Incidence, Settlement and Resolution of Patent Litigation Suits in Germany

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Chapter 1

General Introduction

National patent systems (NPS) are relatively mature institutions: they were installed in the U.S. in the late 18th century and in several European countries during the 19th century. Controversy about their efficiency continues to motivate economic research, however. The fundamental issue is well understood: The investment incentives created by NPS are to some extent offset by the creation of a monopoly-like situation and the price and quantity constraints which such monopolies impose on the market. The one-size-fits-all patent length for patents of different levels of quality and technology fails to provide the appropriate additional benefits which would be necessary to compensate patentees for research and development expenditures and consequently distorts the inherent incentive effects of patents. A particularly egregious example is the enforcement of patent rights on life saving drugs in developing countries.[1] However, even leaving its dynamic aspects to one side, the patent system in its current form also entails the dilemma discussed by Lemley and Shapiro (2004): "Uncertainty, then, is endemic in the patent system. ... They (patents) are government grants of an entitlement to enforce a legal right ". This means that, although the safeguarding and enforcement of property rights are essential for investment, trade and eventually for economic growth, patents are far from ironclad property rights.[2] Their limits of validity have to be enforced when facing potential infringing actions. This pattern is especially important for predominantly intangible intellectual property rights which by definition constitute the most dynamic strate-

[1]For this problem solutions are discussed by Lanjouw (2003), Scherer (2004).

[2]See Djankov et al. (2003).

gic asset: productive knowledge– a problem that has been widely recognized in the economic and law research literature and which has also attracted the attention of policy makers.[3]

Within the European Union there is a vital discussion going on about the design of the European Patent System and consequently about the enforcement system. The patentability of software patents, gene and genetic discoveries is still not finally decided. In addition, there are detailed planes about creating a European Community patent. The aim of creating such a Community patent is to give inventors the option of obtaining a single patent which is legally valid throughout the European Union. The expected advantages of this system are a substantial reduction in patenting costs, particularly those relating to translation and filing, a simplified protection of inventions throughout the territory of the EU thanks to a single procedure, the establishment of a single centralized system of litigation. The creation of a Community patent system remains a sensitive issue as this dossier is still deadlocked after 13 years of discussions by European decision-makers. Two main reasons of this blocking occur. First, the countries would like to keep the patent authorities (the patent offices) in force and maintain their own special characteristics of patent enforcement system. Second, the establishment of a unique enforcement system in the sense of one central patent court creates a number of technical and jurisdictional problems which seems hardly to be solve. One of these problems is the language in which the patent suits should be handled. Another controversially discussed feature is the procedure of the litigation suit. There are special characteristics such as discovery and preliminary injunctions which are differently organized in the EU member states. The experiences of the various European enforcement systems should be evaluated and taken into account when shaping a European Patent system.

This thesis offers a unique empirical investigation of the enforcement of German patent rights. It contains three essays on various aspects of patent litigation in Germany and adds empirical evidence to the existing literature, most of which is built on large data sets for the United States. Lanjouw and Schankerman (1997, 2001, 2003), for example, have shed light on the general mechanism of patent right enforcement in the U.S. To date, however, relatively little research has focused on Germany. The investigation of patent litigation in the German patent system is

[3]See Andersen (2004).

interesting owing to certain important features which distinguish it from the U.S. system. First, for Germany there is an estimated litigation rate of about 1 percent of all patents in force at any given time. In contrast, Lanjouw and Schankerman (2003) estimate a probability of a patent suit being filed of about 2.1 per cent for the United States. Twice as many patent lawsuits per patent are therefore pursued in the US than in Germany. This is particularly interesting from an analytical point of view bearing in mind the lower legal costs borne by litigating parties in Germany where we would therefore, ceteris paribus, expect the litigation rate to be higher. Second, in contrast to the patents analyzed for the U.S., the type of German patents analyzed in this thesis are subject to the European and German system of applying for and granting patents. Third, the enforcement of patents is strictly separated into infringement disputes where the validity of the patent is not questioned and invalidity suits which are filed at a different court.

Each patent suit is unique in its merits, since patents are by definition new and unique to the market. Thus, the infringing action is not defined in prior trials. This differentiates these suits markedly from other civil disputes such as automotive accidents or medical malpractice trials. Furthermore, as legal enforcement of patent rights depends crucially on the judicial system I introduce the German patent system and its enforcement mechanism in Chapter 2. As already noted, German patents, when they are applied for at the European Patent Office (EPO), are subject to the European patent system. In most cases this means that they are valid in more than one European country. Another difference between the German and American patent enforcement systems is the existence of an opposition procedure in the German system which introduces a form of quality control after a patent has been granted.[4] Opposition procedures are regarded as the first legal test of patent validity and can be filed by any third party. All three essays consider the impact on the enforcement system of this distinctive feature of the German patent system.

All essays draw on the same unique data set which was collected by the author using information retrieved from written court files as part of an ongoing procedure. The data set contains all patent litigation suits filed from 1993 to 1995 at two of the three main District Courts in Germany which have jurisdictional responsibility for disputes relating to intellectual property rights. 715 litigation cases involving

[4]See Graham et al. (2003) for discussion

more than 900 patents were identified for this time period. Detailed information about the course of the case as well as patent characteristics from various different data bases have been merged to the patentee data. Chapter 3 includes a detailed description of the database.

In Chapter 4, I estimate the determinants of patent litigation at the two District Courts in Mannheim and Düsseldorf. I analyze the probability of litigation as a function of a set of exogenous variables which reflect characteristics of the patent, market conditions, and characteristics of the patent owner. As one of the main results, I find a significant higher probability of litigation for patents which are more valuable than the average. Small firms are more often involved in patent litigation suits than larger ones which points to the high relative value the litigated patent has for small companies compared to larger ones. Contrary to results for the U.S., I did not find that individual patentees are more likely to be involved in patent suits.

These results have direct implications for the calculation of risk based litigation insurance fees, of the type planned in the EU. In addition, Chapter 4 contributes to the existing literature by providing evidence of a positive relationship between the incidence of opposition procedures and the probability of litigation. One potential reason for this result is that opposition is more likely to high valuable patents which, in turn, are more likely to be litigated. This result contributes to the discussion in the U.S. about whether installing an opposition system there would lead to qualitatively more valuable patents and, hence, to a lower probability of involvement in litigation and challenge suits.

Chapter 5 extends the analysis of Chapter 4 to consider the reasons why trials, which are themselves generally the outcome of a failure to reach settlement during pre-trial negotiations, nonetheless often result in settlements. I look at the settlement decision at various stages of the trial: before the hearing, after the hearing, at first appeal (after court decision at the District Court). Most models explaining pre-trial negotiations neglect the multi-stage structure of these negotiation processes and conclude the analysis with the decision about whether to settle or to litigate. The empirical analysis of Chapter 5 aims at closing this gap. The results suggest that, at the time of litigation, almost all available information is used to decide whether to file a suit or not. Additional information evolving in the course of time, for example because of annulment suits, influence the pattern of settlement at later

stages of the trial. The results suggest that the legal environment exerts a powerful influence on the settlement decision at each stage of the trial. The general settlement rate not only differs considerably between the District Courts, but also at each stage of the trial. The decision to settle at a higher stage is not related to the outcome of adjudication at lower stages. The overall conclusion of the analysis in this Chapter is that, at each stage, the decision to settle is made independently of the preceding decision.

The results from Chapter 5 lead directly to the key issue dealt with in Chapter 6. This Chapter sheds light on how the duration of trials is determined: the speciality of the infringing action may result in efforts being made to terminate the suit, or its duration may be affected by the general characteristics of the patent or of the patentee. In particular, I tackle the question of whether the outcome of a patent litigation suit is influenced directly by the efforts the litigant undertake in order to terminate a legal patent dispute. This analysis goes one important step further than the existing literature by using detailed information about the course of the case. I particularly take the means of defense into consideration: filing an annulment suit, the procedural details of a hearing and requests of suspension. Existing work concentrates on duration investigations in areas of civil law other than intellectual property rights (car accidents and medical malpractice suits). In this body of the literature evidence on infringement is solely based on standardized infringement actions. The property rights there are well defined in the sense that, similar to the U.S. patent system, opposition and annulment procedures are not available as legal means. The results of this Chapter reveal that annulment suits as a means of defense of the potential infringer delays court adjudication but not settlement in German patent litigation suits. Only if suspension is requested is the hazard of termination of both types of patent suit termination decreased. The results suggest that courts are experienced in handling complex litigation claims and expert reports. They therefore do not delay decisions. A large number of originally filed patent claims lowers the hazard of court adjudication, however.

This Chapter is the first study to provide an investigation of settlement decisions in patent infringement suits for Germany. For the German patent system which is part of the European patent system an investigation of the settlement pattern during trials could illuminate some problems to be solved in developing a new European patent court. While patents applied for at the European Patent Office (EPO) are

valid in all countries named on the application enforcement is still the responsibility of the national judical systems. According to the European Commission plans the enforcement of a future Community Patent will be put into the hands of a European Patent Court. A detailed discussion of the advantages and draw backs of various plans is discussed in Luginbuehl (2003). In order to create an efficient European patent enforcement system and to avoid high costs and uncertainty a systematic research of the course of patent cases within the national systems may support the development of this planned European patent court. Similar to the U.S. I find that jurisdictional and strategic factors rather than economic values determine the probability of settlement or non-settlement.[5]

[5]Settlement rates at certain stages of the suit differ considerably between national legal systems. Lanjouw and Schankerman (2003) report trial settlement rates of more than 90% in the U.S. For Germany those rates are only about 55% on average (Stauder, 1989).

Chapter 2

The German System of Patent Litigation

A patent can be subject to litigation before a German District Court if it is valid in Germany. The original application may have been filed at the German Patent Office, as a Patent Cooperation Treaty (PCT) patent or at the European Patent Office, with Germany as the designated state in the latter cases. Before 1976 patent protection for Germany was only available at the DPMA, which received all applications. DPMA examiners conducted searchs and examinations. On average, 37% of the applications resulted in a German patent grant.[1] The requirements for patentability of an invention are novelty, inventive activity, and commercial applicability (§ 1, German Patent Act). An invention is regarded as "novel" if it is not state of the prior art. An invention is the result of inventive activity if the activity is not obvious to an expert on the state of the prior art (§§ 3 and 4, German Patent Act).[2] If the examination of a patent application reveals novelty, inventive activ-

[1]This calculation is based on the application and granting information published by the DPMA Annual reports from 1977 to 2000). There is a large variation among the years. Patent applications submitted in the late 1980s to the mid-1990s had an average granting probability of more than 40%, starting at 36 percent in 1978 and increasing to 48 percent in 1989. From 1995 to 1999 the granting rate decreased to 23 percent.

[2]In Germany, it is possible to apply for a petty patent or registration right. These intellectual property rights have lower requirements for the inventive step (§ 1, Registration Right Act). In contrast to the inventive activity necessary for a regular patent grant, the inventive step for a registration right requires a less detailed examination. However, the same enforcement rules apply

ity and commercial applicability and the formal requirements of the application are fulfilled, the patent right will be granted.

In 1978 the PCT entered into force.[3] A PCT application allows an applicant to file one international application ("international phase") in a process to seek patent protection in multiple contracting states named in the application ("National Phase"). A PCT application can be filed up to twelve months after the priority date and is submitted to the relevant national patent office or to the European office (Art. 10 PCT). Art. 15 PCT specifies how the first international search is to be conducted. The advantages of PCT applications are that the applicant files one application – the international application – in one place and in one language, paying one initial set of fees; this international application also has the effect of a national or regional application. Without the PCT, the applicant would have to file separately for each country. In addition, at the beginning of a patent's life – the "international phase" – its applicant does not face all of the translation costs and application fees at once. They are due when the application enters its respective "national phase".[4]

At the same time, in 1978, the European Patent Organization started working actively with the European Patent Office (EPO) in Munich.[5] The European procedure for patent application, examination, and granting is very similar to the Germany. At the applicant's formal request, an examination concerning the novelty and inventive step determines whether the prerequisites for patentability are fulfilled (Art 92, European Patent Convention, EPC). The examination report is a formal statement of the legal executive authority and serves as the basis for the granting decision. A European application names the member states in which patent protection is sought. In those designated states, a European patent grant becomes a national right.

Both the European and German patent systems provide the opportunity to op-

to these IPRs as to regular patents.

[3]The PCT is a multilateral treaty that was concluded in Washington in 1970. It is administered by the International Bureau of the World Intellectual Property Organization (WIPO), whose headquarters are in Geneva (Switzerland). As of the beginning of 2004, PCT patents can be applied for in 123 contracting states.

[4]See Thumm for a comprehensive description of IPR systems.

[5]The European Patent Office grants European patents for the contracting states to the European Patent Convention, which was signed in Munich on 5 October 1973 and entered into force on 7 October 1977.

pose a patent grant, although the post–granting time frames differ. These requests are decided upon by specialized opposition boards at the patent offices (Art. 99, European Patent Act; § 59, German Patent Act).[6] In Germany, invalidity suits as well as appeals against decisions on opposition are heard by the Federal Patent Court in Munich (§ 81, German Patent Act).

Annulment suits are also part of the patent system. According to § 82, German Patent Act, an annulment suit has to be filed at the the Federal Patent Court. European patent grants for Germany become regular German patent rights. This means that annulment suits against these grants must be filed at the German Federal Patent Court. For patents valid for the German market, issues of infringement and license disputes are left to the specialized District Courts of civil law. These issues are completely separate from questions of patent validity. If property rights are in force, they are civil rights and infringements are dealt with under civil law. Enforcement procedures, such as infringement or license disputes, must be brought before the relevant District Court of first instance. Patents are presumed to be valid by the judges involved. As von Meibom and Pitz (1996) point out, the German District Courts have "no power to revoke the patent or to alter the claims of the patent." The jurisdictional responsibility for patent infringement cases lies with 13 District Courts in Germany. More than 80% of all cases in Germany are covered by the District Courts in Düsseldorf, Munich, and Mannheim. Hamburg, Frankfurt and Braunschweig also have considerable experience despite the relatively small number of cases filed in these cities. The plaintiff has a very free hand when it comes to choosing the legal venue and can either sue at the infringer's domestic business location or in the jurisdictional area where the infringement took place. A potential plaintiff will therefore search for a forum where he or she expects to be awarded the highest damages and/or where the chances of winning the case are greatest. This "forum shopping" is also influenced by differences in the technical qualifications and experience of judges at various District Courts.

The general course of patent infringement suits is determined by the German Code of Civil Procedure. Detailed elements of the course of the suit can differ from one District Court to the next with respect to the time table of actions, and this is

[6]Opposition to a granted German patent must be filed within three months of the grant's announcement (§ 59 German Patent Act). For a European patent, third–party opposition is possible up to nine months after the patent grant is published (Art. 99, European Patent Convention).

another reason for forum shopping. An IPR case starts when the plaintiff issues a statement of claim including the names of the parties, the details of the infringing action, and the particulars of the property right in question. The statement of claim also specifies the remedy requested, including all costs and damages. The court serves the statement of claim to the defendant, who then has an opportunity to respond to the allegation. A common means of defense is to present a nullity claim or an opposition which is often combined with a request to postpone the litigation procedure.[7] The court anticipates the probable outcome of these means of defense and decide whether the legal procedure should be postponed until the Federal Patent Court or the DPMA has decided on the validity of the patent. Evidence is derived mainly from documents, witnesses, and independent experts. The parties are legally bound to deliver all relevant information; there is no discovery, however. The plaintiff in particular is required to exercise due diligence in fully investigating the potential infringement. If the parties are unable to come to a settlement agreement, the judge orders an oral hearing and renders a judgement. The judgement is either condemnation or partial condemnation of the defendant according to the plaintiff's requests or a dismissal of the lawsuit. In case of condemnation, possible remedies include the issue of an injunction, accounting for unlawful profits, or damages. The infringer is then obliged to refrain from continuing the infringing action, provide all necessary information for calculation of the damages and eventually pay them.[8]

In urgent cases and where there is a risk of substantial and irreparable losses, the patentee may apply for a preliminary injunction (§§ 934 and 940, German Code of Civil Procedure). This must be done promptly as soon as the infringement has been detected.[9] The patentee is also required to issue a clear statement that such an urgent injunction would prevent him or her from suffering large losses. If the injunction is granted, the infringer will be required to refrain from continuing his or

[7]Case evidence shows that an opposition or a nullity suit is filed as a means of defense in around 50 percent of cases. See von Meibom and Pitz (1996) for further procedural details.

[8]Usually, judges declare all remedies. But it can be that only condemnation is declared, or damages without accounting have to be paid.

[9]Urgency is assumed by the courts only if the plaintiff files for preliminary injunction without undue delay after obtaining knowledge of an infringement. The undue delay is subject to interpretation. The Munich I District Court considers longer than four weeks undue, and all other patent District Courts consider more than six months. See Pitz (1999) and Marshall (2000)for more details.

her infringing activities (§ 139 German Patent Act).[10]

Two types of expenses are relevant in most cases: court costs and attorney costs. Both are strongly related to the jurisdictional value of the case, which is set by the court after the letter of claims is filed. The court estimates the jurisdictional value considering the value of the invention and the size of the parties involved.[11]. The judge takes into account a fairly rough estimate of the patent holder's recorded sales with the patented invention. Both court costs and recoverable attorney expenses depend on the jurisdictional value based on a fee schedule. According to the applicable British rule, the losing party must pay all of the winning party's court costs, recoverable attorney costs, and expertise expenses as well as its own expenses.

[10]See Körner (1984).

[11]See Stauder (1989), p. 62.

Chapter 3

Data on Patent Litigation in Germany

3.1 Court Data Collection

My empirical analysis of patent litigation cases drew on a database extracted from files contained in court archives. Computerized data on general or specifically patent-related litigation are not available in Germany. All large District Courts with specialized chambers for IPR suits[1] were solicited for access to their archives. The judges at the courts in Düsseldorf and Mannheim agreed to provide access to their written case records.

I chose the filing years 1993-1995 at the courts for two reasons. First, I tried to collect as many cases for a single cohort as possible. Since the archives only contain records of finished cases and since the average duration of suits is about 6.5 years I had to choose suits which were mostly closed at the time of data collection in 1999 and 2000.[2] Second, I needed to choose these filing cohorts to be not so far removed chronologically as to prevent the matching of comprehensive information about the parties and the patents with information from other databases.[3] Virtually all cases

[1] Mannheim, Düsseldorf, Munich, Frankfurt

[2] Stauder (1989) found that more than 60 percent of patent and utility cases are finished within their second year and 95% after six years.

[3] A cohort contains patents with the same year of application.

filed at both District Courts during this period of time are included within the data set. When I assume that there is no significant change of the distribution of case filings among the District Courts compared to the data of Stauder (1989) then I covered around 60% of all cases filed in Germany during this period of time, missing mainly the suits treated in Munich. Data was collected from May to July 1999 in Mannheim and from October 1999 to February 2000 in Düsseldorf.

Even though the chambers at the District Courts are specialized, they hear a wide range of different legal cases - disputes relating to general contracts, license suits, and IPR cases including patents, utility patents, copyrights, and trademarks. For IPR cases, infringement is just one topic of legal disputes; all kinds of contract issues must be decided on. It was therefore necessary to identify the patent and utility infringement cases among all cases filed at those chambers. For the purpose of this research, I chose the legal rights of patents and utility patents because they are relatively strong compared to trademarks and copyrights and they identify technological inventions based on R&D efforts. The procedures for legal disputes on infringement are very similar for both types of property right. The subject line on the front page of the files served as the main indicator: I searched for words and phrases such as "patent," "patent infringement," "utility patent," "injunction," "preliminary injunction," "presentation of accounts," "license agreement," and "employee invention." The first screening revealed about 950 cases of infringement. A second screening, reading the statement of claim and the defendant's responses, disclosed whether the subject matter really related to an infringing action. I restricted myself to unambiguous cases of patent and utility infringements. For the analysis, I included both requests for preliminary injunction and regular filings in the investigation. I discarded all suits regarding disputes over license contracts, legal arguments about compensation for employees' inventions, and other patent and utility patent cases which did not concern infringements. After the second screening 715 infringement cases were left within the sample. By definition of jurisdictional responsibility, challenge suits are not treated at the District Courts. However, there are suits dealing with license disputes where patent claims and license contracts are in question, suits dealing with unauthorized warnings against infringers who actually have not infringed, and suits dealing with advertising with patent rights which are not actually covered by patent claims. These types are similar to challenge suits but are heard by the civil courts; for this reason I retained them within the data set. For the

third step of the detailed investigation, 715 cases of pure patent or utility litigation had to be screened meticulously. The correspondence of the parties, including the statement of claims and the response of the defendant, was checked. This process yielded information about the requested claims and the arguments of the parties. The court decisions and rulings revealed the outcome and the costs of the cases.

The information extracted from the written case files was divided into three main categories: the proceedings of the suit, the parties, and the patent at issue. The first category covers a brief description of the stages of the infringement case. It includes the dates of the filing, the oral hearing, and the ruling. Almost all case files reported the outcomes, including the outcomes of any first and second appeals. Cost figures were also collected, with paid damages added to the costs. The second category covers the names and the locations of the parties involved in the trials. At least one party was located within the jurisdiction of the court. The third category covers information on the patents involved, such as the age of the patent at time of filing as well as the field of technology (IPC).

The two courts differ in terms of the amount of detailed patent data recorded. In Mannheim, the records normally include the patent document or disclosure as well as witnesses' documents and experts reports. At the District Court in Düsseldorf, only the statement of claim, the subsequent correspondence between the parties and the court, and the judgement of the court are kept in the permanent files. I divided the information extracted from the written case files into three main categories: the proceedings of the suit, the parties, and the patent at issue. In order to complete the information about the patents involved in the disputes, data from PATDPA, which is an official database of the German Patent Office (DPA) and one of the EPO's databases, EPOLINE, were added.[4]

[4]As mentioned above, the records of the Regional Court in Mannheim normally include documents providing information about the patent, such as the name of the applicant, IPC classification, dates of application, granting, publishing, and so on. For the Düsseldorf records, the statement of claims contains most of this information, but the records are often incomplete in this regard. A patent number, either issued by the EPO or the DPA, was accessible in 95% of the suits. In cases where patent numbers could be matched, the information was updated using the PATDPA or EPOLINE databases.

3.2 Publicly Available Data

In order to complete the information about the patents involved in the disputes, data from the German Patent Office (DPA) and the European Patent Office (EPO) were added. Information on application dates, granting dates, IPC classifications, and the applicants and inventors are available from the databases PATDPA and EPO-LINE. PATDPA is the database of the German Patent Office and lists all patent applications with all of the information included in the patent document. Additionally, all bibliographic data, such as fee payments, oppositions and their results, changes of patentee, and lapsing of the patent in the public domain are viewable in this file. PATDPA contains around 2.5 million patents and utility patents. It covers patent data from 1976 to 1998. Beginning in 1978, the electronic form contains reliable information on patents and utilities. However, the information on the renewal data is not complete. A similar database, ELPAC, is available from the European Patent office. It includes all patent applications submitted to the EPO with roughly the same variables, encompassing 1.2 million patent applications since 1978. The important information about backward and forward citations was extracted via a comprehensive search of the databases.[5]

As mentioned above, the records of the Regional Court in Mannheim normally include documents which provide information about the patent, such as the name of the applicant, IPC classification, dates of application, granting, publication, and so on. The statement of claims in the Düsseldorf records contains most of this information, although the records are often incomplete in this regard. A patent number, either issued by the EPO or the DPA, was accessible in 95% of the suits. In cases where patent numbers could be matched, the information was updated using the PATDPA or ELPAC databases.

Since an official business register does not exist for Germany, I added the complementary information on corporations using the database of the leading German credit rating agency, the Verband der Vereine für Creditreform (Creditreform data) in Neuss. Merging these data with the litigation data affords a more detailed picture of the corporations involved. Industry codes according to the European NACE classification were added as well as firm size, measured by number of employees.

[5] A detailed description of the creation of the citation data file and the correction for truncation following Hall et al. (2000) is given in Section 4.3.1.

3.3 Creation of the Control Group

For an investigation of the differences between litigated and non-litigated patents, it is necessary to create a control group of patents. I therefore have selected an appropriate data set from the population of all German patents and European patents granted between 1978 and 1995.[6] I have stratified the control group by year of application and the main IPC classification at the four–digit level. For each patent in the group of litigated patents, one matched patent was drawn randomly from the universe of German and European patents. When randomly chosen patents are used as the control group, matched patents consist of those that were not subject to a legal litigation suit. There is still a possibility that a patent chosen for the control group was subject to an earlier or later dispute or to a dispute at one of the other nine District Courts, but it is fairly small (about one percent) and can be disregarded. I could not find comprehensive data in the database for patents in the litigated group which had application dates prior to 1978. To ensure a one–to–one match, I excluded those patents from the investigation group. The final sample of litigated patents contains 824 patents with application dates from 1978 to 1993, and the final reference group of non-litigated patents consists of 824 patents. All relevant variables including citation data and information on patentees and technology fields are included for these patents.

[6]Since all European patents granted in Germany are encompassed in PATDPA, I have drawn the matched patents solely from the PATDPA; some additional information, however, came from other data bases such as ELPAC and EPOLINE.

Chapter 4

Determinants of Patent Suit Filings in Germany

4.1 Introduction

The original function of intellectual property rights (IPR) was to provide an instrument which would ensure that inventors were able to recoup their investment in research. However, awareness of the importance of this original function has declined over the last 20 years. Other forms of appropriation, such as secrecy and first mover- advantage, often prove to be much more effective methods of exploiting innovation.[1] Furthermore, inventions are increasingly produced on a mass scale to build up a knowledge stock which is necessary in some technical areas to keep up with the technological progress in cumulative technologies.[2] As a result, the number of patent applications and grants has risen during these years. In rapidly changing areas of technology, patenting behavior has a signaling character showing the direction of new developments. More strategic functions of patents are widely recognized, such as signaling market potential in assigned fields of technology, safeguarding former patents by enhancing the invention, or building a patent stock which can be used as a bargaining chip in negotiations about new technologies and mergers. Additionally, licensing and cross licensing have evolved into a large–scale profit source for innovative firms with capacity constraints or a need for complementary technology.

[1] See Cohen et al. (2000) for survey evidence.

[2] See e.g. Hall and Ziedonis (2001).

Patents have become strategic weapons, and the enforcement of IPR has become a strategic means in technological competition.

Patent infringement suits are a costly way of enforcing intellectual property rights. This Chapter analyzes the characteristics of patent infringement suits in Germany. The most crucial argument in favor of the decision to file a suit is the expected value of filing a dispute versus the expected value of not filing. The expected value of filing a suit includes the innovation rents secured by the patent right net of all costs involved in this dispute. This value depends mainly on the value of the patented innovation but also on the characteristics of the parties as well as on technical and economic conditions. The econometric analysis combines all these different characteristics. The results show that small firms tend to sue more often than larger ones and that this tendency is independent of the company's technological background. This result has a substantial impact on the conditions of insurance contracts providing cover against the risk of patent litigation.

If patenting has a strategic character, then enforcement of patent rights includes strategic elements as well. Enforcement of IPR includes a successful application and granting procedure at the patent office. In some cases opposition procedures, challenge or nullity suits are filed against granted patents. These procedures and suits are part of the enforcement. A potential litigation suit brought before a district court is the ultimate and most costly method of enforcing patent rights. Settlement is always an option in all of these disputes. This might entail agreeing a license or cross-license agreement which would satisfy both parties. Patenting is a costly process, and enforcing the granted property right against infringement is likewise associated with costs - i.e. the time and cost involved in the legal process. In addition, the uncertainty during the dispute is linked with opportunity cost.

The estimated litigation rate in Germany is about 1 percent of all patents in force at any given time. This figure seems quite low. However, large differences between various fields of technology can be observed. It is expected that the probability of litigation will be higher for more valuable patents (Lanjouw and Schankerman (2003), Harhoff and Reitzig (2004)). The distribution of the value of patents is highly skewed, meaning that most patents have little value.[3] Accordingly, the number of litigation cases is low, compared to the total number of patents in force. However,

[3]See Harhoff et al. (2003a) who analyzed the tail of patented invention value distribution.

the rate of litigation remained constant even with growing numbers of applications and grants.[4]

After an infringement is detected, the patentee may decide to negotiate with the infringer about the IPR. From a game theory perspective it is clear that assuming symmetric and complete information the parties should always reach a settlement solution (Bebchuk (1984), Meurer (1989)). This result would minimize the cost of the dispute, maximize the profits from the invention and optimize the compensation for both parties from a welfare point of view. If agreement were the optimal outcome, it is reasonable to ask why at least one patent suit is nevertheless filed every day in Germany. One explanation for this failure to reach settlement in infringement disputes could be that the parties form different expectations about the respective payoffs and about their chances of prevailing at court, even though they have access to the same information.

This study is the first empirical analysis of the determinants of patent and utility litigation in Germany. A new and unique data set of 715 IPR cases will provide new insight into the course and outcomes of litigation disputes. The data include all cases filed at two of the three main District Courts in Germany during the period from 1993 to 1995.[5] These patent and utility suits covered 910 IPRs in litigation. The data were combined with patent information from the German Patent Office (DPMA) and the European Patent Office (EPO), both located in Munich. Furthermore, a control group of 850 German patents randomly drawn from the population of all patents ensured a comparable investigation and provided a means of developing a system of determinants of IPR litigation in Germany.

Within a probit estimation I analyze the probability of litigation as a function of a set of exogenous variables which reflect characteristics of the patent, market conditions, and characteristics of the patent owner. As expected, I observe a higher probability of litigation for patents which are more valuable than the average. This is significant for all patent characteristics that were shown to be correlated with the value of the patent Harhoff et al. (2003a). An additional strong result is the

[4]I calculated this rate by comparing the numbers in Stauder (1989) with the data I collected for the District Courts in Mannheim and Duesseldorf.

[5]District Courts have special chambers which are exclusively responsible for dealing with IPR suits. These are distributed throughout a region in order to give all possible plaintiffs the chance to file a suit in the vicinity of the infringer.

significant higher probability of small firms being involved in patent litigation and this suggests that patents have a higher relative value for small companies compare to larger ones.

The Chapter is organized as follows: In Section 4.2 I outline a model of the decision to litigate and derive hypotheses about the determinants of patent litigation. Section 4.3 contains a description of the sample. I present empirical results for Germany in Section 4.4. Finally, I discuss the results in section 4.5.

4.2 Theoretical Considerations on Parties' Decision to Litigate or to Settle

4.2.1 Prior Research and Theoretical Framework

Theoretical work on the determinants of patent litigation indicates that the sample of litigation cases is not a random selection of all possible suits (Priest and Klein 1984, Bebchuk 1984, Katz 1987). Following the argumentation in the selection model of Priest and Klein (1984), all determinants of settlement and litigation are purely economic. Their model indicates that parties will settle when their expectations regarding the quality of the dispute and their involved stakes are similar.[6] Furthermore, the litigation rate will increase (and the settlement rate will decrease) when the cost of settlement is high relative to the cost of litigation. The authors assume that the expectations the parties have of the outcome and their actual gains from the litigation suit diverge, while the information on the stakes and the probability of winning is distributed symmetrically. These data include the expected costs of the court decisions, the information that parties possess on the likelihood of success, the reputation gains or losses and the direct costs of a trial. Katz (1987) also observed that demand for litigation is determined by the relation of the gains of a dispute relative to its cost.

Subsequent models allow information to be allocated and knowledge distributed in other ways among the parties and assume asymmetric and/or incomplete information. For example, Meurer (1989) draws conclusions about litigation and settlement

[6]This is the case when the true value of the dispute lies far from the decision standard of the court, whether in favor of the plaintiff or the defendant.

decisions in different information situations and different allocation rules. Bebchuk (1984) developed a model based on the assumption that parties make decisions based on incomplete and asymmetric information. Spier (1992) extends the analysis toward a sequential game with asymmetric and incomplete information.[7] Waldfogel (1998) clearly differentiates between the predictions the two main underlying types of litigation models, asymmetric information and diverging expectations, generate about trial rates and winning rates.[8] However, the approach of Priest and Klein (1984) has become the standard model in economic literature on patent infringement and challenge cases, since information in IP suits flows through documents and electronic files relatively easily and is associated with low costs. Therefore, symmetric information is a reasonable assumption in this case. Moreover, knowledge of law practice is highly internationalized and domestically owned firms do not therefore enjoy significant advantages in this respect over parties from abroad. The results of most empirical research on the enforcement of property rights and the determinants of patent litigation are based on these assumptions in order to model the conditions under which litigation cases will be brought to trial (Lanjouw and Schankerman 2001, 2003, Lanjouw and Lerner 2001, Lanjouw and Lerner 1998, Ziedonis 2003, Somaya 2003). The same basic idea was also applied to a model of opposition to pharmaceutical and biotechnology patents at the EPO by Harhoff and Reitzig (2004).

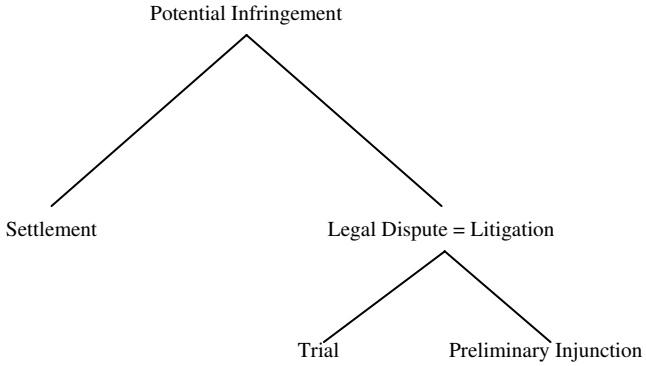
One drawback of these models is that they start their analysis after the suit has already been filed. This approach disregards the decision of the potential infringer to enter the market with a potential imitation as well as the decision of the patentee to file suit against a detected infringer. The problem with analyzing a selection of

[7]Spierpresents a model of sequential bargaining where one-sided incomplete information is assumed. Pretrial negotiations are shown as finite-horizon bargaining game in which the uniformed plaintiff makes the settlement offers. There exist equilibria where no agreement is reached and the agents go to trial even though the court costs are involved in order to accept the final offer.

[8]The diverging expectation model (DE) assumes that the parties estimations of the winning probability and the case quality are random but unbiased. When the underlying model assumes asymmetric information (AI) then one party has private information about the probability of winning. Within the DE model smaller judgement amounts or higher costs (or lower standard deviations of the estimation errors) induce decreased trial rates which cause the win rate to converge to 50 percent. In the AI model a decreased trial rate causes the win rate to approach zero. Only strong defendants will litigate while the weak ones (and those facing strong plaintiffs) will settle.

patent suits is that it is not possible to observe the population of all infringed patents in reference to the potential base of all possible suits. Investigations of litigation always lack observation of the infringement rate. To the best of my knowledge, this problem has not been solved in either the theoretical literature or in empirical investigations.[9] All results regarding the probability of patent litigation are actually statements about the (conditional) probability of a litigation suit given that the patent has been infringed and the infringement has been detected by the patent holder.[10]

Figure 4.1: General Structure of a Patent Infringement Dispute



The general paths of enforcing a property right are shown in Figure 1 according to the legal rules outlined in Chapter 2. First, a potential property right infringement occurs. The patentee then considers one of two possible responses. The first is to make an offer to settle out of court. This usually entails offering a license agreement.

[9]Lanjouw and Schankerman (2003) refer to this problem in their study and argue: "If a patent dispute is settled before a suit is filed, we do not observe the dispute in the data. Thus low filing rates can either reflect low rates of infringement or high probability of pre-suit settlement."(p.149).

[10]Crampes and Langinier (2002) consider a two-stage game involving the decisions of the potential entrant to infringe and of the patentee to sue explicitly. From their model they derive predictions about rate of infringement (in the sense of market entry). Frequency of infringing entry is negatively correlated with the amount of the penalty for infringement and usually also with settlement cost, efficiency of legal procedures, and probability of infringement identification. Within their framework, the bargaining power of the patent holder has no unambiguous impact on the frequency of entry. The predictions of Crampes and Langinier are in the line with earlier results of theoretical literature on litigation and settlement (Perloff and Rubinfeld 1987, Ordover and Rubinstein 1986, P'ng 1983, Cooter and Rubinfeld 1989.)

If this offer is accepted, the matter is then settled. Second and alternatively, the patentee can file a statement of claims in order to start a legal action. A legal action may be a regular suit or a request for a preliminary injunction.[11] Modelling the decision to file a suit I do not distinguish between filing an ordinary suit and a preliminary injunction because, in the German system, the parties expect that an ordinary suit will be filed after the injunction has been granted in order to reach a final judgement.

In the following I introduce the decision problem of the parties in a framework presented by Priest and Klein (1984). The patentee and the infringer decide on whether to litigate or to settle. I assume complete and symmetric information on all facts necessary to form expectations of the probabilities of granting and winning as well as the payoffs and costs of the dispute.[12] However, due to idiosyncracies parties do not necessarily expect the same winning probability or similar values. Parties will go to trial if their expected return net of legal costs is equal or larger than the expected outcome of a settlement. Thresholds of the patentee and the litigant have the following form:

$$p_{pl}\left[V + D(V)\right] + (1 - p_{pl})\left[\frac{\delta}{2}V - C(V)\right] \geq (1+\alpha)\frac{\delta}{2}V \qquad \text{Patentee} \quad (4.1)$$

$$-p_i[D(V) + C(V)] + (1 - p_i)\left[\frac{\delta}{2}V + C(V)\right] \geq (1-\alpha)\frac{\delta}{2}V \qquad \text{Litigant} \quad (4.2)$$

Parties form expectations regarding the probability that the plaintiff (patentee) will prevail. Therefore, p_{pl} and p_i are expected probabilities of the plaintiff and the

[11] Lanjouw and Lerner (2001) apply the request of a preliminary injunction as a second, separate way to start an action before court. The injunction process can have a substantial impact on the payoffs. The patentee has to make clear that in order for him or her to avoid considerable harm a fast decision is necessary. Additionally, he or she has to make the claims clear. Both are very costly in terms of attorney expenses. For a defendant (or the potential infringer) the preliminary injunction imposes a significant danger because it can nullify all or a large part of his or her business (Lanjouw and Lerner 2001)

[12] I cannot completely exclude the possibility of asymmetric information on all matters pertaining to the litigation process and its outcome, such as strength of the patent right and extent of the patent protection which will be elucidated by the judges during the trial. Different knowledge about the applicability of the patented innovation and market conditions can also affect the decision to litigate. But the information about the technical details of the patent, the main economic facts about the litigants and the understanding of the jurisdictional system are available to all parties.

infringer, respectively that the plaintiff will win the dispute. In the case where the patentee prevails, he or she earns V and is paid damages $D(V)$.[13] V is the profit the patentee expects to gain by exploiting the patent alone (i.e., without infringement or license agreement). With probability $1-p$ the court votes against the patentee and he or she has to pay both his or her own legal expenses and those of the prevailing defendant.[14] In this case, more than one company uses the patented innovation and δ reflects the extent to which the respected industry profit is lowered.

The right hand sides of (1) and (2) show the settlement value for the patentee and the infringer, respectively. In order to avoid an infringement suit the plaintiff allowed the competitor to use the patented innovation and received royalty payments for the production of the patented innovation. A license agreement will enhance the profit for the patentee by the license fee α on which the parties agreed. Such a license agreement may include price and output restrictions for the competitor, and it may also define the explicit license fees to be paid to the patentee.[15] The parameter α is the share of profit the competitor has to surrender to the patentee and $(1-\alpha)\frac{\delta}{2}V$ the settlement payoff of the potential infringer.[16] While only C(V) is observable it actually consists of the two two types of legal costs c and a in a way like $C(V) = c(V) + a(V)$. The first type are court costs c which do not depend on the patentee's opportunities on the financial market or on his efforts in the case. The second type is the attorney cost a and depends heavily on the efforts one party undertakes in the suit and on the financial conditions it faces on the market in funding these activities. By law, all legal costs must be proportional to the size of the case by a factor τ smaller than one. The size of the case is the loss the patentee is expected to suffer when the potential infringer uses the invention without permission during the time of dispute and is calculated as difference between the possible monopoly profit and the patentee's fraction of the non-settlement profit, $(V - \frac{1}{2}\delta V)$.

[13]There are three main methods of calculating damages, all of which depend on the value the patent creates on the market (Reitzig et al. 2003). Additionally, the time length of infringement and the time left on the patent is enclosed within the expectations the parties make.

[14]According to the British rule of cost allocation the losing party has to bear all legal costs. However, in jurisdictional practice not all attorney expenses are taxable.

[15]I assume that there is no strong antitrust regime.

[16]It is also possible that the patentee will not proceed to trial even if the potential infringer rejects a settlement offer. The license fee in this case is zero.

4.2.2 Hypotheses on the Determinants of Patent Litigation Filing

Equations (1) and (2) show that the probability of patent litigation depends on the profit V the parties expect to earn by using the patented innovation. V is a function of the characteristics of the patent x_p, the characteristics of the firm, x_{pl} and x_i, $V = V(x_p, x_{pl}, x_i)$. I consider the profit V in the model as a close correlate to the value of the patent which is a wider concept including the strategic capacity as well as the signaling and blocking power of the patent. Thresholds (1) and (2) clearly reveal a positive impact of the value of a patent on the incentives to enforce it (Lanjouw and Schankerman 2001, 2003). With increasing value of the patent for both the patentee and the infringer the direct incentive to proceed to trial rather than settle increases.

Higher values also raise the probability of infringements, which leads implicitly to a higher probability of litigation. As referred to above, the probability of infringement is not observable; the only evidence, offered by Harhoff and Reitzig (2004) shows that the probability of opposition as an early type of attack against a granted patent increases with the value of the patent. In the following I derive hypotheses on how these characteristics influence the probability of a patent litigation suit. The expected winning probabilities p_{pl} and p_i also depend on the characteristics of patentees and the information available to them.

Characteristics of the Patent

The impact the characteristics of patent have on the probability of litigation is mainly due to their correlation with the value of the patent. From the argumentation above I derive the following hypothesis:

H1: The probability of patent litigation at a German Court is ceteris paribus (c.p.) high for patents with a high value.

This Hypotheses is per se not testable. Patents are heterogenous and supply different levels of additional profit to companies through the original protection function and strategic functions (Somaya 2003). The value a single patent has for its patentee is not directly observable. The impact that patent portfolios or patent stocks

have on firm value, profits, and sales is hard to identify from survey data (Harhoff et al. 2003). Using a set of value correlates to derive a set of hypotheses which formulates the expected relationship between those correlates and the likelihood of court litigation in Germany.

In the European patent system the patent applicant suggests patents which should be included as references to the prior art. However, the examiner (either of the EPO or the DPMA) makes the ultimate decision on what patents will be included as backward citations. In contrast, for a U.S. application the applicant is requested to name all references to the state of the art using patent or non-patent literature, which leads to more citations and to the quotation publications which are only tenuously linked to the applied invention. Michel and Bettels (2001) emphasize that US citations appear to represent more of a documentary than patentability search. References to earlier patents in the German and European system mark the boundaries of patentability and the bases the invention builds on. They are used to substantiate the patentability for which novelty and inventive activity is necessary. This function of citations implies that the number of citations received (forward citations) play a similar role to that of references in scientific publications as an indicator for the importance of the patent. Trajtenberg (1990) provided major support for this argument and Harhoff et al. (2003a) provided more broad evidence of the correlation between patent value and citations received in subsequent patent applications. Using the information the citing patents provide, citations can be used as ingredients in the construction of measures for "originality" and "generality" (Hall et al. 2001). Even though the forward citation can point to further development and depreciation of the former invention, the value enhancing effect should be dominant as supportive survey evidence (Harhoff et al. 2003).

H1.1: Patents which received a large number of forward citations in subsequent patent applications have c.p. a higher probability of litigation than less cited patents.

References made to prior patents (backward citations) in both the EPO and DPMA patent applications reflect the related state of the art. Lanjouw and Schankerman (2003) argue that a large number of references in the patent application indicates a well-developed technology with less uncertainty than newly developed technologies, making litigation less likely. Another argument is presented by

Harhoff et al. (2003a). They point out that patent applications with broad patent claims induce a large number of references to prior patents which describe the current patent application more precisely and therefore increase its precision. In line with these arguments a patent with a higher number of references to prior patent applications is more secure against infringement than those with a lower number of references. But, as Harhoff et al. (2003a) also argue, the logic of these references is to indicate subject matter that may restrict the scope of the patent claims when they are presented against the claims of application. Following this argumentation a larger number of backward citations is linked with a higher uncertainty about claims. Competitors are more likely to infringe insecure claims and c.p. the probability of suits will be higher.

H1.2: The correlation of backward citation with the probability of litigation is positive.

Empirical studies found mixed evidence of the relationship between the number of references and the probability of a patent dispute. While the number of references to prior patents is confirmed to be significantly positive correlated with the monetary value of German patents (Harhoff et al. 2003) no significant correlation of the total number of backward citations in EPO applications on the probability of opposition could be found by Harhoff and Reitzig (2004). The U.S.– based study of Lanjouw and Schankerman (2001) does not report any significant effects of backward citations per claim on the probability of litigation either, although - using an updated data set - they do show a negative effect(Lanjouw and Schankerman 2003).

A patentee can file patent applications for the same subject matter in more than one jurisdiction, building a patent family. Within the one year of priority he or she can file exactly the same patent application at certain patent offices while still fulfilling the requirement of novelty. The number of jurisdictions representing family size as a value correlate of patents was introduced by Putnam (1996). He argued that multiple applications are associated with expensive legal fees and translation costs. It is a suitable variable because it reflects the patent holder's private estimation of the patent's value.

H1.3: The number of jurisdictions patent protection was sought for is, c.p., positively correlated with the probability of litigation.

All patent claims define the boundaries of an invention in words to provide the public with notice of what the invention is and to enable it to avoid infringing the patent. A patent usually comprises a bundle of independent claims which define the basic elements of the invention. Additional subordinate claims describe the invention in more detail. The independent claims have greater relevance to the value of the patent than the subordinate claims. Broad patents, indicated by a high number of total claims, are more likely to be infringed. Since the probability of litigation is a condition of the probability of infringement, c.p., the probability of litigation depends on the number of claims. Positive relationships between the number of claims and the probability of a patent being subject to a dispute are found in Lanjouw and Schankerman (2003), Graham et al. (2003) for the American enforcement patent system. Harhoff and Reitzig (2004) reported a higher probability of for patents with a large number of claims. For the probability of litigation before court in the German system I formulate the following hypothesis:

H1.4: The number of claims is c.p. a positively correlated with the probability of patent litigation.

As explained in Chapter 2 there are three different ways of seeking protection in more than one country. First, a patentee can file an application with the domestic patent office in each country. Second, the European Patent Office can provide protection within any or all of the member states of the European Patent Convention via just one application. Applying per PCT application is the third way and offers patent protection in all member states of the PCT. In a study by Thumm (2000) the "road of application" is used to indicate the importance an invention has for the inventor or applicant. PCT applications are similar to EPO patents; they seek protection in more than one jurisdiction within the member states. I assume that facing the higher cost of a PCT or EPO application compared to a DPMA application the applicant expects compensation through higher profits and this values the patent more highly. Even though PCT applications are expensive in total they secure priorities and save translation costs during the first 30 months after application has been made.This period of time is called the "international phase" during which the applicants can further develop the invention and are better informed after 30 months to decide whether they will proceed into the "national phase" or not;

depending on the expected value of the patent application. Only during the "national phase" the designated states for validity have to be presented and do the fees and translations for these applications become due. I anticipate that only the most valuable of patents proceed to the national phase of the PCT application procedure.

H1.5: Patents which are applied for via the PCT path have, c.p., a higher probability of being litigated than patents directly filed at the EPO or at the German Patent Office. The application path via EPO leads to a higher probability of litigation than that of the German Patent Office.

Patents issued by the EPO or the DPMA can be subject to opposition. Any third party can file such a procedure, claiming that the invention is not new or the inventive step is not significant enough. An opposition is an official act at the patent office that seeks to declare a patent invalid or to amend it.[17] If the potentially infringing party opposes the patent before the suit begins it seems likely that this party will have an interest in using the invention itself and not in leaving the right to the patentee. One reason for such an interest could be that the opposing (and potentially infringing) party has made a similar invention. Another reason might be that the expected value of the protected invention is so high that it is worth opposing and later infringing in order to appropriate at least some of the payoffs of the protected innovation. Harhoff et al. (2003a) found that patents which have defeated an opposition procedure are significantly more valuable than those patents which have not been not attacked. This finding was strengthened by the analysis of Harhoff and Reitzig (2004), who show in a theoretical model that opposed EPO patents in biotechnology and pharmaceuticals are generally more valuable, than those which were not opposed when measured by several value indicators. On the one hand a higher expected value of a patent attracts more exploitative interests and leads to a higher probability of legal dispute. On the other hand, a patent which has faced opposition becomes more valuable because it indicates a stronger patent right; this will increase the plaintiff's expectations about the probability of winning the case, p_{pl}. I expect that both effects lead to a positive impact on the probability of litigation (Graham et al. 2003).

[17] See Harhoff and Reitzig (2004) and for a detailed description of the opposition procedure.

H1.6: Patents which faced an opposition procedure after granting are c.p. more likely to be involved in a subsequent litigation procedure.

The hypotheses H1.1 to H1.6 generally state that the patent value correlates are positively linked to the probability of litigation before German courts.

Characteristics of the Patentee

The characteristics of the patentee is related to the idiosyncratic realization of the patent values and the opportunities of the parties to solve a legal dispute before court. Main findings for the U.S. show that the size of the patentee (Lanjouw and Schankerman 2003, Harhoff and Reitzig 2004) and the relative size of the parties (Somaya, 2003) have a considerable impact on the probability of being involved in a patent dispute. In general, large firms are less likely to be involved in litigation suits than smaller ones. One reason for this may be that large firms estimate the value of an invention differently in relation to their overall profits. In most empirical studies, size is measured in technical terms (number of previous patents granted to the patentee). As indicators for the absolute size served mainly dummies for listed and unlisted companies and dummies for individuals. Accounting figures such as turnover or number of employees are rarely available (Lanjouw and Schankerman 2003, Harhoff and Reitzig 2004, Graham and Somaya 2004). It is generally assumed that economically large firms tend to have more patents than small firms. A financially strong firm has a higher potential to threaten a suit as it is better equipped to bear all the costs involved over a longer period of time.

H2: Large firms face, c.p., a smaller probability of patent litigation than small ones.

Companies with a large portfolio of previous patents are more experienced in enforcing their rights. Additionally, firms with a large portfolio of similar patents have more opportunities to keep α small and to offer cross licensing agreements for settlement. This would result in less legal litigation suits even though companies with a large portfolio of patents probably face more infringement issues than companies with smaller patent portfolios. They are likely to be involved in more potential infringement disputes as well as more license bargaining. The argument that repeated

interaction of firms with large patent portfolios leads to a higher threat point in settlement bargaining is made by Lanjouw and Schankerman (2003) and points to a lower likelihood of legal disputes but a higher likelihood of infringement disputes without involvement of courts. However, this is only of importance in cases when the financial markets are incomplete. Firms also use frequent interactions to build up a reputation in respect of their strength in enforcing their property rights. It is not clear whether the experience in bargaining, the reputation gained through prior disputes, or the high expected costs of repeated disputes lead to a smaller probability of litigation before courts for these companies. But this will be of less importance when a certain level of patent portfolio size is reached. Since the effect of higher incidence of infringement when the number of patents in the portfolio is high is still evident, I expect for very high portfolio sizes also a higher likelihood of litigation.

H3: Firms with a large number of previously granted patents (a large patent portfolio) are, c.p., less likely to be involved in patent litigation suits. The relationship will be U-shaped.

Because of an individual patentee's tendency to be personally involved in the enforcement of "their patent", I expect a bias towards more litigation suits when such patent owners are involved. Individuals tend to be more optimistic in evaluating the profits of a patented innovation (Astebro 2003). According to the model outlined above this would lead to a higher risk of litigation for individuals when compared to companies. A significantly higher probability of domestic individuals suing potential infringers is also a stable stylized fact and is shown in the studies on the U.S. above cited. This is partly due to larger relative stakes individuals have in such suits. Individuals patenting software innovations in the U.S. were found by Graham and Somaya (2004) to be more litigious than companies. Lanjouw and Schankerman (2003) offer mixed evidence - positive in the case of domestic individuals, negative for foreign individual patent owners. I also expect individuals to be more likely to be involved in patent litigation than companies.

H4: Individuals are, c.p., more likely to litigate than companies.

I expect the origin of the patentee to be significant owing to the different costs of aquiring access to information. The probability of litigation should be higher for

Germans than for foreign patent owners. I would also expect European patentees to be involved in patent litigation suits more often than owners from non- European countries because of the lower expected costs (Harhoff and Reitzig 2004). Foreign patentees have per se the same access to information regarding the patented invention. However, translation and attorney costs for the German jurisdictional system are considerable and lower their propensity to sue at a German district court.

4.3 Sample Description

4.3.1 Variables

In section 4.2.2 I introduced the theoretical determinants of the probability of litigation. In the following I link them to a set of independent variables consisting of those which are related to the characteristics of the patent as an invention, those which describe the patentee, and those which are related to the market situation and conditions for innovative activity. From the data I introduced in Chapter 3 I use the data on all identified litigated patents and the control group of non–litigated patents. Table 4.1 shows descriptive statistics for the variables used in my the analysis. The first block contains the patent characteristics. The characteristics of the patent holder are displayed in the second block.

Patent Characteristics

For an analysis of forward citations I searched the patent databases PATDPA (FORW_CIT_D) and ELPAC (FORW_CIT_E) and counted the number of subsequent patent applications which cite the investigated patent as "prior art". I truncated the number of forward citations at the first filing year 1993. Furthermore, it is not certain that the full number of citations received is documented in the PATDPA even for the oldest patents with application dates in the early 1970s. To correct for this truncation bias I used the method of "fixed effects" as described in detail in Hall et al. (2002). The underlying assumption of this approach is that all differences in the citation intensities over time are due to artifacts. Citation behavior does not change over time and the number of forward citations per patent and per cohort is constant. Annual effects are eliminated by dividing the number of forward citations

Table 4.1: Descriptive Statistics for all Exogenous Variables

	All	Litigated	Matched
Exogenous Variable	Mean (SD)	Mean (SD)	Mean (SD)
Citations Received in DPMA and EPO (FORW_CIT_D+E)	2.329 (4.302)	3.412* (5.378)	1.246* (2.403)
References made (BACKW_CIT_D+E)	2.981 (2.733)	3.430* (2.905)	2.533* (2.470)
Number of Independent Patent Claims (CLAIMS)	9.558 (8.394)	10.500* (9.621)	8.617* (6.831)
Number of Jurisdictions (FAMILY_SIZE)	5.137 (5.647)	5.576* (6.234)	4.697* (4.956)
Opposition Procedure Survived (OPPOSITION)	0.160 (0.367)	0.271* (0.445)	0.050* (0.218)
Application at EPO (EPO_APPL)	0.266 (0.442)	0.260 (0.439)	0.272 (0.445)
Application via PCT (PCT_APPL)	0.047 (0.211)	0.032* (0.175)	0.062* (0.241)
Number of Patents in Portfolio (PATENT_PORTFOLIO)	0.159 (0.713)	0.074* (0.428)	0.244* (0.905)
Plaintiff is an Individual (INDIVIDUALS)	0.166 (0.372)	0.091* (0.288)	0.241* (0.428)
Plaintiff is a Small Company (SMALL_FIRM)	0.178 (0.383)	0.261* (0.439)	0.096* (0.295)
Plaintiff is Medium Sized Company (MEDIUM_SIZE_FIRM)	0.302 (0.459)	0.335* (0.472)	0.268* (0.443)
Plaintiff is a Large Company (LARGE_FIRM)	0.354 (0.478)	0.313* (0.464)	0.394* (0.489)
Patent Owner is from Germany (OWNER_DE)	0.667 (0.471)	0.771* (0.421)	0.564* (0.496)
Patent Owner is EU, but non-German (OWNER_FOR_EU)	0.174 (0.379)	0.146* (0.353)	0.203* (0.402)
Patent Owner is from the US (OWNER_FOR_US)	0.096 (0.295)	0.065* (0.248)	0.127* (0.334)
Patent Owner is from Japan (OWNER_FOR_JP)	0.047 (0.211)	0.015* (0.120)	0.079* (0.270)
Patent Owner is from Other Countries (OWNER_FOR_Other)	0.015 (0.122)	0.004* (0.060)	0.027* (0.161)
Number of observation	1648	824	824

Numbers with * differ statistically significant at 1% level.

of a patent by the mean of forward citations of its cohort. I used this weighted

forward citation in the analysis.

The samples of both litigated and non-litigated patents include 438 patents that were originally filed at the EPO. The other 1,210 were originally applied for at the DPMA. Reliable information on forward citation was available only at the original patent office. Owing to this lack of data I combined both sources of information and eliminated double counts. The resulting number of citations includes all unique citaions at the EPO and DPMA (FORW_CIT_D+E). Tables 4.2 and 4.3 indicate the main properties of these citation variables and contains the disentangled means for references made and citations received at the DPMA (FORW_CIT_D) and at the EPO (FORW_CIT_E) as well as the combined figures (FORW_CIT_D+E).

Table 4.2: Forward Citation in EPO and DPMA by Litigated and Non-Litigated Patents

	Litigated		Non-Litigated		All	
	Mean (SD)	Obs	Mean (SD)	Obs	Sample Mean (SD)	Obs
FORW_CIT_D	3.271 (2.252)	610	1.055 (0.087)	600	2.172 (0.126)	1210
FORW_CIT_E	2.766 (0.246)	214	1.027 (0.110)	224	1.877 (0.139)	438
FORW_CIT_D+E	3.412 (0.187)	824	1.246 (0.084)	824	2.329 (4.302)	1648

Forward Citations are available for both offices. Forw_Cit_D+E is the sum of both after removing double counts.

First, I draw on table 4.2, column 5 to compare the sample means of the forward citations. On average, an original European patent in the sample is cited in 1.877 subsequent European patent applications. Surprisingly, this number is significantly smaller than for German subsequent applications. Original German applications in the sample have an average of 2.172 forward citations. One reason might be that patents valid in Germany are more frequently cited at the DPMA because it is the relevant market. For European patent citations patents from other EPC member states are more important as far as the first to file rule is concerned. In all cases litigated patents are more frequently cited than unlitigated patents, which is expected in H1.1. On average, the number of combined forward citations is 2.33, while litigated patents received 2.8 times more forward citations than unlitigated

patents (table 5.2).[18]

I now turn to the number of backward citations, which I summarize in detail in table 4.3. This variable was subject to a similar problem to the one affecting forward citations. For the 1,210 patents originally filed at the DPMA I used citations from the DPMA publication (BACKW_CIT_D). For the 438 applications which were made solely at the EPO with designation to Germany I implemented the backward citations from EPO (BACKW_CIT E). While Michel and Bettels (2001) stress the diversity in citation attitudes among the triad patent jurisdictions (US, EPO, JP), there are also differences between the EPO and the DPMA. Again, I use both variables in parallel (BACKW_CIT_D+E) because, for original EPO patents, only the references in the EPO publications documents are available (BACKW_CIT_E). While the average of BACKW_CIT_D is 2.401, the mean of BACKW_CIT_E is 4.559. The difference is statistically significant. In general, litigated patents tend to cite more references to prior patents than unlitigated patents by a factor of 1.5. However this is driven by backward citations of the original German applications. For patents that were applied for at the European Patent Office, BACKW_CIT_EPO is not significantly different between litigated or unlitigated patents.[19]

Table 4.3: Backward Citation in EPO and DPMA by Litigated and Non-Litigated Patents

	Litigated		Non-Litigated		All	
	Mean (SD)	Obs	Mean (SD)	Obs	Sample Mean (SD)	Obs
BACKW_CIT_ D	2.964 (2.744)	610	1.828 (1.974)	600	2.401 (2.459)	1210
BACKW_CIT_E	4.757 (2.950)	214	4.420 (2.672)	224	4.584 (2.813)	438
BACKW_CIT_D+E	3.430 (0.101)	824	2.533 (0.086)	824	2.981 (2.733)	1648

Backward Citation were available only for the original filing patent office. Backw_Cit_D+E is the combination of either Backw_Cit_DPMA or Backw_Cit_EPO.

[18]For all variables in table 5.2 a test of equal means was conducted. Numbers with * indicate significant differences at the 1% level.

[19]I am grateful to Stefan Wagner from Inno-tec Munich who provided excellent citation information from the EPOLINE data bases, collected in cooperation with the EPO.

For the following variables, information is available both for original German patents and original European patents in the same quality. The description is consolidated in table 5.2. The number of claims was received directly from the patent documents which can be downloaded from the databases (CLAIMS). I calculated the number of independent claims. In this study I used the number of claims as a measure of patent breadth.[20]. The number of claims differs between the groups. While 9.6 claims were filed on average across the entire sample, the patents not involved in litigation had an average of 8.6 claims and the litigated patents 10.5.

Patent data bases usually contain a set of variables which reveal family information. FAMILY_SIZE is defined as the number of jurisdictions in which patent protection was sought. It conforms to the definition of family size used by Putnam (1996). After removing double counts this variable was directly obtained from PATDPA to be used in this analysis. At the EPO the variable for family size is not readily available; the number of designated states includes only states which are members of the European Patent Organization and does not include jurisdictions such as the U.S. or Japan. The average family size of litigated patents differs significantly from that of unlitigated patents (5.6 and 4.7).

Patents which were filed via the PCT application path (PCT_APPL) are rare within the sample of litigated patents. The number of PCT application actually remained very small until the end of the 1980s and started growing at the beginning of the 90s. Generally, only 1.7 per cent of patents were sought via PCT in 1980, but this rose to around 25% by the late 1990s. Because the bulk of the patents in the sample were applied for between 1982 and 1987 the PCT applications play only a minor role as a way of seeking patent protection. Across the entire sample, protection was sought via PCT application in 4.7% of the cases and via EPO application in 26.6%. Within the litigated group of patents, the share of PCT_APPL is significantly lower (3.2%). The numbers for original EPO patents (EPO_APPL) differ insignificantly between the two groups.

A dummy variable indicates whether an opposition procedure had been filed (Opposition) either at the EPO or at the DPMA. In this analysis I discuss the issue of prior opposition as such. I have not differentiated between the procedures at the

[20]There exist several concepts of how to operationalize the scope of a patent. Lerner (1994) used the number of four digit IPC-subclasses a patent was assigned to

German Patent Office and the EPO, even though national opposition affects the validity of a patent only for the German market, a European one has effects for all designated states.[21] An opposition against a European patent may exercise an impact on the country in which it is decided to file a litigation suit. As I am not able to conduct a European comparison of patent litigation suits I only use information on whether a patent was opposed after granting or not. Litigated patents were opposed five times more often than patents in the control group.

Characteristics of the Patentee

The dummy variable INDIVIDUAL defines whether the patentee is an individual or a company. In cases where the patentee as potential plaintiff was indicated as a corporation, the size and industry variables were added. For the foreign corporations the data were completed by searches using internet and information from several firm databases.[22] Finally, four size classes were constructed using sales figures. The first includes all individuals, the second small firms with sales totaling less than 10 million DM (SMALL_FIRM); the third is for medium sized firms with sales of more than 10 million DM up to 100 million DM (MEDIUM_SIZE_FIRM); the fourth class includes all large firms with sales of more than 100 million DM (LARGE_FIRM).[23] While the share of SMALL_FIRM for litigated patents is 26.1% , 2.7 times higher than the 9.6% in the group of unlitigated patents, this difference decreases for MEDIUM_SIZE_FIRM from 33.4% to 26.8%, by factor 1.2). LARGE_FIRM are less frequently represented as patentees in the group of litigated patents than in the unlitigated group (31.3% versus 39.5%). The relation is 0.8. Individuals are less likely to be owners of a litigated patent. 24.2% of the unlitigated patents are held by individuals compared to only 9.1% of the litigated patents. Table 5.2 shows that all of differences are statistically significant.

I constructed the variable patent portfolio size (PATENT_PORTFOLIO) as the number of all patents of the patentee which were in force at the time the law suit was

[21]Between European and German patents no significant differences in opposition frequency is observable. The shares of opposed patents are 16.4 and 15.7, respectively.

[22]Commercially provided firm databases are Creditreform, MARKUS, AMADEUS, Hoppenstedt, and for the U.S., the COMPUSTAT file.

[23]The size classes defined in Euro are approximately: less than 5 million Euro, up to 50 million Euro, more than 50 million Euro.

filed. It is the sum of all applications granted at the DPMA starting from 1978 to the year of filing. I also used the EPO applications which were designated for Germany because I intended to interpret the portfolio partly as a means of bargaining in the German market. The average portfolio size is 1,590. It ranges from 1 to 66,369. As expected, for foreign firms the portfolio size is smaller with 1,262 on average. Even though there is a large difference between domestic and foreign applicants, it is not statistically significant. Non-German litigating parties have a larger portfolio than German litigating parties.

Additionally, in table 5.2 I used the respective owner's base nation to identify domestic and foreign patentees. The owners are from the EU, the U.S., Japan, and others (OWNER_FOR_EU, OWNER_FOR_US, OWNER_FOR_JP, and OWNER_FOR_OTHER). The probability of litigation should be higher for Germans, of course, and also among foreigners with respect to European patentees because of the lower expected costs. The share of patent owners who have their headquarters in Germany is almost two-thirds in the sample. Within the group of litigating parties it increases up to 76.6%. The share of European patentees among foreign patent holders is higher than 50 percent. As expected, patentees from the EU are more likely to be involved in litigation suits than patentees from other foreign countries. U.S. patentees are represented less often in the group of litigating parties and the shares of Japanese and other owners are even lower.

4.4 Empirical Results

4.4.1 Descriptive Statistics

My analysis of the determinants of patent litigation suits in Germany is based on a sample of 824 patents for which applications were made to and patents granted by the German Patent Office or the European Patent Office and which were involved in patent litigation at the district court in Düsseldorf or Mannheim during the period 1993 to 1995.[24] Applications for preliminary injunctions are included within the

[24]Stauder (1996) determined that these two district courts treat about 55 to 60litigation cases in Germany. I assume that the tendency to file suits at certain district courts has not changed decisively over time. Likewise, the reasons for forum shopping did not change from the analysis period of Stauder (1989) 1971 to 1973 to the recent period from 1993 to 1995.

group of litigated patents. They are also regarded as filed suits given that a preliminary injunction is usually followed by a regular suit. The number of applications for a preliminary injunction almost doubled from 69 in the period 1972-1974 to 109 in the period from 1993-1995.[25] I begin with describing the structure of the litigation sample as it compares with the control group and the general characteristics of the population of all German patents.

As Lanjouw and Schankerman found for the U.S. the litigation rate varies dramatically among technologies. IPC-codes are used at the DPMA and EPO in the same way to assign inventions to a field of technology. Each patent will be assigned to one (principle) or more IPC classes, each of which consists of a 4 digit main class and a 4-5 digit subclass. The principle IPC class is used to categorize the patent into a technical area (drugs, chemicals, mechanicals, electronics, others). In order to compare the results with the U.S. studies the data were aggregated in a way similar to the area-definition used by Lanjouw and Schankerman (1997). Table 4.4 shows how the distribution within the main technical area differs among the total population of patents within the same cohorts as the sample. It is apparent that the share of pharmaceutical patents is roughly the same in the sample as in the universe. However, patents applied for in chemicals represent half of the share within the sample distribution compared to the overall patent grants. Imitation of chemical raw material is relatively easy to detect. This should be true for pharmaceutical patents as well. However, as biotechnology, which was a relatively new technology in the period of investigation, is also included, the share of pharmaceutical patents involved in disputes is higher than the overall share would suggest. Patented mechanical inventions are the subject of litigation disputes more often than their share among the universe indicates.

Table 4.4 shows the differences in the technology structures. The most striking fact is that the share of litigated patents granted in Mechanics amounts to 52.18% while it is only 37.79% on average in the German population in comparable application years. Defining claims for a mechanical invention is more complicated than in the case of a chemical formula, for example. Thus, infringement is more likely and, more importantly, the proof of infringement is more difficult to obtain. Parties will have different expectations of their probability of winning, and this will make

[25]Refer to the data in Stauder (1989) for comparative purposes.

Table 4.4: Distribution of Patents Across Technical Areas, by Litigated and Non-Litigated Patents

	Frequency and Shares of Patents in Main Technical Areas			
Technology	German population		Litigated Patents	
Pharma	112,396	5.83%	66	8.01%
Chemical	330,999	17.18%	67	8.13%
Electronic	549,965	28.54%	123	14.93%
Mechanical	708,983	36.79%	430	52.18%
Other	224,598	11.66%	138	16.75%
Total	1,926,941	100.00%	824	100.00%

Note: Patents for German population reported in PATDPA with application date from 1978 to 1993

settlement less likely. Only 8.13share of chemical patents in the total German population of patents is more than twice as high. It is relatively easy to detect the imitation of chemical raw materials and this makes the outcomes of litigation suits easy to predict and, as a result, settlement more profitable. Again, this should also hold true for pharmaceutical patents. However, pharmaceuticals are more likely to be involved in litigation suits than chemical patents. Because this field includes biotechnology, which was a relatively new technology in the period of investigation, the share of pharmaceutical patents involved in disputes (8.01%) is higher than the overall share (5.83%) would suggest. Lanjouw and Schankerman (2003) report greater shares in Drugs and Other Health, in Chemical and Electronics within the sample of all filed cases in the U.S. for the suit filing cohorts between 1978 and 1995 in comparison with Germany. Only mechanical patents have a higher share in Germany within the sample of litigated patents. The reason lies partly in the differences in patenting behavior between the two countries. Germany traditionally has a higher percentage of the more traditional mechanical patents owned by small and medium sized firms. The probability of litigation is c.p. higher when more patents are in force. Case study evidence from the chemical industry reports that large German chemical and pharmaceutical companies try to avoid patent litigation

by offering credible settlement amounts and/or cross-licensing agreements.

Table 4.5 contains the distribution across age classes. The average age of a litigated patent is 8.3 years. About one-third of litigated patents are less than 6 years old, and one-third is between 6 and 10 years old. There is no reliable information on the average age of a patent in the universe of all German patents in the period from 1993 to 1995. Therefore, these large shares of young litigated patents can be caused by a general tendency to infringe and subsequently provoke suits at an average age of 8.3 years. However, it may be that across all technology classes the average age of a patent in force is around this figure, and age has no impact on the probability of litigation.

Table 4.5: Age of Patents at Time of Filing in the Sample of Litigated Patents

Patent's Age (years from application date)	Number of patents	percent
0 to 5	255	30.95%
6 to 10	300	36.41%
11 to 15	216	26.21%
16 to 20	53	6.43%
no. of firms	824	100.00%

Note: The average age at the time of filing is 8.3 years

As described in section 3.3 the construction of the control group results in a sample litigation rate of 0.5. Table 4.6 shows how this litigation rate varies among the groups of ownership and for different citation figures. German owners are more likely to be involved in litigation than owners from abroad. The probability of litigation decreases as the geographical distance from Germany increases. The last column of table 4.6, "Total" shows that the German patent owners in the sample face a sample litigation rate of 0.58, while that of all foreigners is below 0.5. Patents with less than 4 forward citations have sample litigation rates lower than 0.5. While Germans still face a probability of 0.48 within this sample patentees from outside the triad are only involved in 0.15 (Japan) and 0.11 of disputes. This table confirms that the litigation rate rises with the number of forward citations, which points to a higher probability of litigation for more valuable patents. For patents owned by

Germans this effect is monotone in the number of citations while for EU owners and patentees from other countries it is not. Irrespective of the origin of the owner, in cases where the number of forward citations is higher than nine the probability of litigation is at least 15 percentage points greater than the constructed litigation probability. In table 4.7 I show the sample litigation rates for patentees of different absolute size owning patent portfolios of various sizes. In general large firms have a sample litigation probability which is less than the average, 0.44. However, if the firm owns a large portfolio with more than 2,000 patents, this probability drops further to 0.20. Small firms have a high expected probability of litigation. For firms with a small patent portfolio of ten patents at most, the probability of litigation amounts to 0.80. Surprisingly, medium-sized firms with a large portfolio have a very high observed probability of litigation (0.70), while firms with a smaller patent portfolio do not significantly deviate from 50 percent. This number is mainly determined by multiple cases of one company defending various patents.

4.4.2 Results from Probit Estimation

In this section I present the results of the probit analysis. I assume that the probability of litigation, given that patent infringement has taken place and has been detected, is correlated to the value of the relevant intellectual property right (first block of Table 4.8) a number of characteristics of the owner of the right, and market characteristics (second block of Table 4.8). FORW_CIT_D+E is positive and highly significant and shows that an increasing number of forward citations leads to a higher sample probability of litigation at a decreasing rate indicated by a negative parameter of FORW_CIT_D+E_SQU. This result confirms H1.1 and is in line with the findings of Lanjouw and Schankerman (2003), related studies by Graham and Somaya (2004) for software patents and Harhoff and Reitzig (2004) for determinants of opposition against pharmaceuticals. Adding one additional citation would raise the litigation probability by 4.5 percentage points.[26]

[26]I used citations per claim in a different probit specification. In doing so I assigned more attention to the valuation of a certain inventive step documented in one claim. The results remained qualitatively the same and were in the magnitude of those of Lanjouw and Schankerman (2003). However, the estimation was not as precise as the one preferred in this analysis and is not reported here.

Table 4.6: Probability of Litigation by Ownership and Forward Citations

	Forward Citation						
Owner from	0	1 – 3	4 – 7	7 – 9	more than 9	Total	Obs
Germany	0.48	0.57	0.74	0.78	0.88	0.58	1100
	(0.50)	(0.50)	(0.44)	(0.42)	(0.33)	(0.49)	
EU	0.21	0.59	0.78	1.00	0.71	0.42	287
	(0.41)	(0.50)	(0.42)	(0.00)	(0.49)	(0.49)	
US	0.27	0.26	0.65	1.00	0.78	0.34	159
	(0.45)	(0.44)	(0.49)	(0.00)	(0.44)	(0.48)	
Japan	0.15	0.11	0.17		0.67	0.16	77
	(0.36)	(0.32)	(0.41)		(0.58)	(0.37)	
other	0.11	0.00	1.00			0.12	25
	(0.32)	(0.00)	(0.00)			(0.33)	
Total	0.38	0.52	0.72	0.80	0.85	(0.50)	1648
	(0.49)	(0.50)	(0.45)	(0.40)	(0.36)	(0.50)	
Obs	793	542	159	60	94	1648	

Table shows the probability of litigation in the constructed sample depending on the origin of the patent owner and the number of forward citations. When the probability of litigation is equal 1 (0) there are only observations in either the group of litigated (unlitigated) patents. Standard errors in parentheses.

BACKW_CIT_D+E has a positive impact on the likelihood of litigation processes in Germany. This effect is estimated precisely and turns out to be robust against sample variation. One additional backward citation added to the mean would increase the probability of litigation by 4.7 percent points. This effect is in the same dimension as that observed for forward citations and is highly significant. The impact of backward citations on the likelihood of patent litigation diminishes as the number of backward citations increases, a fact illustrated by a negative parameter for BACKW_CIT_D+E_SQU. The result suggests that a high number of backward citations indicate either that the patent is probably either questionable because of its similarity to a large number of previously granted patents or that the value of the patent rises, as I argued in section 4.2.2. According to H1.2 I found evidence

Table 4.7: Probability of Litigation by Portfolio Size and Firm Size of the Patentee

	Size Classes of Patentees					
Patent Portfolio	Individual	Small	Medium-Sized	Large	Total	Obs
0 to 10	0.32	0.80	0.56	0.52	0.53	634
	(0.47)	(0.40)	(0.50)	(0.50)	(0.50)	
11 to 250	0.12	0.70	0.54	0.53	0.53	633
	(0.32)	(0.46)	(0.50)	(0.50)	(0.50)	
251 to 1000	0.00	0.33	0.59	0.51	0.51	152
	(0.00)	(0.52)	(0.50)	(0.50)	(0.50)	
1001 to 2000		0.57	0.50	0.42	0.45	65
		(0.53)	(0.53)	(0.50)	(0.50)	
$>$ 2000		0.43	0.70	0.20	0.29	164
		(0.53)	(0.47)	(0.40)	(0.46)	
Total	0.27	0.73	0.55	0.44	0.50	1648
	(0.45)	(0.44)	(0.50)	(0.50)	(0.50)	
Obs	274	294	497	583	1648	

Table shows the probability of litigation in the constructed sample depending on the size of the patent owner and the number of patents in its portfolio. When the probability of litigation is equal 1 (0) there are only observations in either the group of litigated (unlitigated) patents. Standard errors in parentheses.

that this effect dominates the impact of lowered uncertainty in the distinct field of technology. Lanjouw and Schankerman (2003) found a negative effect of backward citations on the probability of litigation of patents in the U.S. Harhoff and Reitzig (2004) described no significant effect of the total number of backward citations on the likelihood of opposition at the European Patent Office for pharmaceuticals but point out that the composition matters considerably.[27] The more claims a patentee

[27]Harhoff and Reitzig (2004) found a significant positive effect of X documents. Because the information on the shares of X and A is not available for German references, only the pure number

has declared the higher the probability of litigation would appear to be. One claim added to the mean of CLAIM raises this probability by 0.6 percentage points. This result confirms H1.4. It is a small but precisely estimated parameter and is again in line with the similar estimation of Lanjouw and Schankerman (2003).

Moreover, patents with a large family size prove to be more likely to be involved in infringement suits. The effect of FAMILY_SIZE on the probability of litigation is positive and highly significant. One additional designated state as new family member would raise the probability of litigation by 0.8 percentage points for the sample. These results do not allow the rejection of H1.3. Regarding the impact of family size on the likelihood of opposition, Harhoff and Reitzig (2004) found a nonlinear effect which is not apparent in this infringement analysis. As referred to earlier the value correlates are all positively correlated with the probability of litigation and are in the line with previous research.

The parameters of the patentee's characteristics are displayed in the second block. The probability of an infringement suit falls as the PATENT_PORTFOLIO increases, as anticipated in H3. I also prove that the effect increases as the number of patents in the portfolio grows. This is consistent with the results of Lanjouw and Schankerman (2003) and the argument that experience in holding and enforcing patent rights has a positive effect on the ability to settle. Additionally, as they argue, there are "beneficial" enforcement spillovers "among patents within a given firm." The ability to settle is much greater for larger firms with bigger patent portfolios. Adding 100 patents to the mean portfolio size of 1,590 decreases the sample litigation rate by 2.3 percentage points. Table 4.9 displays a different specification showing the effects of patent portfolio size in 5 classes. The probability of litigation clearly falls as the number of patents in the portfolio increase. This effect is significant for German patent owners.

In order to test H4 the variables INDIVIDUAL, SMALL_FIRM, MEDIUM_SIZE_FIRM, and LARGE_FIRM are used to indicate the absolute size of the patentee as a determinant of patent litigation. Using INDIVIDUAL as its base category, Table 4.8 and table 4.9 show that regardless of their size

of citations was used here. A detailed investigation such as undertaken by Harhoff and Reitzig (2004) using X, Y and A citations would reveal more about the questioning or strengthening properties of backward citations. This is especially important for German applications where such distinctions are not as yet documented.

Table 4.8: Probit Estimation Specification: Probability of Patent Litigation

	Parameter	Marginal Effect	Parameter	Marginal Effect
	(1)	(2)	(3)	(4)
FORW_CIT_D	0.112***	0.045***	0.096***	0.038***
	(0.015)	(0.006)	(0.015)	(0.006)
FORW_CIT_D+E_SQU	−0.002***		−0.001***	
	(0.000)		(0.000)	
BACKW_CIT_D+E	0.118***	0.047***	0.106***	0.042***
	(0.030)	(0.012)	(0.031)	(0.012)
BACKW_CIT_SQU	−0.005**		−0.006***	
	(0.002)		(0.002)	
CLAIMS	0.015***	0.006***	0.016***	0.006***
	(0.004)	(0.002)	(0.005)	(0.002)
FAMILY_SIZE	0.020***	0.008***	0.016**	0.007**
	(0.007)	(0.003)	(0.008)	(0.003)
PATENT_PORTFOLIO	−0.573***	−0.229***	−0.577***	−0.230***
	(0.157)	(0.062)	(0.159)	(0.063)
PATENT_PORTFOLIO_SQU	0.060**		0.064**	
	(0.027)		(0.027)	
SMALL_FIRM	1.134***	0.403***	1.092***	0.389***
	(0.119)	(0.034)	(0.121)	(0.035)
MEDIUM_SIZE_FIRM	0.682***	0.264***	0.616***	0.239***
	(0.105)	(0.039)	(0.107)	(0.040)
LARGE_FIRM	0.706***	0.274***	0.627***	0.244***
	(0.110)	(0.040)	(0.112)	(0.042)
OWNER_FOR_EU	−0.354***	−0.140***	−0.379***	−0.150***
	(0.097)	(0.037)	(0.101)	(0.039)
OWNER_FOR_US	−0.742***	−0.278***	−0.757***	−0.284***
	(0.125)	(0.041)	(0.130)	(0.043)
OWNER_FOR_JP	−1.026***	−0.356***	−0.990***	−0.349***
	(0.196)	(0.050)	(0.197)	(0.053)
OWNER_FOR_Other	−1.029***	−0.352***	−0.919***	−0.326***
	(0.340)	(0.082)	(0.339)	(0.092)
EPO_APPL	−0.126	−0.050	−0.132	−0.053
	(0.098)	(0.039)	(0.102)	(0.040)
PCT_APPL	−0.108	−0.043	−0.120	−0.048
	(0.176)	(0.070)	(0.183)	(0.073)

Continued on next page

Table 4.8 – continued from previous page

	Parameter	Marginal Effect	Parameter	Marginal Effect
	(1)	(2)	(3)	(4)
OPPOSITION			0.995***	0.359***
			(0.109)	(0.032)
CONSTANT	−1.092***		−1.091***	
	(0.110)		(0.112)	
Wald-statistic (χ^2(degrees of freedom))				
Size variables	81.86(3)***		92.77(3)***	
Ownership variables	58.60(4)***		62.19(4)***	
Pseudo R^2	0.18		0.22	
Obs.	1648		1648	

Notes: Dependent Variable: Patent Litigation (0/1). The reference patent is owned by an Individual from Germany. Standard errors in parentheses. *, **, *** indicate that the parameter is significantly different from zero at the 10%, 5%, 1% significance level.

Table 4.9: Probit Estimation Specification: Probability of Patent Litigation Using Patent Portfolio Classes

	Parameter	Marginal Effect
	(1)	(2)
FORW_CIT_D	0.098***	0.039***
	(0.015)	(0.006)
FORW_CIT_D+E_SQU	−0.001***	
	(0.000)	
BACKW_CIT_D+E	0.102***	0.041***
	(0.032)	(0.013)
BACKW_CIT_SQU	−0.006**	
	(0.002)	
CLAIMS	0.015***	0.006***
	(0.005)	(0.002)
FAMILY_SIZE	0.016**	0.006**
	(0.008)	(0.003)
PATENT_PORT 11-250	−0.306***	−0.121***
	(0.085)	(0.033)
PATENT_PORT 251-1000	−0.330**	−0.130**
	(0.138)	(0.053)
PATENT_PORT 1001-2000	−0.400**	−0.157**
	(0.188)	(0.070)
PATENT_PORT >2000	−0.668***	−0.254***
	(0.182)	(0.063)
FOREIGN*PORTFOLIO	0.012	0.005
	(0.246)	(0.098)
DOMESTIC*PORTFOLIO	−0.130∗	−0.052∗
	(0.070)	(0.028)
SMALL_FIRM	1.186***	0.415***
	(0.125)	(0.034)
MEDIUM_SIZE_FIRM	0.755***	0.290***
	(0.114)	(0.041)
LARGE_FIRM	0.816***	0.314***
	(0.125)	(0.045)
OWNER_FOR_EU	−0.419***	−0.165***
	(0.103)	(0.039)
OWNER_FOR_US	−0.776***	−0.291***

Continued on next page

Table 4.9 – continued from previous page

	Parameter	Marginal Effect
	(1)	(2)
	(0.134)	(0.044)
OWNER_FOR_JP	-1.047^{***}	-0.365^{***}
	(0.211)	(0.054)
OWNER_FOR_Other	-1.015^{***}	-0.351^{***}
	(0.344)	(0.086)
EPO_APPL	$-0.126ion$	-0.050
	(0.103)	(0.041)
PCT_APPL	-0.213	-0.084
	(0.184)	(0.073)
OPPOSITION	1.011^{***}	0.363^{***}
	(0.110)	(0.032)
CONSTANT	-1.002^{***}	
	(0.115)	
Wald-statistic (χ^2(degrees of freedom))		
Size variables	$92.12(3)^{***}$	
Ownership variables	$56.45(4)^{***}$	
Portfolio variables	$21.31(4)^{***}$	
Pseudo R^2	0.23	
Obs.	1648	

Notes: Dependent Variable: Patent Litigation (0/1). PORTFOLIO_SIZE is used as categorical variable in size classes. The reference patent is owned by an INDIVIDUAL from Germany with PORTFOLIO_SIZE of less than 11. Standard errors in parentheses. *, **, *** indicate that the parameter is significantly different from zero at the 10%, 5%, 1% significance level.

companies have a significantly higher probability of patent litigation than individual patentees. This result is statistically significant. It provides no support for H4. One explanation could be that individuals do, in fact, have high stakes in patent litigation relative to their own wealth. However, the stakes are smaller in relation to potential infringers and defendants which are likely to be large firms. Thus, potential defendants might be large and have a lower probability to be involved in litigation due to willingness to accept reasonable settlement offers. This does not, however explain the contrast with the findings for the U.S. Firstly, differences

in the litigation system between Germany and the U.S. may create different incentives, especially for individuals. Due to cost rewarding rules and damage calculation, individuals in Germany might be better off with relatively lower settlement amounts compared to U.S. individual patentees and this may lead to less litigation. Secondly, individuals on the German market might be more pessimistic because of the financial burden a litigation case imposes and because of the imperfect financial market, which leads to more settlement and less litigation by individuals involved in such suits. As companies grow in size the chances of them being involved in litigation decline. In other words, litigation is, c.p. in fact most likely for small firms with turnover of less than 10 million DM compared to other patentees. This result confirms H2 and is in the line with the results of the studies referred to above. There is no monotonic relationship and the marginal effect for MEDIUM_SIZE_FIRM is lower than for large firms. One explanation might be, that for large firms it may be strategically advantageous not to settle sometimes in order to signal a tough enforcement strategy against infringers. Once a reputation as an aggressive plaintiff has been established more profitable settlement agreements can be achieved in subsequent disputes.

The set of ownership variables in table 4.8 shows that foreign patent owners as a whole have a lower propensity to file suit, though foreign owners from the European Union are more likely to sue than U.S. or Japanese patentees. The parameters of OWNER_FOR_EU, OWNER_FOR_US, OWNER_FOR_JP, and OWNER_FOR_OTHER are significant and increase with geographical distance. This is in line with the more general results of Lanjouw and Schankerman (2003) and confirms the expectations outlined in section 4.2.2. The effects are large and robust and show that foreign patentees have less chance of winning as a result of their disadvantage as regards the evaluation of information. This leads to a lower propensity to litigate (Priest and Klein 1984). I do not find support for an effect of the path of seeking patent protection neither for PCT_APPL nor for EPO_APPL. Hypotheses H1.5 has to be rejected. I find no significant difference in the likelihood of litigation between patents originally filed as EPO or as German patents. As both application paths confer German intellectual property rights, there is no jurisdictional difference. All possible diversity is captured by the value correlates. As far as the average date of patent application in the sample is concerned, this route of seeking patent protection may not play an important role in influencing litigation

probability. Although this indicator is shown to be correlated with the value of patents.

I now turn to columns 3 and 4 of table 4.8. Patents that have survived an opposition procedure have a higher probability of litigation. The specification in columns 3 and 4 reveals that the expected probability of litigation for a patent in the sample increases by 35.9 percentage points when an opposition has been filed, compared to patents with the same characteristics that did not face opposition. This proves that H1.6 cannot be rejected. The effect is considerable and estimated precisely. Besides the parameters of FORW_CIT_D+E and Backw_CIT_D+E decrease the results are fairly robust against this change. This result elucidates opposition as an indicator of patent value and may partly explain some of the residual patent value (Harhoff et al. 2003). After withstanding opposition the patentee's position will be very strong. The patentee can be fairly confident and can expect a high probability of winning at trial which leads to more litigation (Priest and Klein 1984). The high magnitude of the coefficient suggests that this variable not only reflects the higher value of the patent, but, also gives the speciality of the procedure a higher weight. An explanation might be that an opponent signals that the patent will be subject to future infringement and subsequent disputes. If the patent is questionable from the beginning of its granted life and is not revoked after an opposition, an infringing action and subsequent infringement suit are more likely for it than for patents that have not been under question through an opposition procedure. The results of the analysis do not suggest that patents that have successfully withstood challenges are less likely to produce costs and uncertainty during litigation suits (Graham et al. 2003).

In table 4.8 I estimated the effects of several patent and party characteristics on the probability of filing a patent litigation suit using a sample of patent litigation cases and a control group of the same size. But using the information of the patent population and an estimation of all cases filed during this period of time 1993 to 1995 I am able to calculate the population probability of litigation.[28] Similar to Lanjouw and Schankerman (2003) I calculate the population probability of litigation for the technical classes for which the sampling was non-random. Separate classes for the cohorts are not needed because of the hypotheses that the litigation model applies to

[28] According to the argumentation in section 3.1 my sample contains about 60 percent of all cases filed in Germany between 1993 and 1995.

all cohorts. Table 4.10 reports the conversion factors for estimating the population marginal effect.

The conversion factors in table 4.10 reveal that the population marginal effects for chemical and electronic patents are lower in the population than in mechanical, pharmaceutical and other. Changes in the patent's and party's characteristics are linked with a smaller change in the probability of litigation than for mechanical patents. The share of patents in the chemical field and the share of patents in the electronic field are much higher in the population of all patents than in the sample of litigated (and matched) patents. This is reflected in the conversion factors.

4.5 Conclusion

In this Chapter of the thesis I have presented an empirical analysis of the determinants of patent litigation suits in Germany. It is the first study of its kind to be undertaken for Germany. The information about the suits, the involved patents, and the parties was obtained by searching written records held at the District Courts of Mannheim and Düsseldorf between 1993 and 1995. The data set was complemented by a search of the patent data bases of the German and European Patent Offices and a number of corporate databases.

The multivariate probit analysis confirms that highly valuable patents are more often the subject of infringement suits. It is not possible to observe whether such patents have been infringed more frequently or whether they are more frequently litigated before court. Using variables which were tested in prior work as highly correlated with the value of the patent right turned out to have a positive impact on the probability of litigation. In this way the results confirm those of Lanjouw and Schankerman (2003). However, value correlates such as many forward citations, large family sizes and a high number of claims point to a higher risk of involvement in an infringement suit. Suits are less likely if the parties are able to settle on justifiable costs. Patent owners with a large portfolio of previous patents may have experience in defending patents and giving them a protecting belt of patents around the potentially infringed one. Additionally, they can use the large portfolio as bargaining chips in licensing negotiations. The differences regarding backward citations are possibly due to their different composition. At this point further research must

Table 4.10: Conversion Factors to Estimate Population Marginal Effects

	Without Opposition	Opposition Included
	(1)	(2)
Pharmaceutical	0.018	0.018
Chemical	0.008	0.007
Electronic	0.007	0.007
Mechnical	0.019	0.019
Other	0.019	0.019

Notes: The conversion factors are calculated as described in Appendix 4.6.

be conducted to investigate the impact of the characteristics inherent to the U.S. and German patent and litigation systems so that the results can be compared. I further conclude, that an opposition prior to a suit is a signal of potential further potential infringement and subsequent disputes. I do not expect that opposition with possibly amending results for the patent claims to reduce the propensity to litigate.

Characteristics of the patentee, such as his or her ability to interact repeatedly and his experience in exploiting and enforcing patents, measured by patent portfolio size lead to significantly lower probabilities of litigation. A credible threat to file a suit, measured in absolute size (sales or employees) of the plaintiff, has a negative impact on the filing rate within the sample. Evidence was also found that small firms tend to have a higher risk of getting involved in suits. At this point it is not clear whether this is due to the relatively high profits these firms expect from their invention or whether there is some kind of self serving bias (Babcock and Loewenstein 1997). This bias would lead these firms to form their expectations towards higher rates of winning at trial and higher gains from suits. However the costs of such suits will harm the small firms more seriously and may well lead to financial distress. Additionally, the uncertainty during the course of the case will cause further losses. This will have a decisiveimpact on the cost of insurance to cover litigation risks. A detailed analysis of the course of the cases will lead to more insight. It is somewhat satisfying that in contrast to the empirical findings for the U.S., the propensity of individuals to be involved in patent litigation is relatively low compared with companies as a result of individuals' lack of experience, high

monitoring efforts, and typically weaker financial background. This is evident in equal measure for both domestic and foreign individual patentees.

4.6 Appendix Chapter 4

Population Litigation Probability

Due to the sampling algorithm the overall litigation probability within the sample of litigated and matched non-litigates patents is 50 percent. In order to calculate the real population probability of litigation I have to inflate the matched sample for a given class to have it reflect the number of non-litigated patents in that class in the population.

I define classes of patents using the characteristics with respect to which the sampling was not random. This characteristic is the 4-digit IPC. Again following Lanjouw and Schankerman, separate classes for cohorts are not necessary because I assume that the litigation model applies to all cohorts. Let $P(X_c)$ be the population probability of litigation for a patent with characteristics X_c) belonging to class c, and let $S(X_c)$ denote the probability of litigation within the sample of litigated and matched non-litigates patents. Following Lanjouw and Schankerman I want to infer $P(X_c)$ from the estimated $S_(X_c)$.

Let L and M denote the number of litigated and and matched patents in the sample, and N the number of non-litigated patents in the class in the population. First, I calculate the aggregate sample probability and population probability, S and P respectively.

$$\begin{aligned} S &= \frac{L}{L+M} \\ P &= \frac{L}{N} \end{aligned}$$

The number of litigated patents L is the same for in both equations.

$$N = \frac{S}{(1-S)P}M = IM$$

The distribution of matched patent characteristics is the same as the population. Thus the expected number of matched patents is with characteristics X_c is $IM(X_c)$

greater than in the sample by the inflation factor I. Similarly, $L(X_c)$ is the number of litigated patents with characteristics X_c. Following that, the expected population probability of litigation for a patent in class c is

$$P(X_c) = \frac{L(X_c)}{IM(X_c)}$$

while the expected sample probability of litigation for a patent in class c is

$$S(X_c) = \frac{L(X_c)}{L(X_c) + M(X_c)}$$

Substituting M leads to

$$P(X_c) = \frac{S(X_c)}{I(1 - S(X_c)}$$

Marginal Effects for the Population

The marginal effect for each characteristic X_k is

$$\frac{\partial P(X_c)}{\partial X_{kc}} = \frac{dP(X_c)}{dS(X_c)} \quad \frac{\partial S(X_c)}{\partial (X_{kc})}$$

While the last term is the sample marginal effect from the probit regression I resolve the first term at the right hand side as following:

$$\frac{dP(X_c)}{dS(X_c)} \approx \frac{P}{S(1 - S)}$$

For P I divide the number of litigated patents in a class by the number of patents in the same class. I corrected the number of litigated patents for the missing cases from the other District Courts (around 30 percent are not reported in Mannheim and Düsseldorf) and the missing cohorts by using the figures of Stauder (1989). Assuming that the probability of litigation has no time trend during 1977 to 1995 I adjusted the number by the growth rate of patent applications at the EPO. The sample marginal effects of each class can be converted to population marginal effects by $dP(X_c)/dS(X_c)$.

Chapter 5

Settlement During Patent Trials

5.1 Introduction

Conflicts in the enforcement of patent rights can be resolved privately or they may escalate into legal suits. As the work of Lanjouw and Schankerman for the U.S. and the results of Chapter 4 show, the decision to file a suit is mainly driven by the characteristics of the parties and the patents involved. In this Chapter I explore why patent litigation cases were settled and whether there are differences between suits settled at different stages of the trial. The ongoing debate about the growing number of litigation suits makes it interesting to assess to what extent the decision to litigate already takes account for an anticipated settlement during this litigation suit (Bessen and Meurer, 2005). For the purposes of establishing of a European patent enforcement system it is crucial to learn more about the incentives driving the parties to re-negotiate a settlement during trial. This Chapter illuminates certain detailed characteristics which are of interest regarding the design of a European system.

While Somaya (2003) focuses on the importance of strategic stakes in disputes in the U.S. enforcement system this Chapter addresses two factors which influence the probability of settlement in German patent suits once the trial has started. The first is whether the relative technological and size position of the parties might be an important factor for the settlement decision. Even though the size and composition of the patent portfolio is known at the beginning, once the suit has started these positions might acquire different weight. The new situation within the legal dispute causes a re-evaluation process since not only the absolute size but also the relation

between the parties could now be of importance, as they are generally related to the stakes involved in the suit. Farrell and Merges (2004) argue that skewed incentives caused by skewed stakes will affect the expenditures for the case.[1] The second factor is how the legal environment and the legal instruments available to the parties influence how they proceed further within the trial. I find that there are considerable differences in the settlement rates between the regional District Courts of Mannheim and Düsseldorf in a horizontal way and between the District Courts and the Higher District Courts in a vertical sense. The first appeal (second instance) is handled by the Higher District Court ("Oberlandesgericht"). Both the information of the first instance outcome and the new constellation of the suit at the Higher District Court are likely to affect the decision to settle or to go ahead with the trial in Germany.

The outline of the Chapter is as follows: In section 5.2, I present the theoretical framework and the hypotheses. I introduce the sample and the variables in section 5.3. The descriptive and econometric results are discussed in section 5.4. Section 5.5 concludes.

5.2 Theoretical Considerations

As pre-trial bargaining is closely related to the settlement negotiations during the legal dispute I rely on the literature on negotiation settlement. Three main mechanisms for non-settlement were formulated.[2] First, uncertainty about the stakes involved and the probability of winning may lead to diverging expectations (Priest and Klein, 1984). In this line Babcock and Loewenstein (1997) argue that the self serving bias is a common source of diverging expectations. Parties form their expectations about their probabilities of winning by drawing from a known distribution in a biased way and consequently overestimate their chances of winning.

Second, the existence of private information may lead to non-settlement (P'ng, 1983, Bebchuk, 1984, Meurer, 1989). Bebchuk (1984) investigated the information conditions which determine the probability of certain outcomes of general legal disputes. He constructed a model where one party has detailed information on the winning probability while the other only knows the density function of the winning

[1] See also Hylton (2002).

[2] Daughety and Reinganum (2004) give an overview of the economic foundations of settlement.

probability. The better informed party reveals its expectations based on its information to the less informed one. The failure to settle follows firstly from the asymmetry of information and secondly from the unfavorable information the uninformed party has. Patent litigation cases where the parties have symmetric information about winning probabilities and size of the case but asymmetric information about validity of the property right are subject of Meurer (1989). His approach can be used to sketch a bargaining game which shows the decision to be made in a German legal dispute on intellectual property rights.

Third, asymmetric stakes tend to hamper settlement because one party thinks that it has more to win than the other party has to lose at trial. Institutional variation such as different rules for cost shifting and contingency fees and their impact on the incidence of trials are discussed by Shavell (1982), Reinganum and Wilde (1986), and Farmer and Pecorino (2005b). Farmer and Pecorino (2005a) show that asymmetric information can be overcome by a complementary use of mandatory discovery and voluntary disclosure. The welfare of both parties will be enhanced depending on the costs linked to the information transmission procedure.

These approaches assess solely the decision of one party to settle or to proceed in trial at one point in time before the trial has begun. Even though they describe several stages of the litigation process they do not investigate repeated interaction of the parties deciding about settlement at particular stages. An exception is the model of P'ng (1983) which explicitly includes later settlements in the bundle of mixed strategies. He models the multiple stages of the patent litigation dispute (pre-trial, during trial, out-of-court negotiations leading to settlements) in detail. He assumes incomplete and asymmetric information which leads to settlement agreements and proceeded trials even though the expected gain might be negative. These signaling games are modelled in a setting with complete and symmetric information. The delay of settlement after the decision to file a suit must be driven by new information or by a different evaluation of previously known information. All information about the characteristics of the patent and the patentee is available at the time the parties decide to go to trial or to settle before any legal action has been started. However, the changing evaluation and the changing importance of certain information might be more decisive once the trial has started. These changes in information status are discussed in the following and form the main focus of interest of the subsequent analysis.

As the discussion above shows the information structure and the distribution of stakes between the parties are the most important elements which drive the negotiations. Equally important is the kind of processing these information because this may lead to different expectations about the outcomes of the dispute - qualitatively and quantitatively. The analysis below tries to shed light on how legal circumstances might affect the pure economic incentives of decision making.

5.2.1 Hypotheses

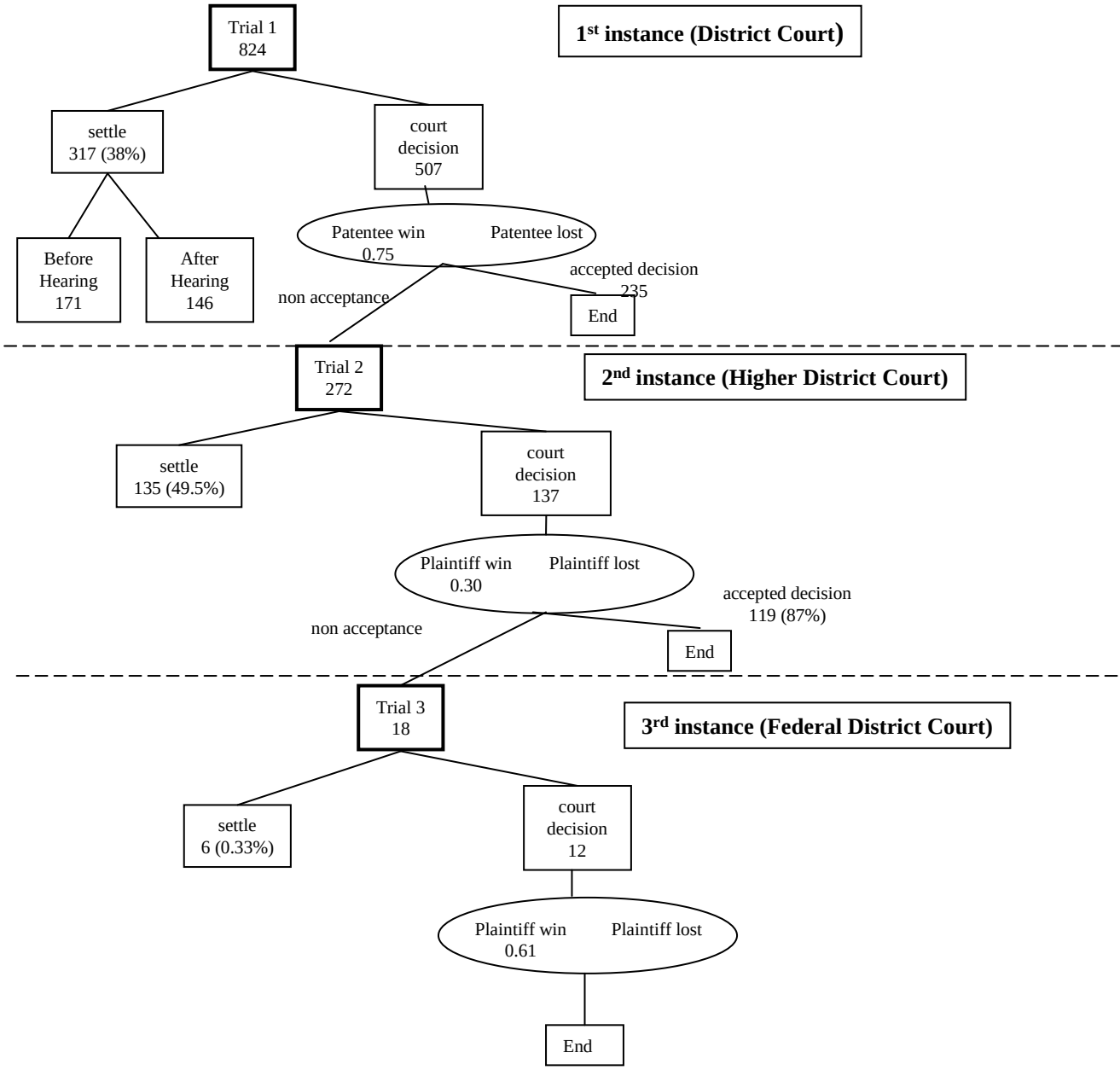
I use the general structure of a litigation process, as shown in Figure 5.1 to outline a set of crucial decisions to be made by the parties regarding the issue of whether to proceed with the trial or not. For the analysis in this Chapter I take six steps into account: 1. settlement prior to oral hearings at the District Court (first instance), 2. settlement subsequent to oral hearings at the District Court, 3. continuation through to a court decision by the District Court, 4. continuation to the Higher District Court (second instance), 5. settlement prior to the decision of the Higher District Court, 6. continuation to a decision taken by the Higher District Court.[3] Recall that all information about the patent characteristics, the parties and the market situation is used to decide whether to file a suit or not (Lanjouw and Schankerman, 2003). I do not expect this information to determine the outcome of the trial in later stages. Existing information may be re-evaluated to some extent, but I do not expect these characteristics to have a significant effect on the probability of settlement after the suit has started. I implicitly assume in this analysis that there is no strategic behavior in this bargaining.

New Information

New information emerging during the actions of litigation suits may affect settlement at later stages of the suit. Two sources of new information arise. The first is the

[3]I do not analyze the probability of winning as such because no decision about the validity of the patent is made in the District Courts. In patent suits at German District Courts the validity of the patent is assumed and only the infringing action is evaluated in respect to the patent claims.

Figure 5.1: Detailed Structure of an Infringement Dispute and Sample Description



opinion of the court during the motions of the first instance. A court decision at the District Court reveals the quality of the case depending on whether the plaintiff prevails or not. Second, the first appeal will be brought to the Higher District Court where the case is re-examined. Whether the plaintiff prevailed at the District Court or not is decisive for the parties deciding whether to proceed or not to the next

instance. They will evaluate this information by accepting the court's decision or not. After they have decided to proceed to the first appeal the potential settlement decision at this stage will not be affected by the court judgement of the previous stage of trial.

However, parties will re-evaluate the stakes involved in the case at the beginning of the second stage. The parties have incurred costs as a result of the trial and the uncertainty about the outcome of trial may affect the expected value of the patent. These factors lead to a new assessment of the settlement value which both parties would find acceptable.[4]I do not therefore expect settlement behavior to be dependent on the judgement of the District Court, but I do expect a re-evaluation process of the stakes involved in the case which would lead to an impact of the patent value on the settlement decision. As I am not able to observe if the plaintiff or the defendant initiates the settlement, there is an ambiguous correlation between the value of the patent and the probability of settlement at the second stage. Additionally, I assume that the incentives to settle not only differ with the size of the stakes but also with the size of the parties. Small firms are faced with higher litigation costs relative to their financial resources than larger companies.

Legal Steps

Uncertainty during trials is frequently enhanced by the means the defendant chooses to attack the patent's validity. Such an invalidity suit will be filed to the Federal Patent Court. The defendant signals that (s)he expects a declaration of invalidity of the patent. The uncertainty about the validity of the patent which is to be decided by the Federal Patent Court may influence the expectations of the patentee about chances to win in the infringement case. The more likely it is that the patent will be declared invalid the more likely is a settlement in the infringement suit.

H1: Suits in which defendants use an invalidity procedure as a means of defense will be settled more frequently than cases without.

[4]Pitz (1999) reports that frequently agreements will be reached at later stages of a dispute because the parties know a lot more about the strength of their position and their technological perspective. Not all options the parties have would have been considered at the beginning of the battle and this only partly because they would not have been available at this point.

An opposition procedure after the issuance of a patent questions the novelty of a patent, i.e. whether it constitutes an inventive step. If a patent has survived this procedure, possibly with an amendment of claims, it will appear to be more valuable. As a result settlement becomes less likely from the position of the patentee. Additionally, it is proven for a second time that the patent is valid. Patentees will be very confident in their expectation of winning the suit. Another argument follows a more jurisdictional interpretation: Opposition against a patent indicates a litigious situation where the patent is questioned from the beginning of the patent's term. Opposition leads to a higher risk of involvement in litigation suits and this might indicate a willingness to argue pending a decision by a legal authority thus preventing settlement being reached (Cremers, 2004).

H2: Suits in which the patent survived an opposition procedure before filing are less likely to be settled early.

I implicitly assume that the patentee (plaintiff) has a large amount of room to move within this negotiation game. He can not only offer settlements or react to the defendant's settlement offer but can also simply bring the case to an end. In other words, if the defendant does not accept an offer, the plaintiff might drop the case. Hypothesis 2 depends on this assumption that the plaintiff is the more active part in the settlement negotiations.

Characteristics of the patents and the parties

The decision to litigate or not is determined by the characteristics. These may have an impact on the decision to settle during the suit or not. However, I do not expect a systematic pattern for all characteristics and value correlates. All information about them are already known at the time when litigation starts and used for the decision to litigate or not.

I expect no significant impact of the value correlates of a patent on the probability of settlement at later stages of a patent suit.

However, I expect that the time left to realize the expected payoff from a patented invention has an effect on the settlement probability during trial. In cases,

where the time a patent will be further in force is long (a young patent), a trial will be less likely to be settled than suits where the patent involved will lapse into the public domain more quickly after the suit. That in turn means that suits where patents are older will be settled earlier than those suits where the patent is younger and will probably in force for many years. The expected payoff will be higher simply by having more time to realize it after the suit will be closed. This would be in line to hypothesis H1 in the previous chapter.

Similar arguments as for the patent characteristics hold for those of the parties, such as size of the plaintiff of defendant and the country of origin. Since all information about the litigants are available at the time of the decision to litigate, I do not expect a significant impact of the those party characteristics on the probability to settle at a certain stage of the suit.

5.2.2 Previous Empirical Work

The analysis of the determinants of settlement failure after detection of infringement has been undertaken extensively for the US (Lanjouw and Lerner, 1996 and 1998, Lanjouw, 1998; Lanjouw and Schankerman, 2001 and 2003; Ziedonis, 2003; Llobet, 2003; Somaya, 2003). Due to data constraints there is little published empirical research for Europe available (Stauder, 1989; Cremers, 2004.) The three mechanisms for settlement failure sketched above were partly validated in empirical studies. Studies for the U.S. distinguish between suits dealing with attacks on validity and suits claiming an infringed patent. In Germany the District Courts presume validity of the infringed patent as long as no annulment suit has been filed at the Federal Patent Court ("Bundespatentgericht").

Seminal empirical investigations of determinants of patent suits have been compiled by Lanjouw and Schankerman(2001 and 2003) who show a strong positive impact of the expected value of a patent on the probability of litigation. Furthermore, they report a higher settlement probability in cases where the patentee's portfolio is very large. A specific investigation of the semiconductor industry has been undertaken by Ziedonis (2003). Lanjouw and Schankerman (2003) focus on the determinants of patent litigation and they investigate outcomes of cases and the timing of eventual settlement. They find, that the probability of being involved

in patent suit in the U.S. is very heterogenous. For individuals or companies with small patent portfolios the probability of litigation suits is much higher than for patentees with large portfolios. Lanjouw and Schankerman interpreted their results in the way that cooperative interaction induced by patents to trade induce more pre-trial settlements. The analysis of these authors reveals a detailed picture of the U.S. patent enforcement system. The heterogeneity of the European patent enforcement system contrary to a harmonized European patent granting system and raises the question whether this peculiarity causes a different pattern of the probability of patent litigation for certain patentees.

Trajtenberg (1990) and Harhoff et al. (2003a) stress the need to take account of the strategic aspects of patenting when assessing the value of patents, and not only the rents achieved by exploiting the patented innovation exclusively. This includes signaling technological capacities, blocking competitor's development of new products and building portfolios of patents as bargaining chips (Hall and Ziedonis, 2001), and as patent thickets protecting major inventions (Shapiro, 2001a; Hall, 2003).

The study of Harhoff and Reitzig (2004) focuses on the analysis of the determinants of opposition procedures against EPO patent grants. Opposition is an early form of patent dispute. Contrary to litigation suits they directly attack the validity of the opposed patent. Additionally, unlike litigation suits there is no direct dispute between the opposing and opposed party but a negotiation between the patent office and the opposed party. However, this study and an investigation of patent litigation in Germany (Cremers, 2004) demonstrate that the value of the stakes included in the suit, namely the patent value and the expected payoffs of the suit, have a positive impact on the probability of non-settlement - i.e.that cases will be filed and brought to trial. The differences in the characteristics of the parties lead to diverging expectations about the value and the market payoffs.

Perloff et al. (1996) performed the first study of trial outcomes and settlement not involving individuals but firms. However, their focus is on testing whether risk aversion plays a role in determining the litigation rates (self selection) and settlement outcomes. For the outcomes of patent trials Lanjouw and Schankerman (2001) and (2003) and Somaya (2003) find that most of the factors correlated with the probability of settlement before the trial do not have any significant effect on the settlement probability once the trial has started. The choice of the court and

the correspondence among the parties and the court provide credible knowledge about the merits of the case and the stakes involved. Rational behavior will likely promote realistic expectations about the outcome of the trial. However, Lanjouw and Schankerman (2003) analyze the winning probability in certain technical areas and estimate settlement probability during trial. They find that more than 80% of all settlements occur before the pre-trial hearing and that the post-trial settlement does not significantly vary with portfolio size or ownership of the patents.

A more detailed analysis of different outcomes (settlement or court decisions at certain stages of a patent suit) is conducted by Somaya (2003). He investigates the impact of the strategic stakes the parties have in a litigation suit. These strategic stakes are measured for the patentee as the number of self citations of the litigated patent. For the non-patentee, the number of his citations to all citations is used as a measure of the strategic stakes. Somaya finds that the respective stakes matter in varying degrees for the computer and research medicine industries as far as the decision to proceed the trial or to settle is concerned.[5]

In the previous studies the reported empirical results with respect to the strategic stakes are ambiguous. Somaya (2003) reports a positive impact of strategic stakes on the probability to proceed to trial until a court judgement. The same interpretation is given by Fournier and Zuehlke (1989) who report a negative effect of costs on the settlement probability. Lanjouw and Schankerman (2003) find that the main characteristics of the patents and the patentees affect neither the probability of settlement nor the plaintiff's win rate in trials. The study by Perloff et al. (1996) reports that risk aversion plays an important role in explaining settlement in antitrust suits.[6] They also argue that the outcomes of antitrust trials vary between certain jurisdictions owing to the existence of different legal rules in different jurisdictions, different enforcement of similar rules, or different attitudes toward plaintiffs on the part of judges. For the U.S. patent system, Farrell and Merges (2004) show that litigation is not a reliable tool to verify patent validity. Asymmetric stakes of the parties imply

[5]In the sample of Somaya (2003) research medicine includes patents from biotechnology, drug delivery systems, assays and dental innovation. The sample of computer patents contains semiconductors, data storage, computer systems, I/O devices, computer applications, and networking technologies.

[6]They find that a change in the winning probability at trial towards 0.5 increases the variance and this in turn leads to an increase in pre-trial settlements.

skewed incentives to litigate and lead to high expenditures on litigation processes which influence the winning probabilities. Farrell and Merges (2004) argue that the efforts depend highly on the stakes involved. If there are asymmetric stakes, the efforts will be asymmetric and this shifts the probability of winning towards the party with the relatively high stakes involved. A study predicting winning probabilities in selected samples of litigation is presented by Waldfogel (1995). In detail, Marco (2004) refers empirically to the selection problem and he finds considerable differences in the winning probabilities. I do not estimate the probability of plaintiff's win at trial since I do not have data which cover a time period sufficiently long to estimate this precisely.

The empirical analysis of this Chapter is related to Somaya (2003). I test whether the strategic aspects of patent right enforcement play a role in the determination of settlement during trial or not. Furthermore I investigate the impact of early stage success of failure of the plaintiff on later stage settlement rates.

5.3 Variables and Descriptive Statistics

Based on the data I introduced in Chapter 3 I use the sample of all litigated patents. The overall settlement rate during the course of the patent litigation suits in this sample is 55.6%. In detail I can observe settlement before the first oral hearing (SETTLE_BEF_HEARING), after the hearing during the first instance (SETTLE_DISTRICT) and during the second instance at the Higher District Court (SETTLE_HIGH_DISTRICT). Figure 5.1 shows that of the 824 suits, 171 (20,8%) are settled before the first oral hearing.[7] This is slightly more than half of those settled during the first instance, 317 (38%). A court ruling is reached in 507 cases in which the winning rate of the patentee is 75%. More than half of the decisions were not accepted by at least one of the parties involved and were brought before a second instance court. Of the 125 patentees who lost in the first instance court, 54 (43.2accept and the other 71 (56.8%) proceeded further by trial. The settlement rate at the second instance, at 49,5%, is significantly higher than at the first stage. In cases where a case comes to a court decision at the Higher District Court the

[7]Somaya (2003) reports a much higher settlement rates of 78% and 62% for computer and research medicine patents in the U.S. respectively.

patentee win rate (30%) is much lower.[8]

Table 5.1: Course of the Case in Mannheim and Düsseldorf

	District Court			Higher District Court		
	Overall	Düsseldorf	Mannheim	Overall	Düsseldorf	Mannheim
(1) Filed suits	824	638	186	272	235	37
(2a) Settled bef. Hearing	171	147	24			
Share of (1)	21%	23%	13%			
(2b) Settled after Hearing	146	86	60			
Share of (1)-(2a)	22%	17%	37%			
(2) Settled suits	317	233	84	135	123	12
Share of (1)	38%	37%	45%	50%	55%	32%
(3) Suits adjudicated	507	405	102	137	112	25
Share of (1)	62%	63%	55%	50%	48%	68%
(4) Plaintiff's won	382	306	76	47	36	11
Share of (3)	75%	76%	75%	34%	32%	44%

Notes: Observations are the number of patents proceeded to the court decision at either court.

Additional to Figure 5.1, Table 5.1 reports the differences among District Courts regarding the settlements at the two stages of the suit. Surprisingly the settlement rate before the first hearing (13%) in Mannheim is much lower than in Düsseldorf (26%) while the opposite is the case after hearing (17% in Düsseldorf and 37% in Mannheim). As the first oral hearing in Düsseldorf, unlike at Mannheim, has no decisive character in terms of adjudication, I would expect fewer suits to be settled compared to the procedure in Mannheim, where the first oral hearing already goes into the merits of the case. However, the settlement rate during the first instance trial is generally higher in Mannheim than in Düsseldorf which leads to fewer cases (absolute and relative) reaching the second instance in Mannheim. This may be due to the fact that the Düsseldorf District Court is regarded as more pro-patentee or because the suits brought to the Düsseldorf court might involve more uncertainty about the outcome. The winning rates do not differ considerably between the courts.

[8]Since the trial at the second appeal (third instance) will only verify whether the jurisdictional issues are handled correctly, I incorporated it into the data of the first appeal.

Table 5.2: Settlement Rates by Technical Areas

Area	Settlement Rate	
	District Court	Higher District Court
	(1)	(2)
DRUG	0.42	0.67
CHEM	0.49	0.39
ELEC	0.39	0.59
MECH	0.35	0.57
OTHER	0.39	0.24
Total	0.38	0.51
OBS	824	272

Notes: OBS is the number of cases at District Court (first instance) are all suits filed (Column (1)). In column (2) is OBS the number of patents which were proceeded to the Higher District Court (first appeal) after the first adjudication.

I grouped the disputed patents into five technological areas: pharmaceuticals (DRUG), chemical patents (CHEM), electronic patents (ELEC) including computers, mechanical patents (MECH) and those from other technologies (OIPC).[9] Looking at different industries involved into these suits the settlement rates vary remarkably. Table 5.2 shows that at the first instance DRUG patent suits are settled in 42% of the cases while owners of MECH patents come to an agreement with the litigant less often (35%). This confirms the result of Cremers (2004) who shows that the litigation rate for chemicals and drugs is lower than the average and far lower than for mechanical patents. In other words, litigants in areas which are highly litigious in the first place, such as MECH, are persistent in their aversion to settlement. This may be due to the fact that for mechanical devices the burden of proof of infringement is higher while, thanks to precise analytical methods, it is easier to prove whether or not a CHEM or DRUG patent has been infringed. It is important to keep in mind that there is no question about validity during the civil suit of patent litigation. For suits which reached the second instance (first appeal) the settlement rate is even higher. It suggests that at least one party has a strong incentive to reach an agreement.[10]

[9]The classification follows Lanjouw and Lerner (1996).

[10]Somaya (2003) also reports interindustry differences of settlement decisions in the U.S.

Table 5.3: Plaintiff Win Rates by Technical Areas

Area	District Court		Higher District Court	
	Observations	Win Rate	Observations	Win Rate
	(1)	(2)	(3)	(4)
DRUG	38	0.84	6	0.0
CHEM	34	0.74	11	0.36
ELEC	74	0.85	13	0.31
MECH	278	0.74	76	0.46
OTHER	83	0.68	31	0.13
TOTAL	507	0.75	137	0.34

Notes: Observations are the number of patents proceeded to the court decision at either instance.

As Figure 5.1 shows, the overall win rate for plaintiffs (WIN_PL) at the first instance District Court is 75%. This figure is about the same as Waldfogel (1995) reports for IPR cases. Detailed win rates for plaintiffs are reported in Table 5.3. There is not much variation in the winning rates between technical areas or between the two District Courts, Mannheim and Düsseldorf. However, differences can be observed between the first and second instance. In both instances the win rate diverges significantly from the 0.5 which is postulated by Priest and Klein (1984). However, in the first instance at the District Courts it is remarkably higher than this rate between 0.68 for OIPC and 0.85 for ELEC. It is possible that plaintiffs are better at estimating their chances of winning disputes which are brought to trial and that they drop cases or accept settlements before filing in those cases in which they believe the probability of winning is too low. Another explanation of these high winning rates may be that there is asymmetric information about the extent to which the patent has been infringed. The assumed validity of the patent leaves out all cases of probably invalid patents. The win rates at the second instance at the Higher District Courts differ remarkably from those at the District Courts. The average win rate is 0.34. Suits brought in Mannheim suits (0.44) are closer to 50 % than the Düsseldorf suits with 0.32.

Table 5.4 summarizes the statistics of litigated patents in suits which were settled at certain stages and Table A5.1 in the Appendix 5 contains a definition of the variables. The first columns contains means and standard deviations of the main independent variables for all litigated patents. Columns (3) and (4) show the statistics

Table 5.4: Description of Exogenous Variables by Stage of Settlement, Means (SD)

Variable	All litigated Patents	Settled at District Court before Hearing	Settled at District Court after Hearing	Settled at Higher District Court
	(1)	(2)	(3)	(4)
AGE_PATENT	8.358	7.871**	8.637	9.021**
	(4.281)	(4.196)	(4.068)	(4.330)
CLAIMS	10.500	12.959	9.130**	10.872
	(9.621)	(14.097)	(6.583)	(9.049)
FAMILY_SIZE	5.576	5.930	4.993	5.142
	(6.234)	(5.155)	(6.843)	(5.702)
CIT_D+E	3.412	3.919	3.106**	5.277***
	(5.378)	(4.911)	(4.308)	(6.434)
REF_D+E	3.430	3.520	3.589	4.043*
	(2.905)	(2.491)	(3.059)	(3.505)
INDIV_PL	0.262	0.175***	0.329**	0.199**
	(0.439)	(0.381)	(0.471)	(0.400)
SMALL_PL	0.188	0.187	0.185	0.220
	(0.391)	(0.391)	(0.390)	(0.416)
MEDIUM_PL	0.286	0.368***	0.171	0.284
	(0.452)	(0.484)	(0.378)	(0.452)
LARGE_PL	0.263	0.269	0.315*	0.300
	(0.441)	(0.444)	(0.466)	(0.459)
PORTFOLIO_PL/1000	0.736	1.301**	0.626	0.447
	(4.279)	(4.356)	(5.506)	(2.519)
PORTFOLIO_DF/1000	0.219	0.226	0.296	0.158
	(1.440)	(0.717)	(1.593)	(0.839)
RATIO_PORTFOLIO	508.547	839.594	548.851	279.444
	(4085.170)	(4073.611)	(5505.392)	(2502.836)
OWNERSHIP_DE	0.771	0.731*	0.774	0.794
	(0.421)	(0.445)	(0.420)	(0.406)
OWNERSHIP_EU	0.146	0.140	0.144	0.142
	(0.353)	(0.348)	(0.352)	(0.350)
OWNERSHIP_NEU	0.084	0.129	0.082	0.064
	(0.277)	(0.336)	(0.276)	(0.245)
NULLITY	0.249	0.351***	0.260	0.482***
	(0.433)	(0.479)	(0.440)	(0.501)
OPPOS	0.271	0.286	0.233	0.262
	(0.445)	(0.453)	(0.424)	(0.441)
WIN_PL				0.787
				(0.035)
EPO	0.260	0.310	0.219	0.269
	(0.439)	(0.464)	(0.415)	(0.445)
PCT	0.031	0.035	0.041	0.028
	(0.175)	(0.185)	(0.199)	(0.167)
Observations	824	171	146	141

Notes: The number of patents litigated at District Court (first instance) are all patents involved in suits filed. Patents in suits at the Higher District Court (Second instance) are suits which proceeded to the first appeal at Higher District Court after the first adjudication at the District Court. Numbers with ***,** or * differ statistically significant at 1%, 5% or 10% level from the sample mean (column (1)).

for all patents of which the dispute were settled at the first instance and the last two columns, (5) and (6), report statistics for those patents for which the disputes were

settled at the Higher District Court (second instance). The upper panel describes the patent characteristics, the middle part the parties characteristics and the lower one the legal variables. In the last two rows "EPO" and "PCT" are controls for the route of application.

I include the age of the patent (AGE PATENT) as an indicator of the length of time for which the patent has already been in force. It is defined as the number of years from the application to the filing of the litigation. Age may reflect the time period in which the patented invention could have produced a value for the patentee and which could be lost due to infringement. It could also be an indicator of how long the patent might be in force afterwards. Suits which are settled at the second stage deal on average with older patents (9.021) than most of the patents in the sample (8.358). The latter may provide information about the extent to which it may be worthwhile to enter a dispute about the patent. The age of the patent is an indicator of the payoff which can be expected after the trial. A patent is mainly qualified by its claims (CLAIMS). The average number is 10 for the whole sample of litigated patents. Patents for which the dispute was settled after the first instance hearing have significantly fewer claims (9.13). FAMILY_ SIZE is defined as the number of jurisdictions in which patent protection was sought. It conforms to the definition of family size used by Putnam (1996). It is a measure of the importance a patent has for the patentee him/herself. The mean of FAMILY_SIZE is 5.576 and does not vary among the groups of settled patent disputes. The number of citations received from subsequent patent applications (CIT D+E) is calculated by searching both patent databases (PATDPA and EPOLINE). I excluded double counts and corrected for truncation bias.[11] Citation correlates very closely to the value of the patent. As I argued above (Cremers, 2004), it might also be an indicator that the claims are similar to other inventions and that infringement therefore is more likely. The numbers show that the patents in suits settled after the first instance hearing have on average significantly fewer citations (3.106) than the patents not settled at this stage while the mean number of citations at later stage settlements is significantly higher (5.277). These figures reflect that more valuable patents are more likely to go through the whole trial without reaching a settlement. The number of references to prior patent applications (REF_D+E) measure how the examiner

[11] See Hall et al. (2002) for a description of the methods regarding truncation biases in citation data.

and the patentee refer to prior art. These references can define the scope of the patent by potential litigious older patents or support patentability by referring to additional developments to earlier patents. Additional control variables are EPO or PCT which indicate the way of seeking patent protection.

The characteristics of the patentee are described in the second panel of Table 5.4. Measures of absolute size are defined in size classes of individual, small firm, medium sized firm and large firm. The distribution within the sample shows that 26% of the plaintiffs are individuals while small firms can be found less often within the sample. Around half of plaintiffs are medium and large firms. I assume that the characteristics of the companies relative to each other as well as absolute values may impede settlement. I therefore relate the portfolio sizes of the plaintiff to the portfolio size of the defendant (RATIO_ PORTFOLIO). The average (RATIO_PORTFOLIO) is 508 for all litigated patents. RATIO_ PORTFOLIO reflects that parties with higher technological power compared to the defending party are more often represented in the group of early settling parties than in those which settle at the second stage. Although the difference appears to be high in magnitude, it is not statistically significant. The plaintiffs are on average much larger in terms of patent portfolio than their counterparts in disputes. This is also shown by the mean values of PORTFOLIO_ PL and PORTFOLIO_ DF. The distribution of the portfolio size is highly skewed with median values dramatically lower than the mean values. I expect a nonlinear effect of PORTFOLIO_PL on the decision to settle early in trial.[12] It is not clear whether the differences in the characteristics are due to selection at certain stages of trial or if they really reflect the different patterns in settling at different stages of the trial. The origin of the plaintiff is differentiated into German, European, and non-European patentees (OWNERSHIP_DE OWNERSHIP_EU OWNERSHIP_NEU). The shares remain relatively stable over the groups of settlement during trial.

The dummy variable OPPOS indicates whether an opposition procedure has taken place or not. The legal dispute is characterized by prior opposition procedures. However, the numbers do not differ for suits which are settled at the first (p = 0.262) or higher stage (p = 0.262). Whether the defendant filed an invalidity suit

[12]For the probability of litigation Lanjouw and Schankerman (2003) and Cremers (2004) find that small companies have a higher risk of being involved in patent suits which appears to contradict this result.

at the Federal Patent Court or not is indicated by the dummy variable (NULLITY). The last panel of Table 5.4 suggests that filed invalidity suits NULLITY as means of defense for settlements at the second stage are more relevant compared to the first stage. In order to characterize differences between the two District Courts I created interaction variables OPPOSxMA, OPPOSxDUE, NULLxMA, and NULLxDUE. These interaction terms are chosen because I expect the differences in courts to occur mainly through the legal instruments used prior or during trial.

5.4 Empirical Specification and Estimation Results

I argued in section 5.2.1 the parties will settle if the expected payoff of settling is higher than the expected value of proceeding through adjudication and further to a higher instance. I assume that the decision to settle at a certain stage of trial is made using all available information on the patent and the court. After a new stage is reached new settlement offers and negotiation about them are possible.

I look at the settlement decision in several ways. First, parties may or may not settle during the trial. This is an estimation of the settlement likelihood during trial conditional on the dispute having been selected for filing a suit.[13] Second, parties can settle before or after the pre-trial hearing at the District Court. At this point the costs of the legal dispute are still low.[14] It is not clear what kind of negotiations or internal factors lead to the settlement. A third way of looking at the timing is to treat the three possible instances of a civil suit in Germany as three sequential choices of settlement or non-settlement. Lanjouw and Schankerman (2003) estimate the probability of settlement without selection correction only in terms of whether the parties settled before or after the pre-trial hearing. Somaya (2003) controls for the selection of litigation from the universe of patents.

In order to estimate the determinants of settlement during trial I use a probit

[13] I do not investigate the settlement of patent infringement disputes before filing a suit. There is no observable settlement rate of all disputes, because the number of detected infringements is not known.

[14] Pitz (1999) reports about DM 70 000 for the first instance.

with sample selection in order to take unobserved heterogeneity into account.[15] First there is the selection of a patent into litigation as opposed to pre-trial settlement or lack of any controversy. The following settlement equation reflects the determinants for the settlement after the trial has started. Both equations are written in latent variables which are the unobserved propensity to litigate (Lit^*) and to settle (Set^*).[16]

$$Lit^* = X_1\beta_1 + \varepsilon_1 \tag{5.1}$$

$$Set^* = X_2\beta_2 + \varepsilon_2 \tag{5.2}$$

Lit^* is a latent variable with an unknown threshold to induce filing a suit. The other latent variable, Set^*, denotes the settlement decision during the suit. X_1 and X_2 are the exogenous variables determining the latent variables. The observable variables are litigation at all (Lit))and subsequent settlement (Set).

$$\begin{aligned} Lit &= 1 \quad \text{if} \quad Lit^* > 0 \\ &= 0 \quad \text{otherwise} \\ Set &= 1 \quad \text{if} \quad Set^* > 0 \\ &= 0 \quad \text{otherwise} \end{aligned}$$

I include the characteristics of the patent, the patentee and the defendant and legal variables into these vectors. Litigation and settlement during trial may be driven by unobserved heterogeneity and the error terms, ε_1 and ε_2 would thus be correlated. I assume that the error terms are jointly distributed with a bivariate normal distribution which leads to the supposed sample selection specification. The resulting log likelihood function is as follows:

[15] See Somaya (2003) and Boyes and Low (1989).

[16] I also considered applying a nested logit including all outcomes of a legal patent dispute. However, this procedure does not control for the timing of litigation. A sequential probit would be the suitable econometric model for testing which variables influence the timing of the settlement. However, I cannot exclude the possibility that the decision to settle at later stages of the dispute is independent of the decision to file a suit. As argued by Waelbroeck (2004) argued the sequential probit model depends heavily on the assumption that the unobservable variables at each stage are not correlated.

$$\begin{aligned}\ln L(\beta_1, \beta_2, \rho) &= \sum_{n=1}^{N} Lit_n Set_n \ln F(X_{1n}^{'}\beta_1, X_{2n}^{'}\beta_2; \rho) \\ &+ Lit_n(1 - Set_n) \ln \left[\Phi(X_{1n}^{'}\beta_1) - F(X_{1n}^{'}\beta_1, X_{2n}^{'}\beta_2; \rho)\right] \\ &+ (1 - Lit_n) \ln(\Phi(X_{1n}^{'}\beta_1)).\end{aligned}$$

The observations are indexed by n. F and Φ are the respective bivariate and univariate standard cumulative normal distribution functions. The value correlates of the patent drive the selection, not the settlement decision which determines the exclusion restriction.

5.4.1 General Choice of Settlement During Trial

I first consider the decision to settle after the trial has started without taking account of the stage at which the settlement has occurred. Table 5.5 contains the estimation results.[17] The selection equation shows a pattern similar to those documented in Cremers (2004) for Germany and in Lanjouw and Schankerman (2003) for the U.S. The higher the expected value of a patented innovation the more likely it is that a patent will be involved in a patent litigation suit, given the patent has been infringed. Stakes involved in the potential suit are highly positively correlated with the litigation probability (CLAIMS, CIT_D+E, REF_D+E, FAMILY_SIZE). Prior legal steps against the patent point to a higher rate of litigation (OPPOS). If the plaintiff has a great deal of bargaining power as manifested by a large patent portfolio, this is negatively correlated with a patent's probability of being litigated. Patent owners from other countries than Germany (OWNERSHIP_EU, OWNERSHIP_NEU) have a significantly lower probability of becoming involved in a litigation suit.

Columns (2) and (3) present the estimated coefficients and marginal effects of the settlement equation within the section model. I included the value correlates in the settlement equation. The cumulative measures of the patent value involved in the suits appear to be insignificant for the general decision to settle during trial.

[17] The upper panel describes the patent characteristics, the middle part the parties characteristics and the lower one the legal variables. In the last two rows "EPO" and "PCT" are controls for the route of application.

Table 5.5: Probit Estimation of Settlement in Patent Suits with Sample Selection Correction

	Litigation	Settlement with selection		Settlement without selection	
	Coefficient	Coefficient	Marginal Effect	Coefficient	Marginal Effect
	(1)	(2)	(3)	(4)	(5)
AGE_PATENT		−0.003	−0.001	−0.004	−0.002
		(0.012)	(0.005)	(0.013)	(0.005)
CLAIMS	0.013***	0.013**	0.005**	0.014**	0.006**
	(0.005)	(0.006)	(0.003)	(0.006)	(0.002)
FAMILY_SIZE	0.020**	−0.012	−0.005	−0.013	−0.005
	(0.008)	(0.010)	(0.004)	(0.009)	(0.004)
CIT_D+E	0.117***	0.013	0.005	0.013	0.003
	(0.015)	(0.031)	(0.012)	(0.016)	(0.005)
CIT_D+E_SQU	−0.002***	−0.001		−0.001	
	(0.000)	(0.001)		(0.000)	
SELF_CIT	0.084	−0.119	−0.047	−0.049	−0.019
	(0.151)	(0.184)	(0.073)	(0.188)	(0.074)
REF_D+E	0.133***	0.008	0.003	0.017	0.002
	(0.030)	(0.049)	(0.019)	(0.038)	(0.836)
REF_D+E_SQU	−0.006***	−0.001		−0.002	
	(0.002)	(0.003)		(0.002)	
SELF_REF	0.258	−0.036	−0.014	−0.068	−0.027
	(0.177)	(0.214)	(0.085)	(0.213)	(0.084)
OWNERSHIP_EU	−0.417***	−0.420*	−0.166*	−0.481**	−0.190**
	(0.101)	(0.234)	(0.086)	(0.206)	(0.079)
OWNERSHIP_NEU	−0.823***	−0.298	−0.118	−0.376*	0.149*
	(0.114)	(0.335)	(0.128)	(0.223)	(0.087)
LN_PORTFOLIO_PL	−0.087**	0.146	0.058	0.175*	0.004
	(0.043)	(0.099)	(0.039)	(0.098)	(0.009)
LN_PORTFOLIO_PL2	−0.002	−0.014*		0.017**	
	(0.004)	(0.008)		(0.008)	
LN_PORTFOLIO_DF		0.035	0.014	0.024	0.019
		(0.109)	(0.043)	(0.116)	(0.018)
LN_PORTFOLIO_DF2		−0.002		−0.002	
		(0.009)		(0.009)	
RATIO_PORTFOLIO		−0.005	−0.002	−0.016	−0.006
		(0.014)	(0.006)	(0.015)	(0.006)
NULLxMA		1.039***	0.347**	0.985***	0.318***
		(0.318)	(0.103)	(0.323)	(0.072)
NULLxDUE		0.479***	0.185***	0.514***	0.196***
		(0.115)	(0.049)	(0.117)	(0.042)
OPPOS	1.012***				
	(0.110)				
OPPxMA	−0.493	−0.593*	−0.227	−0.657***	−0.255***
	(0.314)	(0.322)	(0.132)	(0.216)	(0.078)
OPPxDUE	0.044	0.018	0.007	0.019	0.008
	(0.259)	(0.264)	(0.105)	(0.122)	(0.048)
EPO	−0.254**	−0.100	−0.040	−0.121	−0.048
	(0.104)	(0.138)	(0.055)	(0.134)	(0.053)
PCT	−0.477***	0.248	0.098	0.277	0.106
	(0.183)	(0.293)	(0.111)	(0.281)	(0.103)
CONSTANT	−1.128***	0.816		0.512	
	(0.160)	−1.260		(1.112)	

Continued on next page

Table 5.5 – continued from previous page

LR Test of Significance for Dummy Variables - (χ^2(degrees of freedom))		
Technology variables	8.85(5)	3.61(4)
Ownership variables	83.47(5)***	6.11(2)**
Relative Ownership	27.34(4)***	18.28(3)***
Size variables	17.69(7)**	2.38(2)
Relative Size		29.34(11)***
Rho (p-value)	0.012(0.528)	
χ^2 (DF)Prob> χ^2	85.03(33) p<0.001	
Pseudo R^2		0.109
Observation	1648	824

Notes: The unit of observation is a single patent. The reference patent is a drug patent owned by a German individual litigating a German individual defendant. p-value of ρ is the p statistic of the test of ρ being significant different from zero. *, **, *** indicate that the coefficient is significantly different from zero at the 10%, 5%, 1% significance level. Standard errors are in parentheses.

One exception is the number of patent claims (CLAIMS). The effect is small and only weakly significant. I assume that a larger number of claims (CLAIMS) imposes a higher degree of precision in the description of the patent. If this leads to more certainty about the scope of the patent and to more confidence whether the potential infringing action is de facto an infringement, the propensity to settle will be higher for both parties.

I find that the probability to settle at some point during the trial is significantly higher in cases in which an annulment claim has been filed as a means of defense. The effect is more pronounced at the Mannheim district court (NULLxMA) compared with Düsseldorf (NULLxDUE). Filing an annulment claim will raise the probability of settlement during trial by 34 percentage points in Mannheim and by 18 percentage points in Düsseldorf. This legal instrument can be regarded as a new source of information. Furthermore it can be a signal of the strength of the defendant which leads to a higher propensity to settle faced with the risk of loosing the patent to the public. Only in Mannheim does an opposition procedure prior to trial have a significant effect on settlement probability. In cases where an opposition against the patent was filed the probability of settlement falls by 23 percentage points. Following that, hypothesis 1 that a questionable patent is more likely to remain under dispute until the court decides, is only supported for suits filed in Mannheim.

Controlling for technology differences I find no evidence to suggest that there is a difference in the settlement rates. Moreover, the size dummies display no significant

effect. But the combined effect in the selection equation and the settlement equation is jointly significant at the 5 % level. The coefficients for the dummies indicating the combination of domestic and foreign litigants (Relative Ownership) reveal a mixed pattern. Taking Germans litigating against each other as the reference group, suits where foreigners sue Germans or Germans sue foreign defendants are more likely to be settled during trial. If there are only foreigners involved there is no significant difference in the settlement probability.

The correlation ρ between the error terms of the two equations turned out to be insignificant, however, the estimation specification is significant.[18] Because there is no significant correlation between the error terms of the selection equation and the settlement during trial equation I can estimate the settlement equation separately as shown in column (4) and (5) of Table 5.5. The probability of settlement is determined by the set of exogenous variables X and is unconditional whether it is selected for a suit or not. I use the same specification as in the model with sample selection. As expected, column (4) reveals no substantial differences to column (2). The effect of the EU- ownership (OWNERSHIP_EU) is estimated more precisely and the coefficient is larger than in the model with selection while the coefficient of the Non-EU-ownership (OWNERSHIP_NEU) emerges as positive and significant. The estimates show a more precisely estimated negative coefficient of the opposition procedure in Mannheim (OPPxMA). As both the conditional and unconditional regressions in Table 5.5 display, the occurrence of a settlement at some point during a patent litigation suit is mainly driven by the characteristics of the parties, in particular the combination of foreign and domestic litigants. Furthermore, the legal instruments used prior to the suit (opposition procedure) and during the suit (annulment suit) have an impact on the course of the case and the settlement.

5.4.2 Settlement at Different Stages During Trial

Following the general discussion of the occurrence of settlement during trial Table 5.6 shows the marginal effects of probit regressions of the occurrence of settlement

[18] I could not find a difference with respect to treating each litigated patent as one separate suit or investigating multi-patent suits dealing with more than one patent, which is the case in more than one third of the cases filed (34.7%). It confirms the assumption that each patent matters in the enforcement strategies of patent protected products.

at different points in time of the legal suits without sample selection effects.[19] First I consider a settlement before the first oral hearing (column (1)). Second, column (2) displays the results for settlement that occur after the first oral hearing but still before the District Court renders an official judgement. In column (3) I consider settlement during the second instance prior the ruling of the Higher District Court. I assume that there are new decision environments at each stage. Therefore I estimated the probability of settlement at each stage of the trial unconditional on reaching this stage (first instance: before hearing and after hearing at District Court, second instance: at higher court).

I discuss the estimated marginal effects of the explanatory variables comparing the effects at all stages. The legal instruments annulment suits and opposition procedures display rather different patterns for Mannheim and Düsseldorf. The effect is ambiguous for Düsseldorf (NULLxDUE). While the effect is positive for settlements before the oral hearing it is negative after it. The changes are beneath 10 percentage points in case of an annulment suit and only significant at the 10 percent level. During the second instance in Düsseldorf settlements becomes more likely by a rate of 21.9 percentage points when an annulment suit is filed. One explanation might be that the litigants face annulment suits which are of varying quality causing varying expectations about the probability of the patent being declared invalid during this annulment suit. Additionally, the quality of the nullity claims becomes apparent over time. For Mannheim (NULLxMA) I observe a clear rise in the settlement probability in case of an annulment suit of 40 percentage points after the first oral hearing. A prior opposition procedure decreases the probability of settlement at the second instance of trial for suits originally filed in Mannheim by almost 50 percentage points (48.5), while the effect is not evident in Düsseldorf. It is somewhat surprising that hypothesis 2 holds for one District Court but not the other.

The age of the patent (AGE_PATENT) is only of some importance for the settlement prior to the oral hearing (0.8 percentage points). Value measures such as the number of claims and citations do not systematically affect the probability of settlement at a certain stage. One additional claim to the average will increase the probability of pre-hearing settlement by 0.8 percentage points which is in the same dimension as the effect observed for the general settlement equation (See previous

[19] Table A5.2 in the Appendix displays the estimated coefficients.

Table 5.6: Probit Estimation of Timing of Settlement - Marginal Effects

		SETTLE_	
	BEF_HEARING	DISTRICT	HIGH_DISTRICT
	(1)	(2)	(3)
AGE_PATENT	−0.008**	−0.003	0.001
	(0.004)	(0.004)	(0.011)
CLAIMS	0.004***	−0.001	0.006
	(0.001)	(0.002)	(0.005)
FAMILY_SIZE	−0.002	−0.002	−0.006
	(0.003)	(0.003)	(0.008)
CIT_D+E	−0.002	−0.007	0.027***
	(0.004)	(0.005)	(0.010)
CIT_D+E_SQU			
SELF_CIT	−0.032	0.065	−0.289∗
	(0.050)	(0.065)	(0.154)
REF_D+E	−0.0004	0.004	0.010
	(0.008)	(0.008)	(0.020)
REF_D+E_SQU			
SELF_REF	−0.149*	0.050	−0.081
	(0.087)	(0.055)	(0.203)
OWNERSHIP_EU	0.009	−0.088∗	−0.224
	(0.057)	(0.047)	(0.184)
OWNERSHIP_NEU	0.039	−0.002	−0.458∗∗∗
	(0.065)	(0.070)	(0.089)
LN_PORTFOLIO_PL	0.012∗	−0.009	0.021
	(0.007)	(0.008)	(0.021)
LN_PORTFOLIO_PL2			
LN_PORTFOLIO_DF	−0.011	0.021	−0.039
	(0.013)	(0.014)	(0.038)
LN_PORTFOLIO_DF2			
RATIO_PORTFOLIO	−0.006	0.002	0.005
	(0.004)	(0.005)	(0.027)
NULLxMA	−0.067	0.404***	−0.002
	(0.073)	(0.122)	(0.301)
NULLxDUE	0.058*	−0.065*	0.219***
	(0.035)	(0.035)	(0.078)
OPPxMA	−0.027	−0.046	−0.485***
	(0.060)	(0.052)	(0.065)
OPPxDUE	0.011	−0.011	0.085
	(0.034)	(0.040)	(0.096)
EPO	0.050	−0.055	0.041
	(0.041)	(0.038)	(0.107)
PCT	0.039	0.055	0.496***
	(0.086)	(0.096)	(0.081)
WIN_PL			0.012

Continued on next page

Table 5.6 – continued from previous page

	SETTLE_		
	BEF_HEARING	DISTRICT	HIGH_DISTRICT
	(1)	(2)	(3)
			(0.094)
Test of Significance for Dummy Variables			
LR-statistic (χ^2(degrees of freedom))			
Technology	1.71(4)	3.33(4)	6.42(4)
Relative Ownership	0.92(3)	4.37(3)	10.47(3)**
Size variables	17.00(12)	30.09(12)***	25.40(12)**
Pseudo-R-Squared	0.097	0.113	0.264
Obs.	824	653	272

Notes: Dependent Variable: Settlement 1/0 at a certain stage of trial. The reference patent is owned by an Individual from Germany. Standard errors in parentheses. *, **, *** indicate that the parameter is significantly different from zero at the 10%, 5%, 1% significance level. Standard errors in parentheses.

table 5.5, column (5)). Assuming that more claims provide more certainty about the scope of the patent and allow a more precise evaluation of the potential infringing action, settlements are more likely since both parties would have similar expectations about the outcome of a judgement. However, the results in Table 5.6 by no means provide clear evidence to explain why this effect is the exact opposite of more claims leading to a higher litigation rate.[20] The content of the claims and the structure might play a more important role once the suit has started.[21] On the one hand, claims might describe a patent as detailed as possible and therefore hamper infringement and litigation by their precise description. On the other hand, excessive claims might provide room for more infringement and hence more litigation with less settlement.

At the second stage (column (3) of Table 5.6) received citations matter both as a cumulative measure (CIT_D+E) and as the separated measure of self citation (SELF_CIT). If CIT_D-E rises by one, the probability of settlement at the second stage goes up by 2.7 percent points. But if the owner cites its patent one more time, the settlement at the late stage in second instance becomes less likely by 28.9 percentage points. These results suggest that value as well as strategic stakes matter

[20]See Table 5.5, column (1) and Cremers (2004).

[21]Harhoff and Reitzig (2001) analyze some aspects of strategic formulations of patent claims in order to reach earlier issuance of patents and a higher persistence.

while the strategic effect is more pronounced.[22]

The plaintiff's portfolio size still has a positive impact on the settlement choice before the first hearing (column (1)) which I interpret as bargaining power of the plaintiff inducing a higher rate of agreements. An increase in the size of the portfolio increases the probability of settlement prior to the hearing by 1.2 percentage points. This effect is small and not observable after the first oral hearing. While the relative size is negatively correlated with the general settlement (Table 5.5) I do not find an impact of the size variables on the decision to settle at the pre-hearing stage of trial. This is in line with recent findings of Lanjouw and Schankerman (2004) who find that among other characteristics the size of the litigants do not affect trial settlement. Additionally, the legal status of the litigants has no effect on the outcome of the trial.

Further control variables show that in suits where the patent is owned by an Non-EU-Foreigner the settlement probability is considerable lower (45.8 percentage points) than for German owned litigated patents. This result is to be expected where foreigners have borne higher costs for the suit up to this stage. However, ownership does not play a decisive role during the earlier stages of the suit.

In Table 5.6 there is no support for the assumption that the new information about the outcome of the first instance decision of the District Court (WIN_PL) has any impact on the settlement decision at the second instance at the Higher District Court. Since I do not observe which party induced the settlement at the second instance, I cannot observe whether a plaintiff who was defeated at the first instance proceeded to the Higher District Court and then agreed to settle, or if it was a defendant who lost at the first instance and then later forced a settlement in the second instance. The outcome of the first instance will be used by the defeated party to decide whether to proceed to the next instance or to drop out. However, the propensity to settle is not influenced by the outcome of the first instance court decision.

In neither of the stages do I find a significant correlation between the technology and the settlement rates. It supports the earlier findings that easily accessible information is used in the decision to file a suit at the very beginning of the dispute.

[22]See Somaya (2003)

Whether the litigants are foreigners or Germans is only decisive in the second instance where foreign litigants are less likely to reach a settlement. Taking German litigants solely as a reference group, in the case of a foreign plaintiff against a German defendant the settlement probability at the second instance increases by 38.8 percentage points (SE 0.13). This is consistent with the large negative marginal effect of OWNERSHIP_NEU. Highly significant after the first hearing are the dummy variables for RELATIVE_SIZE which control for the various combinations of individuals, small, medium, and large size companies as plaintiffs and defendants. Settlement after the oral hearing is significantly more likely in cases where there is no individual involved, neither as plaintiff or as defendant. In general, the patterns of the determinants of settlement during several stages of the trial (Table 5.6) appear differently in early the early stage and in later stages. Observable variables for the patent characteristics, the characteristics of the parties and the characteristics of the two parties do not systematically have an impact on the choice of settlement during trial.

Finally, I employed an ordered probit model to show whether settlement during trial is commonly affected by the factors described in the prior regression. The estimation results in table A5.3 supports the previous results. I use the stage of settlement as the dependent variable. (No settlement (0), late settlement after the first instance (1), settlement after hearing (2) and settlement before hearing (3)). The number of claims appears to be correlated in a highly significant way with early settlement. A highly significant coefficient for plaintiff's portfolio size pronounces the relatively weak effect which I find when applying separated probit estimations as in Tables 5.6 and A5.2. The coefficients for annulment show that in both District Courts earlier settlement is triggered by annulment suits. Opposition hampers settlement during trial only in Mannheim, as the prior results suggest.

5.5 Conclusion

In this Chapter I have analyzed the determinants of settlement in patent infringement suits, using a unique data set of patent litigation suits handled in the District Courts of Mannheim and Düsseldorf. Linking information about litigants and their portfolios allows me to investigate the determinants of the outcomes of patent liti-

gation trials.

I find that most of the settlement during trial cannot be explained by the characteristics of the patent and the parties involved. This supports the assumption that this information is symmetrically known to the parties and immediately used at the beginning of a patent dispute. For the timing of settlement neither the absolute nor the relative size of the plaintiff matters considerably. Only the absence of an individual as plaintiff or defendant is a factor which leads to more settlement during the later stages of trial.

Expectedly, the legal environment has an impact on the settlement behavior during trial. On one hand, I find that annulment suits matter for the general decision to settle during trial. On the other hand, suits treating patents which were opposed appear not systematically different in their propensity to settle than those treating non-opposed patents. However, differences between the District Courts appear to be significant. In general, the settlement patterns differ among the District Courts. Settlement before hearing is more frequent in Düsseldorf than in Mannheim while after the hearing and in later instances the Mannheim cases are settled more often than in Düsseldorf. This is at least partly due to the differently organized oral hearings. The interpretation is limited in the respect that I cannot separate the effect of the personal impact of the presiding judge from the decision to settle made by the parties. Further research should concentrate more intensively on the differences among the District Courts in their interpretation of important legal rules and on the experience and background of the judge.

The results suggest that the parties behave rationally in the sense that all the information about the patents and the litigants available at the beginning of the dispute is exploited in deciding whether or not to file a suit. Additional information emerging during trial by filing claims against validity plays a significant role in settling during the course of the suit.

So far I regarded settlements as favorable for the parties by saving costs and by decreasing uncertainty about property rights. Settlements are discussed in the economic literature as a source of anti-competitive actions as well. In cases where parties settle and agree on exclusive license contracts, patent pools and even on mergers ((Shapiro 2001)) the danger of anti competitive actions increases. Capacity constraints could be overcome and deter entrance of other licensees. Whether a

settlement agreement is socially desirable or not mainly depends on the conditions of the settlement agreement and the type of product or technology which is involved. In the extreme case both parties hold a monopoly of substitutes which block any other patent in this area. In order to analyze these issues in detail further research of case study type is necessary.

5.6 Appendix Chapter 5

Table A5.1:Definition of Variables

Variables	Definition
Dependent Variables	
SETTLE_TRIAL	Dummy = 1 if settlement during trial at all
SETTLE_DISTRICT	Dummy = 1 if settlement during the first instance at District Court
SETTLE_HIGH_DISTRICT	Dummy = 1 if settlement during the second instance at Higher District Court
SETTLE_BEF_HEARING	Dummy = 1 if settlement before trial hearing
Exogenous Variables	
Patent characteristics	
AGE_PATENT	Age of Patent at time of filing in years from application date
CLAIMS	Number of claims
FAMILY_SIZE	Number of jurisdictions the invention was applied for a patent
CIT_D+E	Number of citations received, combined at DPMA and EPO
CIT_D+E_SQU	Number of citations received, combined at DPMA and EPO, squared
REF_D+E	Number of references to prior patents combined at DPMA and EPO
REF_D+E_SQU	Number of references combined at DPMA and EPO, squared
Characteristics of the Parties	
INDIV	Dummy = 1 if Plaintiff is an Individual
SMALL_PL	Dummy = 1 if Plaintiff is a small firm
MEDIUM_PL	Dummy = 1 if Plaintiff is a medium size firm
LARGE_PL	Dummy = 1 if Plaintiff is a large firm
PERSON_0-3	Dummy = 1 if a person sues: 0-person 1-small firm 2-medium firm 3-large firm
SMALL_0-3	Dummy = 1 if a small firm sues: 0-person 1-small firm 2-medium firm 3-large firm
MEDIUM_0-3	Dummy = 1 if a medium firm sues: 0-person 1-small firm 2-medium firm 3-large firm
LARGE_0-3	Dummy = 1 if a large firm sues: 0-person 1-small firm 2-medium firm 3-large firm
PORTFOLIO_PL	Number of plaintiff's patents in force at the time of filing the suit
PORTFOLIO_DF	Number of defendant's patents in force at the time of filing the suit
RATIO_PORTFOLIO	Ratio of plaintiff's portfolio to defendant's portfolio
LN_PORTFOLIO_PL	Log of plaintiff's patents in force at the time of filing the suit
LN_PORTFOLIO_PL2	Log of plaintiff's patents in force at the time of filing the suit, squared
LN_PORTFOLIO_DF	Log of defendant's patents in force at the time of filing the suit
LN_PORTFOLIO_DF2	Log of defendant's patents in force at the time of filing the suit, squared
OWNERSHIP_DE	Patent owned by a German patentee
OWNERSHIP_EU	Patent owned by an European patentee
OWNERSHIP_NEU	Patent owned by a patentee from other than an European country
Variables regarding the legal dispute	
Düsseldorf	Dummy = 1: suit filed in Düsseldorf, = 0 if suit was filed in Mannheim
NULLITY	Dummy = 1 if a nullity suit is filed after filing the infringement suit
NULLxMA	Interaction Dummy: Nullity claims in suits filed in Mannheim
NULLxDUE	Interaction Dummy: Nullity claims in suits filed in Düsseldorf
OPPOS	Dummy = 1 if an opposition has been filed
OPPxMA	Interaction Dummy: Opposition in Mannheim
OPPxDUE	Interaction Dummy: Opposition in Düsseldorf
WIN	Dummy = 1 if plaintiff won at District Court
EXP_LEGAL_COST_P	Expected legal costs per patent at suit

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Table A5.1 – continued from previous page

Variables	Definition
EXP_LEGAL_COST_S	Expected legal costs per suit
Other control variables	
EPO	Dummy = 1 if patent was originally applied at the EPO
PCT	Dummy = 1 if patent was originally applied as a PCT application
DRUG	Main technological class the patent was assigned to: Drugs and Pharma
CHEM	Main technological class the patent was assigned to: Chemicals
ELEC	Main technological class the patent was assigned to: Electronics
MECH	Main technological class the patent was assigned to: Mechanical
OIPC	Main technological class the patent was assigned to: Other technology

* Subgroup of settlements at District Court during first instance.

Table A5.2: Probit Estimation of Timing of Settlement - Estimation Coefficients

	BEF_HEARING	SETTLE_ DISTRICT	HIGH_DISTRICT
	(1)	(2)	(3)
AGE_PATENT	−0.031**	−0.011	0.002
	(0.014)	(0.016)	(0.027)
CLAIMS	0.016***	−0.005	0.016
	(0.006)	(0.009)	(0.012)
FAMILY_SIZE	−0.010	−0.008	−0.015
	(0.011)	(0.011)	(0.020)
CIT_D+E	−0.006	−0.029	0.080***
	(0.020)	(0.027)	(0.030)
CIT_D+E_SQU	−0.000	−0.000	−0.002***
	(0.001)	(0.001)	(0.001)
SELF_CIT	−0.126	0.264	−0.801
	(0.201)	(0.265)	(0.523)
REF_D+E	0.026	0.024	0.054
	(0.053)	(0.046)	(0.074)
REF_D+E_SQU	−0.004	−0.001	−0.004
	(0.004)	(0.003)	(0.004)
SELF_REF	−0.596*	0.203	−0.202
	(0.351)	(0.223)	(0.509)
OWNERSHIP_EU	0.035	−0.414	−0.587
	(0.224)	(0.262)	(0.523)
OWNERSHIP_NEU	0.147	−0.007	−1.532***
	(0.234)	(0.287)	(0.547)
LN_PORTFOLIO_PL	0.352***	−0.068	0.020
	(0.100)	(0.139)	(0.244)
LN_PORTFOLIO_PL2	0.027***	−0.003	−0.003
	(0.009)	(0.011)	(0.020)
LN_PORTFOLIO_DF	0.208*	−0.043	0.094
	(0.124)	(0.143)	(0.250)
LN_PORTFOLIO_DF2	0.015	−0.008	0.012
	(0.010)	(0.011)	(0.020)
RATIO_PORTFOLIO	−0.024	0.008	0.013
	(0.017)	(0.019)	(0.067)
NULLxMA	−0.314	1.167***	−0.005
	(0.404)	(0.313)	(0.756)
NULLxDUE	0.222*	−0.282*	0.555***
	(0.127)	(0.165)	(0.206)
OPPxMA	−0.114	−0.204	−1.897**
	(0.266)	(0.256)	(0.743)
OPPxDUE	0.042	−0.046	0.214
	(0.134)	(0.165)	(0.243)
EPO	0.191	−0.236	0.103
	(0.150)	(0.174)	(0.268)
PCT	0.145	0.205	1.928*
	(0.305)	(0.330)	−1.026
WIN_PL			0.030
			(0.236)

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Table A5.2 – continued from previous page

	BEF_HEARING	SETTLE_ after hearing first instance	adopt
	(1)	(2)	(3)
Constant	−4.686	0.299	−6.260
	(0.000)	−1.160	(0.000)
Test of Significance for Dummy Variables LR-statistic (χ^2(degrees of freedom))			
Technology	1.71(4)	3.33(4)	6.42(4)
Relative Ownership	0.92(3)	4.37(3)	10.47(3)**
Size variables	17.00(12)	30.09(12)***	25.40(12)**
Pseudo-R-Squared	0.097	0.113	0.264
Obs.	824	653	272

Notes: Dependent Variable: Settlement 1/0 at a certain stage of trial. The reference patent is owned by an Individual from Germany. Standard errors in parentheses. *, **, *** indicate that the parameter is significantly different from zero at the 10%, 5%, 1% significance level. Standard errors in parentheses.

Table A5.3:Ordered Probit Estimation of Timing of Settlement

	Settlement
AGE_PATENT	−0.014
	(0.011)
CLAIMS	0.014***
	(0.005)
FAMILY_SIZE	−0.010
	(0.008)
CIT_D+E	−0.001
	(0.014)
CIT_D+E_SQU	−0.000
	(0.000)
SELF_CIT	0.193
	(0.233)
REF_D+E	0.009
	(0.032)
REF_D+E_SQU	−0.002
	(0.002)
SELF_REF	−0.193
	(0.191)
OWNERSHIP_EU	−0.233
	(0.173)
OWNERSHIP_NEU	−0.076
	(0.188)
LN_PORTFOLIO_PL	0.252***
	(0.082)
LN_PORTFOLIO_PL2	0.021***
	(0.007)
LN_PORTFOLIO_DF	0.090
	(0.097)
LN_PORTFOLIO_DF2	0.005
	(0.008)
RATIO_PORTFOLIO	−0.018
	(0.013)
NULLxMA	0.518**
	(0.232)
NULLxDUE	0.299***
	(0.099)
OPPxMA	−0.387**
	(0.191)
OPPxDUE	0.039
	(0.105)
EPO	−0.007
	(0.115)
PCT	0.193
	(0.233)
Test of Significance for Dummy Variables	
LR-statistic (χ^2(degrees of freedom))	

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Table A5.3 – continued from previous page

	SETTLE_
Technology	1.71(4)
Relative Ownership	0.92(3)
Size variables	17.00(12)
Pseudo-R-Squared	0.097
Obs.	824

Notes: Dependent Variable: Ordered Variable 0 no settlement, 1 settlement after first instance, 2 settlement after hearing 3 settlement before hearing. The reference patent is owned by an Individual from Germany. Standard errors in parentheses. *, **, *** indicate that the parameter is significantly different from zero at the 10%, 5%, 1% significance level. Standard errors in parentheses.

Chapter 6

Determinants of the Duration of Patent Trials

6.1 Introduction

Enforcement of patents in the framework of lawsuits is a time consuming undertaking which is made in order to secure rents from an intellectual property right. First, intellectual property rights such as patents have to be enforced in order to obtain sustained benefits which are intended to recoup the investments in its development. This enforcement takes time and, up to a certain limit, the duration of patent suits has a positive implication for the efficiency of the patent system. The more effort a litigating party invests in enforcement disputes against a potential infringer, ceteris paribus, the longer it would take to solve the dispute. Documentary evidence must be prepared, in some cases with the help of experts. Providing the court with valuable and credible information delays the decision of the court as well as settlement agreements. Second, a long lasting patent suit creates real expenditures. Lawyer salaries or legal fees, and the loss of rents that would otherwise have been received from exploiting the patent must also be taken into consideration.

A court decision which either provides compensation to the owner of an infringed patent or which absolves an unjustly accused defendant is one solution to the case. Settling on the merits of the dispute is the other. Either conclusion may be influenced not only in terms of the type of outcome but also in terms of the length of time the patent is disputed by all involved parties and the judge. Not only private but also

social costs evolve during a time of suit. Delayed civil suit termination is regarded as a grave economic and social problem.[1] On the one hand, during the course of a patent suit uncertainty and the loss of market share are a common sacrifice added to the general direct costs of a patent litigation suit such as legal fees and attorney salaries. Managerial and judicial resources are tied up. Uncertainty about the scope of the patent reduces the expected profits from the patent and infringement directly depletes the returns of the innovation rents. Furthermore, the expected value of the patented invention is diminished by the risk of losing the the trial. On the other hand, qualitatively valuable court decisions or profitable settlements disentangle the merits of the dispute and therefore solve this uncertainty.

In addition to the private consequences of varying suit duration, society faces additional welfare effects. Long lasting patent disputes erode incentives created by the patent system for innovation investments. At the same time inadmissible civil claims filed by patentees can diminish the incentives for potential competitors to invent around or improve similar technologies. Court decisions can partly solve the problems of the patent system which distorts market forces.[2]

In this Chapter, I analyze the behavior of the parties involved in patent litigation suits with respect to the duration of the termination of the legal dispute. Based on a model developed by Spier (1992) and adapted by Fenn and Rickman (1999), I formulate hypotheses to explain the effect of ongoing time on the way a suit is terminated and to link the efforts the parties make during suits to the incentives provided by the enforcement system. In addition to the model I allow for suits to be closed by two mutually exclusive termination events - settlement agreements and court verdicts (adjudication). Moreover, for the investigation of the duration of both types of termination I relate the behavior of the parties to the legal environment and the characteristics of the patents involved in the dispute. The main findings are that complex and multiple claim suits take longer to solve via settlement while there is no effect on the duration of the adjudication process. Furthermore, I find that verdicts take much longer to reach in Düsseldorf.

This analysis extends the existing literature on the duration of civil suits, especially patent suits by drawing on detailed information about the course of the case.

[1] See Vereeck and Mühl (2000) and Kessler (1996).

[2] See Menell and Scotchmer (2005) and Scotchmer (2005) for further arguments.

Danzon and Lillard (1983),Hughes and Snyder (1989), Kessler (1996), Spurr (1997), Hughes and Savoca (1999) , and others empirically investigate the duration of personal civil injuries suits such as medical malpractice or car accidents. This work mainly builds on the work of Priest (1989) and Spier (1992 and 1994) who reveal the incentives of the parties to delay or to speed up suits. As for patent litigation suits, Somaya (2005) and Kesan and Ball (2005) examine U.S. data to analyze the timing of patent suits for the American system. Somaya (2005) provides a detailed empirical investigation of both competing termination routes and finds that strategic patenting behavior such as defensive strategies, exclusivity and trading aspects have an impact on the timing of settlement or adjudication. He uses a large data set of patent litigation to analyze patent strategies, such as blocking or fencing, and their impact on suits. Kesan and Ball (2005) investigate a smaller data set of two filing cohorts at a certain District Court.

Using a data set of three cohorts of filed patent litigation suits between 1993 and 1995 in Germany, described in Chapter 3, I apply a competing-risks proportional hazard model. The estimation results reveal that for the termination of a patent suit the direct efforts of the parties are particularly important. Settlement is delayed by requesting an expertise and filing a large number of different litigation claims. Annulment suits as a means of defense employed by the potential infringer delay court adjudication but not settlement. In the data I do not find that patent strategies as such affect the duration of one or the other outcome.

The remaining Chapter is organized as follows. In the next section I relate my analysis to the existing theoretical and empirical work and formulate hypotheses. Section 6.3 contains the data description. In section 6.4 I introduce the econometric model and discuss the results. Section 6.5 concludes.

6.2 Theoretical and Institutional Considerations

There are two lines of research accessing the determinants of lawsuit delays. First, models of bargaining and the sources of negotiation breakdown in different information settings generate predictions about the driving forces of settlement delay. Second, as soon as the patent disputes are filed to District courts they will be mediated by judges. The judges' motives and the institutional specificities also have an

impact on the time of termination, by both settlement and verdict. In the following I describe the results of the research lines in order to develop hypotheses for the patent litigation trial in Germany.

6.2.1 Duration of Negotiations

In the economic literature the delay of termination of disputes is embedded in the research of settlement behavior during negotiations (P'ng 1983, Bebchuk 1984, Nalebuff 1987 Spier 1992). It is important to distinguish between investigations, theoretical and empirical, which analyze the delay to settlement only (Fenn and Rickman 1999, Kessler 1996), those which only consider adjudication outcomes (Lanjouw and Schankerman 2001, Nerkar A. and Paruchuri 2004) and those regarding the termination of litigation by settlement *and* court adjudication (Posner 1972, Priest 1989, Spurr 1997, 2000). However, all approaches rely on the assumption that litigation and, at later stages, court adjudication represents a failure of settlement negotiations. Thus I apply the model of Fenn and Rickman (1999) which is based on the work of Spier (1992).

A defendant decides in favor of settlement offer in each of the negotiation periods t , $t \in (1, T-1)$ under conditions of incomplete information. The damages to be paid by the defendant are drawn from a uniform distribution $[\gamma\underline{D},\ \gamma\overline{D}]$ with $\gamma > 0$ as an indicator of the severity of the case. The probability of losing the case and paying the costs C is p. Both parties discount the future at the same rate $\delta \in (0, 1)$. The defendant makes settlement offers in each period in order to minimize his expected payout and takes into account the fact that plaintiffs with a lower type γD would have accepted earlier offers. In a Perfect Bayesian Equilibrium the defendant determines the partition of the plaintiff types by a set of T settlement offers. This partitioning is crucial for the probability of settlement in each period.

$$D_t = \gamma\underline{D}\frac{1}{p}\delta^{-T}\sum_{i=1}^{t-1}\delta^i C, \qquad \text{t = 2, ...,T} \tag{6.1}$$

$$D_{t+1} = D_t + \frac{C}{p} \tag{6.2}$$

In equation (6.1) the damages to be paid by the defendant are written as the sum of the costs until the termination at time T, $\sum_{i=1}^{t-1}\delta^i C$, times the severity of the

infringement, $\gamma \underline{D}$ and the probability of losing $\frac{1}{p}$. The benefits of settlement in an earlier period t are written in equation (6.2) as the costs to be saved in period $t+1$. The defendant's share of benefits falls as the anticipated probability of the plaintiff winning (higher liability of the defendant) rises. This predicts the hazard rate as a function of the expected damages $p\gamma\Delta D$ and the cost C of the next period. With $\beta = \frac{p\gamma\Delta D}{C}$ the hazard rate of suit settlement is derived as follows:[3]

$$h(t, C, p, \gamma, \Delta D) = \frac{(1-\delta)\delta^{t-T}}{(1-\delta)\beta - \delta^{-T}(\delta - \delta^{t})} \tag{6.3}$$

β is the relation of the defendant's expected damages ΔD and the cost C of the next period. C would be saved by settling in the current period. Assuming that h increases monotonically, equation 6.3 immediately leads to predictions about the hazard rate of settlement termination by settlement agreements. First, the higher the costs of trial the higher is the hazard rate of patent litigation suit termination by settlement is. Second, the more severe a suit is the lower is the hazard rate of patent litigation suit termination by settlement. The model does not explicitly predict the hazard rates for adjudication. However, since adjudication occurs after settlement negotiations have failed, court related activities of the litigants delay or speed up adjudication.

In another model context developed by Admati and Perry (1987) settlement delay may signal information about the bargaining strength of the litigants. The timing of offers and their revision reveal information about how strong the bargaining position is. A late settlement offer and a delayed refinement of settlement offers signal a larger bargaining power than the litigant might actually exercise. It follows that if the patentee thinks he has a weak patent he might prolong the time between the offers he makes and therefore delay settlement. As a result, I expect that disclosed bargaining power will speed up the termination of suits by adjudication.

6.2.2 Hypotheses

Based on the discussion in the previous section 6.2.1 I derive hypotheses about the factors driving the duration of patent suits terminated by two mutually exclusive

[3]The detailed model is presented in Fenn and Rickman (1999).

types of suit termination. Legal costs are closely linked to the amount at stake, whereby high amounts lead to late settlement. This is stressed by Fenn and Rickman (1999) who find that a higher value of the incorporated stakes lead to lower settlement hazards. The amount in dispute is defined by the court. Related to this value the court fees as well as the private attorney fees are calculated.

H1 The higher the amount in dispute, the lower is c.p. the hazard rate of settlement.

In an indirect sense forgone rents of a patent in future periods are part of the cost C. These rents are determined by the term of the patent. Thus, younger patents will lead to a speedy adjudication since there are more years of applicability of the rents. Somaya (2005) stresses this argument in the sense that patentees who aiming to achieve a strategic goal of exclusivity are particularly interested in speedier adjudication (in favor of the patentee).

The claims filed within the litigation process are a direct means to constitute the trial. The claim for omission and demand for compensation are the regular litigation claims filed.[4] Additionally the plaintiff can demand a presentation of accounts in order to calculate damages or to estimate restitution after unjust enrichment. Providing this information is associated with costs and a loss of reputation concerning the internal interest of the defendant's secrecy. In addition to the foregoing arguments, it is reasonable to assume that the more claims are filed the larger is the workload of the judges and the parties in terms of preparing the documents and the decision.

H2 The more litigation claims are filed, the longer c.p. the patent litigation suit lasts. The hazard rate of both settlement and adjudication termination will be lower.

Litigants evaluate the merits of the case more closely when they request an expert opinion. They emphasize the severity and the importance of the patent involved.

[4] A request for preliminary injunction forcing the defendant to refrain from all infringing activities might be followed by the collapse of the defendant's entire business. This can be one of the most damaging claims, particularly for small firms (Lanjouw and Lerner 2001 and Lanjouw and Schankerman 2004). I consider this effect in analyzing the baseline hazards separated for cases where preliminary injunctions have been requested.

Finding evidence in these cases is more time consuming and directly delays the termination of the suit for both types. For settlement termination, an expertise will refine the information about the infringing action. The parties then face a different information structure which results in a new negotiation round. Settlement will be delayed. As far as adjudication is concerned, expert opinions speed up the decision making process for the court and help the it to reach a decision more quickly. I anticipate that the two effects will cancel each other out and that there will be no correlation between the request for an expert opinion and the hazard rate for adjudication.

H3 In cases where an expert opinion is used to find evidence the hazard rate of settlement is c.p. lower. There is no effect of an expert opinion on the hazard rate for adjudication.

It follows directly from the model that impatient litigants favor early settlement and speedy adjudication since the discount of future compensations is high. Impatient litigants might be individuals and small companies which have no alternative but to tie up a relatively large amount of their resources in the litigation proceedings. However, as I find in Chapter 4 and 5 individuals are more likely to become involved in litigation in later stages than companies.

6.2.3 Court Delays and Procedural Details

Further arguments of delay in patent suit termination lie in the incentives the jurisdictional system provides. Court delay in trials causes a delay of settlement. Kessler (1996) and Vereeck and Mühl (2000) argue that the discount of the value of the case and the deterioration in the quality of the evidence lead to a lower propensity to settle for the defendant which offsets the higher propensity to settle for plaintiffs.

The independence of courts is politically desirable and in many jurisdictional systems a constitutional right.[5] Nevertheless, judges at court do have private incentives of their own in the sense that they also seek promotion to higher courts and to reduce their workload. Depending on whether the capability of judges is measured

[5]See Landes and Posner (1975) and Salzberger (1993)) who argue that judicial independence is a necessary precondition if unpopular decisions are to be shifted on to judges.

by the citations or the number of cases in which their decision have not been not overturned by an appellate court, the judge will decide on the merits or follow precedence cases. These reputation motives have been taken into account by Levy (2005) and Miceli and Coşgel (1994) arguing that these motives can create conflictive decision incentives. In the German litigation system an additional promotion-related incentive for judges involves the encouragement of settlements. Judges who achieve settlement between the litigants are regarded as capable and are therefore promoted to higher courts more quickly or promoted to higher salary groups.[6] It is clear that, all other factors being equal, this incentive will lead to higher settlement rates. But it is unclear whether these settlements would occur much earlier.

In Düsseldorf the District Court uses the first oral hearing as a procedural conference which fixes the conditions for the further negotiations. Only in the next session does the hearing involve the merits of the case. The Mannheim court immediately begins hearing finding evidence on the merits. I do not expect the settlement termination to have an impact on the duration of the suit. However, the adjudication will be per se delayed. I expect that suits at the Düsseldorf District Court have c.p. a lower hazard rate of suit termination by adjudication.

At this point I draw the reader's attention to a discussion on the impact of legal doctrines and damage paying rules on the outcome and duration of patent litigation suits. Carpentier (2004) stresses that the punishment of delayed patent right enforcement (doctrine of laches) may cause efficient delays the in enforcement of patent rights to prevent overlapping suits.[7] A similar finding is reported by Schankerman and Scotchmer (2001) who evaluate the rules of damage payments in terms of the benefits of the parties. In this context the impact of endurance is shown as a factor affecting the length of a litigation suit as well. In cases where an interest rate is paid for the duration of the trial the adjudication should be delayed by the parties. The English rule which is applied in Germany forces the defeated party to bear all the costs. This leads ex ante to higher settlement rates than verdict drop outs ((Hughes and Savoca 1999)).[8] Daughety and Reinganum (2004)

[6]These in-court settlement offers usually contain a lower damage payment for the defendant and therefore lower compensation for the plaintiff but an end of the suit which is combined with certainty and lower legal expenses.

[7]

[8]I do not consider adjudication limits. They are a restriction to the settlement delay and

argue specifically that the use of a certain legal doctrine can produce externalities such as delay of settlement.[9] Arguments relating to the differences in the legal procedures cannot be used in this analysis given that, in the German system, there is no significant difference among the courts in applying these rules.

6.3 Data and Descriptive Statistics

I use a sample of all patent litigation suits filed during the time period between 1993 and 1995, as described in Chapter 3. From all 652 suits filed at the two District Courts, Mannheim and Düsseldorf, 306 suits remained in the sample for the analysis duration. Suits for which the date of termination did not appear correctly as the real end of the dispute had to be excluded.[10]. Additionally, some of the litigation claim variables were not available or had been incorrectly observed. I tested whether there is a selection bias for the most important exogenous variables and found that those cases were not significantly different in their means.

174 suits were closed by settlement either before court or out of court.[11] Court adjudications terminated suits in 132 cases. Appeals are included in the sample.

Vereeck and Mühl (2000) condense the time of a trial into four periods: First, the negotiation time between the discovery of the infringement and filing a suit; second, the time between the decision to file and clarification of the administrative requirements in preparation for the trial; third, time between filing the suit and the start of the trial; fourth, the duration of the trial up to its termination by a settlement agreement, a court decision or the case being dropped. In this analysis I combine the third and fourth periods and define it as the duration of a patent suit

reduce the duration endogenously.

[9]Djankov et al. (2003) measure the procedures at courts in several countries and find that the level of formalism affects the duration of trials. But this is more of importance when comparing national systems of enforcement.

[10]Especially in Düsseldorf, closing dates are reported which lie after the end of the decision about the merits

[11]For the researcher there is no distinction observable between a settlement agreement with compensation payment (e.g license fees, damages) and a drop. For all out of court settlements there are no data available for compensation payments or changes or stop in the potentially litigating action (Shavell 2003).

and regard the time from filing the letter of claims to the District Court until the final notification of the end of the trial as the duration of the suit which is in this case also the duration of the trial.

Settlement takes on average 30 days longer than termination by court decision (Table 6.1). Independent of whether the suit has been terminated by settlement or by adjudication, suits in Düsseldorf last on average almost 9 months longer than at the Mannheim District Court. In both District Courts the average duration of trials differ, but not significantly, according to type of termination.

Table 6.1: Time Length of Suits by Kind of Termination and District Court

Termination by	at Mannheim Mean (SD)	at Düsseldorf Mean (SD)	Total Mean (SD)	Obs.
Adjudication	366.85 (432.41)	662.97 (534.84)	517.15 (507.50)	133
Settlement	399.51 (571.22)	632.17 (478.37)	540.72 (527.69)	173
Total	383.55 (506.50)	644.17 (499.81)	530.52 (518.33)	
Observation	134	172		306

Table 6.2 shows the means and standard errors of most exogenous variables explaining the duration of patent suits in Germany which were closed either by settlement or by court decision. The first panel displays the variables describing the characteristics of the suit. Plaintiff's activities are measured as the number of litigation claims (LIT_CLAIMS) filed and the request for an expert opinion (EXPERT). EXPERT is coded as an indicator variable defining whether an expert opinion was requested or not. Defendants' efforts are recorded in terms of whether they file an annulment suit (DUMMY_NULLITY) at the Federal Patent Court (BpatG). In cases where the defendant requested a stay after filing an annulment, the duration of the stay (DURATION_OF_STAY) is longer prior to settlement if the suit is closed by settlement rather than court adjudication. Patent characteristics are shown in panel two of table 6.2. There are more patent claims (CLAIMS) involved in suits which terminate with settlement rather than in those which were adjudicated. The higher value of AMOUNT_IN_DISPUTE for settled cases is in line with this finding

Table 6.2: **Description of Main Exogenous Variables According to Type of Termination**, Mean (SD)

	Full Sample	Settlement	Adjudication	
DURATION_OF_STAY (days)	79.18	105.431	44.58	**
	(281.86)	(317.19)	(223.55)	
LITIGATION_CLAIMS	2.79	2.86	2.70	
	(1.65)	(1.61)	(1.71)	
EXPERTISE	0.16	0.13	0.20	**
DUMMY_STAY	0.14	0.18	0.09	**
DUMMY_NULLITY	0.25	0.30	0.17	***
DUMMY_HEARING	0.83	0.84	0.80	
AMOUNT_IN_DISPUTE (in Mio DM)	0.68	0.83	0.47	*
	(1.97)	(2.58)	(0.47)	
OPPOSITION	0.27	0.23	0.32	*
CLAIMS	9.98	10.73	8.99	*
	(9.20)	(10.75)	(6.54)	
SELF_REFS	0.02	0.03	0.015	
	(0.14)	(0.15)	(0.12)	
SELF_CITES	0.04	0.03	0.04	
	0.24	(0.16)	(0.32)	
REFERENCES	3.88	3.90	3.87	
	(3.39)	(3.37)	(3.44)	
CITATIONS	4.17	3.90	4.53	
	(5.59)	(4.70)	(6.56)	
FAMILY_SIZE	4.85	4.43	5.40	**
	(5.08)	(5.07)	(5.05)	
PATENT_AGE	9.05	9.10	8.97	
	(4.25)	(4.08)	(4.47)	
PORTFOLIO_RATIO	0.54	0.47	0.63	
	(5.38)	(5.04)	(5.81)	
PORTFOLIO_PL	623.21	583.64	675.37	
	(5382.45)	(5048.16)	(5813.08)	
PORTFOLIO_DF	205.45	197.47	215.97	
	(1383.41)	(1086.80)	(1701.71)	
INDIVIDUAL	0.31	0.27	0.36	*
Observations	306	174	132	

Notes: The Table shows the means of the main exogenous variables. *, **, *** indicate that the means of the sub samples settlement and adjudication differ significantly at the 10%, 5%, 1% significance level. Standard errors in parentheses.

since the AMOUNT_IN_DISPUTE is correlated with the number of patent claims.[12]

[12]The numbers correspond to those in table 5.4 in the previous Chapter.

6.4 Competing Risk Analysis

In the following section I present the competing risk analysis of patent suit termination by settlement and termination by court adjudication.

6.4.1 Econometric Model and Estimation Techniques

For the competing risk analysis of the duration of patent litigation suits I use a semi-parametric, proportional hazard model. Termination of the suits can happen by one of two mutually exclusive events. I distinguish between settlement agreements S as one termination event and court adjudication A as the second termination event (Hughes and Savoca, Somaya 2000). Termination occurs at time T and is observable at the T^S and T^A for each suit. T is defined as $T = \min(T^S, T^A)$. Following the Cox model two type-specific hazards are estimated in the stratified version of the proportional hazard model (Cox 1972). I assume that the two types are mutually independent. From this assumption, it follows that the observable hazard function equals :

$$h^c(t; X = x) = \lim_{\Delta t \to 0} \frac{P\left(t \leq T^c < t + \Delta t | t \leq T = \min\left(T^S, T^A\right), X = x\right)}{\Delta t} \tag{6.4}$$

A result of the independence assumption is that I can estimate the hazards for each type in a single-risk model where the suits are terminated by competing risks (or types) of termination.

$$h^c(t) = exp(-\beta' X) h_0(t)) \qquad \text{where} \qquad c \in S, A \tag{6.5}$$

X refers to the exogenous determinants influencing the hazard rates. It reflects the legal strategies the plaintiff and the defendant use to solve the dispute as well as the general characteristics of the patent involved.

Similar to Somaya (2005) and Kessler (1996) I apply this approach to avoid the determination of a time dependency of the hazard function up front. I can take into account the possibility that the baseline hazard rate may have a non-monotonic

distribution with decreasing and then increasing time dependency or vice versa.[13] 12 Empirical findings on suit duration in civil law are mixed as far as the distribution of the hazard rate is concerned.[14] I estimate baseline hazard function for each type of termination by stratifying the sample type of trial used - normal suit or request for preliminary injunction. In order to account for time varying variables such as annulment suits and time of suspension I report robust standard errors which are calculated using the variance-covariance estimator of Lin and Wei (1989). Since the sample includes only cases which were completed at the time of data collection (End of 1999 until Spring 2000) I introduce a downward finite sampling horizon bias.[15]

6.4.2 Estimation Results

The baseline hazards are displayed in figure 6.1. I applied a Kaplan-Meier estimator for the calculation according to the model in equation 6.5. All hazards reveal nonlinear patterns for settlement and adjudication. The overall hazard function for both types of suit termination (Graph A) appears differently from the separated hazards for settlement and court adjudication (Graph B). Settlement hazards do not vary much over time but drop sharply after about 5 years.

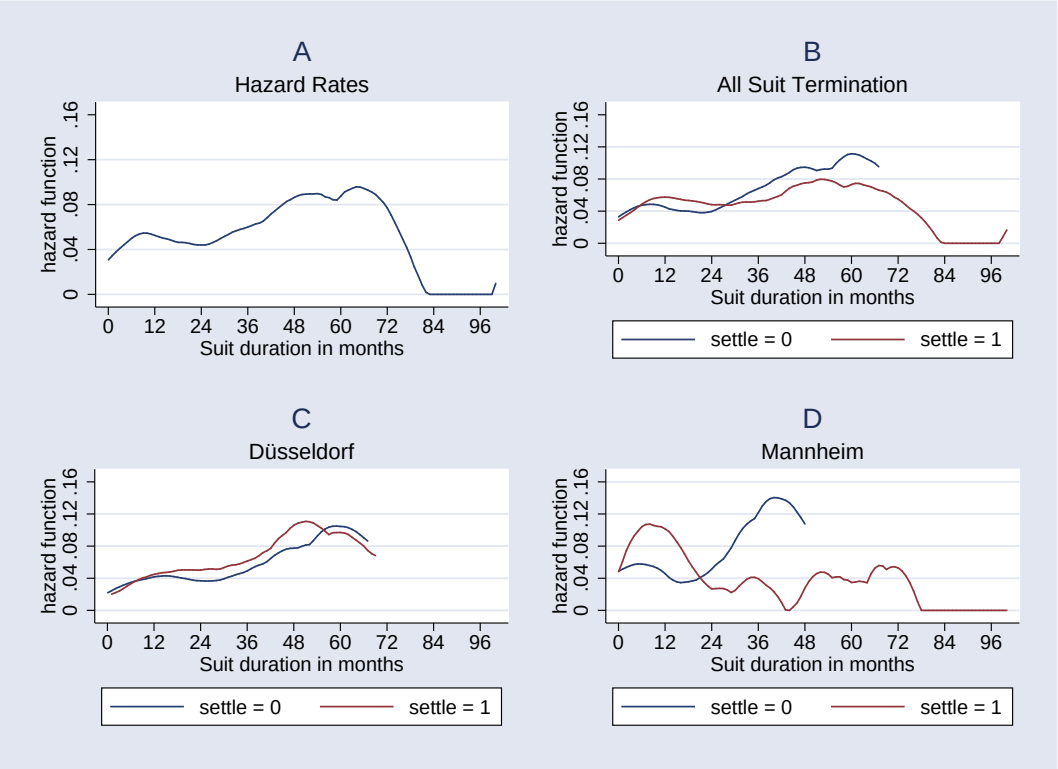
The hazard functions of suit termination by settlement and adjudication are deviating considerably between Düsseldorf (Graph C) and Mannheim (Graph D). In Düsseldorf the hazard function of adjudication is always below the settlement hazard function. Cases in Düsseldorf always have a higher hazard of being terminated by settlement than by adjudication. The hazards in both cases increase up to a duration of about 4 years for settlement and 5 years for adjudication. After a duration of 5 years the hazards decrease while suits are subject to a greater hazard of termination by adjudication. This pattern suggests that there might be an adjudication limit

[13](In her model of strategic bargaining Spier (1992) predicts a U-shaped distribution with decreasing and then increasing time dependency of the hazard function in pre-trial negotiations.

[14]Fenn and Rickman (1999) found a monotonically increasing baseline hazard in their analysis of clinical negligence and employee claims while Kessler (1996) reports a declining baseline hazard in a study of the settlement of automobile bodily injury insurance claims.

[15]The share of unfinished suits is estimated by the judges at somewhat under 2 per cent. Following Scherer and Harhoff (2000) who stress the general skewed distribution of value parameters in the universe of patents, I presume that long lasting suits may involve very specific patents. However, evidence was not provided within the case documents because of confidentiality.

Figure 6.1: Baseline Hazard Functions



which forces the court to decide on unfinished cases after a duration of more than 5 years.

In Mannheim the hazard rate for settlement is higher than in Düsseldorf up to a duration of 2 years while it increases within the first year of suit duration only to decrease sharply thereafter. If the suit lasts longer than two years, the settlement hazard in Mannheim does not fit any particular pattern. Adjudication hazards increase and then decrease again after 3 years. The results for Düsseldorf suits mainly confirm the prediction of the model. Settlement hazards increase over time. The adjudication hazards follow this course at a lag of a few months. The settlement hazards in Mannheim have completely different characteristics. These differences are probably due to differences in the oral hearing systems in Mannheim and Düsseldorf.

Table 6.3 shows estimated covariate effects for settlement termination and adjudication. I tested two model specifications. In the first model I included only the variables which explain the active efforts of the parties and the court discrimination

variable. In the second model I tested legal activities together with patent and party characteristics as control variables.

In the first model (Model 1) I estimate the hazard rates of termination by settlement and by adjudication corresponding to the hypotheses in sections 6.2.1 and 6.2.3. I assume that the duration of a trial is driven by the efforts parties invest in enforcing the intellectual property right or determining infringing actions. The AMOUNT_IN_DISPUTE is the value the court attaches to the patent under dispute. I only find an effect on the settlement or on the adjudication type of termination when I control for the patent and patentee characteristics (Model 2). Settlement is prolonged by a higher AMOUNT_IN_DISPUTE. This result confirms hypothesis 1. The hazard rate for adjudication is larger than one and thus indicates that court decisions are reached more quickly if the value of the patent involved appears to be high and the costs involved in the suit are higher.

The number of litigation claims filed at the beginning of the suit (LIT_CLAIMS) is an indicator of the severity of the potential infringement. The coefficient of LIT_CLAIMS is less than one and significant at the 5 per cent significance level. This is in line with hypothesis 2. However this effect vanishes if the control variables for patent and litigant characteristics are included. Requesting an expert opinion (EXPERTISE) has a large and significant negative impact on the hazard ratio in the settlement equation. The information revealed by the expert's report resets the information basis and probably discloses the type of infringement and the strength of the patent. As hypothesis 3 states, termination by settlement is delayed by requesting an expert's opinion. As expected, no effect on the adjudication hazard is observed.

The indicator variable DÜSSELDORF is coded one if the suit was filed at the Düsseldorf District Court and zero if it was filed in Mannheim. In the adjudication equation of Model 1 for DÜSSELDORF the coefficient is smaller than one which tells us that the hazard rate of adjudicated trials is lower in Düsseldorf compared to Mannheim. This is in line with my expectations. The coefficient of DÜSSELDORF represents the differences between the personalities of the judges and their experience and capability of interpreting the law. Applying Model 1 I find no effect for DÜSSELDORF in the settlement equation. The duration of an adjudicated suit is significantly slowed down by the fact that it is filed in Düsseldorf. Contrary to the

Table 6.3: **Hazard Rate Model Estimates by Kind of Suit Termination**

	Model 1		Model 2	
	Settlement	Adjudication	Settlement	Adjudication
AMOUNT_IN_DISPUTE[1]	0.967	1.056	0.931*	1.091**
	(0.026)	(0.041)	(0.036)	(0.047)
LIT_CLAIMS	0.892**	1.021	0.923	0.996
	(0.050)	(0.071)	(0.065)	(0.077)
EXPERTISE	0.399***	0.926	0.338***	1.137
	(0.097)	(0.230)	(0.083)	(0.326)
DUMMY_STAY	0.554***	0.323***	0.476***	0.315***
	(0.127)	(0.109)	(0.111)	(0.106)
DUMMY_NULLITY	0.988	0.632*	0.943	0.621*
	(0.192)	(0.165)	(0.186)	(0.178)
DUMMY_HEARING	0.496***	0.406***	0.501**	0.317***
	(0.121)	(0.113)	(0.144)	(0.090)
DÜSSELDORF	1.096	0.547***	0.875	0.628*
	(0.204)	(0.111)	(0.212)	(0.158)
OPPOSITION			0.807	0.535*
			(0.191)	(0.189)
OPPxMA			0.277**	1.839
			(0.159)	(0.866)
CLAIMS			0.998	0.957**
			(0.010)	(0.018)
REFERENCES			0.992	1.032
			(0.025)	(0.026)
CITATIONS			0.978	1.010
			(0.016)	(0.012)
FAMILY_SIZE			0.944**	1.013
			(0.024)	(0.024)
PATENT_AGE			0.991	0.977
			(0.028)	(0.030)
PORTFOLIO_RATIO			0.999	1.003
			(0.013)	(0.014)
PORTFOLIO_PL			1.011	1.069
			(0.044)	(0.048)
PORTFOLIO_DF			1.002	0.902**
			(0.045)	(0.043)
INDIVIDUAL			0.982	1.333
			(0.199)	(0.301)
Wald-statistic (χ^2(degrees of freedom))				
Ownership Indicator	–	–	1.55(2)	1.80(2)
Relative Ownership	–	–	7.52(3)*	4.60(3)
Observations	306	306	306	306
log Likelihood	−743.29	−525.95	−723.64	−512.36

Notes: The Table shows the estimation results of the Cox proportional hazard-rate models. The reference suit is a case filed by a German company against a German company. *, **, *** indicate that the parameter is significantly different from zero at the 10%, 5%, 1% significance level. Robust standard errors in parentheses.

results displayed in figure 6.1, Graph C and D, I do not find the difference in the hazard function in the pattern between Mannheim in Düsseldorf to be significantly different.[16]

Variables which describe legal means which are used during trial and which directly influence the course of the case are the filing an annulment suit (DUMMY_NULLITY), a request for a suspension after filing an annulment suit (DUMMY_STAY), and the holding of a hearing (DUMMY_HEARING). These are tested to ascertain whether they influence both types of patent suit termination. In cases where a hearing is conducted the coefficients are significantly smaller than one, which indicates a lower hazard rate. A filed annulment suit has no effect on the hazard rates of the settlement equation, either in Model 1 or in Model 2. However, adjudication is delayed by an annulment suit which is indicated by a lower hazard rate. The effect remains weakly significant over the two model specifications. The fact that the defendant applies for a suspension of the litigation suit while the annulment case is pending lowers the hazard rate significantly for both types of termination however. This is straightforward because the suspension time adds directly to the duration of the suit.

In columns three and four of table 6.3 I control for several patent and party characteristics (Model 2). Whether a patent has been involved into an opposition procedure (OPPOSITION) leads to a decrease in the hazard rate for adjudication termination. . Even though the effect is only weakly significant, it may indicate that primary questionable patents are either more important and therefore worth fighting for or that the scope of the patent is still not defined conclusively. Both arguments lead c.p. to longer adjudication delays. Similar to results in Chapter 5 I can only show an effect of prior opposition for the Mannheim District court suits. Case evidence strongly supports in-court settlements at the Mannheim District Court. This is in line with a higher in-court settlement rate in Mannheim.[17] In cases in which prior legal steps have been taken, such as opposition, these settlements are harder to achieve in Mannheim, even though the settlement hazard does not significantly differ between the District Courts. The coefficient of the number of claims (CLAIMS) is significant lower than one in the adjudication equation. Although more patent

[16]The specification of the Cox proportional hazard model leads to different results compared to the Kaplan-Meier estimator when considering other covariates.

[17]See Table 5.1 in section 5.3.

claims define the scope of the patent more precisely, they make it more complicated to produce evidence and may end up delaying court decision. This confirms the result that a large number of litigation claims do not delay the decision of the judge because he is more familiar with them compared to the patent claims. Patent claims are different for each patent and cause more specific attention of the judge.

The length of settlement negotiations during trial is not strongly affected by the patent value. Only the number of jurisdictions where the patent was applied for (FAMILY_SIZE) has a significant negative impact on the hazard rate of settlement termination. While the number of references made to prior patents (REFERENCES) or received by subsequent patent application at the German or European Patent Office (CITATIONS) are strong indicators for patent value, they do not show significant coefficients for the hazard rates in either kind of suit termination. This result differs from the findings of Somaya (2005) who reports a smaller hazard rate for citation in the settlement equation. Neither do I find any evidence that the portfolio size ratio has an impact on the hazard rates in the settlement equation. However, for adjudication the portfolio size of the defendant (PORTFOLIO_DF) reveals a coefficient smaller than one indicating that the hazard rate for adjudication is smaller for those defendants compared to the baseline hazard. This is a surprising result bearing in mind that portfolio size is often interpreted as technological strength linked to bargaining power.[18] This bargaining power is mainly brought to bear in settlement negotiations. However, at this very last stage of negotiations in court parties may fail to settle more often in cases where the defendant has a large portfolio size and thus adjudication will close the suit, but very late. Summing up, the competing risk analysis reveals that the links of patent characteristics to the suit termination by settlement differ from those to the adjudication termination. These differences reflect different underlying decision rules.

6.5 Conclusion

In this Chapter I analyze the determinants of patent suit termination in the two District Courts of Mannheim and Düsseldorf. While the theoretical literature mainly concentrates on the duration of negotiations which are terminated by settlement I

[18] See Lanjouw and Schankerman (2001, 2003, 2004) and related studies.

distinguish between suit termination by mutual settlement agreements and court adjudication. This Chapter complements and expands related work by Somaya (2005) for U.S. data on patent litigation suits and Fenn and Rickman (1999) on health care negligence suits. I included information on the litigation claims and the means used by the parties to solve or delay the termination of the suit which are particular for the German system. I found significant differences in the determinants between the factors influencing the delay of court adjudication and settlement.

The hazard rate for the settlement hazard decreases with the complexity of the case. As for adjudication termination, neither a large number of filed litigation claims nor a request for expert's reports significantly delays the duration of the case. Only direct means of delay such as a suspension of the suit after filing an annulment case reduce the hazard rate for both types of patent suit closures. Adjudication hazard is found to be generally lower in cases where an opposition procedure has been filed prior to the litigation suit. Questionable patents remain questionable in the long run or attract greater interest from potential imitators. However, settlement hazards are only lower for cases in Mannheim which faced a prior opposition.

The amount in dispute is defined by the court and indicates, on the one hand the expected value of the patent and, on the other hand, the legal costs related to this value. These two types of termination have opposite effects on the hazards. While hazards are lower for settlement the hazards for adjudication increase with the amount in court. This result indicates that higher costs speed up adjudication. If settlement is reached, the costs are divided beneficially for both parties and not simply borne by the defeated party.

Delayed suit termination increases the costs of plaintiffs disproportionately to the increased benefits they enjoy. This and increased public cost are socially harmful. It has not been unambiguously proven, however, that policies introduced to reduce the duration of suits lead to a socially beneficial result. As Priest (1989) and Posner (1972) argue along with Spurr (2000) (1997, 2000), who empirically tested for medical malpractice trials in the U.S., delay reduction programs reduce the time of suit termination in the short run but lead to an increase in the number of cases filed. Assuming no change in the infringement rates, more cheap suits would be filed.

One limitation of the analysis is the short time period to which available data relates. Court congestion and cases with the same patents certainly have an impact

on the length of patent suits. I have not discussed whether a settlement agreement is socially beneficial. Settlement agreement may lead to a license contract and subsequently to collusive behavior. The consequences are not welfare enhancing as long as there is no anti-trust policy incorporated ((Shapiro 2003)). This is even exaggerated by very long trials. Furthermore, the static view of the social effects of a delay of court decisions clearly shows that the social effects of long trials are negative in terms of the court costs borne by the public purse and in terms of the uncertainty of trial outcomes. In "a more than one period world" the demand for cases would decrease because the plaintiff's private litigation costs would increase with the court delay. The assumption that the two types of suit termination are independent is crucial for the competing risk analysis. However, introducing adjudication deadlines into the model may violate this assumption. Taking this problem of correlation of hazards into account will be the subject of future research.

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