman, 2004; Squicciarini, Dernis and Criscuolo, 2013). These metrics are the average number of backward citations, the average number of independent claims, the average family size, the average number of forward citations divided by the age of the patent, the average number of applicants, the average number of oppositions, the proportion of patents with a licence, the average number of non-applicant inventors. For citations, whether they are backwards or forwards, each patent involved in a case was weighted by the share of self-citations in the total number of citations before computing the average citations for the litigation case. Each of these eight characteristics is explained by the common (case-specific) latent factor and two other groups of exogenous variables. The first group gathers two dates corresponding to the cohorts of respectively the oldest and the most recent patents in the patents' portfolio. The second group is a set of dummy variables for technological classes (IPC largest technological fields).

Insert Table 1

As shown by Table 1, the latent factor model induces an important increase of the share of the explained variance of the eight patent metrics. Figures in Table 1 correspond to estimates made on the subset of 379 litigation cases obtained after having discarded all suits regarding disputes over license contracts, legal arguments about compensation of employees' inventions, and other cases with patents and utility patents involved but where no infringement took place. Whereas at least 1.8% and at most 16.8% of the variance is explained by a basic linear model with cohorts and technological fields as explanatory variables, these shares raise respectively up to 6.7% and 27% thanks to the latent common factor. Table 1 also reports the coefficients of the common latent factor in the equation explaining each metric (the  $\lambda_c$  in equation 1.a) and the coefficient of each patent metric in the expected value of the latent factor (the elements of the row vector  $\Lambda'(\Lambda\Lambda'+\Psi)^{-1}$  in equation 2.a). More interestingly, the last row of Table 1 indicates the average contribution, over the different litigation cases, of each patent metric in the overall expected value of the latent factor. Backward citations and claims clearly appear as the most prominent metrics contributing the latent quality of the set of patents involved in the different litigation cases followed by the number of non-applicant inventors and the family size. At the opposite, the average number of opposition has a low contribution. More surprisingly, forward citations poorly contribute to the expected index of quality. This result sharply contrasts with the key role generally outlined in the empirical literature, for instance the survey studies by Harhoff, Narin, Scherer and Vopel (1999) or Gambardella, Harhoff and Verspagen (2008). Note however that our results are not directly comparable with that of these previous studies because we focus on those patents involved in a litigation case, not on the whole set of patents.

Insert Figure 1

The distribution of the quality index represented in Figure 1 is in line with the recurrent findings in the empirical literature on patents that the distribution is highly skewed. The negative values of the index of quality observed on Figure 1 result from the fact that the expected value of the latent factor is assumed to follow an *ex ante*  $N(0,1)$  distribution.



However, this is a normalization and any linear transformation of this value produces a consistent indicator of the quality of patents involved in each case.

### Insert Table 2

In the first step of the « Heckit » model that explains the outcome of the litigation case, the binary explained variable takes value one if the merit of the case is examined and the patent holder win the case and value zero otherwise. We obtain that 108 cases over the 379 cases judged on the merit were won by the patent holder. Thus, only 28.5% of the cases judged on the merit end in favor of the patent holder. This percentage stresses how uncertain are patent as property rights. Dummy variables for technological fields (IPC classes) and the estimated expected value of the « quality » index for the portfolio of patents involved in the case were used as exogenous variable, in addition to the intercept. Table 2 reports the estimation results for the first step of the « Heckit » model. The Probit model defined in (4.a) and (4.b) above poorly improves on a purely stochastic model of the outcome of the litigation case. Except for the technology field “Chemistry; Metallurgy”, no significant impact of the technology field is found. Moreover, the quality index of the patents involved seems to have no significant influence on the outcome. It thus appears that the outcome of the litigation rather relies on idiosyncratic unobserved factors than on the few explanatory variables used in the model and thus remains mainly unpredictable. It may be thought of as a positive result in the sense that it means that the judge is neither influenced by the context (at least by the sector) nor by an *a priori* quality of patents involved but rather examine in details the case.

### Insert Table 3

In the second step of the « Heckit » model that explains the level of damages for those cases judged on the merits and won buy the patents holder, the duration of litigation the total patent count for the patent holder at the date of assignment and the inverse Mills ratio were introduced as additional exogenous variables compared to the first step. The last variable is

intended to capture a potential selection bias but is statistically not significant. Therefore, we conclude that the selection bias in our problem is not relevant. The total count or stock of patents was introduced in order to account for the size of the patent holder but it reveals to have no significant impact on the damages decided by the judge. More interestingly, the duration of the litigation has a positive and highly significant influence on damages. Thus, the judge compensates the patent holder, in the case she wins the litigation, for a long lasting procedure. Last but not least, the expected quality index inferred from the common latent factor model also exhibits a positive and highly significant coefficient. This clearly suggests that the damages are based on objective grounds related to the quality of the patents involved in the case. In order to further investigate this point, an alternative model has been estimated. In this alternative model, each patent metric has been introduced as a separate exogenous variable instead of aggregating these metrics in the index of quality. Therefore, the alternative model enables us to assess the weight accorded by the judge to each metric whereas the previous model constrains these weights to the values obtained with the factor model. The resulting linear combination of patent metrics may be thought of as the quality index of the patents involved in the case that the judge estimates on her own. Table 4 reports the coefficient estimated for each metric in the model and the average contribution of each metric to this alternative index of quality. The last line of Table 4 can be directly compared to the last line of Table 1. Accordingly, Table 4 shows that the judge substantially over-weights backward citations and under-weights most of the other metrics compared to the factor model. Nevertheless, if we plot the index of quality as assessed by the judge against the index of quality obtained from the factor model, we conclude that there is a strong correlation between the two (see Figure 2). We thus conclude that damages are not set arbitrarily or on the basis of unforeseen elements but are highly predictable and correlated to an objective measure of the quality of patents involved.

Insert Table 4

Insert Figure 2

## 6-Conclusive remarks

Our results show that, whereas the outcome of litigation on patents are mainly influenced by idiosyncratic elements that make it unpredictable, patent damage awards attributed by French judges are positively and significantly linked to patent quality as assessed from a statistical point of view. Given the high proportion of litigation cases in our dataset that are judged on the merit but lost by the patent holder, this means that patents are unsecured property rights but that, when they are confirmed to their holder, their value is correctly assessed by the judge. This suggests that the uncertainty that surrounds patents is rather due to a lack of accuracy at the grant stage than to difficulties to assess their value at the litigation stage.

## References

- Baker, S; and Mezzeti, C. (2009), Optimal patent jurisprudence, *TILEC Discussion Paper 6*, Tilburg University.
- Bartholomew, D.J., Knott, M. (1999). *Latent Variable Models and Factor Analysis*, New York: Oxford University Press, 2<sup>nd</sup> ed.
- Bebchuk, L.I. (1984), Litigation and settlement under imperfect information, *RAND Journal of Economics*, 15, 404-417.
- Bessen, J; and Meurer, M.J. (2004). The patent litigation explosion, *Working Paper N°05-18*, Boston University School of Law.
- Choi, J.P. (1998), Patent litigation as an information transmission mechanism, December, *American Economic Review*, 1249-1263.
- Cotter, T.F. (2013), *Comparative patent remedies : a legal and economic analysis*, Oxford University Press.
- Cooter, R. and Rubinfeld, D.L. (1989). Economic analysis of legal disputes and their resolution, *Journal of Economic Literature* 27, 1067-1097.
- Crampes, C. and Langinier, C. (2002). Litigation and settlement in patent infringement cases, *RAND Journal of Economics* 33(2), 258-274.
- Cremers, K; (2004). Determinants of patent litigation in Germany, *Working Paper 04-72*, ZEW.

Cremers, K., Ernicke, M., Gaessler, F., Harhoff, D., Helmers, L., Mc Donagh, L., Paula Schliessler, P. and N. van Zeebroeck (2013). Patent Litigation in Europe, *ZEW Discussion Paper* No. 13-072, Mannheim.

Cremers, K., Harhoff, D., Georg Licht, Peters, B., (2006). Determinants of duration of patent trials, *Working paper ZEW*.

Gambardella, A., D. Harhoff, B., Verspagen, (2008). The Value of European Patents, *European Management Review*.

Harhoff, D., F. Narin, F. M. Scherer, K. Vopel, (1999). Citation Frequency and the Value of Patented Innovation, *Review of Economics and Statistics*, 1999, 81, 3, 511 - 515.

Heckman, James J., 1979. Sample Selection Bias as a Specification Error, *Econometrica* 47(1): 153-161.

Lanjouw, J.O. and Lerner, J. (1998). The enforcement of intellectual property rights : a survey of the empirical literature, *Annales d'Economie et de Statistiques* 49/50, 223-246.

Lanjouw, J.O. and Schankerman, M. (1997). Stylized facts of patent litigation : value, scope and ownership, *Working Paper* N° 6297, NBER, Cambridge, MA.

Lanjouw, J.O. and Schankerman, M. (2001). Characteristics of patent litigation : a window on competition, *RAND Journal of Economics* 32, 129-151.

Lanjouw, J.O. and Schankerman, M. (2003). Enforcement of patent rights in the United States, in W.M. Cohen and A. Merrill (eds), *Patents in the knowledge-based economy*, The National academic Press, Washington.

Lanjouw, J.O. and Schankerman, M. (2004). Patent quality and research productivity : measuring innovation with multiple indicators, *Economic Journal*, 114 (495), 441-465.

Marshall, H. (2000). The enforcement of patent rights in Germany, *International Review of Industrial Property and Copyright Law* 31(6), 646-676.

Pitz, J. (1999). Economic aspects of patent litigation in Europe, *Patent World*.

Priest, G.L. and Klein, B. (1984). The selection of disputes for litigation, *Journal of Legal Studies* 13, 1-55.

Reitzig, M., Henkel, J. and Heeeaaath, C. (2003). Who really profits from patent infringements ? A comparative international, *Technical report*, University of Munich.

Squicciarini, M., H. Dernis and C. Criscuolo (2013). « Measuring Patent Quality : Indicators of Technological and Economic Value », *OECD Science, Technology and Industry Working Papers*, 2013/03, OECD Publishing [En ligne]. [<http://dx.doi.org/10.1787/5k4522wkw1r8-en>].

Waldfogel, J. (1998). Reconciling asymmetric information and divergent expectations theories of litigation, *Journal of Law and Economics* 41, 451-476.

*Table 1 :*  
*results of the common latent factor model*

	Bacwards citations	claims	Family size	Forward citations	applicant	oppositions	licences	inventors
% of variance explained without the common latent factor	0,0281	0,0567	0,0821	0,0939	0,0897	0,0182	0,1144	0,1678
% of variance explained with the common latent factor	0,0673	0,1875	0,2638	0,1270	0,1915	0,1054	0,1494	0,2699
Coefficient of the latent factor in the estimated equation	0,8490	0,8838	13,6344	0,1129	0,1599	0,7334	0,0629	0,5492
Coefficient of the patents' characteristic in the expression of the expected latent factor	0,0327	0,0934	0,0091	0,0818	0,3216	0,1029	0,2057	0,0816
Average share of the expected latent factor corresponding to the patents' characteristic	0,2583	0,2066	0,1388	0,0232	0,1152	0,0300	0,0602	0,1674

*Table 2 :*  
*results for the first step of the « Heckit » model*

		Variables	Estimated coefficient (t-stat)
		intercept	-0.6581 (-5.3447)
Technological field	A	<i>“Human necessities”</i>	reference
	B	<i>“Performing operations; Transporting”</i>	0.2650 (1.7114)
	C	<i>“Chemistry; Metallurgy”</i>	-0.4467 (-2.1165)
	D	<i>“Textiles; Paper”</i>	0.0981 (0.2284)
	E	<i>“Fixed constructions”</i>	0.0997 (0.5022)
	F	<i>“Mechanical engineering; Lighting; Heating; Weapons; Blasting”</i>	-0.0738 (-0.3537)
	G	<i>“Physics”</i>	-0.0651 (-0.3091)
	H	<i>“Electricity”</i>	0.1866 (0.8563)
		Expected « quality » index of the patents	-0.0700 (-0.7776)

*Table 3 :*  
*results for the second step of the « Heckit » model*

Variables		Estimated coefficient (t-stat)
	intercept	-0.7964 (-0.0992)
Technological field	A Human necessities	reference
	B Performing operations; Transporting	-3.2621 (-1.3355)
	C Chemistry; Metallurgy	5.2626 (1.4731)
	D Textiles; Paper	-0.8604 (-0.6973)
	E Fixed constructions	-0.8782 (-0.9222)
	F Mechanical engineering; Lighting; Heating; Weapons; Blasting	1.7732 (2.2727)
	G Physics	1.3720 (2.0010)
	H Electricity	-1.9469 (-1.1185)
	Expected « quality » index of the patents	1.4811 (2.3448)
	Duration of the litigation	0.0007 (5.4108)
	Stock of patents at the litigation date	0.0001 (0.1576)
	Inverse Mills ratio	24.8168 (1.3434)
R <sup>2</sup>		0.3097



*Table 4 :*

*decomposition of the quality index as assessed by the judge*

	Bacwards citations	claims	Family size	Forward citations	applicant	oppositions	licences	inventors
Coefficient of the patents' characteristics used by the judge to determine damages	0.1347	0.0894	0.0100	0.3477	0.2218	0.3976	0.4952	0.1001
Average implicit weight of the patents' characteristics used by the judge to determine damages	0,5211	0,1018	0,0803	0,0468	0,0650	0,0261	0,0607	0,0981

Figure 1 :

*distribution of the quality index obtained with the common latent factor model*

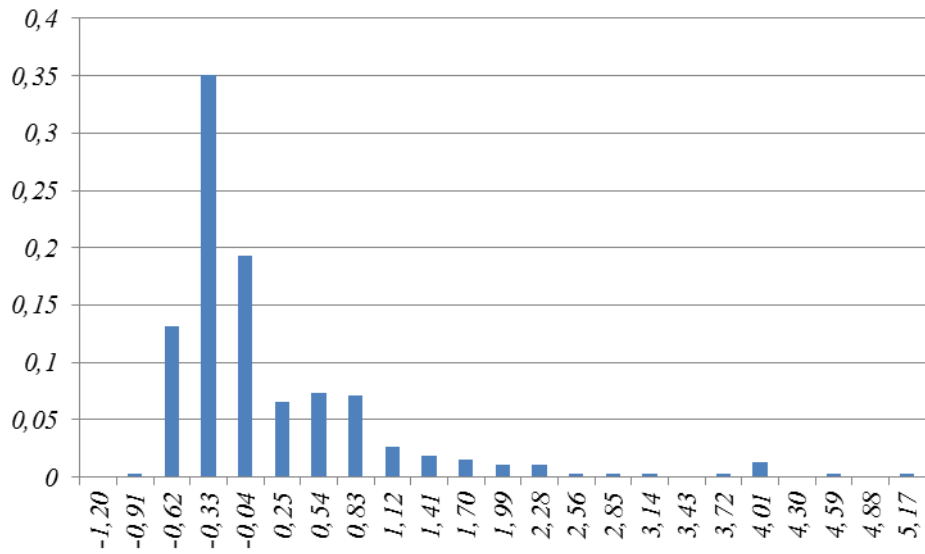


Figure 2 :

*comparison between the quality index obtained with the common latent factor model (in abscissa) and the quality index implicitly assessed by the judge (in ordinates)*

