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Discussion paper

Investing in legal advice – What determines the costs of enforcing intellectual property rights?

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What determines the costs of enforcing intellectual property rights?

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Abstract

This paper studies the determinants of investment in legal advice by plaintiffs in patent litigation. A hand-collected sample of US patent litigation cases is used to identify the empirical factors that determine the number of legal counsels employed by the plaintiffs. It turns out that more valuable patents lead to a higher investment in legal advice. Large firms, and plaintiffs with large patent portfolios employ more counsels, whereas individual litigants employ fewer. Software patents are related to a lower investment by the plaintiffs. These findings help not only to understand the cost drivers of litigation but have also important implications for the discussions on software patents, and the role of the litigant status for litigation success.

Keywords: litigation, patents, litigation costs, software patents, litigant status

JEL classification. K00, K41, O34

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1. Introduction

The aim of the patent system is to provide incentives for innovation. However, patents are not self-enforcing; the patent owners have to enforce their rights through costly litigation. The number of patent litigation cases grew rapidly over the past decades, increasing the importance of patent lawsuits for innovative firms. Because the costs of enforcing patent rights can be tremendous, increasing litigation activity may have an adverse effect on innovative activity. For this reason, patent litigation received increased attention of policymakers, and legal and economic scholars.

The main objective of this article is to identify the main empirical factors that determine a plaintiff's investment in legal advice during a patent lawsuit. I use a hand-collected sample of US patent litigation cases and focus on an important decision of the parties; their counsel choice. Several studies analyze the litigation investment decision and its drivers theoretically (e.g., Farmer and Pecorino, 1999; Katz, 1987). The underlying assumption behind these theoretical models is that the litigants' investments influence the probability of winning. In my analysis I rely on the number of counsels employed as the measure for the investment in legal advice by the plaintiff[1]. Ashenfelter and Dahl (2012) and Ashenfelter et al. (2013) show that the lawyer choice has an important effect on the probability of winning in litigation or related procedures. Assuming that the number of lawyers is positively correlated with the monetary investment, my results identify important drivers of the costs of enforcing patent rights at court. Even though recent studies analyze the litigation risk of a patent and show that patent and patent owner characteristics are important determinants of the litigation risk of a patent (Lanjouw and Schankerman, 2001a, 2004; Lerner, 2010), still little is known about the factors that shape the costs of litigation once it occurred.

The decision to invest in legal advice is basically a problem of weighing up costs and benefits. Therefore, the level of investment depends on the factors determining the productivity and the marginal costs of the investment. The productivity of influencing the

[1]As in every Principal-Agent relationship the incentives of the lawyer might not be aligned with the client. Because I do not observe the agreements between the lawyers and the clients, I abstract from these problems throughout the article.

court decision depends on the value and complexity of the patents, whereas the costs of the investments depend on the litigants characteristics (e.g., financial constraints). Indeed, my analysis shows that the number of counsels employed is significantly affected by patent and litigant characteristics. More valuable patents and a larger number of defendants increase the plaintiff's investment. Software patents are related to a lower investment of the plaintiffs. Large firms employ more counsels, whereas individual litigants employ fewer. Furthermore, the larger the patent portfolio size of the plaintiffs the larger is the number of counsels.

These results have several implications. First, more valuable patents are not only those that have a higher litigation risk, the costs of enforcing the patent at court are also higher. Second, software patents are often blamed to be associated with "fuzzy boundaries" leading to increased litigation activity (Bessen and Meurer, 2008). My result shows that even though software patents may have a higher litigation risk, the costs of the lawsuit are lower. Third, the result that large firms invest significantly more than small firms and individuals identifies a channel through which large firms become more successful at court. This finding complements the literature on the role of the litigant status for success and the related discussion of "haves" and "have-nots" (e.g., Galanter, 1974; Black and Boyd, 2012; Eisenberg and Farber, 1997).

Finally, the latter result is related to Lanjouw and Schankerman (2004). The authors show that patents owned by individuals, small firms and firms with small patent portfolios are more likely to be involved in patent litigation. They argue that a large patent portfolio allows trading of technologies and that large firms are more likely to be involved in repeated interaction. Two factors that facilitate cooperative resolutions of disputes. However, their results may potentially be also explained by the anticipation of a more costly legal battle. Because large firms invest more in legal advice, the lawsuit becomes potentially more costly for the litigants in sum[2], decreasing the likelihood of infringements and increasing the scope for cooperative solutions. Hence, small firms are not only

[2] Two effects may be present here. First, a defendant confronted with a large firm has to invest more in order to compete at court. Second, even though the large firms has lower marginal cost savings, these cost-savings may be overcompensated by the increased investment in legal advice.

disadvantaged in protecting their patent rights because they are not able to achieve a cooperative solution but also because they are at a disadvantage at court.

In addition to the literature on litigation risk, my analysis is related to the literature that analyzes the likelihood of pre-trial settlements, and the duration of lawsuits (Galasso and Schankerman, 2010; Lanjouw and Schankerman, 2004; Somaya, 2003). The outcome and duration of a case are also likely to be related to higher costs. However, investments in legal advice by the litigants during the (prospective) case is a factor that influences the respective outcome; thereby, potentially driving the results.

The article is organized as follows. The next section describes the sample. I present the empirical analysis and the results in Section 3, and conclude in Section 4.

2. Data

2.1. Data collection

My analysis relies on patent litigation data collected from the Lex Machina database. The database contains the population of all intellectual property litigation cases filed in the United States. By hand-collecting the data I obtained detailed information on each case. The information allow the identification of the litigants and their counsels, the respective court and judge, and the asserted patents. Because of the time-consuming data collection process, a full collection of data is not realizable. Therefore, I focused on every tenth case filed between April 2004 and March 2007. This process resulted in a random sample of 779 cases.[3]

Unfortunately, I have to exclude some of the cases from the sample. For a number of cases, the relevant documents (the complaints and answers) are not available. Hence, I am neither able to extract the underlying patents nor the participant characteristics. Because these characteristics are essential for the analysis, I have to exclude these cases. Furthermore, because it is not possible to clearly follow cases that were consolidated, consolidated cases are dropped, too. The final cleaned data set consists of 582 cases.

[3]In the sampling process cases were sorted according to their filing date and information on every tenth case was collected.

Patent litigation cases can be distinguished into two types of cases. In patent infringement suits the plaintiff accuses one or several economic subjects of infringing a technology that is protected by his patent. In contrast, a declaratory judgment suit for non-infringement and potentially patent invalidity is filed by an accused infringer. Declaratory judgment suits are structurally very similar because only economic subjects that were accused of patent infringement are allowed to file a declaratory judgment suit for non-infringement. The similarity is confirmed by the empirical literature that finds similar settlement patterns for both kind of cases (Lanjouw and Schankerman, 2001a,b). Therefore, I include both kind of patent cases in the following analysis. However, all estimations are also presented excluding declaratory judgments, which represent roughly 16 percent of the cases in my sample.

2.2. The investment in legal advice

In the first step of a lawsuit the plaintiff files a formal complaint, which may accuse multiple economic subjects. As a second step the pretrial discovery takes place. Defendants answer the complaint, and provide information for their opponents and the court. Afterwards, the trial takes place leading eventually to a judgment. However, a settlement may take place in every phase of the lawsuit. In fact, in most legal areas the majority of disputes settle. If a dispute fails to settle and the plaintiff prevails, the court adjudges the plaintiff a certain amount for compensation of the damage. Additionally, it deters the infringers from selling any product that is based on technologies protected by the patent.

My following analysis relies on the number of counsels employed by the plaintiffs at the time of the case filing as the measure for a plaintiff's investment in the dispute. Lawyers produce evidence and arguments that favor the position of the plaintiff; therefore increasing the expected payoff from a judgment. The underlying assumption behind this variable is that more lawyers increase the costs of legal representation, i.e., that there exists a close relation between the number of counsels employed by a litigant and his intended investment in monetary terms. I derive this information from the respective complaint.

Figure 1 shows the distribution of the number of plaintiff counsels[4] across the cases. On average a plaintiff employs 3.043 counsels. The figure shows quite some variation across the different cases (standard deviation = 1.835). Different plaintiffs invest different amounts in different cases. The question that arises from this observation is whether there exist structural factors that explain the variation.

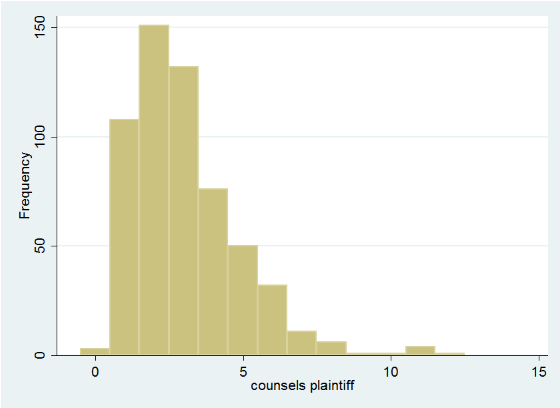

Figure 1: Distribution of the number of counsels across plaintiffs and defendants

A potential concern for the interpretation of the measure, and for identification of the determinants, is the quantity-quality relation of the legal investment. Litigants may see quantity and quality as substitutes, i.e., that investing into one high-quality lawyer is equivalent to investing in several low-quality lawyer. In order to analyze the rational of the litigants I ranked all law firms in my sample. Several publicly available rankings are potential candidates for this purpose, each with its own advantages and disadvantages. I focus my attention on three rankings, the *Vault Law 100* ranking from 2007, the *US News* ranking for intellectual property litigation from 2014 and the Lex Machina ranking from 2014. Before analyzing the relationship between the number of counsels and the ranking, I shortly describe the background and methodology of the different rankings.

2007 Vault Law 100:

The Vault Law 100 is a yearly ranking of the most prestigious law firms based on the perceptions of currently practicing lawyers at peer firms. The survey asked attorneys to score each of the 156 proposed law firms on a scale from 1 to 10 based on how prestigious it

[4]This measure includes “of counsels”.

is to work for the firm. Associates were not allowed to rank their own firm. In total 15,350 attorneys returned anonymous surveys to Vault. Based on the answers Vault creates a ranking of the 100 most prestigious law firms.[5] The advantage of this ranking is its reputation and it's availability for the year 2007. However, it covers only 100 law firms and some high-quality law firms specializing on intellectual property may be missing.[6]

2014 US News ranking:

Best Lawyers, a provider of a peer-reviewed lawyer ranking, and *U.S.News & World Report*, a leading rankings publication in the U.S., jointly created this ranking. It is based on an evaluation process that includes the collection of client and lawyer evaluations, peer review from attorneys in their field, and review of additional information provided by law firms as part of the formal submission process.[7] According to this evaluation process, 615 law firms are categorized into 3 national tiers. This ranking is more comprehensive, which makes a lack of more specialized firms less likely. Unfortunately, only the 2014 version was accessible. This is a relatively long time lag, potentially causing problems of comparability to the time the litigants made their decisions. Furthermore, the ranking into 3 tiers implies only few variation.

2014 Lex Machina ranking:

Lex Machina ranks the 300 most frequent law firms in patent cases since 2011. This makes the ranking very comprehensive and also specific with respect to patent law. Unfortunately, the ranking is only available from 2011 on.[8]

I matched the rankings to the respective law firms in my sample.[9] I then calculated the minimum rank of all law firms that are hired by a plaintiff for the respective case. Table 1 presents the results of the matching. The second column shows the number of

[5]For the detailed methodology, see: `http://www.vault.com/company-rankings/law/vault-law-100/RankMethodology?sRankID=2&rYear=2007&pg=1`

[6]There exists also a ranking that focuses on Intellectual Property. Unfortunately, the earliest version in 2010 ranked only 15 firms, and the most actual one only 25 firms.

[7]For the detailed methodology, see: `http://bestlawfirms.usnews.com/methodology.aspx`

[8]The ranking used in the study was downloaded on December 31, 2014. Therefore, it covers the years 2011-2014.

[9]All matches were double-checked manually. Unfortunately, the matching is still not perfect. A problem lies in the fact that many law firms had mergers and/or partner changes which makes an identification using the names difficult.

plaintiffs for which at least one legal counsel shows up in the ranking. The coverage of the ranking is as expected important for the likelihood that a law firm in our sample is part of the ranking. The last column presents the related mean and standard deviations of the minimum rank of the law firms employed by the plaintiffs.

Variable	**Obs.**	**Ranked**	**Mean rank (Std. Dev.)**
Vault Law 100	582	124	51.911 (28.020)
US News	582	295	1.176 (0.424)
Lex Machina	582	247	87.028 (70.663)

Table 1: Summary statistics - rankings

Table 2 relates the number of counsels employed to the likelihood that at least one of the law firms is ranked, and to the associated minimum rank by presenting the correlation coefficients. The table shows a significant positive correlation between the number of counsels and the likelihood of choosing a law firm that is ranked.[10] Furthermore, it shows a significant negative correlation between the number of counsels and the minimum rank of the associated law firms for the Vault 100 and Lex Machina rankings. Unfortunately, the US News ranking shows no such correlation.

This evidence leads me to conclude that those litigants who employ more lawyers employ also the higher quality lawyers. An alternative interpretation for that observation is that a litigant chooses the quality of the law firm rather then the number of lawyers. A high quality law firm then assigns more lawyers to the case. In this interpretation, the number of counsels serves as a proxy variable for the quality of the law firm which is itself likely to be correlated with the intended investment.

I observe a variety of patent, case and litigant characteristics that may shape the decision of the plaintiff. In the following I describe these characteristics and the expected influence on the decision of the plaintiffs.

[10]The likelihoods that a law firm is part of a ranking are themselves also highly correlated: Vault/US News 0.462, Vault/Lex Machina 0.528 and US News/Lex Machina 0.701.

Ranking	Correlation ranked	Cond. correlation rank
Vault 100	0.203***	-0.178**
US News	0.299***	0.018
Lex Machina	0.321***	-0.154***

Table 2: Correlation coefficients of the number of counsels and the associated minimum rank

2.3. Variable description

By deciding to invest in legal advice the litigants want to influence the judgment in their favor. The litigants weigh up the productive effect of their decision with the associated costs. Hence, factors influencing the productivity of legal advice and the respective costs are the important parameters for this decision. From the perspective of my empirical analysis there exist three main factors influencing the decision: the value at stake, the complexity of a case, and the litigation costs of the parties. These three factors guide my analysis.

2.3.1. Value at stake

A higher value at stake increases the benefits of winning; therefore, increasing the marginal benefit of investing in legal advice. As a consequence, the litigants invest more. Therefore, one would expect that the level of investment increases in the value of the underlying patents. To proxy for the value at stake I determine the number of asserted patents, and multiple patent characteristics that indicate the value of a patent. For the calculation of the different patent measures, I rely on patent data provided by Lai et al. (2011). This data contains information on all patents assigned between 1975 and 2010, including their industry classifications and citations. The data is based on information provided by the US Patent and Trademark Office.

Forward and backward citations: Each patent application has to cite all related prior US patents, and a patent examiner ensures that all relevant patents are cited. From these citation patterns one can derive the backward citations, i.e., the number of patents the respective patent cites, and the number of forward citations, i.e., the number of patents that cite the respective patent. The number of forward citations, indicate the importance of the patent for future innovations, and are used as a standard measure for the patent value. Several studies confirm this assumption and show that this measure is related to the actual value of a patent (Trajtenberg, 1990; Harhoff et al., 1999; Hall et al., 2005). Harhoff et al. (2003) argue that the number of backward citations are used to back the claims of the patent application; therefore indicating a broad scope of the patent.

Additionally, I determine the share of citations that the patent received from patents belonging to the same patent owner. A larger share of forward self-citations indicates that the patent protects the basis of a cumulative innovation developed by the patentee (Lanjouw and Schankerman, 2004); increasing the importance and therefore the value of the patent. Indeed, Hall et al. (2005) show that forward self-citations are even more valuable than external citations. In contrast, a larger share of backward self-citations indicates that a later stage is protected, potentially implying a lower value.

In order to take different citation patterns across time and across technology fields (Hall et al., 2001) into account I calculate measures that relate the number of citations of a patent in technology class τ (the 36 two-digit categories as defined in Hall et al. (2001)) with application year t to the average number of citations of all patents in τ with the same application year. Specifically, I define the measure as

$$Relative\ citations_{\tau t} = \frac{C_{\tau ti}}{\frac{1}{n}\sum\limits_{j}^{n} C_{\tau tj}}.$$

$C_{\tau ti}$ denotes the number of forward (backward) citations of patent i with application year t and technology class τ. The sum in the denominator denotes the average forward (backward) citations of all patents in τ that have the same application year. Hence, the average of this relative measure for all patents with the same application year in τ equals one.

Generality and Originality index: The "generality" and "originality" indexes proposed by Trajtenberg et al. (1997) are additional citation based value indicators. The bias adjusted "generality" index is defined as follows:

$$Generality_i = \frac{C_i}{C_i - 1}\left(1 - \sum_{\tau}\left(\frac{C_{i\tau}}{C_i}\right)^2\right),$$

where $C_{i\tau}$ denotes the number of patents cited by patent i that belong to technology class τ, and C_i denotes the sum of all backward citations. The factor $\frac{C_i}{C_i-1}$ removes the downward bias of the Herfindahl-index as recommended by Hall et al. (2001) The "generality" measures the variety of other technologies that rely on the patent. "Originality" is similarly defined, except that it uses the percentage of patents belonging to technology class j that cite patent i. Originality measures the variety of technologies on which the patent relies.

Claims: The claims described in the patent application define the boundaries of patent rights. The more claims a patent has, the broader is the scope of the patent.

Patent breadth: Each patent is assigned to all classes of the UPTO patent classification system to which it is related. The more patent classes are assigned to the patent the broader is the technological scope of the patent (Lerner, 1994). The number of patent classes is used as an indicator of its technological breadth. Patent breadth and the number of claims regularly serve as complementary measures for the value of a patent.

Ownership concentration of patent rights: The ownership concentration of specific technologies may affect the value of patent for two reasons. First, it increases the market power for a technology. Second, if patents complement each other the value of a patent increases with it's portfolio size (e.g. Galasso and Schankerman, 2010). I compute the share of patents with an application year within five years in either direction of the suit accounted for by the top four patentees for the related technology class τ.

2.3.2. Complexity of a case

The complexity of a case is an additional important variable. The more complex the case is the more difficult it is for the jury/judge to oversee the case and the more the jury/judge depends on the evidence provided; increasing the productivity of influencing the judgment. Two measures are related to the complexity of a case, the fraction of design patent and the fraction of software patents.

Design patent: In contrast to utility patents, design patents do not protect a technological innovation but a special type of intellectual property: the ornamental design.[11] Design patents are not part of any of the technology fields defined above. Because design patents

[11] The distinction between design and utility patents is the following: "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" (US Patent and Trademark Office, *Manual of Patent Examining Procedure (MPEP)*, Chapter 1502.01).

secure a specific design and are not related to a technology, the boundaries of the patent are relatively clearly defined. Hence, there exists a relatively low level of complexity and the litigants invest less in legal representation.

Software patent: In contrast, it is often argued that the boundaries of software patents are less clearly defined, requiring more subject specific knowledge (Bessen and Meurer, 2008). Software patents are often blamed to be on average of inferior quality because examiners lack the relevant knowledge and data; a problem that was especially severe in the early years of software patenting (Dam, 1995; Merges, 1999; Hall and MacGarvie, 2010). This inferior quality leads potentially to more legal uncertainty. Unfortunately, the definition of a software patent is relatively unclear and follows not straightforwardly. Researchers relied mainly on two approaches to identify software patents. The first one uses the technology classification of the patents (Graham and Mowery, 2003, 2005), whereas the alternative relies on a keyword search of the patent specification (Bessen and Hunt, 2007). Any kind of identification method may lead to two types of misspecification, failing to identify a software patent (type I error) and specifying non-software patents as such (type II error). Whereas the keyword method performs better with respect to the type I error, it performs worse with respect to the type II error (Hall and MacGarvie, 2010; Layne-Farrar, 2006). Therefore, I follow the approach of Hall and MacGarvie (2010) and use a combination of both approaches. First, I identify potential software patents according to three methods individually. I use the IPC classification according to Graham and Mowery (2003)[12], the USPTO classification according to Hall and MacGarvie (2010)[13][14], and the keyword method proposed by Bessen and Hunt (2007)[15]. This procedure results in three sets of

[12] Graham and Mowery (2003) identify the technology classes according to the patenting activity of the six largest personal computer software manufacturer (based on 1995 revenues) in the US between 1984-95 (Microsoft, Novell, Adobe Systems, Autodesk, Intuit, and Symantec). The resulting IPC classes are G06F/3/5/7/8/11/12/13/15, G06K/9/15, H04L/9.

[13] Hall and MacGarvie (2010) identify US patent class-subclass combination according to the patenting activity of fifteen software firms (Microsoft, Adobe, Novell, Autodesk, Symantec, Macromedia, Borland, Wall Data, Phoenix, Informix, Starfish, Oracle, Veritas, RSA Security, and Peoplesoft). I am grateful to Megan MacGarvie and Bronwyn H. Hall for making these information available.

[14] Graham and Mowery (2005) use a similar approach that is based on the USPTO classification resulting in a wider definition of patent classes. All results are robust to using his definition.

[15] Bessen and Hunt (2007) characterize patents as software patents if the specification contains either the keyword "software", or "computer" and "program", and at the same time not "antigen", "antigenetic", or "chromatography", and not "chip", "semiconductor", "bus", "circuit", or "circuitry" in the title.

patents. In a second step, I use the union of identified patents of either classification system. The reason for doing so is that both classification systems use different class definitions that do not match perfectly. Finally, I intersect this union with the set of patents that results from the keyword method.

2.3.3. Costs of legal advice

The litigation costs of the litigants play presumably an important role for the legal investment. The higher the (marginal) costs of investing in legal advice the less a plaintiff invests. The issue of litigant status on litigation success has been discussed since Galanter (1974). Several studies show that the "haves" typically come out ahead of the "have-nots", i.e., large firms with more resources have a higher probability of winning (e.g., Black and Boyd, 2012; Eisenberg and Farber, 1997). Besides experience and other advantages of repeated litigation (e.g., informal relations to institutional incumbents), the ability to invest in legal advice may serve as an explanation for this observation.

In the following, I use the litigants' characteristics as indicators for the associated litigation costs. By investigating the case documents, I am able to distinguish individuals from firms. Some cases involve individuals that are key employees of the plaintiff or one of the defendants. In these cases, the respective parties are grouped and treated as firms. I create a dummy variable that equals one whenever the litigant is an individual.

As a measure for firms size of the non-individual plaintiffs and defendants I use the Forbes Global 2000 list from 2007. I create a dummy variable that equals one whenever the litigants name is on the list. I use the global edition of the list because the parties are not exclusively from the US; also foreign firms or subsidiaries of foreign firms are observed. Finally, I rely again on the information provided by Lai et al. (2011) to determine the size of the patent portfolio of the litigants. I identify the set of the litigant's patents within a five-year window in either direction of the filing date of the case.[16] The portfolio size can be interpreted as an additional measure of firm size

Large firms are likely to have lower perceived costs of employing counsels for two reasons. First, large firms are presumably more often involved in lawsuits; therefore, they

[16] All of the following results are robust to using the total number of patents owned by the litigants.

may use master agreements with law firms. Second, large firms are less likely to be subject to financing restrictions. Hence, firms with lower costs and/or deeper pockets have advantages in employing counsels which may result in superior legal representation. Assuming that the same effects are present for the defendants, a plaintiff will invest more if he is confronted with a larger firm.

Variable	**Obs.**	**Mean**	**Std. Dev.**	**Min.**	**Max.**
counsels plaintiff	582	3.043	1.835	0	12
no of patents	582	2.010	2.066	1	29
avg fwd citations	582	28.826	39.350	0	263
avg relative fwd citations	582	2.252	2.811	0	36.717
avg percent fwd self-citations	582	0.086	0.182	0	1
avg citations	582	21.471	34.306	0	475
avg relative bwd citations	582	1.819	2.512	0	28.212
avg percent bwd self-citations	582	0.043	0.117	0	1
avg claims	582	22.569	22.912	1	300
avg originality	582	0.372	0.285	0	1
avg generality	582	0.383	0.277	0	1
avg C4	582	0.176	0.102	0.030	0.601
avg patent breadth	582	8.672	11.589	1	88
percent software	582	0.048	0.198	0	1
percent design	582	0.091	0.271	0	1
percent chemical	582	0.065	0.237	0	1
percent computer and communication	582	0.216	0.403	0	1
percent drugs and medical	582	0.131	0.334	0	1
percent electric and electronic	582	0.104	0.291	0	1
percent mechanical	582	0.156	0.350	0	1
no of defendants	582	1.531	2.044	1	27
individual	582	0.082	0.272	0	1
forbes	582	0.091	0.287	0	1
portfolio size	582	157.629	721.123	0	8717
percent defendant individual	582	0.032	0.166	0	1
percent defendant forbes	582	0.133	0.323	0	1
avg defendant portfolio	582	339.109	1806.340	0	22994
declaratory	582	0.158	0.365	0	1

Table 3: Summary statistics

2.3.4. Additional control variables

As mentioned above, I observe infringement and declaratory judgment cases. A dummy variable is created to differentiate between infringement and declaratory judgment cases in order to take potential differences into account.

Furthermore, I use the primary USPC class to categorize the utility patents to the five broad technology fields defined by Hall et al. (2001). The utility patents are classified into the technology fields *Chemical*, *Computers and Communication*, *Drugs and Medical*, *Electrical and Electronic*, *Mechanical*, and *Other*. Note that according to my definition of software patents the set of software patents in my sample is a subset of patents belonging to *Computers and Communication*.

Finally, in many cases the plaintiff sues multiple unique defendants[17][18] using multiple patents. I determine the number of defendants from the formal complaint of the plaintiff. The number of defendants might influence a plaintiff's decision through different channels. A plaintiff suing multiple defendants is likely to receive a higher benefit of winning. Furthermore, more defendants may also be associated with stronger opposition by the defendants. However, both effects are likely to increase a plaintiff's investment; therefore, I expect a positive effect on the number of counsels employed.

Table 3 delivers the summary statistics for all variables. Because a plaintiff may sue multiple defendants using multiple patents, the respective measures are averaged. The table confirms the result from the literature that litigated patents are on average cited more often. The average relative forward citations amount to 2.010; the patents in my patent are cited twice as much as a comparable patent with the same application year from the same technology class. The same is true for the average relative backward citations which mean amounts to 1.819. Both measures are significantly different from 1. However, the skewness of the distribution has a large effect on the mean. The median for average

[17] Note that all observation are cleaned for double counts, i.e., subsidiaries of a company, exclusive licensees or the co-owner of a patent that are involved in the same case are not considered individually.

[18] A few cases involve also multiple plaintiffs. These are typically the patent owner and a (exclusive) licensee of the patent. However, both litigants do not act independently. In these cases, I treated the licensee similar to a subsidiary of the plaintiff. Controlling for the presence of an exclusive licensee does not change any of the following results.

forward (backward) citations equals 1.290 (1.078) only. On average the patents receive 8.6 percent of their forward citations from patents of the same owner, whereas 4.3 percent of their backward citations belong to patents of the same owner. Software patents account for 4.8 percent of all patents. A reasonable number given the number of patents filed in the 90s and early 2000s (see Hall and MacGarvie, 2010).

The plaintiffs use on average 2.01 patents and sue on average 1.531 defendants. More defendants than plaintiffs are part of the Forbes list, and the average portfolio size of the defendants is also twice as high. Hence, the plaintiffs tend to sue stronger opponents.

3. Empirical analysis

3.1. Baseline results

To study the effect of the different variables on the number of counsels employed by the plaintiffs, I adopt a linear regression model with heteroscedasticity-consistent standard errors. Table 4 summarizes the estimation of the regression model. The R^2 of the different specifications show that the variables considered in the analysis account for up to 27.9 percent of the variation for infringement and declaratory judgment cases.

Specifications 1 shows the expected effect of patent breadth. However, the effect is not robust to including industry controls and litigant characteristics. Furthermore, there exists no robust effect of the average share of forward self-citations, and the average relative backward citations. Naturally, there exists a correlation between the share of self-citations and the patent portfolio size of the plaintiffs. Once I control for the plaintiffs characteristics, the estimated coefficient is not significantly different from zero.

In contrast, the effect of the average relative forward citations of the patents[19] and the average number of claims show a robust positive but declining effect on the plaintiffs' investments.[20] Moreover, the coefficient of the average share of backward self-citations turns

[19]A similar pattern can be observed by using the absolute number of forward citations instead of the normalized measure.

[20]Because the marginal effect of the relative forward citations is non-linear, it is not significantly larger than zero anymore if the average relative forward citations exceed roughly 1300 percent (see Brambor et al., 2006). However, this is only the case for less than 3 cases (0.5 percent of my sample). The same is true for the average number of claims. If the average number of claims exceed 50, the marginal effect is not significantly different from zero anymore. This is the case for 46 cases (7.9 percent).

Variable	Pred.	(1)	(2)	(3)	(4)	(5)	(6)
no of patents	+	0.040	0.037	0.025	0.013	0.011	0.011
		(0.036)	(0.035)	(0.043)	(0.045)	(0.048)	(0.047)
avg relative fwd citations	+	0.123***	0.112***	0.098**	0.103**	0.141*	0.116***
		(0.044)	(0.042)	(0.042)	(0.042)	(0.079)	(0.043)
avg relative fwd citations^2	-	-0.003**	-0.004***	-0.003***	-0.003***	-0.008	-0.003**
		(0.001)	(0.001)	(0.001)	(0.001)	(0.007)	(0.001)
avg fwd self-citations	+	0.459	0.693*	0.478	0.430	0.643	0.178
		(0.401)	(0.386)	(0.384)	(0.381)	(0.412)	(0.387)
avg relative bwd citations	+	0.011	0.020	0.003	-0.004	0.007	-0.008
		(0.057)	(0.057)	(0.056)	(0.056)	(0.057)	(0.056)
avg relative bwd citations^2	-	-0.002	-0.002	-0.001	-0.001	-0.001	0.000
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
avg bwd self-citations	-	2.682***	2.494***	1.741*	1.593*	1.515	1.566
		(0.934)	(0.911)	(0.935)	(0.936)	(1.152)	(0.962)
avg claims ($\cdot 10^{-2}$)	+	2.716***	1.384**	1.452**	1.622**	1.748**	2.842***
		(0.588)	(0.685)	(0.668)	(0.651)	(0.717)	(0.559)
avg claims^2 ($\cdot 10^{-4}$)	-	-1.172***	-0.726***	-0.751***	-0.790***	-0.856***	-1.196***
		(0.216)	(0.223)	(0.217)	(0.214)	(0.230)	(0.208)
avg patent breadth	+	0.061**	0.038	0.023	0.024	0.037	0.040
		(0.030)	(0.029)	(0.027)	(0.026)	(0.032)	(0.026)
perc. design	-		-0.345	-0.380*	-0.285	-0.444*	
			(0.234)	(0.223)	(0.232)	(0.258)	
perc. software	+		-1.678***	-1.623***	-1.499***	-1.607***	-0.786**
			(0.347)	(0.343)	(0.342)	(0.380)	(0.309)
individual	-			-0.822***	-0.934***	-0.908***	-1.011***
				(0.191)	(0.203)	(0.213)	(0.214)
forbes	+			0.535	0.655*	0.597	0.776**
				(0.362)	(0.360)	(0.415)	(0.358)
portfolio size ($\cdot 10^{-4}$)	+			8.625**	8.002**	6.967**	8.195**
				(3.364)	(3.276)	(3.271)	(3.360)
portfolio size^2 ($\cdot 10^{-8}$)	-			-14.779***	-13.879***	-12.678**	-14.070***
				(5.346)	(5.121)	(5.085)	(5.121)
perc. defendant individual	-				-0.624*	-0.829*	-0.761**
					(0.366)	(0.491)	(0.350)
perc. defendant forbes	+				0.479	0.415	0.577*
					(0.322)	(0.328)	(0.335)
avg defendant portfolio size ($\cdot 10^{-4}$)	+				2.391**	2.382*	2.667**
					(1.205)	(1.217)	(1.308)
avg defendant portfolio size^2 ($\cdot 10^{-8}$)	-				-1.102*	-1.077	-1.144*
					(0.656)	(0.662)	(0.660)
perc. chemical			0.379	0.237	0.225	0.195	
			(0.307)	(0.302)	(0.307)	(0.362)	
perc. computer and communication			1.401***	1.275***	1.142***	1.210***	
			(0.270)	(0.264)	(0.254)	(0.293)	
perc. drugs and medical			0.734***	0.607**	0.570**	0.758***	
			(0.244)	(0.241)	(0.241)	(0.270)	
perc. electric and electronic			0.348	0.385	0.340	0.422	
			(0.282)	(0.271)	(0.265)	(0.279)	
perc. mechanical			0.071	0.072	0.109	0.117	
			(0.197)	(0.189)	(0.188)	(0.211)	
no of defendants		0.092*	0.067	0.098	0.100*	0.096*	0.119*
		(0.050)	(0.043)	(0.061)	(0.056)	(0.054)	(0.061)
declaratory		-0.159	-0.237	-0.266	-0.190		-0.135
		(0.170)	(0.170)	(0.164)	(0.161)		(0.159)
Intercept		1.711***	1.762***	1.909***	1.821***	1.684***	1.784***
		(0.169)	(0.208)	(0.211)	(0.208)	(0.226)	(0.172)
Observations		582	582	582	582	490	582
R^2		0.154	0.219	0.263	0.288	0.292	0.252

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

Heteroscedasticity-consistent standard errors in parentheses.

Table 4: Estimation of the plaintiffs' counsel choices

out to be significantly positive. Again, one can observe the correlation of the backward self-citation and the portfolio size of the plaintiff as the coefficient decreases by 30 percent from specification 2 to 3. However, the coefficient remains to be significantly different from zero. Note that this result contradicts the initial expectations. The reasoning was based on the assumption that a larger share of backward self-citations indicate a later stage innovation of a cumulative development, for which Lanjouw and Schankerman (2004) argue that it indicates a lower patent value. However, I observe a significant positive correlation between the number of patents and the share of backward self-citations. Hence, it could be the case that a plaintiff uses all of the patents protecting the cumulative innovation.

Given this evidence, one may conclude that the plaintiffs hire more legal counsels the more often the patent is cited in relative terms, and the more claims the patent has. I see that as evidence that more valuable patents promise higher payoffs from winning the cases, leading to higher investments in legal advice.

Turning to the role of complexity, we can analyze the role of the involvement of design and software patents. The involvement of less complex design patents shows the expected negative effect in specification 3 and 4. However, this effect is also not significantly different from zero in the preferred specification 4 (p-value=0.112). In contrast, the table shows significant negative coefficients for the percentage of software patents in all specifications. The coefficient in specification 1-6 shows the effect of software patents compared to other patents within the *Computers and Communication* technology field. Specification 6 that leaves out all of the industry controls shows that this negative effect is also present if I am not controlling for any of the other fields. The coefficient in this specification shows the effect of a comparison of software patents to an “average” patent. This negative effect contradicts my initial expectations. Even though the effect is robust to the inclusion of additional patent value indicators, it may potentially be explained by a difference in the part of the value of the patents that is not captured by the value indicators. However, Hall and MacGarvie (2010) and Hall et al. (2007) find some evidence that software patents are more valuable than other patents, which would also imply higher investments rather than the observed lower number of counsels.

There also exist some differences across technology fields. A plaintiff hires significantly more counsels the more non-software patents from the *Computers and Communication* technology field are involved (the baseline are patents that fit not in any of the technology fields). The coefficient is significantly larger than zero irrespectively which category serves as the baseline.

With respect to the proxy variables for the (marginal) litigation costs of the plaintiff, I observe, consistent with the prediction, that individual plaintiffs employ significantly fewer counsels, and Forbes-plaintiffs significantly more. A Forbes-plaintiff hires on average more than two counsels more than an individual. As argued before, the portfolio size can be interpreted as an additional measure for the size of the litigant; therefore, serving as an additional proxy for costs in hiring lawyers. There exists a non-linear effect of the number of the patents owned by the plaintiff. The number of counsels increase at a diminishing rate in the portfolio size.[21]

These results on the effects of the "size" of the plaintiff help to explain why "haves" are more successful at court than "have-nots" (e.g., Galanter, 1974; Black and Boyd, 2012; Eisenberg and Farber, 1997). Large firms can afford a better legal representation, and invest more in legal advice. Assuming that these investments have a productive effect that should lead to the common observation that larger firms, those that "have", are more likely to win a lawsuit.

Furthermore, these results present a complementing explanation why small firms are handicapped in protecting their patent rights. Lanjouw and Schankerman (2004) show that patents owned by individuals, small firms and firms with small patent portfolios are more likely to be involved in patent litigation. The authors argue that a large patent portfolio allows trading of technologies and that large firms are more likely to be involved in repeated interaction. These two factors may facilitate cooperative resolutions of disputes. However, their observations may potentially be also explained by the anticipation of a more costly legal battle. Because large firms invest more in legal advice, the

[21]The marginal effect is not significantly larger than zero for plaintiffs who own more than 2000 patents. In my sample this is the case for 14 cases (2.4 percent).

lawsuit becomes potentially more costly for both sides, decreasing the likelihood of infringements and increasing the scope for cooperative solutions. Hence, small firms are not only disadvantaged in protecting their patent rights because they are not able to achieve a cooperative solution but also because they are at a disadvantage at court. The estimates of the defendant's characteristics show the expected effects.

By focusing on infringement cases only in specification 5, I cannot reject the hypothesis that the effects of the average rel of the patent portfolio size of the defendant has a linear effect on the plaintiffs lawyer choice are linear. All other results remain mainly unchanged if declaratory judgment cases are excluded.

Table 5 performs a few additional robustness checks. First, it also includes the generality, originality and ownership concentration measures. I use these additional measures to test the robustness of the software patent coefficient and the effects of the patent owner characteristics. A potential concern is that some unobservable value characteristics of the patents correlate with the size of the patentee, and the characteristics of software patents. Hence, including additional value indicators potentially captures at least a part of this omitted characteristics. All effects are qualitatively robust to including the additional value indicators.

Second, the table controls additionally for the filing year of the cases in order to take potential time trends into account. Third, as an robustness check for geographical differences, I add dummy variables for the 12 different federal judicial circuits. Finally, I add dummy variables for all district courts for which I observe at least 10 cases. This is the case for 20 district courts. Unfortunately, including dummy variables for all district courts is given the relative low number of observations not possible. The majority of district courts show up only very few times. Controlling for all of these additional variables leads to a respectable R^2 of 0.381. However, none of the additionally included citation based measures has a significant effect. Furthermore, we can again not reject that the effect of the defendant's portfolio size is linear. All other effects are qualitatively robust.

Variable	Pred.	(1)	(2)	(3)	(4)
no of patents	+	0.017	0.008	-0.004	-0.024
		(0.046)	(0.045)	(0.047)	(0.048)
avg relative fwd citations	+	0.104**	0.109**	0.110**	0.079*
		(0.042)	(0.043)	(0.043)	(0.043)
avg relative fwd citations^2	-	-0.003***	-0.003***	-0.003**	-0.002*
		(0.001)	(0.001)	(0.001)	(0.001)
avg fwd self-citations	+	0.394	0.368	0.158	0.076
		(0.384)	(0.376)	(0.388)	(0.428)
avg relative bwd citations	+	-0.005	0.003	0.001	0.011
		(0.058)	(0.057)	(0.058)	(0.058)
avg relative bwd citations^2	-	-0.001	-0.001	-0.001	-0.002
		(0.002)	(0.002)	(0.002)	(0.002)
avg bwd self-citations	-	1.590*	1.541*	1.618*	1.797*
		(0.938)	(0.930)	(0.893)	(0.930)
avg claims ($\cdot 10^{-2}$)	+	1.626**	1.627**	1.590**	1.711***
		(0.663)	(0.660)	(0.639)	(0.633)
avg claims^2 ($\cdot 10^{-4}$)	-	-0.782***	-0.801***	-0.774***	-0.835***
		(0.215)	(0.217)	(0.215)	(0.213)
avg patent breadth	+	0.023	0.024	0.033	0.029
		(0.027)	(0.026)	(0.027)	(0.028)
avg generality	+	-0.080	-0.068	-0.081	-0.170
		(0.300)	(0.303)	(0.302)	(0.298)
avg originality	+	0.077	0.047	0.011	0.014
		(0.293)	(0.292)	(0.290)	(0.293)
avg C4	+	-0.676	-0.803	-0.645	-0.503
		(0.723)	(0.733)	(0.738)	(0.743)
perc. design	-	-0.283	-0.286	-0.094	-0.037
		(0.282)	(0.285)	(0.284)	(0.284)
perc. software	+	-1.445***	-1.385***	-1.105***	-1.031***
		(0.343)	(0.343)	(0.333)	(0.349)
individual	-	-0.931***	-0.913***	-0.864***	-0.794***
		(0.203)	(0.204)	(0.202)	(0.211)
forbes	+	0.643*	0.617*	0.627*	0.665*
		(0.364)	(0.364)	(0.359)	(0.371)
portfolio size ($\cdot 10^{-4}$)	+	8.146**	8.499***	8.083**	6.969**
		(3.307)	(3.222)	(3.279)	(3.456)
portfolio size^2 ($\cdot 10^{-8}$)	-	-13.899***	-14.104***	-13.145**	-11.647**
		(5.158)	(4.985)	(5.186)	(5.427)
perc. defendant individual	-	-0.620*	-0.633*	-0.698**	-0.535*
		(0.370)	(0.373)	(0.350)	(0.314)
perc. defendant forbes	+	0.497	0.536*	0.456	0.360
		(0.327)	(0.322)	(0.309)	(0.312)
avg defendant portfolio size ($\cdot 10^{-4}$)	+	2.396**	2.385**	2.018*	2.011*
		(1.208)	(1.215)	(1.168)	(1.233)
avg defendant portfolio size^2 ($\cdot 10^{-8}$)	-	-1.098*	-1.103*	-0.973	-1.043
		(0.657)	(0.660)	(0.680)	(0.673)
no of defendants		0.097*	0.099*	0.095*	0.076*
		(0.056)	(0.054)	(0.051)	(0.046)
declaratory		-0.204	-0.182	-0.165	-0.078
		(0.161)	(0.161)	(0.170)	(0.173)
Intercept		1.948***	2.006***	1.757***	1.782***
		(0.298)	(0.382)	(0.485)	(0.509)
sector controls		yes	yes	yes	yes
filing year dummies		no	yes	yes	yes
circuit dummies		no	no	yes	yes
largest district courts dummies		no	no	no	yes
Observations		582	582	582	582
R^2		0.290	0.302	0.343	0.381

Significance levels: $*$: 10% $**$: 5% $***$: 1%
Heteroscedasticity-consistent standard errors in parentheses.
The largest district court dummies include dummy variables for the Districts of Delaware, Massachusetts, Minnesota, New Jersey, Nevada, and Oregon, the Central, Northern, and Southern Districts of California, the Eastern and Southern Districts of Texas, the Eastern Districts of Michigan, Missouri, Pennsylvania, and Wisconsin, the Northern District of Georgia, Indiana, and Ohio, and the Southern Districts of Florida, and New York.

Table 5: Additional robustness checks

4. Conclusion

This paper uses a novel approach to identify factors that determine a plaintiff's investment in legal advice; a decision that affects the costs of enforcing intellectual property rights. So far the literature focused on characteristics that drive the likelihood of patent litigation, and the duration. However, the analysis of the lawyer choice of the litigants provides interesting additional information about the intensity of the legal battle.

The empirical analysis focuses on an important decision of the plaintiffs, their counsel choice. Using a sample of hand-collected US patent litigation cases I find that the a plaintiff hires significantly more counsels the more valuable the asserted patents are. In contrast, in software patent cases plaintiffs tend to invest less in legal advice. Large firms with large patent portfolios employ more counsels, whereas individual litigants employ fewer.

These results do not only identify cost drivers of patent litigation but these results have also important implications for the patent system, and the litigation system in general. The patent system is under scrutiny because it is blamed for too many patents with "fuzzy boundaries" in the software sector (Bessen and Meurer, 2008). It is often argued that these "fuzzy boundaries" of software patents are partly responsible of the steep increase of the number of patent litigation cases. The same characteristics of software patents should affect also the behavior of the plaintiffs at court; the more legal uncertainty is involved the bigger is the scope for influencing the judge and the jury. It turns out that the plaintiffs treat software patents indeed differently. However, plaintiffs invest less in cases handling software patents; attenuating the potential inefficiency related to software patents.

The results of the effect of the size of the firm and their patent portfolio complements the literature on litigation risk of a patent. Lanjouw and Schankerman (2004) argue that a large patent portfolio allows trading of intellectual property rights, and that large firms are more likely to interact more often. Both effects benefit a cooperative resolution of patent disputes, decreasing the litigation risk of patents owned by large firms. However, the results of this paper at least complement their finding, potentially they even serve as an alternative explanation for their empirical observation. Because large firms invest significantly more, the costs of a potential infringer increase. Therefore, they are more able to discourage infringement, and at the same increase the scope for out of court resolution of disputes once infringement occured; both effects also decrease the litigation risk of a patent.

Furthermore, this latter result has important implications for the analysis of litigation in general. The impact of the status of litigants has been an important issue since Galanter (1974). "Haves" tend to be more successful than "have-nots". My findings identify a channel for his observation. "Haves" are able to invest more in legal advice which increases their success at court.

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