Law and Economics of Litigation: New Insights from Patents*

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PRELIMINARY VERSION

Abstract

We study how patent, firm and judge characteristics influence the duration of patent disputes. We derive hypotheses from a theoretical framework and test the predictions using a hand-collected dataset on patent litigation. We show that the value of a patent increases the duration of a case, while lower uncertainty, measured by judge experience and patent characteristics, decreases the duration. The presence of large firms has a positive influence on the settlement time. Contrary, non-practicing entities, often referred as patent trolls, reduce the settlement time. The results give further insights to the analysis of patent litigation but also to litigation in general.

Keywords: litigation, patents, settlement, patent trolls, bargaining
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1 Introduction

The laws and rules of a society set the framework for individual behavior. Even though many rights are secured by law, other rights especially in civil law are not protected automatically. In order to enforce rights, one has to go through (costly) litigation. Therefore, litigation is one of the most important mechanisms to enforce the (civil) laws and rules of a society.

In this paper, we focus on the duration of litigation. We present a model proposed by Galasso and Schankerman (2010), which is based on Bebchuk (1984), and extend it for the purpose of analyzing party characteristics. We derive several hypotheses from the model and test these predictions empirically. We give new insights with respect to the characteristics of the parties and the judges.

The general economic analysis of litigation always hinges on the question why we observe litigation at all. With perfect information, involved parties anticipate the judgment and settle their dispute upfront in order to avoid legal costs. Although litigation can involve tremendous costs, we do observe trials quite often and the literature on this topic has given some explanations for this observation. First, asymmetries in stake sizes may lead to situations in which they are not able to come to a bargaining solution (Cooter and Rubinfeld, 1989). Following this idea, uncertainty and the resulting divergent expectations about likely outcomes between parties may be reasons for asymmetric stakes and the failure of finding a settlement solution (Priest and Klein, 1984). Second, asymmetric information may circumvent settlement because at least one party does not know its correct winning probability and may hence not be willing to offer a sufficient settlement amount (Bebchuk, 1984; P'ng, 1983). Analyzing the occurrence of litigation is closely related to the duration of litigation. Litigation occurs whenever a settlement between the parties fails. For a longer duration of a case, the parties failed to settle more often.

The asymmetric stake size hypothesis as well as the asymmetric information hypothesis fit very well to the case of patent infringement. Patents very often involve specific knowledge which leads to a lack of understanding for outsiders or less informed parties. The parties may have private information, or they may diverge in their understanding of the law or their assumptions about the judge. In addition, as patents secure monopoly positions on markets, and parties' risk attitude may differ, stake sizes are likely to differ as well. Further, a patent case with unclear boundaries of the intellectual property usually involves some degree of uncertainty which could be quite complicated to be resolved. Considering an example of a simple tort case in which the amount of damage is obvious, the legal situation and consequences could be resolved more easily.

In order to test our predictions, we exploit the detailed information of a data set on patent litigation. We pretty much follow the analysis of Galasso and Schankerman (2010)

but extend their analysis with respect to characteristics of the parties. We show that the value of the associated patents, and the (endogenous) litigation costs of the parties affects the duration of a case. In particular, we show that the presence of non-practicing entities (NPEs), often referred as patent trolls, reduces the duration, while the presence of large firms increases the duration. Furthermore, the more information are known about a judge, and the better he can be analyzed by the parties, the shorter is the duration.

An important strand of the literature has concentrated on patent litigation risk, i.e., the risk of patents to be involved in litigation. These studies match litigated and non-litigated patents to determine the influence of specific patent characteristics on the litigation risk of a patent. The first to mention is the analysis of Lanjouw and Schankerman (2001) who use a data set on US patents. They find that the probability of litigation increases in the patents' value, measured by future references a patent received.

Other empirical studies in the field of patent litigation are Cremers (2004), Lerner (2010), and Somaya (2003). Cremers (2004) uses a data set similar to Lanjouw and Schankerman (2001), but focusses on German patents. Her results with respect to the patent value are in line with Lanjouw and Schankerman (2001). Lerner (2010) concentrates on patents in the financial industry and finds that these patents are much more frequently litigated than other patents. Within the group of financial patents, those patents indicating a higher patent value again increase the probability of litigation. Somaya (2003) focuses on the computer, and medicine industry, and finds that the likelihood for patent suits to be settled is lower if one of the parties has a strategic stake in the respective patent, which corresponds to a higher stake size in a case.

Except Somaya (2003) and Galasso and Schankerman (2010) the mentioned studies estimate the probability of patents to become subjects of litigation. Litigation risk is principally driven by two effects, the probability of an incident and the failure of an out-of-court settlement. Because most of the studies focus on litigation risk on the patent level, they are not able to disentangle these two effects clearly. By focusing on cases of litigated patents, our results contributes to the solution of this problem. The results are independent of the probability of an incident and can be explained solely by the failure of settlement between the parties.

Our study also tackles the research on costs of litigation. Lanjouw and Schankerman (2001) notice that *"very little is known about the costs of enforcing patent (and other intellectual property) rights. To make an economic assessment, one needs three types of information: the probability of litigation, the pattern of outcomes (settlement rates and win rates in trials), and the costs of settling and going to trial"*. We investigate the second and third kinds of information. Longer cases are usually associated with higher costs for all participants. We study drivers of trial costs and, therefore, litigation costs.

The paper is organized as follows. In the next section we present the theoretical foundation for our analysis. Chapter 3 describes our data. We state our hypotheses n chapter 4 and present our results in the 5th chapter, before we conclude in chapter 6.

2 Theoretical foundation

We present a two-period model proposed by Galasso and Schankerman (2010) which is based on Bebchuk (1984). A patentee sues an infringer for infringement of a patent. The infringer has private information about important facts of the infringement. An infringer of type p knows that he loses the case with probability p. The patentee does not observe the infringer's type and only knows that p is distributed uniformly over $[0, 1]$ with density equal to one.

The timing of the litigation game is as follows. In period $t = 0$, the patentee makes a take-it-or-leave-it settlement offer S to the infringer. The infringer either accepts or rejects the offer. For the case he accepts the offer, the game ends. In case he rejects the offer, the trial takes place in $t = 1$. If the patentee wins the case, the court awards the patentee damages equal to Z. Both parties have to bear (fix) litigation costs L_i and L_p, respectively. Figure 1 summarizes the game.

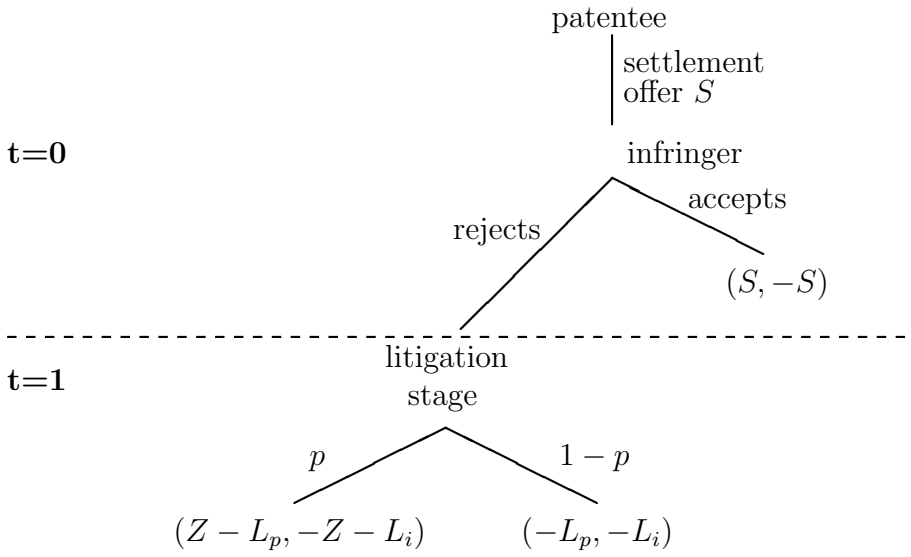

Figure 1: Timing of the game

An infringer of type p accepts a settlement payment as long as it is lower than the expected trial award plus the litigation costs, i.e., if $S \leq pZ + L_i$. Making a settlement offer is equivalent to choosing a cutoff value $\tilde{p} = (S - L_i)/Z$ from the viewpoint of the

patentee. Every infringer of type $p \geq \tilde{p}$ accepts the offer while an infringer of type $p < \tilde{p}$ rejects the offer. It follows directly that the patentee can maximize its profit by choosing the optimal cutoff type $\tilde{p}\epsilon[0,1]$:

$$\max_{\tilde{p}} \quad \pi = (1-\tilde{p})(\tilde{p}Z + L_i) + \tilde{p}(\frac{1}{2}\tilde{p}Z - L_p). \tag{1}$$

The settlement offer influences the average type of defendants in the trial which becomes $\frac{1}{2}\tilde{p}$. Hence, the expected payoff from litigation amounts to $\frac{1}{2}\tilde{p}Z - L_p$. Maximizing the profit function yields the optimal cutoff type:

$$p^* = 1 - \frac{L}{Z}, \tag{2}$$

where $L = L_i + L_p$.

Because of the uniform distribution, the fraction $1-p^*$ of all cases settle before trial in period $t = 0$, while the fraction p^* proceeds to trial in period $t = 1$. Hence, the expected settlement time is determined by p^*:

$$E(t^*) = p^*. \tag{3}$$

Proposition 1 *The expected settlement time decreases in the (fix) litigation costs and increases in the value at stake.*

Obviously, higher litigation costs of the patentee make a trial less appealing. Higher litigation costs of the infringer increase the settlement amount and increase the attractiveness of a settlement further, too. Because the settlement amount increases in the cut-off type to a larger extend than the expected payoff from litigation, a higher Z lets the patentee increase the cut-off type to earn higher rents from the settlements.

Using the result of Proposition 1, we can also analyze the effect of risk-aversion of the parties on the settlement timing. Risk-aversion of the infringer lowers the attractiveness of risky litigation and the infringer is willing to accept ceteris paribus a higher settlement amount. This makes settlement more attractive and lowers the settlement time. Similarly, risk-aversion of the patentee lets the patentee demand a lower settlement amount. More types of infringers accept and the settlement time is lower.

Proposition 2 *The expected settlement time decreases with risk-aversion of the parties.*

The effect of uncertainty. Galasso and Schankerman (2010) also address the issue of a variation in uncertainty. Assume that the probability that the plaintiff prevails at trial p is distributed over the interval $[\frac{1}{2}(1-\lambda), \frac{1}{2}(1+\lambda)]$ with $\lambda\epsilon[0,1]$. Varying λ preserves the mean at $\frac{1}{2}$, but changes the variance of the distribution. An increase of λ increases the uncertainty for the patentee.

With a varying λ the optimal cutoff type changes to

$$p^*(\lambda) = \frac{1}{2} + \frac{\lambda}{2} - \frac{L}{Z}. \tag{4}$$

Calculating the expected settlement time gives

$$E(t^*(\lambda)) = \frac{p^*(\lambda) - \frac{1}{2}(1-\lambda)}{\lambda} = 1 - \frac{L}{\lambda Z}. \tag{5}$$

Proposition 3 *The expected settlement time increases in uncertainty.*

The effect of endogenous dispute costs. Until now we assumed fixed litigation costs. However in practice, parties invest in legal counsels in order to provide evidence in their favor. Therefore, the absolute costs depend on their investment in effort in a case. The amount they invest depends on the marginal benefits of the investment, an increase in the probability of winning, and the marginal costs. In order to analyze the behavior of different kinds of parties, we allow parties to invest in effort before the case is judged. We assume that each party can invest a quantity $x_p, x_i \geq 0$ which influences the probability of winning in their direction. These investments are costly. The patentee incurs cost of $h_p x_p^2$, while the infringer incurs cost of $h_i x_i^2$. The cost parameters h_p and h_i are publicly known. Figure 2 summarizes the timing.

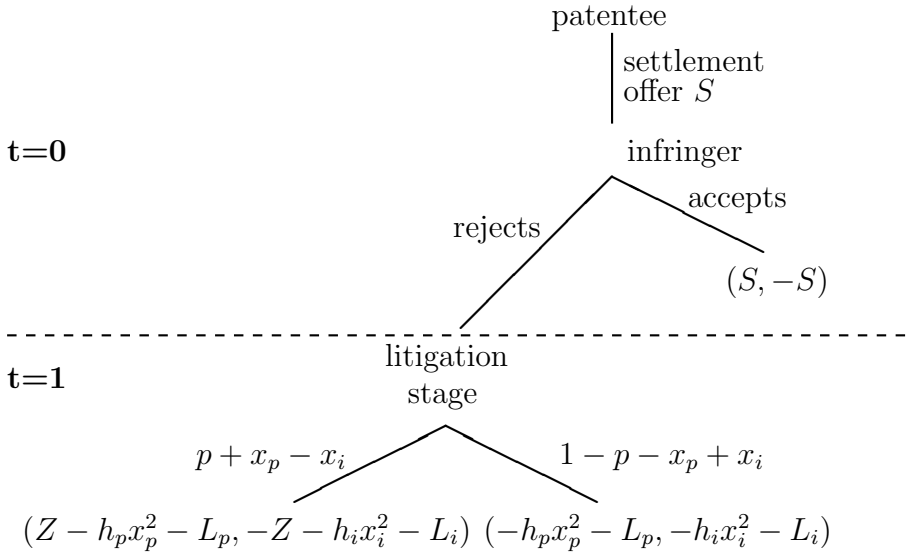

Figure 2: Timing of the game

Given this set-up, the payoff functions at the litigation stage change to

$$P_p = (p + x_p - x_i)Z - h_p x_p^2 - L_p, \tag{6}$$

$$P_i = -(p + x_p - x_i)Z - h_i x_i^2 - L_i. \tag{7}$$

For simplicity, we assume that $h_p \leq h_i$[1].Maximizing the payoffs with respect to the efforts gives $x_p = Z/2h_p$ and $x_i = Z/2h_i$. The effort choice is independent of the cost parameters of the opponent. Plugging these values in the payoff functions gives the equilibrium profits of the litigation stage:

$$P_p = pZ + \frac{h_i - 2h_p}{4h_p h_i} Z^2 - L_p, \tag{8}$$

$$P_i = -pZ + \frac{h_p - 2h_i}{4h_p h_i} Z^2 - L_i. \tag{9}$$

These payoff functions show the rent-seeking characteristics of the game. Litigation is a zero-sum game and any investment in influencing the winning probability is therefore wasteful from a social point of view. In the case of equal marginal costs, both parties invest the same amount and both parties are in equilibrium worse off compared to no investment. In contrast, if one of the parties is sufficiently more productive than the competitor, the increase in the expected award may outweigh the additional costs.

Taking these activities into account while offering the settlement in the first stage, the optimal cutoff type becomes

$$p^*(h_i, h_p) = E(t^*(h_i, h_p)) = 1 - \frac{L}{Z} - \frac{h_p + h_i}{4h_p h_i} Z. \tag{10}$$

Proposition 4 *The expected settlement time increases in the marginal effort costs.*

At first sight, this result is surprising. One would expect that parties with higher costs favor settlement. However, the increase in settlement time is a direct following of the rent-seeking characteristics of litigation. For lower marginal costs of effort, parties invest more and the absolute costs of litigation increase. Higher absolute costs of litigation favor a settlement and, therefore, decrease the settlement time.

3 Dataset

We use patent litigation data extracted from Lex Machina database, a comprehensive source of intellectual property litigation cases filed in the US. The database allows the construction of a unique and hand-collected data set on the structure of patent cases.[2]

[1]This assumption avoids distinguishing cases for the infringers. Because the infringer knows its type and invests only until the winning probability becomes 0, we receive corner solutions for infringers with a "low" p. These corner solutions also influence the behavior of the infringer. In order, to keep the analysis simple, we avoid these corner solutions. An alternative assumption would be to restrict the type space of infringers.

[2]Lex Machina is also known as *Intellectual Property Litigation Clearinghouse* (www.lexmachina.com).

Because of the time-consuming data collection process, a full data collection is not realizable. To construct a random sample, we focused on cases filed between April 2004 and June 2007. In order to rule out potential season effects, we sorted cases according to their filing date and gathered information on every tenth case. This resulted in a sample of 779 observations. We compared characteristics of our sample with the overall data in order to rule out biases.

Unfortunately, we need to exclude 235 observations from our analysis. As we are not able to clearly follow cases in Lex Machina which have been transferred from one court to another, we drop these observations. The same is true for cases consolidated to a lead case. For those cases, we are not only concerned because of missing information, but also because these cases differ in their structure compared to the other cases. We also exclude cases which are dismissed by the court because of a lack of jurisdiction. We do not consider such a dismissal as a judgment as it does not solve the underlying issue. The dismissal states only that the case cannot be carried in the specific form at the specific court. Furthermore, we take only terminated cases into account. We also exclude all cases for which we are not observing the patents involved. We are left with a revised data set of 544 cases.

We observe different kinds of case outcomes. A case can be settled out-of-court (settlement), or terminated by different kind of judgments.[3] As we do not observe any characteristics of the out-of-court agreements, we simply characterize every case terminated voluntarily by one of the parties as an out-of-court settlement. We add cases with consent judgements which could be characterized as legally binding settlements. Settlements account for about 88 percent of all cases in the revised data set. The numbers of the different outcomes and the relative values of our figures are very much in line with the overall Lex Machina database.

Outcome	**Obs.**
settlement	434
consent judgment	47
trial and judgment	15
summary judgment	42
default judgment	6
excluded	235

Table 1: Case outcomes

In addition to the outcomes, we observe the parties involved, the patents which are the objects of dispute in the cases, the court district, and the judges. Furthermore, we do

[3]We do not consider appealed cases; the cases end at latest with a judgment. Note that the possibility of an appeal does not change our reasoning, since it is contained in the (expected) costs of litigation.

not only observe the duration of the cases in days but also all docket events from the filing until the termination date. A docket event is any event that is directly associated to a case. This includes all orders but also all further declarations by the judge as well as all motions of the parties. With respect to the parties, we can distinguish between the plaintiff(s) and defendant(s) as well as potential counter-claimant(s) and counter-defendant(s).

We matched additional information about the patents, parties, judges, and district courts. We gathered information on patent characteristics from the United States Patent and Trademark Office (USPTO). The characteristics include the patent age, the number of claims, and the number of backward citations and future references. A patent may be either a design or utility patent.

Regarding the party characteristics we used several sources. The complaint of each case tells us whether the party is an individual or a firm, the main place of business, and country and state where the firm is founded. We also checked each individual if she is the owner of another party involved. If she is not an independent individual, we handled her similar to a firm. In recent years, non-practicing entities (NPEs) became more and more present in patent litigation. NPEs are firms that hold patents only for licensing purposes without using the patent for own production. We received a characterization of our parties as NPEs from Patent Freedom, the most comprehensive database on NPEs. Furthermore, we performed a matching of our parties with the Forbes Global 2000 from 2007. This list comprises the 2000 biggest companies in the world. Even though we analyze US cases, we also observe foreign companies in our sample. Because the Forbes Global 2000 contains more than 600 US companies, it is even with respect to the US more comprehensive than any alternative list.

We downloaded the biography of all district judges from the Federal Judicial Center and extracted their age and the nomination date as a federal judge to our cases. Finally, we collected district court characteristics such as the number of case filings or the number of vacant judgeship month from the website of the Federal Courts. Because statistics about patent cases are not available via the Federal Courts we used the information about the number of patent filings from Lex Machina.

Since all cases involve more than one party, and many cases more than one patent, we build averages on patent characteristics (e.g., the average of the number of references in a case), and on characteristics of the parties. Table 2 summarizes our data sources.

Table 3 shows descriptive statistics and gives an overview over the variables. The average case involves 3.5 parties[4], involves on average 5.2 percent individuals, has a duration of 1.3 years and takes 81.5 docket events. The average number of patents involved in a case

[4]Note that we only consider identified parties in our analysis and excluded parties whose identity is unknown or withheld.

Data	Data source
Patent litigation cases	Lex Machina
Patent characteristics	United States Patent and Trademark Office (USPTO)
Party characteristics - NPEs	Patent Freedom
Party characteristics - Firm size	Forbes Global 2000 (list of 2007)
Judge characteristics	Federal Judicial Center
District court characteristics	Federal Courts

Table 2: data sources

is 2. On average 9.6 percent of the patents are design patents, and the average number of future references over all patents in a case is 33. Only 11.6 percent of all cases terminate with a judgment. 87.9 percent of the cases are patent infringement cases, thus, only 12.1 percent are patent invalidity suits. With respect to the parties, on average 7.7 percent of the parties in a case are large firms and 5 percent are NPEs. Notice that the statistics on the district court characteristics are averages among the cases and are calculated at the filing date. Furthermore, 15 cases end before they were assigned to the calendar of a district court judge. These cases settled either very early after the filing, or were handled by a magistrate judge and settled before the case was handed to a district court judge.

Variable	Obs	Mean	Std.Dev	Min	Max
judgment	544	0.116	0.320	0	1
infringement	544	0.879	0.327	0	1
docket events	544	81.544	125.626	3	1044
time in days	544	455.553	432.742	3	2485
no of parties	544	3.539	3.156	2	29
no of plaintiffs	544	1.261	0.596	1	6
no of defendants	544	2.244	3.016	1	27
no of patents	544	1.990	2.095	1	29
percent design patents	544	0.096	0.279	0	1
avg references of patents per case	544	33.018	44.960	0	281
avg patent age in days	544	2142.401	1716.931	0	7657
percent individuals	544	0.052	0.153	0	1
percent forbes global 2000	544	0.077	0.184	0	1
percent NPEs	544	0.050	0.147	0	0.75
judge experience in years	529	10.490	7.753	0	40
judge's age in years	529	59.446	8.638	37	87
patent filings per judge	544	9.048	9.718	0.333	44.875
total filings per judge	544	493.535	181.317	207	2452
vacant judgeship month	544	10.075	9.718	0.333	44.875

Table 3: Summary statistics

4 Hypotheses

We use the findings from the theoretical foundation section and derive hypothesis using several proxy variables. Proposition 1 states that the case duration increases in the value at stake. Two factors influence the value at stake in patent litigation. First, the value increases with the number of patents involved in a case. Second, the value in dispute increases, the more valuable each patent is. It is the common view that there are several indicators for the value of a patent. One of these is the number of references or future citations of a patent. The number of references shows how often a patent is cited by other patents issued after the respective patent. It indicates a patent's recognition in related patents and/or the relevant industry and reveals how much the patent contributed to follow-on innovations. More references increase the importance of a patent and therefore presumably also its value (Trajtenberg, 1990; Lanjouw and Schankerman, 2001). We calculate the average references of the patents in the respective case and use this as another proxy variable for the value of the case.

Hypothesis 1 *The higher the value in dispute, the longer is the case duration. More specifically,*

1. *the more patents are asserted to a case, the longer is the case duration, and*
2. *the higher the value of the asserted patents (measured by the average number of references), the longer is the case duration.*

Regarding risk-aversion of the parties we have very few information available. However, we know whether parties are individuals or firms. Individuals are assumed to have a higher degree of risk-aversion compared to firms. Therefore, we use this information to measure the influence of risk-aversion on the failure of settlement.

Similar to patents, we have multiple parties in a case which are usually of different types, either an individual or a firm. In order to test the implications of risk-aversion on the failure of settlement, we use the percentage of individuals among all parties in a case.

Hypothesis 2 *The higher the fraction of individual parties, the shorter is the case duration.*

In order to test Proposition 3, we use two different variables. A patent can be either a utility or a design patent. Design patents secure a particular form of an item and are usually much easier to understand compared to utility patents. A specific technical

knowledge, e.g., in engineering or chemistry, is not necessary.[5] Therefore, we argue that the higher the fraction of design patents involved in a case, the lower is the uncertainty associated to the case. Parties can figure out easier the boundaries of the patent and have, hence, better information about their standing with respect to the jurisdiction.

The judge takes an important role during litigation. Even though, a jury decides about the case in a full trial, the judge has much decision power before trial hearings start. Furthermore, many cases are not based on a matter of fact but on a matter of law. If the actions of the parties are clear, while it is unclear whether these actions infringed the patent, the case handles a matter of law. For cases that are based on a matter of law, the judge takes the decision without going through a full trial with a jury. We argue that the more information about the case history of a judge is available to the parties the lower is the degree of uncertainty. The case history of a judge provides information about her interpretation of the law. Because we know the date on which each judge received commission, we are able to calculate the experience in years at the beginning of a case.

Hypothesis 3 *The lower the uncertainty, the shorter is the case duration. More specifically,*

1. *the higher the fraction of design patents asserted to a case, the shorter is case duration, and*

2. *the more experienced the judge, the shorter is the case duration.*

In Proposition 4 we conclude that higher marginal costs of litigation decrease the case duration. We use party characteristics as indicators for the marginal costs of litigation of the parties. NPEs are firms that hold large patent portfolios which they license to manufacturers. These firms are highly specialized on legal issues, usually with a track record of patent litigation cases. In principle, NPEs are associations of lawyers and act on their own accounts. We argue that the marginal litigation costs for NPEs are smaller compared to other firms.

Furthermore, large firms very often have legal departments, a sound understanding of legal issues and sometimes even master agreements with legal counsels. Similar to NPEs, we expect that the larger the associated parties the lower are their marginal litigation costs. Because we do not know revenue figures for all of our parties, we use the information whether a party was listed on the Forbes Global 2000 as a measure of size.

[5]Distinction between design and utility patents: "In general terms, a utility patent protects the way an article is used and works, while a design patent protects the way an article looks." Design patents are "issued for a new, original, and ornamental design for an article of manufacture", whereas utility patents are "issued for the invention of a new and useful process, machine, manufacture, or composition of matter, or a new and useful improvement thereof". (see www.uspto.gov)

Hypothesis 4 *The lower the marginal costs, the shorter is the duration of the law suit. More specifically,*

1. *the higher the fraction of NPEs present in a case, the shorter is the settlement time, and*

2. *the higher the fraction of members of the Forbes Global 2000 in a case, the shorter is the settlement time.*

5 Results

We have two potential measures for duration available in our sample, duration measured in days, and measured in the number of docket events. Both measures are closely, but not perfectly, correlated with each other (correlation: 0.632). We focus on the number of docket events because we think that the number of docket events includes less noise compared to a measure of time. While dockets are necessary for the resolution of a case, the time in days may also be influenced by other factors such as the workload of the judge (e.g., Coviello, Ichino, and Persico, 2010). We consider the number of docket events as a better predictor for the absolute litigation costs. Using time could also bias the results since the costs of the parties are rather influenced by the actual litigation costs than by potential opportunity costs. Hence, parties are assumed to care more about a shorter case duration measured in real progress than in time. In a second step, we deliver also estimates for the duration measured in days. In these regressions we control additionally for the judge's workload.

Table 4 presents the results of the Tobit-estimations on the duration of a case for the number of docket events as the duration measure. In ordert to correct for outliers, we use the natural logarithm of the number of docket events. Furthermore, the logarithm of the dependent variable allows us to interpret the estimated coefficients as semi-elasticities.

Lanjouw (1998) and Schankerman (1998) report different patent values for different technology fields. In order to take technology specific effects into account, we cluster the patents by their International Patent Classification category into technology fields. We us the same clustering method as Lanjouw and Schankerman (2001). Patents are categorized into the fields "drugs and health", "chemical", "electronic", and "mechanical". All patents that fit not into one of these categories are described as "other". Design patents cannot be associated to a specific cluster as there exists no classification in the IPC system for design patents. Therefore, design patents are a subset of the patents categorized as "other".

We control for the sectors of the patents in the last column of table 4. We also controlled for the number of parties in the case in this column. Because the effects are robust among the different specifications, we use the last column in the following discussion of the results.

Variable	ln docket events	ln docket events	ln docket events	ln docket events	ln docket events
no of	0.096***			0.086***	0.0566**
patents	(0.027)			(0.030)	(0.0220)
avg references	0.004***			0.004***	0.0029***
per case	(0.001)			(0.001)	(0.0011)
percent design		-0.869***		-0.793***	-0.6312***
patents		(0.182)		(0.185)	(0.2099)
judge experience		-0.017**		-0.014**	-0.0132**
in years		(0.007)		(0.007)	(0.0063)
percent			-0.931***	-0.754**	-0.9744***
individuals			(0.348)	(0.343)	(0.3421)
percent NPEs			-0.944**	-1.240***	-1.0693***
			(0.369)	(0.374)	(0.3706)
percent forbes			1.498***	1.267***	1.0605***
global 2000			(0.262)	(0.264)	(0.2526)
no of					0.1143***
parties					(0.0147)
intercept	3.096***	3.703***	3.412***	3.374***	2.9764***
	(0.083)	(0.096)	(0.066)	(0.119)	(0.1617)
sector controls	no	no	no	no	yes
observations	544	529	544	529	529

Significance levels: $*$: 10% $**$: 5% $***$: 1%
Robust standard errors in parentheses

Table 4: Influence on settlement time measured in docket events (Tobit regressions)

With respect to our first hypothesis we find that both of our proxy variables for value significantly increase the duration of settlement. One further patent increases the number of docket events by 5.7 percent. Regarding the coefficients for the average number of references of patents, the results are also in line with Hypothesis 1. It turns out that the coefficient is positive and significant at the one percent level. Increasing the number of references by 10 references leads to a 3 percent larger number of docket events.

Result 1

1. *A larger number of patents in a case increases the case duration.*

2. *A larger number of average references of the patents increases the case duration.*

We hypothesize in Hypothesis 2 that the presence of individuals in a case decreases the case duration. It turns out that the influence of individuals in a case takes the predicted

direction in the Tobit-estimations. A higher fraction of individual parties decreases the duration of a case. The effect is not only statistically significant but has also a high impact in economic terms.

Result 2 *A larger fraction of individual parties, the shorter is the duration of settlement.*

Regarding the effect of uncertainty on the settlement time, both proxy variables show the same pattern. A higher fraction of design patents and a more experienced judge decrease the settlement time. Cases handling only design patents need 63.1 percent fewer docket events compared to pure utility patent cases. Correspondingly, each year of experience reduces the settlement time by 1.3 percent.

Result 3

1. *A larger fraction of design patents asserted to a case decreases the case duration.*
2. *A more experienced judge decreases the case duration.*

By analyzing the effect of marginal litigation costs, we find ambiguous results. The effect of more NPEs is negative and highly significant. Cases with NPEs, who take always the position of the patentee in our dataset, have a much shorter duration than comparable cases. However, the effect of the presence of large firms contradicts Hypothesis 4. The effect is positive and also highly significant in statistical and economic terms.

Result 4

1. *A larger fraction of NPEs in a case decreases the duration.*
2. *A larger fraction of members of the Forbes Global 2000 in a case increases the duration.*

We conjecture that the size of the firm influences not only the marginal litigation cost but is also correlated to the value at stake. Galasso and Schankerman (2010) and Somaya (2003) show that the duration increases in the strategic value of a patent. The strategic value of a patent depends on the characteristics of the parties, for example, their patent portfolio. The size of the patent portfolio correlates presumably with the firm size. We are currently trying to receive the relevant information in order to disentangle the effects further.

Table 5 delivers estimates for regressions using the natural logarithm of the time in days as the dependent variable. As expected, there is more noise in the estimation and the considered variables explain much less of the variation compared to the specifications using docket events as the dependent variable, i.e., the Pseudo R^2 halves from 0.07 to

0.035. In order to account for the workload of the judge, we included the per judge filings in the respective district, and the vacant judgeship month to the estimation. Unfortunately, some of the variables are insignificant. Both measures for the value at stake and the effect of design patents are not robust to the change of the dependent variable.

Variable	ln time in days	ln time in days	ln time in days	ln time in days	ln time in days
no of	0.037*			0.034	0.023
patents	(0.021)			(0.021)	(0.016)
avg references	0.001			0.001	0.001
per case	(0.001)			(0.001)	(0.001)
percent design		-0.401***		-0.407***	-0.339**
patents		(0.130)		(0.133)	(0.160)
judge experience		-0.012**		-0.011*	-0.011**
in years		(0.006)		(0.006)	(0.006)
percent			-0.386	-0.229	-0.394
individuals			(0.274)	(0.283)	(0.288)
percent NPEs			-0.949***	-1.050***	-0.861***
			(0.295)	(0.307)	(0.307)
percent forbes			0.677***	0.594***	0.503**
global 2000			(0.211)	(0.229)	(0.223)
no of					0.053***
parties					(0.012)
per judge					0.0001
total filings					(0.0003)
vacant judgeship					0.0001
month					(0.002)
intercept	5.584***	5.861***	5.706***	5.766***	5.588***
	(0.063)	(0.076)	(0.050)	(0.092)	(0.135)
sector controls	no	no	no	no	yes
observations	544	529	544	529	529

Significance levels: $*$: 10% $**$: 5% $***$: 1%

Robust standard errors in parentheses

Table 5: Influence on settlement time measured in time in days (Tobit regressions)

6 Conclusion

We see the main contribution of our paper in the insights of firm and judge characteristics on the duration of litigation. These results contribute to two strands of literature. First, we give insights how characteristics of the parties and the judge effects the settlement of a dispute in general. A more experienced, or more transparent, judge decreases the settlement time. This is an important result because it shows that transparency helps to reduce not only private but also social costs of litigation. An obvious possibility how policy makers can increase transparency is to make recent case history more easily accessible. For example, it is rarely common to get access to case data using online platforms in non-US jurisdictions. Further, we show that parties with lower marginal litigation costs make litigation more efficient as they decrease the settlement time significantly.

Second, these results have implications for the literature on patent litigation and therefore innovation in general. We confirm that more valuable patents take longer to settle and are therefore more difficult to secure. In recent years, a further industry trend gained increased attention. So called non-practicing entities were more frequently observed in patent litigation. There influence on the patent system is a highly controversial issue. It is unclear whether the positive effect of creating a market for innovations outweighs the potential negative effect of excessive litigation. Our results suggest, that NPEs rather prefer to settle than to go through a full trial. For a given dispute they have a positive influence as they reduce the costs of litigation.

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