TUM School of Management
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Patent Validity—Extent, Drivers and Management Implications of Patent Invalidation

Hans Sebastian Zischka

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Vorsitzender:	Univ.-Prof. Dr. Reiner Braun
Prüfer der Dissertation:	1. Univ.-Prof. Dr. Joachim Henkel
	2. Univ.-Prof. Dr. Christoph Ann

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—Hans Zischka

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List of abbreviations

BGH	Bundesgerichtshof (Federal Court of Justice)
BPatG	Bundespatentgericht (Federal Patent Court)
CAFC	Court of Appeals for the Federal Circuit
cf.	Confare (compare)
Coeff.	Coefficient
DDR	Deutsche Demokratische Republik (German Democratic Republic)
DE	Deutsch (German)
Def.	Defendant
DPMA	Deutsches Patent- und Markenamt (German Patent Office)
EBIT	Earnings before interest and taxes
EGT	Ergebnis der gewöhnlichen Geschäftstätigkeit (results from ordinary business activity)
e.g.	exempli gratia (for example)
EP	European
EPC	European Patent Convention
EPO	European Patent Office
GKG	Gerichtskostengesetz (Court Fees Act)
GRUR	Gewerblicher Rechtsschutz und Urheberrecht
GVG	Gerichtsverfassungsgesetz (Courts Constitution Act)
HTC	High Tech Computer Corporation
IBM	International Business Machines Corporation
ICT	Information and communications technology
i.e.	Id est (that is)
INPADOC	International Patent Documentation Center
INPI	Institut national de la propriété industrielle
IntPatÜG	Gesetz über internationale Patentübereinkommen (Law on International Patent Treaties)
IP	Intellectual property
IPR	Intellectual property right
ISI	Fraunhofer Institute of Systems and Innovation Research
IT	Information technology
JPO	Japan Patent Office
LG	Landgericht (District Court)

Log	Logarithm
Max	Maximum
Min	Minimum
MP	Matched patent
NPE	Non-practicing entity
NPL	Non-patent literature
OLG	Oberlandgericht (Higher Regional Court)
OST	Observatoire des Sciences et des Techniques
Own.	Owner
PAK	Patentanwaltskammer (Chamber of Patent Attorneys in Germany)
PatG	Deutsches Patentgesetz (German Patent Act)
PatKostG	Patentkostengesetz (Law on Patent Charges)
PATSTAT	EPO Worldwide Patent Statistical Database
R&D	Research and development
RVG	Gesetz über die Vergütung der Rechtsanwältinnen und Rechtsanwälte (Law on the Remuneration of Attorneys)
S.E.	Standard error
SIC	Standard Industrial Classification
SME	Small and medium-sized enterprises
SPC	Supplementary Protection Certificates
Std. dev.	Standard deviation
U.S.	United States
UMTS	Universal Mobile Telecommunications System
UK	United Kingdom
USPTO	U.S. Patent and Trademark Office
WIPO	World Intellectual Property Organization
ZPO	Zentrale Prozessordnung (Code of Civil Procedure)

Zusammenfassung

Wesentlicher Bestandteil eines funktionierenden Patentsystems ist die Möglichkeit Patente durchsetzen zu können. Eine Durchsetzung ist jedoch nicht mehr möglich, wenn das Patent für nichtig erklärt wird. Tatsächlich wird ein großer Anteil von Verletzungsstreitigkeiten durch eine Nichtigerklärung des Streitpatents entschieden. Diese Beobachtung beschreiben Lemley und Shapiro (2005) mit dem Begriff „probabilistic patents“. Die Rechtsbeständigkeit von einmal erteilten Patenten ist äußerst unsicher, ein Sachverhalt, der zu Ineffizienzen sowohl für den Patentinhaber als auch für Dritte führt. Sowohl für Politik als auch das Management von geistigem Eigentum ist es demnach eine wichtige Fragestellung, wie ernst dieses Problem tatsächlich ist. Nur wenige Patente sind jemals einem Gerichtsverfahren ausgesetzt und diejenigen die einem Verfahren ausgesetzt sind, stellen keine zufällige Auswahl dar. Die vorliegende Dissertation beschäftigt sich daher mit den folgenden Fragen: Mit welcher Wahrscheinlichkeit würde ein zufällig ausgewähltes Patent für nichtig erklärt werden, wenn es einem Nichtigkeitsverfahren ausgesetzt werden würde? Welche Eigenschaften des Patents sowie der Streitparteien haben einen Einfluss auf das Ergebnis eines Nichtigkeitsverfahrens, wenn überhaupt? Betrachtet werden diese Fragen am Beispiel des deutschen Systems, in dem Patentnichtigkeitsverfahren getrennt von Patentverletzungsverfahren behandelt werden. Methodisch basiert die Studie auf einer statistischen Analyse deutscher Gerichtsurteile zwischen 2000 und 2012, einer ökonometrischen Untersuchung der Urteile, die zwischen den Jahren 2010 bis 2012 gesprochen wurden, 19 Stunden Experteninterviews und einer Befragung von 323 Patentanwälten.

Die deskriptiven Ergebnisse zeigen, dass 54% der Nichtigkeitsverfahren – die am Bundespatentgericht zwischen 2000 und 2012 entschieden wurden – ohne Urteil endeten, wohingegen 46% zu einer finalen Entscheidung führten. Gegen 69% der Urteile wurde Berufung eingelegt. In der jeweils finalen Instanz lauteten insgesamt 34% aller Urteile auf „nichtig“ und 40% auf „teilweise nichtig“. Das heißt, dass in nur 26% der entschiedenen Fälle das Patent vollständig aufrechterhalten wurde. Die Wahrscheinlichkeit einer teilweisen oder vollständigen Nichtigerklärung scheint sowohl für deutsche Patente als auch deutsche Teile von europäischen Patenten in etwa gleich groß zu sein. Zudem zeigt eine durchgeführte deskriptive Untersuchung, dass sich die erstinstanzliche Verfahrensdauer im Durchschnitt auf 19 Monate beläuft und dass das neue Gesetz zur Vereinfachung und Modernisierung des Patentrechts die

durchschnittliche zweitinstanzliche Verfahrensdauer von 40 auf 22 Monate – für Verfahren die nach September 2009 erhoben wurden – reduziert hat. Die Analyse der Eigenschaften der beteiligten Parteien zeigt, dass sich die Streitparteien, in den Fällen, die zwischen 2010 und 2012 entschieden wurden, hinsichtlich ihrer medianen Umsatz- und Mitarbeitergröße sehr ähnlich sind. Zudem können die Klägerinnen und Beklagten primär der verarbeitenden Industrie zugeordnet (ca. 65%) und überwiegend als Wettbewerber charakterisiert werden (86%). Darüber hinaus haben mehr als 50% der Streitparteien ihren Hauptsitz außerhalb von Deutschland. Die deskriptive Untersuchung zeigt auch, dass in 64% der Kanzleien, die an den analysierten Verfahren beteiligt waren, weniger als 11 Anwälte arbeiten. 53% der Kanzleien waren über den betrachteten Zeitraum in nur einem der entschiedenen Verfahren involviert und 27% waren in keinem dieser Verfahren erfolgreich.

Die Interviewpartner sowie die Umfrageteilnehmer betrachten die Patente, die in ein Nichtigkeitsverfahren kommen, als ungefähr so rechtsbeständig wie das Durchschnittspatent. Weniger als die Hälfte aller Nichtigkeitsverfahren enden jedoch mit einer Entscheidung und diejenigen, die mit einer Entscheidung enden, betreffen rechtsbeständigere Patente – die zugrunde liegende Logik ist, dass der Patentinhaber, bei einer absehbaren Nichtigerklärung, dem Kläger eine freie Lizenz im Austausch gegen eine Klagerücknahme anbieten wird. Außerdem wird dem Klägerbudget ein positiver Effekt in Bezug auf die Wahrscheinlichkeit einer Nichtigerklärung zugeschrieben. Gemäß dem vom Patentamt vorausgesetzten absoluten Neuheitsbegriff sollte der Standard einer Rechtsbeständigkeitsprüfung eine sehr gründliche Recherche nach Stand der Technik sein, was am besten mittels eines großen Budgets erfüllt werden kann. Unter der Annahme, dass im hypothetischen Verfahren mit einem zufällig ausgewählten Patent, seitens des Klägers ein großes Budget eingesetzt wird, erhöht sich somit die Wahrscheinlichkeit gegenüber der Strichprobe aus den tatsächlichen Entscheidungen. Dadurch ist der Anteil der Urteile, die eine teilweise oder vollständige Nichtigerklärung des Streitpatents beinhalten – in Deutschland sind dies 75% für die Jahre 2000 bis 2012 und 79% für 2010 bis 2012 – eine konservative Schätzung des Anteils aller Patente, die im Streitfall teilweise oder vollständig für nichtig erklärt werden würden. Eine ökonometrische Analyse von 305 Urteilen zwischen den Jahren 2010 und 2012 bestärkt dieses Ergebnis, indem für eine Stichprobe von zufällig ausgewählten Patenten eine durchschnittliche Wahrscheinlichkeit von ungefähr 82% an teilweiser oder vollständiger Nichtigerklärung vorhergesagt wird. Angenommen, dass alle Kläger groß sind – eine

Annäherung an die Erfüllung des absoluten Neuheitsbegriffes und damit an eine sehr gründliche Suche nach Stand der Technik – erhöht sich die Vorhersage einer erstinstanzlichen (teilweisen oder vollständigen) Nichtigerklärung einer Stichprobe von zufällig ausgewählten Patenten auf 87%. Man kann daraus den Schluss ziehen, dass mindestens 80% aller aktiven deutschen Patente teileweise oder vollständig latent nichtig sind. Die angeführten Argumente sollten sich auch auf andere Gesetzgebungen übertragen lassen. Um dem Problem der zahlreichen latent nichtigen Patente entgegenzuwirken, wird eine signifikante Erhöhung der für die Erteilung benötigten Erfindungshöhe, zusammen mit einem unveränderten Erfindungshöhestandard im Nichtigkeitsverfahren vorgeschlagen.

Abstract

The possibility to enforce patents is essential for the patent system to work. However, enforcement may fail if the focal patent is invalidated. In fact, much infringement litigation is decided by the invalidation of the patent in suit, an observation that Lemley and Shapiro (2005) capture with the notion of "probabilistic patents." The legal stability of granted patents is highly uncertain; a fact that entails inefficiencies for the patentee as well as for third parties. The degree of severity of this problem is an important question for intellectual property (IP) policy and management. Few patents are litigated, and those that are is not by random selection. Hence, this dissertation focuses on the following questions: if a randomly picked patent underwent revocation proceedings, what would be the odds of it being invalidated? And which characteristics of the patent and the parties in suit, if any, influence the outcome of the revocation proceeding? These questions are addressed for the case of Germany, where revocation proceedings are separate from infringement suits. The approach followed in this study is based on a statistical analysis of German court decisions between 2000 and 2012, an econometric analysis of the judgments rendered between 2010 and 2012, 19 hours of expert interviews, and a survey among 323 patent attorneys/lawyers.

The findings on a descriptive level reveal that 54% of invalidity suits before the Federal Patent Court between 2000 and 2012 settled, while 46% concluded with a decision. Of these, 69% were appealed. Overall, the decision in the respective final instance was "fully invalid" in 34% and "partially invalid" in 40% of all cases. This means that only 26% of the cases ended in decisions that the patent was held fully valid. The likelihood of a partial or full revocation is found to be similar for German parts of European patents as well as for German patents. The descriptive analysis further revealed that the first instance case duration averages 19 months and that a new regime for cases filed after September 2009 reduced the average second instance case duration from 40 to 22 months. With regard to the parties' characteristics, the litigants in the cases that were decided between 2010 and 2012 are very similar in terms of median revenue and employee size, are primarily assigned to the manufacturing industry (roughly 65%) and can predominantly be characterized as competitors (86%). Furthermore, more than 50% of the rivaling parties are not headquartered in Germany. The descriptive analysis also shows that 64% of the law firms involved in the analyzed proceedings employ less than 11 attorneys, 53% were only involved in one proceeding during the considered period and 27% were not successful in any of their case(s).

Interviewees and survey participants alike consider patents entering revocation proceedings as legally robust as the average patent. However, less than half of all revocation proceedings conclude with a decision, and those that do involve more robust patents—the logic being that, anticipating invalidation, the patentee would offer the plaintiff a free license in exchange for withdrawal of the suit. Furthermore, the plaintiff's budget was seen as having a positive effect on the likelihood of invalidation. Given the patent office's requirement of absolute novelty, the standard for testing validity of a patent should be a very thorough search for prior art, which can best be performed with a large budget. Thus, assuming that a large budget was spent by the plaintiff in the hypothetical suit involving a randomly picked patent, the likelihood of invalidation would be further increased compared with the sample of actual decisions. Thus, the share of court decisions that declare the patent in suit partially or fully invalid—in Germany, 75% for 2000 to 2012 and 79% for 2010 to 2012—is a conservative estimate of the share of all patents that would be partially or fully invalidated if challenged in court. An econometric analysis of 305 court decisions between 2010 and 2012 supports this finding, predicting for a sample of randomly drawn patents an average probability of (partial or full) invalidation of around 82%. Assuming that all plaintiffs are large, as a proxy for the fulfillment of the absolute novelty requirement and therefore a very thorough search for prior art, increases the prediction of a partial or full invalidation for a sample of randomly drawn patents in the first instance to roughly 87%. It is thus safe to conclude that around 80% or more of all active German patents are latently invalid, partially or fully. The given arguments should carry over to other legislations. To address the problem that many patents are latently invalid, a significant increase of the inventive step required for grant combined with an unchanged inventive-step standard in litigation is suggested.

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1 Introduction[1]

1.1 Motivation and Aim of the Study

The importance of intellectual property rights (IPR), and especially patents, has tremendously increased during the last decades. Filings at the European Patent Office (EPO), the German Patent Office (DPMA), as well as at the United States Patent and Trademark Office (USPTO) reached a new high in 2014 (Deutsches Patent- und Markenamt, 2015b; European Patent Office, 2015b; United States Patent And Trademark Office, 2015). Just as the filings, the number of filed patent infringement cases has steadily increased in countries such as the U.S. or Germany during the last years (Cremers et al., 2013; PricewaterhouseCoopers, 2014),[2] a finding that can be further interpreted as a sign of the importance of patents for the companies in these economies.

The classical function of imitation protection, however, is only one reason why inventors file for patent protection. The system allows for a variety of other purposes, which have been thoroughly analyzed in earlier studies (e.g., Arundel and Patel, 2003; Blind et al., 2006; Cohen et al., 2000; Granstrand, 1999). Blind et al. (2006) group these reasons into four filing motives: blocking, reputation, exchange, and incentive. Hence, patents are filed to offensively/defensively block competitors, increase an external reputation as an innovative company, increase one's bargaining power and licensing income as well as to incentivize or measure the performance of research and development (R&D) personnel. In addition, especially for start-ups or young firms, a patent stock positively influences both the probability of raising money and receiving venture capital investments (e.g., Baum and Silverman, 2004; Hsu and Ziedonis, 2013; Mann and Sager, 2007). Applying for patent protection is not the only way to obtain strategically important patents. Companies invest huge amounts of money buying patents from other companies. The Rockstar Consortium (including Apple and Microsoft), for example, spent $4.5 billion on purchasing 6,000 of Nortel's[3] patents in 2011 (e.g., Church and Banerjee, 2011). One year later, Google bought Motorola Mobility for $12.5 billion, presumably in

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[1] This dissertation is based on joint work with Joachim Henkel, which has already been published as a working paper and presented under the title "Why most patents are invalid – Extent, reasons, and potential remedies of patent invalidity." Parts of that paper can be found throughout the present dissertation.

[2] Initial adjudicated damages awards of up to $1.6 billion were reached in a case between Centocor Ortho Biotech Inc. *v.* Abbott Laboratories (PricewaterhouseCoopers, 2014).

[3] A Canadian telecommunication company that filed for bankruptcy in 2009.

order to protect its Android mobile operating system with some of the 17,000 Motorola patents included in this deal (e.g., The Economist, 2011).

All these purposes of utilization and the patent deals assume that the underlying patents are valid. However, looking at different studies dealing with patent infringement and revocation reveals that at least 50% of the once litigated patents are held (partially or fully) invalid (e.g., Helmers and McDonagh, 2013; Hess et al., 2014; Mann and Underweiser, 2012; Oyama, 2012; Weatherall and Jensen, 2005).[4] It seems that a patent grant decision does not automatically guarantee validity of the patent. According to Lemley and Shapiro (2005), patents are therefore seen as "probabilistic" property rights.

The possibility to enforce patents is especially essential for the patent system to work.[5] However, as to the aforementioned high invalidation rates, it seems likely that this enforcement may fail because the litigated patent is ruled invalid. According to Lemley and Shapiro (2005, p. 75) it is like "[…] rolling the dice. If the patent is found invalid, the property right will have evaporated." But, it may also happen that a court decides on infringement even if the focal patent is possibly invalid.[6] These potential outcomes cause serious drawbacks for the patentee, who cannot fully rely on the possibility of a proper enforcement of his/her patent and for the alleged infringer who might face damages due to an infringement ruling based on a patent that should not have been granted.

These disadvantages are particularly obvious when looking at the bifurcated German system, where infringement and revocation are decided at different courts (e.g., Cremers et al., 2013). This separation can cause a situation where a District Court (Landgericht or LG)—presuming the validity of the enforced patent—renders a judgment in the infringement case and (preliminarily) enforces the decision notwithstanding a pending validity decision by the Federal Patent Court (Bundespatentgericht or BPatG).[7] Several disputes involving patents that were upheld as infringements and subsequently revoked by the BPatG have aroused public interest.[8] Among others, Munich-based IPCom argued with HTC about whether the Taiwanese telecommunication company infringed on IPCom's UMTS/3G related patent EP 1186189. In a District Court ruling in

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4 The actual rate depends on the legislation and reaches up to 73% in Japan or 79% in Germany (Hess et al., 2014; Oyama, 2012).

5 Patent enforcement is seen at least as important as patent grant (Ann, 2009).

6 Referring to a bifurcated court system.

7 Assuming that the alleged infringer has also challenged the patent.

8 See Cremers et al. (2014) for a list of proceedings during which a patent was first ruled infringing and subsequently revoked.

February 2009, the patent was found to be infringing and IPCom was granted a preliminary injunction, keeping HTC from selling its 3G mobile phones in Germany (e.g., Mueller, 2011). However, a BPatG decision in a counterclaim revocation suit struck down roughly two-thirds of the claims of the patent in December 2010, while an appellate proceeding at the Federal Court of Justice (Bundesgerichtshof or BGH) resulted in a full invalidation of the patent in October 2014.[9]

"Probabilistic patents" might also be the basis for royalty payments even though they are actually invalid. An example that received attention in the media is that of Eolas suing a dozen companies for infringement of its patent US 7599985.[10] Faced with a lawsuit, several companies such as Apple, Yahoo, and Amazon agreed to take a license. However, allegedly infringing companies such as Google and Adobe refused the licensing offer and challenged the patent in court, which finally revoked important claims (e.g., Kirsch, 2013). Thus, in view of the settled cases, royalties were paid for a patent that legally should not have been granted.

These examples show that there is a high level of uncertainty about a patent's legal robustness that entails inefficiencies for the patentee who cannot fully rely on its patents; for third parties, who are facing more exclusion rights than legally should have been granted; and for policy makers concerned about incentives to innovate. Patents that are "latently invalid"—i.e., are valid but would be invalidated if challenged in court—unduly restrict innovative activities of third parties, expose them to the risk of infringement litigation, impose a cost burden for invent arounds or licensing, and obfuscate the patent system, making patent search and monitoring more difficult.

It is thus important for intellectual property (IP) policy and management to investigate the severity of this problem. Only a very small fraction of all patents are litigated, and this fraction is not a random selection. It may be that those patents are litigated that lack legal robustness, in which case the problem of probabilistic patents would be less severe for the universe of all patents. But it may also be that patents in suit are more robust than the average patent: invalidity decisions are mostly triggered by infringement proceedings, and given the choice a patentee is more likely to enter these with robust patents.

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[9] The revocation action involved both HTC and Nokia on the plaintiff side. Nokia also achieved an invalidation in a parallel UK proceeding in January 2010.

[10] This patent protects "A system allowing a user of a browser program on a computer connected to an open distributed hypermedia system to access and execute an embedded program object. The program object is embedded into a hypermedia document much like data objects." (US 7599985, p. 1).

The present study addresses a simple yet very important question. If a randomly picked patent underwent revocation proceedings, what would be the odds of it being invalidated? Are these odds higher or lower than the share of patents that, after being actually challenged in court with a decision reached, are in fact declared invalid?

I address the above questions for the case of Germany where the bifurcation between infringement and invalidation proceedings facilitates a focused analysis of the latter. The study is based on a combination of several data sources and methods: a descriptive analysis of all decisions in invalidity suits by the Federal Patent Court and the court of second (and last) instance (the Federal Court of Justice) from 2000 until 2012; 19 hours of expert interviews; a survey among 323 patent lawyers; a descriptive analysis of the cases that reached a final judgment at the BPatG between 2000 and 2012; and a multivariate analysis of first and second instance judgments issued between 2010 and 2012, accounting for several patent and litigant characteristics.

Various measures against the abundance of latently invalid patents have been proposed, such as spending more on examination or increasing the fees for examination and grant. Furthermore, Allison and Hunter (2006) mention the “second pair of eyes” review according to which the application is assessed by more than one examiner before a possible grant decision. Due to reasons explained in the further course of this dissertation, none of these measures appears effective. Thus, at the end of this study, I will provide a possible solution to the problem of latently invalid patents and discuss the benefits and challenges of such a measure as well as the transferability of the outcomes to other legislations.

1.2 Structure of the Dissertation

This dissertation comprises seven chapters and is structured as follows. After this introduction, Chapter 2 establishes the theoretical foundations including further information on patent protection and enforcement. First of all, I introduce the mechanisms supporting the innovator to profit from his/her innovation (2.1), followed by further insights into the legal background on receiving a grant decision for a patent as one type of appropriability mechanism (2.2). After a patent has been granted, the owner is entitled to enforce his/her patent and third parties may challenge its validity. An insight into the legal frameworks behind these proceedings (for the case of Germany) is part of Section 2.3.

Chapter 3 reviews the extant literature on relevant determinants of patent infringement (3.1), patent validity (3.2), as well as dispute settlements (3.3). Patent

enforcement, however, may fail due to the probabilistic nature of patents. This results in inefficiencies that are further discussed in Section 3.4. Based on the theoretical findings, the research question is introduced in Section 3.5.

Chapter 4 provides a more detailed description of the empirical setting of this dissertation, introducing methods and data used. After presenting background information on the qualitative interview approach (4.1), I address the two quantitative studies conducted during the course of this dissertation (4.2). In this context, Section 4.2.1 outlines the design and implementation of the survey among patent attorneys/lawyers. Section 4.2.2 includes the data sources and setup of the dataset for the econometric analysis of the German court decisions between 2000 and 2012.

Chapter 5 highlights the results of the qualitative interviews as well as the survey. Specific quotes from the interviews and the corresponding survey results are reported to illustrate which factors influence the probability that a patent will be selected to take part in revocation actions and which factors determine the outcomes of invalidation proceedings. The results contribute to an overall understanding of the selection effects at work and complement the findings of the following econometric analysis.

Chapter 6 includes the outcomes of the econometric analysis. Section 6.1 outlines the descriptive findings on various characteristics related to revocation proceedings for the cases that reached a final judgment at the BPatG between 2000 and 2012. Section 6.2 includes the results of the multivariate analysis of the dataset of court decisions in the period of 2010 to 2012. Based on the identified correlates of entering a revocation proceeding (6.2.1) as well as the outcomes of these proceedings (6.2.2), I run an out-of-sample prediction determining the share of all invalid patents among the universe of all patents (6.2.3).

Chapter 7 summarizes the overall results of this study, provides a discussion of the findings, features implications for theory as well as practice, and provides suggestions for further research.

2 Theoretical Background on Patent Protection and Enforcement

The ability to profit from an innovation does not solely rely on the quality of the underlying invention. Among other appropriability mechanisms, such as complementary assets, it is essential how the innovator protects his/her invention by trying to secure a certain degree of exclusivity as user or licensor. Patent protection is one mechanism to exclude others from using a certain invention.[11] Once issued, the patent right enables the patentee to earn higher returns on his/her innovation than s/he would earn in cases where imitation was legal. However, "this approach tended to assume that the patent was valid, that it granted a right of definite scope, and that users of the patented technology respected that right or were forced by courts to do so" (Lemley and Shapiro, 2005, p. 75). Yet, according to Lemley and Shapiro (2005), patents are characterized by a high degree of uncertainty regarding their legal robustness. This uncertainty issue becomes even more severe when looking at the actual invalidation rates of granted patents (see Chapter 3.2.2).

To facilitate a better understanding of patent protection as the object of investigation, the following subsections set forth some background information on the nature of patents and the German patent enforcement system. Chapter 2.1 provides a short and general overview of how an innovator can capture value from his/her invention. Focusing on patent protection as one appropriability mechanism, Section 2.2 highlights the legal requirements that need to be fulfilled to obtain this kind of exclusion right, followed by an introduction to the legal procedures to enforce and invalidate granted patents (Chapter 2.3).

2.1 Profiting from Innovation

Appropriating the returns from innovation describes to what degree an innovator is able to capture the rents from innovation (Ceccagnoli and Rothaermel, 2008).[12] Profiting from innovation, however, is not a matter of course—some innovators do while others do not (e.g., Teece, 1986). The ability highly depends on the strength of the respective inventor's appropriability regime and his/her position with regard to complementary

[11] See Granstrand (1999) for an overview of various types of IPRs such as patents, copyrights, trademarks, or design rights.

[12] In general innovation can be defined as a commercialized invention (e.g., Brockhoff, 1999; Hauschildt and Salomo, 2011; Roberts, 1987). Therefore, the invention itself is only a first step to innovation and not enough for a commercial success (Teece, 1986).

assets (Teece, 1986). In this context, Chapter 2.1.1 outlines the two main drivers of innovation rents, followed by further insights into specific appropriability mechanisms, focusing on patent protection as the fundamental mechanism of the present dissertation (Section 2.1.2).

2.1.1 Basic Concepts of Profiting from Innovation

According to Teece (1986), the main factors influencing an inventor's capability to profit from his/her innovation are the *appropriability regime*, the *complementary assets,* and the *life cycle phase*.[13]

Teece (1986) defines the *appropriability regime* as the environmental factors influencing an innovator's ability to capture the value created by his/her innovation.[14] In this context, the "nature of the technology, and the efficacy of legal mechanisms of protection" (Teece, 1986, p. 287) are considered as the most important dimensions. Depending on how tacit and codified the knowledge is, as well as on the degree of applicability and effectiveness of the legal protection mechanisms—such as patents or copyrights—Teece (1986) distinguishes between "tight" and "weak" appropriability regimes. In "tight" regimes, technologies are relatively easy to protect, whereas the technology protection in "weak" regimes is almost impossible, thus, increasing the likelihood of imitation.

Especially within a "weak" appropriability regime it is essential for the innovator to hold a strong position regarding his/her *complementary assets*. Following Teece (1986), complementary assets are all capabilities or assets supporting the inventor in effectively commercializing his/her invention and therefore making the most out of its innovation. Among others, these assets include marketing, after-sales, and manufacturing capacities (Teece, 1986). Complementary assets predominantly promote the ability to profit from an innovation in two ways. On the one hand, by offering additional services and customer benefits, complementary assets can increase the value created and therefore the size of the pie from which innovators can capture value. On the other hand, complementary assets can serve as an isolation mechanism (Rumelt, 1984). If an innovator has better access to relevant complementary assets than a competitor, s/he will more likely capture a larger "share of the pie" (Gulati and Wang, 2003, p. 209) generated

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[13] The last factor, which builds on the work of Abernathy and Utterback (1978) as well as Dosi (1982), has not been seen as important as the other two determinants (Pisano, 2006). Moreover, it does not apply to all industries (Teece, 1986). Thus, the following section will only focus on the first two determinants.

[14] This does not include firm and market structure (Teece, 1986).

by the innovation (Teece, 1986).[15]

Nowadays the appropriability regime is not solely exogenously predetermined but increasingly endogenously influenced by a company's behavior and strategy (Pisano, 2006). Thus, firms have even started to form their appropriability regime in a way that allows them to maximize the value of their given complementary assets.[16] In this context, appropriability mechanisms play an important role, including the strategic use of IPRs.

2.1.2 Appropriability Mechanisms

According to the basic concept of profiting from innovation (see 2.1.1), several appropriability mechanisms exist that assist the inventor in profitably commercializing his/her invention. Among those, some of the most discussed are patents, secrecy, complementary assets, and lead time advantages (e.g., Cohen et al., 2000; Harabi, 1995; Levin et al., 1987). The following chapter will provide a short overview of the application range of the exclusively considered mechanism in the context of this dissertation—patent protection.

Among the range of IPRs, patents are the strongest form of exclusion rights (Teece, 1998). Once granted they award the patent holder the right to exclude others from using the patented technology for a period of 20 years (Section 16 German Patent Act (PatG)).[17] However, relative to other protection mechanisms (e.g., secrecy, lead time advantage), patents are, in practice, regarded as less effective as theoretically assumed (e.g., Arundel, 2001; Cohen et al., 2000; Cohen et al., 2002; Harabi, 1995; Levin et al., 1987; McLennan, 1994; Sattler, 2003; Taylor and Silberston, 1973). According to these studies, a patent is not perceived as a perfect appropriability mechanism, effectively impeding imitation, in a number of different industries—with the exception of the pharmaceutical and chemical industry (e.g., Levin et al., 1987; Mansfield, 1986; Taylor and Silberston, 1973). However, the classical function of imitation protection is only one reason to file patent protection (Blind et al., 2009). Patents are more and more considered as an "extra resource of the company to be used in its overall strategy" (Pitkethly, 2001, p. 426) and thus

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[15] Teece (1986) differentiates between generic assets, with no need to be tailored to the innovation, specialized assets, which are unilaterally dependent on the innovation (or vice versa) and co-specialized assets defined by a bilateral dependency between innovation and assets.

[16] Pisano (2006) provides examples from the fields of genomics and open source software. According to the latter example IBM—having itself a strong downstream complementary asset position—proactively weakened its upstream appropriability regime by revealing source codes and promoting the open source movement. This strategy positively influenced its downstream business of e.g. hardware or service (while hurting other companies).

[17] Up to 25 years are granted for pharmaceutical patents, when filing for a Supplementary Protection Certificates (SPC) (e.g., Kraßer and Bernhardt, 2009).

frequently contribute, as an integral part of companies' IP management, to a company's individual strategy. According to this, the strategic use of patents has become increasingly important (e.g., Ziedonis, 2004) and patents gain an incremental strategic value detached from innovation (Macdonald, 2004). A review of the literature reveals a number of studies analyzing the strategic use of patents, including defensively/offensively blocking competitors, setting up market barriers and utilizing patents as bargaining chips (e.g., Arundel and Patel, 2003; Blind et al., 2006; Cohen et al., 2000; Granstrand, 1999). Arundel and Patel (2003) classify these types of uses into *defensive* and *offensive* strategies.

Offensive strategies primarily include activities of blocking competitors from filing patents that might result in rival products or disrupt the development of own products (Afuah, 1999). In this context, companies set up "patent fences" (Cohen et al., 2000; Granstrand, 1999; Guellec and van Pottelsberghe de la Potterie, 2007) by patenting not only their initial invention but also variations of it. These patents (or even pending applications) very likely complicate possible invent arounds and block competitors from patenting substitute inventions (e.g., Arundel and Patel, 2003; Blind et al., 2009; Cohen et al., 2000; Granstrand, 1999; Henkel and Jell, 2009). More actively targeting competitors' patents, following a "surrounding" or "patent flooding" strategy (Granstrand, 1999), companies try to block their competitors by filing patents around strategically important patents of the competing company. All these strategies prevent contestants from patenting rival technologies and impede the development of their products without risking a patent infringement. According to Reitzig (2004b), a patent owning company pursuing these strategies can therefore strengthen its competitive position and increase the barriers for potential market entries.[18] Finally, companies pursuing an offensive patent strategy will directly benefit from licensing revenues and possible damage compensations due to patent infringement (e.g., Arora, 1997; Hall and Ziedonis, 2001).

Defensive strategies rather aim at protecting oneself against a possible patent blocking strategy pursued by any competitor: "firms patent in order to prevent their own technological room to manoeuvre being reduced by the patents of others" (Blind et al., 2006, p. 657). Companies might therefore file patent protection for inventions that are not directly used or do not yield a positive cash flow (Arundel and Patel, 2003; Blind et al.,

[18] Due to increased costs and time needed for an imitation or invent around, competitors are more willing to take a license or stay out of the market (Granstrand, 1999).

2009).[19] However, if a competitor obtains patent protection for these inventions, the likelihood of being exposed to an infringement action increases. This results in an uncertainty that can effectively be reduced by pursuing a defensive patenting strategy (Cohen et al., 2002; Reitzig, 2004b) though, in principle, through defensive publishing. Another defensive strategy aims at increasing the size of the patent portfolio in order to improve one's bargaining power in possible cross-licensing negotiations and to reduce the likelihood of legal attacks (Cohen et al., 2000; Hall and Ziedonis, 2001). Particularly in "complex" technology industries such as information and communications technology (ICT), patents are often used as "bargaining chips" in order to gain access to competing companies' technologies (Arundel and Patel, 2003; Blind et al., 2006; Cohen et al., 2000).[20] In the context of patent infringement, a large portfolio increases the credibility of a potential counterclaim, which might force the potential plaintiff to drop his/her action and possibly negotiate a cross-licensing agreement (Cohen et al., 2002; Hippel, 1995).

Even though patents might not offer perfect imitation protection, they are increasingly important for strategic reasons. Especially due to potential defensive and/or offensive use, patents are likely infringed and thus involved in infringement proceedings. A certain degree of a patent's legal robustness is therefore essential for the patentee to ensure the possibility of an effective enforcement of his/her IPR. In this context, the inventive step is seen to be the basic requirement ensuring the proclaimed legal certainty.[21] The factors and procedural steps involved in assessing the necessary preconditions—including the required inventive step—for a patent grant decision are described in the following section.

2.2 Legal Background on Patents

Once a German patent has been granted by the German Patent Office (DPMA) or respectively by the European Patent Office (EPO) as the German part of a European patent, its validity can be challenged in an opposition proceeding or after the opposition

[19] Simply publishing the invention, without filing for patent protection, also creates prior art reducing the probability that patents are granted on the respective technology (Ann et al., 2010; Arundel and Patel, 2003; Blind et al., 2009). This strategy is also referred to as "defensive publishing" (Henkel and Lernbecher).

[20] Complex industries are characterized by products consisting of a wide range of individual inventions (Kash and Kingston, 2001). This makes it nearly impossible for a single company to own all relevant patents involved in its product.

[21] According to Hess et al. (2014), newly introduced prior art and therefore the lack of an inventive step is the major invalidation reason in German patent revocation proceedings (see Chapter 2.3.3).

period in a German revocation proceeding.[22] However, several formal and substantive requirements have to be met before one of the offices may grant patent protection for an invention. With respect to the high revocation rate in revocation and opposition proceedings (see Chapters 2.3.2 and 3.2.2) it seems that the patent owner cannot fully rely on his/her patent's legal robustness even after an examination and a grant decision. Once challenged in court, the likelihood of a (partial or full) revocation is substantial, indicating that the patenting requirements were obviously not properly satisfied.

In this context, Section 2.2.1 presents the most substantial requirements for a patent application to reach a grant decision, followed by a more detailed look at the inventive step assessment procedure at the EPO as well as the DPMA (Section 2.2.2).[23]

2.2.1 Patenting Requirements

According to Section 1(1) PatG, patents "shall be granted for inventions in any technical field if they are novel, involve an inventive step, and are susceptible of industrial application."[24] A short description of the substantial requirements *novelty*, *inventive step,* and *industrial application* is part of the following paragraph.[25]

Novelty. For a technical invention, novelty is an as yet unknown technical solution to a technical problem (German Patent and Trade Mark Office, 2013). In line with Section 3(1) PatG, the *novelty* requirement is met and an invention therefore defined as new if it does not constitute part of the existing state of the art. The state of the art can be considered as anything that was "made available to the public by written or oral description, by use or by any other manner before the date relevant for the priority of the application" (Section 3(1) PatG). Section 3(2) PatG further considers "patent applications with earlier relevant filing dates which have been made available to the public only on or after the date relevant for the priority of the later application" as state of the art and therefore as novelty destroying. Current law thus requires absolute novelty, as all public available information can be regarded as novelty destroying without any constraints on

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[22] See Chapters 2.3.2 and 2.3.3 for further details on these procedures.

[23] As this study focuses on German proceedings and therefore on German patents or German parts of European patents, the subsequent section preliminary outlines the requirements set by the German Patent Act (PatG). The conditions, however, mostly apply for both the PatG and the European Patent Convention (EPC). Substantial discrepancies will be pointed out if necessary.

[24] Original German phrasing: "Patente werden für Erfindungen auf allen Gebieten der Technik erteilt, sofern sie neu sind, auf einer erfinderischen Tätigkeit beruhen und gewerblich anwendbar sind" (Section 1(1) PatG).

[25] European regulations are similar and can be found in Sections 52 et seq. of the EPC.

time (until the filing date of the patent), place and type of publication (Kraßer and Bernhardt, 2009).[26]

Inventive step. Complying with the novelty requirement is not sufficient for an invention to be patentable. The underlying idea must also satisfy a certain degree of inventiveness. According to Section 4 PatG an invention seeking patent protection meets the *inventive step* requirement, if it "is not obvious to a person skilled in the art from the state of the art" (Section 4, first sentence, PatG).[27] The notional person skilled in the art should therefore not be able to modify the state of the art—solely by using his/her expertise—in a way that s/he would come up with the same idea as the applicant.[28] Thus, the inventive step requirement aims at avoiding the patenting of obvious solutions. In this context, minor and obvious changes of the state of the art should not be remunerated with an exclusion right, since doing so would hinder the further technology development in the respective field without being a necessary incentive for the inventor.

Industrial applicability. Furthermore, an invention has to be industrial applicable. This requirement is met "if its subject matter can be produced or used in any industrial field, including agriculture" (Section 5 PatG).[29]

According to practitioners' estimates, the assessment of the inventive step is probably the most difficult barrier for a patent on the way to a possible grant decision (Bardehle Pagenberg Partnerschaft, 2014a). Even after "successfully" passing this obstacle, a certain degree of uncertainty remains of whether the inventive step requirement was really met and indeed, the predominant invalidation reason in a

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[26] Until 1978, legislation only claimed for a relative novelty, defining as novelty destroying everything that was published within the last century or was of domestic prior public use (Kraßer and Bernhardt, 2009).

[27] "Should the state of the art also include documents within the terms of Section 3(2), these documents shall not be considered when assessing the inventive step" (Section 4, second sentence, PatG).

[28] The person skilled in the art is not the patent examiner, but a "fictitious average person skilled in the art that is active in the field of the determined state of the art and is redefined for each examination" (German Patent and Trade Mark Office, 2013, p. 11). S/He is familiar with the prior art in the respective technical field s/he works in at the date of the patent filing. In addition to that, the EPO Guideline for Examination (G-VII 3) further adds that the person skilled in the art might also consider other technical fields if necessary. In combination with his/her general knowledge, s/he undertakes routine work and research. Furthermore s/he "makes use of general principles of action and of his or her experience, such as the pursuit of efficiency" (German Patent and Trade Mark Office, 2013, p. 11). In some cases, the EPO Guideline for Examination (G-VII 3) suggests that the person skilled in the art be defined as a group of people.

[29] General patentability (further specified in Sections 1, 1a, 2 & 2a PatG) and sufficient disclosure (specified in Section 34(4) PatG) of an application have to be considered as well.

revocation proceeding is the lack of an inventive step (see Section 2.3.3).[30] Referred to as "false positive" (Meurer, 2009) or "type II errors" (Jensen and Webster, 2004; Palangkaraya et al., 2011), the high share of incorrectly granted patents (see also Chapter 3.4) indicates that the assessment of the inventive step seems to be an especially challenging task. The following section (2.2.2) will therefore outline the European and German evaluation procedures dealing with the inventive step criterion.

2.2.2 The Inventive Step in the Patent Grant Process

As indicated in the previous subsection, the assessment of the inventive step plays an important role during the patent examination procedures at the different patent offices. Focusing on the German or European Patent Office, the basic procedure is similar. However, the EPO follows a more formalized approach.

2.2.2.1 The Assessment in the EPO Process

A fundamental part of the patent description is to disclose the invention by describing the technical problem and its solution (Part III, Chapter II, Rule 27 1(c) EPC). In this regard, the inventive step is exactly the step from the stated problem to the denoted solution. Since the early 1980s, the EPO has been following a formal approach—the so called "problem-and-solution approach"—to assess the inventive step.[31] According to G-VII 5 of the EPO Guidelines for Examination (European Patent Office, 2014), the procedure is threefold and comprises the following main steps:

1. determining the "closest prior art" (to the invention),
2. establishing the "objective technical problem" to be solved, and
3. considering whether or not the claimed invention, starting from the closest prior art and the objective technical problem, would have been obvious to the skilled person (European Patent Office, 2014).[32]

The *closest prior art* or the hypothetical "starting point" from which the inventor developed his/her idea—assessed from the point of view of a person skilled in his/her art—is defined as one single reference disclosing a combination of features with the highest probability to challenge the existence of the inventive step of the considered

[30] Hess et al. (2014) discover that 75% of all (partial or full) invalidation rulings in revocation proceedings are based on a lack of patentability due to newly introduced prior art. Furthermore, a recent study by van de Kuilen (2013) reveals that the main revocation reason in opposition proceedings is lack of inventive step (43%), followed by lack of novelty (22%).

[31] The approach aims at foreseeing the invention from the prior art and tries to omit any retrospective view (e.g., Kraßer and Bernhardt, 2009).

[32] See also Part III, Chapter II, Rule 42(1)(c) EPC.

invention. “In practice, the closest prior art is generally that which corresponds to a similar use and requires the minimum of structural and functional modifications to arrive at the claimed invention” (European Patent Office, 2014, p. 709). In other words, the closest prior art should show a similar purpose as well as effect as the claimed invention and should have the most technical features in common with the invention seeking patent protection—compared with any other cited prior art.[33]

The establishment of the *objective technical problem* addresses the task that the invention claims to solve and accordingly the difference between the closest prior art and the invention (van Pottelsberghe de la Potterie, 2011). It aims at a reconstruction of an objective technical problem based on the technical effects the claimed invention achieved (Xiang et al., 2013). This step includes an identification of the distinguishing features between the claimed invention and the closest prior art and therefore the contribution of the considered invention (without these features a lack of novelty would exist). According to the EPO’s Guidelines for Examination (G-VII 5.2), the objective technical problem can be derived by “modifying or adapting the closest prior art to provide the technical effects that the invention provides over the closest prior art.” (European Patent Office, 2014, p. 710).[34]

After the identification of the closest prior art and the objective problem to be solved, the problem-and-solution approach concludes with a third step referred to as the *“could-would approach”* (see G-VII 5 of the EPO Guidelines for Examination). The fundamental question to be answered during this step is: “Would the claimed invention, starting from the closest prior art and the objective problem, have been obvious to the skilled person?” (Harguth and Carlson, 2011, p. 75). Therewith, an invention is not yet obvious if the person skilled in the art *could* theoretically have arrived at the claimed invention by combining or modifying the closest prior art. It is more likely a question of whether s/he *would* have done so, based on an expectation to solve the objective technical problem or achieve any improvement or advantage.[35] In cases where the distinguishing features are known from the prior art and the person skilled in the art would have combined those features with the closest prior art to solve the objective technical problem,

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[33] The following assessment of the inventive step is not limited to only one document (Harguth and Carlson, 2011).

[34] According to G-VII 5.2 of the EPO Guidelines for Examination, the objective problem should, however, not include any pointers to the technical solution of the invention.

[35] Thus, the approach not only accounts for the ability of a person skilled in the art but also for his/her motivation.

the inventive step requirement is not met.[36] Otherwise it can be regarded as a proof of non-obviousness, if the person skilled in the art could only theoretically solve the technical problem by combining these features with the closest prior art (not driven by any motivation) (European Patent Office, 2014).

2.2.2.2 The Assessment in the DPMA Process

The assessment at the DPMA follows a less formalized process. However, according to Kraßer and Bernhardt (2009) the DPMA examiners inadvertently proceed according to the EPO's approach, without having it as a rule to follow. Hence, to identify relevant prior art, published prior to the respective application filing date, the examiner starts with an intensive research on the subject matter of the invention seeking patent protection.[37] Based on the documents found, the fundamental question during the assessment of the inventive step is "whether the person skilled in the art had any reason to take up, change accordingly or supplement an embodiment known from the state of the art" (German Patent and Trade Mark Office, 2013, p. 11)—likely resulting in the claimed invention.[38] An invention is thus to be regarded as obvious and therefore not patentable if the person skilled in the art would come up with a solution to the claimed problem by relying on the identified prior art and his/her knowledge as well as skills. The person skilled in the art can also combine sources of prior art—to so called "Mosaiks" (Kraßer and Bernhardt, 2009, p. 319)—depending on how close these sources are and if they fit together (German Patent and Trade Mark Office, 2013).[39]

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[36] "The most relevant or closest prior art is to be considered not in isolation, but together with common technical knowledge and more frequently one or more additional documents. All of these documents must have been known before the priority date of the application under consideration." (Errat, 1996, p. 78).

[37] Prior art might "include anything made available to the public by written or oral description, by use or by any other means, such as international patent specifications as well as articles from non-patent literature, including journals, proceedings or Internet sources. Even citations from specialist books, theses, handouts from trade fairs and notes of public lectures may form the relevant state of the art" (German Patent and Trade Mark Office, 2013, p. 11).

[38] Therefore, the entire state of the art is regarded as relevant, not only the closest prior art (Harguth and Carlson, 2011).

[39] There is no official limit to the number of sources to combine. However, it is a rule of thumb that if three or more sources have to be combined to come up with a solution to the claimed problem, the inventive step criterion can be regarded as fulfilled (this information was taken from an e-mail conversation with a BPatG judge).

2.2.2.3 Conclusion

According to Kraßer and Bernhardt (2009), the problem-and-solution approach can be assessed as a useful guideline, which the DPMA inadvertently follows to some extent. Following Harguth and Carlson (2011), however, the DPMA applies more flexible rules than the EPO when it comes to the assessment of the inventive step. According to a Federal Supreme Court decision,[40] the closest prior art should not necessarily be regarded as the only starting point for an inventive step assessment. Defining one (or more) starting points, however, depends on the motivation of the person skilled in the art to find a better or different solution (compared to the existing prior art) to a certain problem. The Federal Supreme Court further allows that the person skilled in the art might also combine documents and "teachings of two different areas of the same technical field" (Harguth and Carlson, 2011, p. 76), given that "at the priority date appliances or methods were already known that crossed the boundaries between the technical areas, and if the technical problem to be solved is pertinent to both areas" (Harguth and Carlson, 2011, p. 76).[41] Compared to the EPO's problem-and-solution approach, the flexibility in the German system might, however, result in less predictable decisions, providing less legal security (Harguth and Carlson, 2011).[42]

2.3 Legal Background on Patent Infringement and Revocation

After a positive assessment of the essential patentability criteria, a claimed invention obtains patent protection. Once granted, a patent might be enforced by the owner in an infringement proceeding or challenged in an opposition/revocation proceeding. Compared to other countries, the German patent enforcement system is characterized by a disjunction of the infringement and revocation proceeding. The following section describes the institutional setting of the German bifurcated court system with respect to patent enforcement. Due to the bifurcation, questions regarding infringement and invalidation are not subject to the same proceeding and are handled at different courts. Section 2.3.1 provides further insights into the patent litigation procedure, followed by an explanation of the opposition procedure (2.3.2). A detailed summary of the German patent revocation proceeding is part of Chapter 2.3.3. Figure 1

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[40] See BGH, June 18, 2009, Gewerblicher Rechtsschutz und Urheberrecht (GRUR) Int 2009, 1041, Xa ZR 138/05, "Fischbissanzeiger."

[41] See BGH, April 15, 2010, GRUR 2010, 712, Xa ZR 69/09, "Telekommunikationseinrichtung."

[42] See Kraßer and Bernhardt (2009, p. 321) for potential sources of error while applying the problem-and-solution approach.

illustrates a simplified overview of the patent dispute system in Germany (without any consideration of time and duration aspects), which is further explained in the following sections.

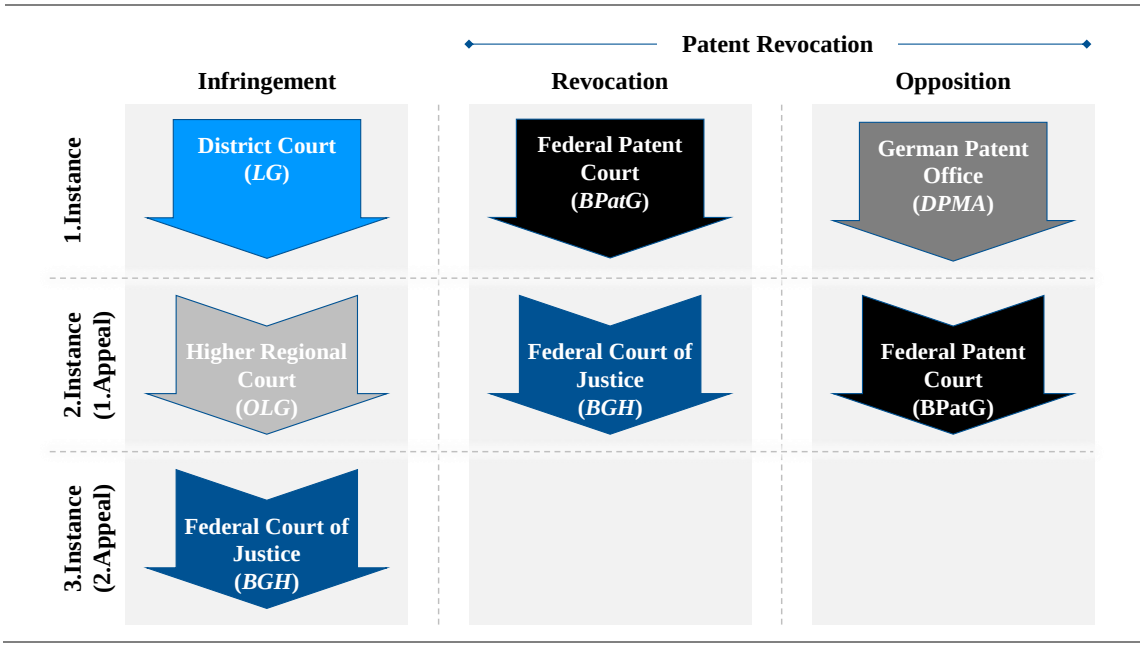

Figure 1: Patent dispute system in Germany (simplified)

2.3.1 Patent Infringement

Once the patent owner or an exclusive licensee has detected a potential infringement of one or more of his/her patents, s/he has the right to initiate an infringement proceeding at one of the 12 German District Courts.[43] In every District Court, at least one specialized chamber is responsible for hearing patent cases. Three legally trained judges, rarely technically trained, are assigned to each chamber (Wuttke and Guntz, 2012). The plaintiff can either choose to file the suit at the jurisdiction of the alleged infringer's headquarters/place of residence or where the potential infringement has occurred.[44] After the case filing, the district courts examine alleged infringement, assuming validity of the patent in suit.[45] However, according to Section 148 of the Code of Civil Procedure (ZPO) the court can stay an infringement proceeding—even ex officio—if it expects a (partial or full) revocation of the patent in a co-pending revocation proceeding (Keukenschrijver,

[43] 80% of the cases are heard before the courts in Mannheim, Dusseldorf, and Munich (Coster, 2012).

[44] In case of an online distribution of the potentially infringed technology, the plaintiff is free to choose from one of the 12 district courts.

[45] A potential invalidity of the patent in suit is an inadmissible defense. A revocation proceeding has to be filed with the Federal Patent Court (see 2.3.3).

2014; Kraßer and Bernhardt, 2009; Kühnen, 2013).[46] In case of a first instance infringement (and a pending final ruling, for example, due to a lodged appeal), the judgment can provisionally be enforced by the patentee after providing a security (e.g., cash deposit or bank guarantee). This entitles the patent owner to several rights (cf. Kühnen, 2014). Among others, s/he can claim

- an injunctive relief, not allowing the infringer to further use the technology under protection (Section 139(1) PatG),
- a destruction and callback of the infringing products that are the subject matter of the patent (Section 140a(1) & (3) PatG),
- a revealing of information on channels of distribution, manufacturers, and further involved parties (Section 140b et seq. PatG),
- a disclosure of accounts for a possible damage calculation and compensation of the occurred damages (Section 140d(1) PatG).

In cases where infringement and validity of the patent are relatively obvious and the patent owner clearly suffers from the infringement, the patentee can further claim a preliminary injunction, prohibiting the potential infringer to use the protected product even before a rendered judgment (e.g., Kühnen, 2013, 2014).[47] Drawing from Section 717(2) ZPO, if the appellate judges do not identify an infringement or the patent gets invalidated in a parallel revocation proceeding, the patentee has to reimburse the defendant for potential damages caused by the provisional enforcement (Cremers et al., 2013).[48] Within one month after the first instance judgment, the losing party can file for an appeal at the Higher Regional Court (Oberlandesgericht or OLG). Again, three legally trained judges decide on facts that were predominantly submitted in the first instance proceeding.[49] A second appeal can be filed at the Federal Court of Justice.

With regard to the case duration, a first instance proceeding takes roughly 12 to 15 months. An appellate case may last for another 18 to 24 months and a proceeding at the

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[46] Practically, this rarely happens (<10% of the cases) and only if the implied likelihood of a (partial or full) revocation is seen to be high (Wuttke and Guntz, 2012).

[47] See Sections 935 et seq., ZPO for further legal information on the preliminary injunction.

[48] Therefore, practitioners carefully evaluate costs and benefits of a provisional enforcement. The risk of an overruling of the first instance decision and the potential costs due to an early enforcement should be weighed against the potential benefits of an early enforcement (Bardehle Pagenberg Partnerschaft, 2013b).

[49] The court of appeal has to base its hearing and decision on facts established by the first instance. It is only permitted to introduce not yet considered facts that could not have been known during the first instance proceeding (Section 529(1), No. 1, ZPO).

Federal Court of Justice may take an additional two to three years (Bardehle Pagenberg Partnerschaft, 2013b; Coster, 2012).[50]

The losing party must compensate the succeeding party for any legal costs—depending on the litigation value.[51] According to practitioners' estimates, the costs for German first instance proceedings are typically in the range of €75,000 to €230,000 for values in dispute from €500,000 to €5,000,000 (Bardehle Pagenberg Partnerschaft, 2013b). In rare cases, the litigation value might increase up to $30,000,000 raising the cost risk accordingly.[52] Costs for the second instance proceeding are estimated to be roughly 15% higher (Bardehle Pagenberg Partnerschaft, 2013b).[53] This cost risk is said to keep financially weaker enterprises and single inventors from enforcing their patents (Liedel, 1979).

2.3.2 Patent Oppositions

During the first nine months after grant of a patent by the EPO, or the German Patent and Trademark Office, the patent's validity can be challenged by any third party through an opposition (post-grant review) before the respective patent office. Just as revocation actions before the Federal Patent Court, oppositions may be triggered by an infringement suit,[54] but in the majority of cases are filed as a preventative action against "potentially dangerous patents of competitors" (Bardehle Pagenberg Partnerschaft, 2013a, p. 5). Doing so is an attractive option not least because the fees for an opposition are rather low. Cost estimates for each instance and party reach from €15,000 to € 25,000 (Harhoff and Reitzig, 2004) to € 50,000, depending on the complexity of the case

[50] Drawing from the expertise of an independent expert might cause a delay of nine to 12 months (first instance) and up to another 12 months for the second instance proceeding (Bardehle Pagenberg Partnerschaft, 2013b).

[51] The litigation value includes court fees as well as attorney costs and further expenses and is limited to €30 million (see Section 39(1) of the Court Fees Act (GKG)).

[52] The cost risk for the losing party includes the court fees, the opposing party's statutory attorneys' fees, further expenditure as well as own attorneys' fees and expenses (e.g. Bardehle Pagenberg Partnerschaft, 2013b).

[53] According to the American Intellectual Property Law Association (2013) each party in an U.S. litigation proceeding faces median costs of $700,000 for patents worth < $1 million. Those costs can increase up to $5.5 million for patents valued at more than $25 million (American Intellectual Property Law Association, 2013).

[54] During the opposition period, invalidation of the focal patent can only be effected through an opposition; a suit before the Federal Patent Court is only possible after that period. Accordingly, a defendant in an infringement suit filed during the opposition period needs to resort to an opposition (or to wait until the end of the opposition period) if it wants to take legal steps to invalidate the patent.

(Bardehle Pagenberg Partnerschaft, 2013a).[55]

This study focuses on invalidation proceedings without including oppositions, for the following reason. The fact that they are initiated by third parties (while nearly all revocation actions are triggered by infringement suits) implies that patents perceived as weak should be opposed more often. Since a relatively large share of all granted patents are opposed (roughly 5%),[56] this suggests that the opposition procedure weeds out quite a few weak patents. In fact, approximately one-third of each are fully revoked, maintained with amendments, and fully maintained.[57] Accordingly, those still in force after the end of their respective opposition period should be more robust. By focusing on invalidation proceedings rather than including oppositions, the study obtains a more conservative estimate of the share of all patents that would be invalidated if challenged.[58]

Nonetheless, due to the obvious parallels between invalidation actions and oppositions, it is appropriate in the context of this study to review existing research on the latter. Specifically, findings on the correlates of the incidence and outcome of oppositions related to the patent and to the parties involved are reported in section 3.2.3.[59]

2.3.3 Patent Revocation

Once the opposition period has expired, or an opposition proceeding—if filed—reaches a final decision, the validity of a German patent or the German part of a European patent can be challenged through a revocation proceeding.[60] Any legal entity is entitled to initiate such proceedings, both for its own and for a third party's purpose (Keukenschrijver, 2014; van Hees and Braitmayer, 2010).[61] Nevertheless, a revocation suit is usually filed as a counterclaim to an ongoing infringement dispute

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[55] This is significantly less expensive than the cost risk of an invalidation proceeding (see 2.3.3).

[56] See, e.g., Bardehle Pagenberg Partnerschaft (2013a), Calderini and Scellato (2004), Caviggioli et al. (2013), Harhoff et al. (2007), Scellato et al. (2011). Oppositions are significantly more frequent than invalidation proceedings (Harhoff et al., 2003; Harhoff and Reitzig, 2004). Out of 24,116 granted patents with the priority year 1979, 2,036 were opposed and only 73 of them were subject to a revocation proceeding (Harhoff et al., 2003).

[57] See Caviggioli et al. (2013), Harhoff et al. (2007), Scellato et al. (2011). The outcomes of German national cases are quite similar to EPO cases (cf. Caviggioli et al., 2013; Scellato et al., 2011).

[58] One could also consider oppositions as part of the granting process. In this sense, this study focuses on those patents whose granting process is fully completed.

[59] For an overview of the similarities and differences between German revocation and opposition proceedings, see van Hees and Braitmayer (2010, pp. 246 et seq.).

[60] See Art. II Section 6 of the Law on International Patent Treaties (IntPatÜG) as well as Section 81 PatG.

[61] See Section 81(1) & (3) PatG.

(Keukenschrijver, 2014; Stauder, 1989; van Hees and Braitmayer, 2010).[62] Due to the German bifurcated patent litigation system, questions regarding infringement and invalidation are not subject to the same proceeding (see Figure 1). Whereas District Courts—as already mentioned in 2.3.1—are responsible for the first instance of infringement proceedings, the first instance jurisdiction over revocation disputes lies with the Federal Patent Court.

The Federal Patent Court as one of the highest federal courts in Germany is concerned with cases involving the grant, denial, or withdrawal of IPR. Currently, seven senates of the Federal Patent Court handle patent revocation issues (Bundespatentgericht, 2015). Generally, two legally and three technically trained judges (mostly former patent examiners) are assigned to each revocation senate (*Nichtigkeitssenat*).[63] Once a revocation proceeding has been filed with the Federal Patent Court,[64] the judges have to decide whether the patent at stake is valid, partially invalid, or invalid—as far as it has been challenged by the plaintiff.[65] The reasons for a patent revocation are based on Section 22 in conjunction with Section 21 of the German Patent Act and can be classified as follows:

1. Non-patentability of the subject matter
2. Lack of sufficiently clear and complete disclosure of the invention, enabling a person skilled in the art to carry out the invention
3. Usurpation of essential contents of the patent by the patentee[66]
4. Inadmissible extension of the subject matter beyond the content of the application as originally filed
5. Extension of the scope of protection

Non-patentability is based on different factors given in Sections 1 through 5 of the PatG and includes—as it has been further described in Chapter 2.2.1—the issues of novelty, industrial application, and level of inventiveness (e.g., Pakuscher, 1986). Among those factors, Liedel (1979) identified non-patentability due to a lack of an inventive step

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62 In this context, van Hees and Braitmayer (2010) estimate a rate of 90%.

63 There has to be one legal member in a three judge constellation (Section 67(2) PatG).

64 See Section 81(4) PatG.

65 According to van Hees and Braitmayer (2010), the plaintiff's (in the revocation proceeding) invalidity complaint has to include the patent number, to which extent s/he files for revocation of the patent (partial or full), and on which revocation reasons the suit is based (see also Section 81(5) PatG).

66 Section 21(1) PatG talks about usurpation if "the essential content of the patent has been taken from the descriptions, drawings, models, implements or equipment of another person or from a process used by this person, without his consent."

as the predominant reason for an invalidation ruling.[67] Hess et al. (2014) verified this finding in a more recent study, analyzing the years 2010 to 2013.[68] An action is dismissed—and the patent therefore maintained as granted—if the claim is inadmissible or the examination shows that the claimed invention is patentable.

Whereas "invalid" and "valid" are unambiguous decisions, a partial invalidity ruling is not. However, it can usually be interpreted as either "invalid" or "valid" in the context of the infringement case that triggered it, depending on the fate of the claims relevant in that case. The parties in the revocation case may also restrict their challenge, or defense respectively, to a subset of all claims (Keukenschrijver, 2014; van Hees and Braitmayer, 2010). As indicated above, the plaintiff may request a partial invalidation of the patent, contesting only certain claims. The court then only examines those claims for which the plaintiff filed invalidation. A "partial invalid" ruling in line with the plaintiff's filing effectively amounts to a full invalidation from the plaintiff's point of view (Liedel, 1979). In turn, the defendant has the option to restrict its defense to a limited number of claims. Only these claims will be subject to the court action, while the non-defended claims become by operation of law invalid (Keukenschrijver, 2014).[69] In this case the patent can be ruled partially invalid—if some or all of the defended claims are upheld and some claims are invalid—or invalid if the defended claims are ruled invalid. A possible indication of whether a "partial invalid" decision means a success for the plaintiff or the defendant is the filing of an appeal by one or the other party (Liedel, 1979).

Overall, approximately two-thirds of the first instance decisions on the merits are appealed before the Federal Court of Justice (Liedel, 1979; Stauder and Luginbuehl, 2009) where five legally trained judges (Section 139(1) Courts Constitution Act (GVG)) of the X. Senate decide on the validity of the patent within one oral hearing (Keukenschrijver, 2014).[70] Contrary to the first instance proceeding, the senate often draws on the expertise of an independent expert, due to the lack of technically trained judges (van Hees and Braitmayer, 2010).[71] A ruling by the Federal Court of Justice is final

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[67] In his study, Liedel (1979) identified that 80% of the (partial or full) revocation rulings are based on the lack of an inventive step.

[68] According to the authors, 75% of all (partial or full) invalidation rulings are based on a lack of patentability due to newly introduced prior art.

[69] See also BPatG, March 5, 2009, 3 Ni 27/08 (EU) "Oxaliplatin; m.w.N."

[70] See Sections 110-121 PatG.

[71] This frequently results in a delay of the second instance proceeding, due to difficulties in finding an appropriate expert, not related to any of the parties involved (van Hees and Braitmayer, 2010).

and cannot be appealed. If the first-instance plaintiff withdraws its claim in a Federal Court of Justice proceeding, the patent remains valid notwithstanding the first instance ruling.[72] This leads to the fact that a notable share of already (partially or fully) revoked patents remains valid after a withdrawal (Liedel, 1979). A withdrawal of the appellate suit will result in a legally binding first instance decision.

As to the case duration, roughly 45% of the first instance decisions on the merits were ruled within one year, whereas only 10% of the proceedings were decided after two years (Liedel, 1979). In more than two-thirds of the appellate cases, the second instance decision was ruled within between two to four years after the filing of the case, while 10% of the actions reached a judgment after four years. Nowadays practitioners estimate a first instance proceeding to be decided within roughly two years, whereas an appellate action takes an additional two years (Bardehle Pagenberg Partnerschaft, 2014b; Coster, 2012).[73]

As for the infringement proceeding (see 2.3.1), the court as well as the attorney fees are determined by the litigation value—the latter is defined by the court (Keukenschrijver, 2014).[74] In general, the litigation value is derived from the patent value at the time of the case filing, including further claims for damages (Keukenschrijver, 2014).[75] As for infringement proceedings, the defeated party has to pay the court fees and compensate the winning party for its statutory and refundable attorney fees.[76] In cases where both parties partially succeed and partially lose, the costs will be shared proportionally (Keukenschrijver, 2014). According to van Hees and Braitmayer (2010) the average litigation value is estimated to be €750,000 and usually lies between €50,000 and

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[72] See Section 269(3), first sentence, ZPO.

[73] Due to a new regime introduced for cases filed after September 2009, a modification of the second instance proceeding resulted in a reduction of the appellate case duration from roughly four years to two years. According to the new regime, the BGH no longer operates as a trail court in patent revocation proceedings. Thus, technical experts have to be appointed less frequently, as the second instance primarily checks the first instance decision for errors (Deutscher Bundestag, 2008). Furthermore, the BPatG "has to provide directions for the parties as early as possible in the proceedings" (Luginbuehl, 2011, p. 27).

[74] See Section 36 of the Court Fees Act (GKG 2004); Section 2(2), fourth sentence, of the Law on Patent Charges (PatKostG), Section 2 and Section 32 of the Law on the Remuneration of Attorneys (RVG).

[75] The litigation value is either based on a subjective assessment by the respective revocation senate or—in case of a parallel infringement proceeding—on the litigation value determined by the District Court (in this case the litigation value reflects the alleged infringer's interest in an invalidation of the patent). According to the latter assessment procedure, the litigation value is set to 125% of the assumed litigation value in the parallel patent infringement proceeding to account for the actual value of the patent, which typically exceeds the individual interest (see BGH, April 12, 2011, X ZR 28/09, "Nichtigkeitsstreitwert Leitsatzentscheidung"). The litigation value is limited to €30 million (Section 39(2) GKG 2004, Section 22(2) RVG).

[76] Including further expenses like travel or translation costs.

€30,000,000 for the first instance proceedings. Practitioners estimate the typical litigation value to be in a range between €500,000 and €5,000,000 (Bardehle Pagenberg Partnerschaft, 2014b). The corresponding first instance costs risk for the losing party—including court fees, own expenses, and opponent reimbursements—therefore varies from €40,000 to €240,000. This cost risk linearly increases for higher litigation values up to €1,300,000. In the second instance, the cost risk is said to be 30% higher than in the first instance proceeding (Bardehle Pagenberg Partnerschaft, 2014b). According to Liedel (1979) this cost risk can be substantial, especially for smaller parties.

2.3.4 Conclusion

The bifurcation of the German patent infringement/revocation court system bears advantages as well as disadvantages. A main benefit is the specialization among the different courts, which results in high quality decisions at reasonable costs—compared with countries such as the U.S. or the UK (e.g., Coster, 2012; Harhoff, 2009; Cremers et al., 2013). Furthermore, bifurcation allows for a relatively fast judgment on infringement claims, since validity is not assessed within the same proceeding (Cremers et al., 2013; Wuttke and Guntz, 2012). Thus, the German patent system enjoys a good reputation among foreign companies, which frequently choose Germany as the venue for patent enforcement (Ann, 2009; Coster, 2012; Mueller-Stoy and Bewer, 2013).[77] A disadvantage (especially for the alleged patent infringer) may result from the interaction of infringement and revocation actions. The staggered timing of the case filings as well as different case durations may result in situations where a provisional infringement enforcement may initially occur—often connected to a preliminary injunction—even though the underlying patent is subsequently revoked in a parallel revocation action (Cremers et al., 2014). This may cause irreparable damages to the alleged infringer and can be especially harmful for smaller companies, which often build their business on one technology (Wuttke and Guntz, 2012). A statement published by a group of well-known organizations such as Adidas, Apple, Google, and Samsung addresses exactly this issue, indicating the consequences of the aforementioned procedural discrepancy in the bifurcated system: "[…] the potential exists for a court to order an injunction prohibiting the importation and sale of goods even though the patent may ultimately be found invalid. This result unduly reduces competition, can increase the cost of products in the market

[77] According to Luginbuehl (2011), more than half of the infringement proceedings in Europe are brought to the German courts.

and reduce product choices, all negatively impacting consumers."[78] The legislator therefore tries to minimize the time discrepancy between infringement and revocation decisions by taking measures to reduce the case duration of the first and second instance revocation proceeding (see 2.3.3). However, the number of cases in which patents are declared infringed prior to an invalidation ruling is still high (Cremers et al., 2014). The offset between infringement and revocation judgments enables the patent owners to exploit the threat of a preliminary injunction based on a possibly invalid patent and results in a high degree of legal uncertainty. The incongruity of case durations thus clearly privileges the plaintiff in the infringement suit (Wuttke and Guntz, 2012). According to Wuttke and Guntz (2012), this privilege is mainly enabled by the fact that stay decisions are seldom rendered during the course of infringement proceedings (Chapter 2.3.1). Furthermore, additional uncertainty arises due to the possibility of inconsistent claim interpretations in infringement and revocation proceedings. Also referred to as the *angora cat* approach, the bifurcated system allows for a wide construction of claims[79] in infringement actions—increasing the likelihood of a preliminary injunction—and a narrow claim interpretation in a parallel revocation proceeding—decreasing the probability of an invalidation ruling (Cremers et al., 2013; Cremers et al., 2014; Keukenschrijver, 2014).[80] Finally, according to Luginbuehl (2011), a further disadvantageous feature of bifurcation is that one court cannot examine the patent in its entirety, which creates inefficiencies.

2.4 Multiple Selection Stages on the Way to Patent Revocation

The central question addressed in this dissertation concerns the selection effects that lead from the population of all active patents to those that enter revocation proceedings that end with a decision (see Figure 2). In this population, there is an unknown number of infringed patents (1). Some of these infringed patents and some of the non-infringed patents become involved in infringement proceedings (2). A certain share of these patents

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[78] See https://news.microsoft.com/download/presskits/iplicensing/upcindustrycoalition.pdf, accessed July 06, 2015.

[79] According to Lemley (2005, p. 101) claim construction is "the process of defining the words of the claim in other, theoretically clearer words."

[80] Giving his judgment in the case "European Central Bank v. Document Security Systems Incorporated, [2008] EWCA Civ 192," Lord Justice Jacob referred to Professor Mario Franzosi's comparison of the different claim interpretations with an Angora cat: "When validity is challenged, the patentee says his patent is very small: the cat with its fur smoothed down, cuddly and sleepy. But when the patentee goes on the attack, the fur bristles, the cat is twice the size with teeth bared and eyes ablaze" (England and Wales Court of Appeal (Civil Division), 2008).

(plus very few others) are subject to a revocation proceeding (3). Cases that are not settled reach a first instance decision at the Federal Patent Court (4). A percentage of the aforementioned Federal Patent Court rulings are appealed before the Federal Court of Justice (5) and result in a final ruling unless they are settled (6).

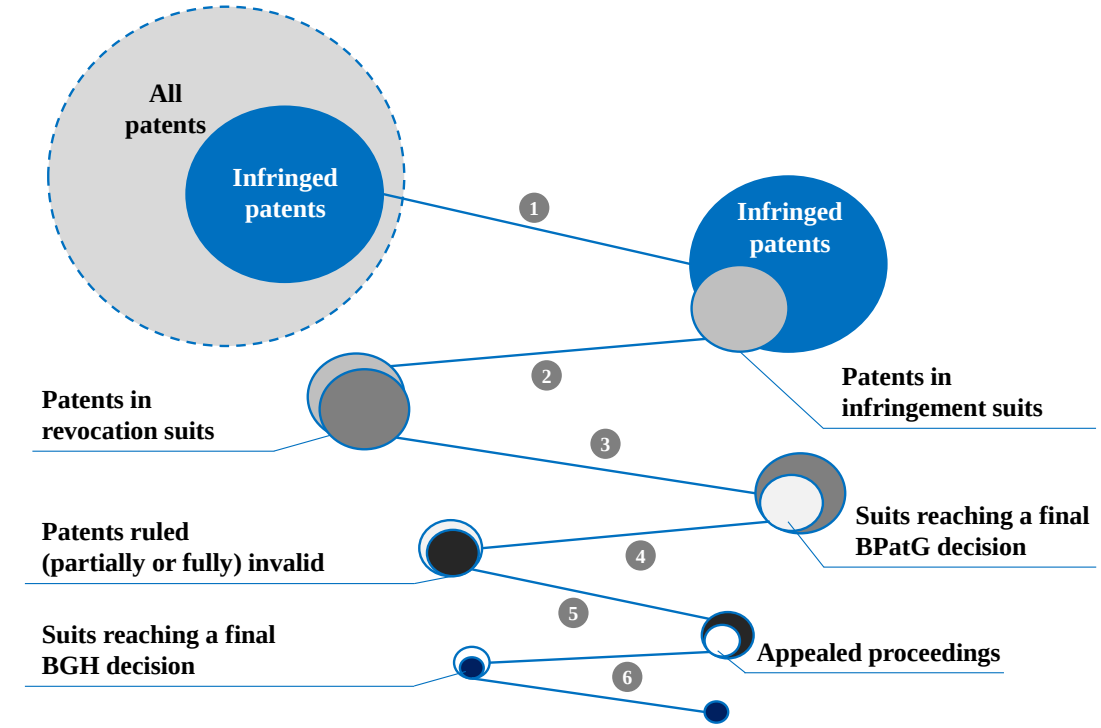

Figure 2: Selection stages in the patent revocation process

Several mechanisms have taken effect before a patent receives a final ruling in a revocation proceeding, such that those patents are obviously not a random sample of the population of all German patents. Several legal, patent-related and party-specific determinants exist that potentially influence the probability that a patent proceeds to the next stage. In order to obtain an estimation of the (partial or full) invalidation likelihood of a randomly picked patent,[81] I will identify and assess the determinants of revocation proceedings in the further course of this study. The following section provides an overview of the literature dealing with factors that affect the different selection stages.

[81] See Chapter 3.5 for a detailed explanation of the research question.

3 Literature Review on Patent Infringement and Revocation

As has already been mentioned in Sections 2.3.2 and 2.3.3, a common defense against an infringement action is to challenge validity of the underlying patent (e.g., Keukenschrijver, 2014; Lanjouw and Schankerman, 2001), such that patents facing a revocation action are usually preselected at the infringement stage. Thus, it is necessary to examine patent infringement and its determinants as well as the selection to undertake infringement proceedings before addressing the factors influencing revocation.

3.1 Patent Infringement

One of the inefficiencies caused by latently invalid patents is that they may unduly expose other parties to the risk of being sued for infringement. This is more of a cause for concern the more widespread infringement is in general. So, how frequent is patent infringement? Infringement litigation, in any case, is rare—according to Lemley (2001), only about 1.5% of all U.S. patents are ever asserted in court.[82] For Germany, Stauder (1989) estimates a share of 1% of all patents undergo infringement litigation.[83] However, actual litigation is only the tip of the iceberg as patentees might not find out about the infringement, might not react to it, or might settle with the infringer (Weatherall and Webster, 2014). Since patents do not fulfill their notice function properly as argued by Bessen and Meurer (2008), it is plausible that much patent infringement is inadvertent and also goes unnoticed by the patentee. For Australia, Weatherall and Webster (2010) find that 28% of the patents in the sample were perceived by the respective inventor as having been infringed.[84] Considering that most inventors do not actively search for infringement, the actual number will likely be higher.

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[82] This number varies strongly by industry and reaches six percent for the biotechnology sector (Lerner, 1995).

[83] According to Allison et al. (2009, p.4), compared to the average patent, litigated patents can be seen as "extreme outliers, since the parties are willing to spend millions of dollars per side in legal fees in order to litigate them."

[84] While the authors mostly use "copying" instead of "infringement," they make clear that they do not differentiate between the terms. They use "copying" to mean "conduct the inventor perceives as involving use of their idea/invention" (Weatherall and Webster, 2010, p. 24) without implying intent on the part of the presumed copier.

3.1.1 Determinants of Patent Infringement

Various surveys, recently reviewed by Weatherall and Webster (2014), study the incidence of infringement on the level of firms. Kingston (2000) and Rodwell et al. (2007) find that two-thirds to three-quarters of the European small and medium-sized enterprises (SMEs) in their sample faced some kind of IP infringement. By surveying UK SMEs (10-249 employees) and micro-firms (0-9 employees), Greenhalgh et al. (2010) discovered that roughly 25% of the respondents had already faced a patent dispute.[85] While firm-level results are not directly informative of the incidence of infringement on the patent level, they do support the notion that patent infringement is far more widespread than patent litigation. This, in turn, implies that the risk of being sued for infringement of latently invalid patents is a serious cause of concern.

3.1.2 Determinants of Involvement in Infringement Proceedings

To understand the selection effects that lead to patents being involved in revocation actions, I now review the factors that affect the likelihood of a patent being involved in infringement litigation (which in turn triggers most revocation actions).

Patent characteristics. The most obvious of these factors is the patent's commercial value. One possible driver of this is the invention the patent protects.[86] Thus, the more valuable the underlying invention, the more likely it is that third parties will pursue similar research and design products or processes that infringe on the focal patent inadvertently or even consciously. This economic reasoning is confirmed by empirical observations showing that patents with a higher number of forward citations—an established indicator of patent value (see Chapter 4.2.2.2.2)—are more likely to enter infringement actions (Allison et al., 2004; Cremers, 2004; Lanjouw and Schankerman, 2001, 2004b; Somaya, 2003).[87] The same is true for patents that are part of a larger patent family (Cremers, 2004; Harhoff et al., 2003), which also indicates patent value (as perceived by the applicant).

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[85] Greenhalgh et al. (2010, p. 1) defines intellectual property dispute "as any infringement, whether or not this ended in legal proceedings."

[86] Even if a patent's commercial value likely correlates with the value of the underlying invention, it cannot be regarded as a guaranteed relationship. Thus, it might be that a patent is highly valuable only for the patentee even though the underlying invention itself has no significant commercial value (e.g., when a patent is strategically used for blocking others).

[87] See Cooter and Rubinfeld (1989) as well as Lanjouw and Schankerman (2001) for an overview of the key determinants of litigation in general and with respect to patent litigation, respectively.

Furthermore, a patent being involved in litigation, which causes considerable cost,[88] constitutes in itself a signal of value (Lemley and Shapiro, 2005). Finally, Harhoff et al. (2003) and Cremers (2004) find a positive correlation between a patent's having survived opposition or re-examination and the incidence of later infringement proceedings.

Several studies find a positive relation between the number of backward citations of a patent and the likelihood of it being involved in infringement litigation (Allison et al., 2004; Cremers, 2004; Harhoff et al., 2003; MacGahee, 2011). In contrast, Lanjouw and Schankerman (2004b) find a negative relationship, arguing that backward citations are an indicator for a well-developed field of technology where uncertainty less likely results in legal disputes. Further, a positive relationship has been identified with the number of claims (Allison et al., 2004; Lanjouw and Schankerman, 2001; MacGahee, 2011), the application-to-grant lag (Allison et al., 2004; Somaya, 2003), and patent age (Allison et al., 2004).

Patent owner characteristics. Results of studies on U.S. proceedings show that foreign-owned patents seem to less likely to be involved in a patent infringement action than domestic-owned patents, likely due to the higher costs as well as cultural and language differences foreign parties would face (Allison et al., 2004; Lanjouw and Schankerman, 2001; MacGahee, 2011; Moore, 2003). Analyzing U.S. proceedings between 1978 and 1999, Lanjouw and Schankerman (2004b) find that patents assigned to individuals and domestic firms with small patent portfolios are more likely to be part of infringement proceedings than patents owned by firms holding larger patent portfolios. This finding has been confirmed by other scholars analyzing similar settings (e.g., Allison et al., 2004; Ball and Kesan, 2009; Bessen and Meurer, 2005; Somaya, 2003). The outcomes are similar for Germany (Cremers, 2004) and Australia (Weatherall and Webster, 2010). Greenhalgh et al. (2010), however, come up with a contrary finding. According to their study on UK cases between 2003 and 2009, large foreign firms were prominent among the litigants. Weatherall and Webster (2014) summarize possible explanations for the finding that small firms are more likely to be involved in patent litigation: they only have a small number of patents available for possible cross-licensing and, therefore, reduced bargaining power; they have more at stake and, hence, more to lose; they have mistaken expectations and are more confident of winning a dispute; and

[88] See 2.3.1 for the costs at risk for infringement proceedings. Total costs (including revocation action) can be as high as €2 million for €10 million in dispute (IP Campenhausen, 2004; Mejer and van Pottelsberghe de la Potterie, 2012). Moreover, an estimation by Bessen and Meurer (2012) for U.S. public firms on proceeding-related costs for alleged infringers exceeds $16 billion a year.

they may face issues of asymmetric information as larger firms are typically more experienced about patents and how to litigate them. With respect to the business model of the parties involved, several scholars find a steadily increasing share of non-practicing entities (NPEs) in U.S. infringement proceedings (Ball and Kesan, 2009; Chien, 2009; Freedman, 2010). This finding is quite intuitive as NPEs' business model is based on enforcing patents against alleged infringers to earn damage or settlement payments (e.g., Golden, 2007; Lemley and Shapiro, 2007; Reitzig et al., 2007).

Of interest in the underlying study is whether patents entering infringement actions are more robust than the average patent. The correlations reported above are mostly inconclusive in this regard, however. Value should increase with both the patent's inventive step and with its breadth; legal robustness, however, should increase with the former but decrease with the latter. Any predictions regarding a correlation between robustness and backward citations, number of claims, grant lag, or age appear even more speculative. The same is true for characteristics of the patent holder, which various authors have studied as potential correlates of infringement litigation (as indicated above).

What is relevant in this context is the positive correlation between a patent being involved in infringement proceedings and its having survived opposition or re-examination (Cremers, 2004; Harhoff et al., 2003). Such patents have shown a certain legal robustness, by virtue of which they increase the average robustness of all patents involved in infringement proceedings. A second argument pointing in the same direction is based on the patentee's decision situation. Legal action is not an automatic reaction to detecting infringement. A patentee will be more likely to file suit if it perceives the allegedly infringed patent as robust; and in cases where a product is seen to infringe on several patents, the patentee will ceteris paribus select those it perceives as most robust for its legal action. Summarizing, I posit that patents involved in infringement proceedings are more robust than the average patent.

3.2 Patent Validity

About 1% of all granted patents find their validity challenged in court, both in Germany and in the U.S. (e.g., Keukenschrijver, 2014; Lanjouw and Schankerman, 2001). For Germany, Stauder and Luginbuehl (2009) identify a steady upward trend. Nearly all of these validity challenges are triggered by infringement proceedings (Keukenschrijver, 2014, pp. 83–84; Stauder, 1989, p. 39; Stauder and Luginbuehl, 2009, p. 296). In turn, one-third to half of all patents that are involved in infringement proceedings are subsequently subject to validity challenges instituted as a defense by the alleged

infringer.[89] In countries where validity is challenged within infringement proceedings, this share is considerably higher: Stauder (1989) reports 81% for France and 93% for the UK. For the U.S., the share is estimated to be above 90%.

3.2.1 Determinants of Involvement in Revocation Proceedings

Which characteristics of a patent correlate with the likelihood of it entering invalidation proceedings? Obviously, since most invalidation proceedings are triggered by infringement proceedings, the selection effects at work for the latter also come to bear for the former if the reference group is the universe of all patents. Beyond that, I am aware of two studies that address this question specifically. For suits before the Federal Patent Court, Fischer (2015) finds that a patent's forward and backward citations, its having been contested in opposition proceedings, and the number of its family members and claims—all indicators of a patent's value— as well as being owned by an individual are positive correlates of a selection into a revocation proceeding. In contrast, the number of assigned IPC classes, a higher grant lag, and examination at the EPO (as opposed to the German Patent and Trademark Office) are negatively correlated with the likelihood of the patent entering invalidation proceedings. Using U.S. data, Miller (2013) shows, among other things, that patents owned by individuals or by foreign firms are less likely, and those owned by licensing firms more likely to be challenged in court.

Of these results, Fischer's (2015) finding of a positive relationship with the patent's forward citations might indicate that the patents in German invalidation proceedings that conclude with a decision are more robust than the average patent. Beyond that, based on economic reasoning I had identified a selection of more robust patents into infringement proceedings in Section 3.1.2. In a bifurcated system as in Germany this selection effect is counteracted at the invalidation stage by the fact that the alleged infringer will be more likely to challenge the patent the less robust it is perceived to be. Thus, compared with all patents in infringement proceedings, those in invalidity proceedings should, on average, be less robust. To judge the net effect of both selections—relative to the population of all patents—on the basis of earlier research and economic arguments alone appears unfounded. I will address this issue empirically in the results section (Chapters 5 et seq.).

The counteracting selection effect described above is largely absent in legal systems

[89] For the period of 1972 to 1974 Stauder (1989) reports a share of 44% to 57%. Averaging over the years 2000 to 2008 (filing year of the respective infringement action), Cremers et al. (2014, p.20) find that "slightly less than a third of infringement cases (counted at the patent level) are associated with a revocation action."

such as the U.S. where validity is challenged in most infringement proceedings. In such countries, patents whose validity is tested in infringement proceedings should thus be more robust than the average patent.

3.2.2 Determinants of Outcomes of Revocation Proceedings

When invalidity proceedings in Germany are concluded with a decision, significantly more than half of all patents are either partially or fully invalidated. For the period 1963 to 1971, Liedel (1979) finds a rate of partial or full invalidation of 71% in the first as in the second instance. Keukenschrijver (2014) reports for the first instance a rate of 66% for 1961 to 1980 and 52.1% for 1980 to 1990. In the same range, Fischer (2015) finds a rate of 65% in the first instance for the period 1985 to 1999, and Stauder and Luginbuehl (2009) even report a rate of 76% for 2000 to 2008. This number is in line with my own analysis, reported below, for 2000 to 2012. In the most recent study, Hess et al. (2014) show a first instance (partial or full) invalidation rate of 79% analyzing the years 2010 to 2013.[90]

High rates of invalidation as reported above are not specific to Germany. Early studies on U.S. patent litigation unveil an invalidation rate of 60% to 70% for the period 1948 to 1954 (Federico, 1956) and roughly 65% from 1953 to 1978 (Koenig, 1980). Allison and Lemley (1998) report an overall invalidation rate of 46% for the period of 1989 to 1996. More recently, Mann and Underweiser (2012) find that for the years 2003 through 2009 the Federal Circuit held 60% of the patents in the cases it adjudicated not valid. In other countries, invalidation rates are in similar ranges. For Australia, Weatherall and Jensen (2005) report a rate of full or partial invalidation of 53% (first and second instance) for the period of 1997 to 2003. Oyama (2012) finds an invalidation rate of 73% at the Japanese district courts, and a UK study examining the years 2000 to 2008 indicates an overall rate of about 50% partially or fully invalid in the first instance (Helmers and McDonagh, 2013). France seems to be a special case with, according to Véron (2010), only 27% of the cases before the court of first instance in Paris between 2000 und 2009 resulting in a revocation decision.

Given that globally more than half of all invalidation proceedings that conclude with a decision lead to partial or full invalidation of the patent, the question arises which factors correlate with, or even drive, the likelihood of invalidation. I address, in turn, factors relating to the granting process, the patent, and the parties in suit.

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[90] The authors further specify that 75% of all (partial or full) invalidation rulings in revocation proceedings are based on a lack of patentability due to newly introduced prior art.

Granting process. Henry and Turner (2006) trace how the establishment of the Court of Appeals for the Federal Circuit (CAFC) in 1982 affected decisions of invalidity. Analyzing the years 1953 through 2002, they show that the CAFC significantly decreased the rate of revocation and overruled the first instance invalidity decision (not affirming an "invalid" decision) three times more often than the second instance had done before. As a result, the lower courts halved their revocation rulings and patentees appealed more likely in cases of a first instance invalidity. Cockburn et al. (2002) analyzed the CAFC rulings during the period 1997 to 2000 with respect to examiners' characteristics, but found no correlation between the examiners' experience, his/her workload, or the age of the patent and the outcome of the invalidation proceedings. Further, Marco (2006) estimated the probability of inadvertent findings of validity and invalidity rulings by district as well as appellate courts, running a prediction based on observable patent case characteristics. Allison and Lemley (1998) find that juries are more patentee friendly and patents in jury trials are therefore more likely upheld. Atkinson et al. (2009) show that patents in patentee-defendant cases—where the patent challenger initiates litigation—are less likely ruled valid. According to MacGahee (2011), this effect significantly increases for cases involving continuations. Finally, Cockburn et al. (2002) and MacGahee (2011) find a positive relationship between the time a patent spends in examination and the probability of invalidation, while Fischer (2015) identifies a positive relationship of grant lag and the probability of a complete survival. [91]

Patent characteristics. Various patent characteristics have been analyzed regarding their correlation with the likelihood that a patent would be ruled invalid. Results have been partly contradictory. For the number of backward citations, MacGahee (2011) finds a negative relationship analyzing U.S. cases between 1929 and 2006, while Fischer (2015) finds a positive correlation for German revocation suits between 1985 and 1999. Whereas Miller (2013), who analyzes litigated patents subject to obviousness and anticipation decisions in the U.S. between 2000 and 2010, finds no significant effect, Fischer (2015) identifies a positive correlation of the number of forward citations and the probability that a patent survives a revocation attempt partially or fully. Fischer (2015) and MacGahee (2011) show a negative relationship with the number of claims (Fischer, 2015; MacGahee, 2011).[92] Fischer (2015) further specifies that a larger number of claims positively correlates with partial, but not with complete survival—a plausible finding

[91] Miller (2013) finds a negative, however not significant, relationship.

[92] Miller (2013) finds a negative, however not significant, relationship.

since a larger number of claims makes it more likely that at least one is upheld in invalidation proceedings. Equally plausible, Fischer (2015) finds a positive correlation between the number of IPC classes a patent is assigned to and its surviving invalidity proceedings without any amendments. Results on the effect of an application-to-grant lag are contradictory. Finally, Atkinson et al. (2009), MacGahee (2011), and Miller (2013) find that older patents are less likely to be ruled invalid, while Cockburn et al. (2002) find no such correlation.

Characteristics of the parties in suit. There is little research on how characteristics of the parties in suit correlate with invalidation probability. Using patent portfolio size as a proxy for company size, Fischer (2015) finds no plaintiff and defendant size effect on the outcome of a revocation proceeding. Miller (2013), using a binary coding of small vs. large firms,[93] did not find any size effects. Further, there is evidence that corporate as well as foreign patentees are more likely to win, i.e., to have their patents upheld (MacGahee, 2011). In addition, while an invalidation ruling is less likely if the defendant in the infringement suit is a foreign firm, patents owned by licensing firms seem to face a higher probability of being ruled invalid (Miller, 2013). Table 1 provides an overview of the aforementioned studies including the determinants influencing selection into a revocation proceeding as well as the outcomes.

[93] "Large" companies are product firms that are publicly traded or listed on the Forbes' list of the largest private companies (Miller, 2013).

Determinant	Study	Multivariate correlation…
Selection into revocation proceeding		**….with selection into proceeding**
Patent characteristics		
Number of patent forward citations	Fischer (2015)	+
Number of patent backward citations	Fischer (2015)	+
Number of patent claims	Fischer (2015)	+
Number of assigned IPC classes	Fischer (2015)	-
Contested in opposition proceeding	Fischer (2015)	+
Number of family members	Fischer (2015)	+
Examination at the EPO	Fischer (2015)	-
Application-to-grant lag	Fischer (2015)	-
Patent owner characteristics		
Patent Owner = Individual	Fischer (2015) Miller (2013)	+ -
Patent Owner = Foreign firm	Miller (2013)	-
Patent Owner = Licensing Firm	Miller (2013)	+
Determinants of revocation likelihood		**…with revocation likelihood**
Patent characteristics		
Number of forward citations	Fischer (2015) Miller (2013)	- not sign.
Number of backward citations	Fischer (2015) MacGahee (2011)	+ -
Number of claims	Fischer (2015) MacGahee (2011)	- -
Number of assigned IPC classes	Fischer (2015)	-
Contested in opposition proceeding	Fischer (2015)	not sign.
Examination at the EPO	Fischer (2015)	not sign.
Application-to-grant lag	Fischer (2015) MacGahee (2011) Cockburn et al. (2002)	- + +
Patent Age	Atkinson et al. (2009) MacGahee (2011) Miller (2013) Cockburn et al. (2002)	- - - not sign.
Patent owner characteristics		
Company Size (size of patent & trademark portf.)	Fischer (2015)	not sign.
Patent Owner = Corporate	MacGahee (2011)	-
Patent Owner = Foreign firm	MacGahee (2011)	-
Patent Owner = Licensing Firm	Miller (2013)	+

+ = positive correlation; - = negative correlation

Table 1: Studies on determinants of patent revocation

3.2.3 Determinants of Opposition Proceeding

As the focus of this dissertation is on revocation proceedings at the BPatG (see Chapter 2.3.3), only a short overview of the determinants of the opposition procedure is provided in the following.

Several studies have demonstrated that more valuable patents are more likely to be challenged in opposition proceedings. Empirical research identified among others that the

number of forward and backward citations, the number of claims, and the size of the patent family are positively correlated with the probability of facing an opposition (Caviggioli et al., 2013; Graham et al., 2002; Hall et al., 2009; Harhoff and Reitzig, 2004; Jerak and Wagner, 2006; Schneider, 2011). Evidence on correlates of opposition outcomes is mixed. Caviggioli et al. (2013) report a positive correlation with patent value indicators such as backward citations and number of claims on the survival likelihood. Family size, however, shows a positive correlation with a revocation probability. Furthermore, Graham et al. (2002) identified a higher amendment probability for highly cited patents and patents with many claims.

With respect to characteristics of the parties involved, Harhoff and Hall (2002) were able to show that oppositions in the haircare industry repeatedly occur between larger firms. Contrary to this finding, Calderini and Scellato (2004) provide evidence from the telecommunication industry that larger firms more likely oppose patents of smaller companies, whereas the probability of opposition between two larger players is significantly lower. In his study on cases in the plant biotechnology sector, Schneider (2011) discovered that patents of companies with larger patent portfolios more likely face an opposition. However, there seems to be no statistical difference between large firms and small firms as measured by the number of employees (Schneider, 2011).

Thus, by and large the identified correlates of invalidation probability are consistent between oppositions and invalidity actions. The key difference, as explained, resides in the way either is initiated, which should select more robust patents into invalidity actions than into oppositions.

3.3 Determinants of Dispute Settlements

The parties involved in patent-related lawsuits frequently reach an out-of-court settlement. Analyzing German infringement proceedings between the years 2000 and 2008, Cremers and Schliessler (2012) revealed that only 40% of the trials proceeded to a final judgment. The settlement rate in German first instance revocation proceedings is found to be roughly the same (e.g., Stauder and Luginbuehl, 2009; own analysis).[94] However, compared with the settlements in infringement actions, out-of-court agreements during the course of revocation lawsuits very likely affect third parties, as latently invalid patents may remain valid and thus further deter others from using the patented

[94] See Chapter 6.1.1.1.

invention.[95] Hence, settlement may be a profitable option for the involved parties, but it involves social costs (Weatherall and Webster, 2014).[96] Due to this special nature, different factors might drive the settlement probability in revocation proceedings compared with infringement actions. Identifying these determinants is not the focus of the underlying study.[97] Nonetheless, I will point out the major factors driving settlement decisions in infringement proceedings in the following, as some might also apply to invalidation lawsuits.

Once a patentee has filed for infringement, s/he might decide to take the potential infringer to trial or to reach an out-of-court agreement. Literature argues that under perfect certainty with regard to the case outcome—and therefore complete and symmetric information—it would be irrational to spend money on a trial and, thus, a dispute settlement is most likely (Bebchuk, 1984; Kesan and Ball, 2006; Meurer, 1989).

Early studies on the economic reasons of a settlement or trial decision in general legal disputes deal with the private (Baxter, 1980; Gould, 1973; Landes, 1971; Posner, 1973) as well as social incentives of the litigants (Shavell, 1982).[98] More recent research follows a game-theoretic approach, considering legal disputes as a bargaining game between the parties influenced by asymmetries as to information, expectation, and value at stake (Bebchuk, 1984; Cooter and Rubinfeld, 1989; P'ng, 1983; Priest and Klein, 1984). According to the "divergent expectations theory" (Waldfogel, 1998, p. 451), Priest and Klein (1984) argue that the influencing factors on settlement or going to trial are purely economic. The authors assume that only the most uncertain disputes go all the way to a ruling, whereas in more certain cases, the parties are more likely to settle their dispute to save litigation costs. According to their model, settlement will be more likely if the parties share the same expectation about the quality of the dispute and their values at stake. A trial will rather occur if the parties estimate the prospects of winning differently (e.g., the

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[95] In the context of revocation proceedings, the patentee most likely offers the plaintiff a license on favorable terms in exchange for a withdrawal of the suit if s/he anticipates an invalidation ruling. In contrast, the patentee might prefer reaching a final judgment if s/he expects a "valid" decision (see Chapter 5.3). Chapter 5.3 shows empirical evidence for this argumentation.

[96] Weatherall and Webster (2014) mention that settlement might also be driven by financial constraints of one party, making it impossible to reach a final decision.

[97] To the best of my knowledge, the studies on settlement of patent disputes exclusively deal with infringement proceedings.

[98] According to Shavell (1982), compared with private incentives, which include costs and benefits considered separately for each party, social incentives include the costs and benefits for plaintiff as well as defendant. Thus, social costs, for example, comprise the legal expenses of plaintiff and defendant, but no public expenses such as court operation costs.

plaintiff is significantly more optimistic than the defendant) and when the settlement costs are high compared to the costs of litigation (Priest and Klein, 1984).[99] Katz (1987) further showed that the litigation probability is promoted by a better cost-benefit ratio.[100] In line with the "asymmetric information theory" (Waldfogel, 1998, p. 451), Bebchuk (1984) models the settlement decision assuming asymmetric as well as incomplete information. Since only one party has information on his/her private odds of winning the trial, s/he will merely accept a settlement amount greater than the expected payoffs for a litigation success. The settlement likelihood is again influenced by the costs of litigation and the values at stake for the litigants (Bebchuk, 1984).[101] According to Cremers (2004), the model by Priest and Klein (1984) has evolved into the standard model for patent-related disputes.[102]

Based on these general models, Weatherall and Webster (2014) grouped the reasons for a trial versus a settlement decision—in patent-related cases—into four categories, justifying the categorization by quoting different studies:

1. Diverging expectations about the trial outcome due to legal uncertainties or asymmetric information;
2. Different stakes;
3. Fast and inexpensive courts;
4. Strategic reasons.

Regarding an increased trial likelihood due to diverging expectations (1), Weatherall and Webster (2014) quote Moore (2000), who proposes that a rise in jury trials might be a reason for the increase in U.S. patent litigation because jury trials are assumed to be relatively unpredictable and therefore related to a higher degree of uncertainty. Concerning the influencing nature of different stakes (2), the authors draw from the studies by Moore (2000), Somaya (2003), and Farrell and Merges (2004). Thus, a plaintiff is said to have more at stake as s/he might risk losing his/her patent in a parallel validity examination, increasing the intention to settle (Weatherall and Webster, 2014). With regards to fast and inexpensive courts (3), Meurer (1989) shows in his cost model that litigants prefer trial to settlement due to the high costs associated with the settlement

[99] Assuming a symmetrical distribution of information on values at stake, as well as the winning probability, and contrary to that diverging expectations of the outcome as well as the gains from a trial.

[100] Thus, lower costs than potential gains will favor litigation.

[101] See Waldfogel (1998) for a summary of the divergent expectations and asymmetric information theories.

[102] This is due to the nature of IP-related information that is easily accessible at low costs, resulting in a symmetric information distribution (Cremers, 2004).

option.[103] Hence, lower court costs can further stimulate a trial decision. Strategic reasons (4) can also influence the decision to choose the litigation option. Weatherall and Webster (2014, p. 16) argue that "plaintiffs desire their day in court for strategic reasons (to perhaps establish a reputation for aggression)." In this context, Harhoff and Hall (2002) revealed that more aggressive opponents are less likely to become involved as defendants in opposition proceedings than others.[104] Chien (2009) further supports the assumption that this approach might be strategically motivated. She argues that selective enforcement has a signaling character that keeps others from imitation (cf. Weatherall and Webster, 2014).

In contrast, Cremers and Schliessler (2012) in analyzing German cases found evidence that specific events during a patent litigation trial positively influence the likelihood of reaching a settlement decision. These events can be connected to some of the categories defined by Weatherall and Webster (2014). Drawing from Cremers and Schliessler (2012), consulting an expert during the trial can minimize possible information asymmetries. This might adjust the parties' expectations on winning and lead to an increased settlement probability (1). Moreover, the potential threat to the patentee of losing his/her patent due to a filed revocation action during an infringement proceeding changes the values at stake (2), increasing the likelihood of a settlement (Cremers and Schliessler, 2012). Also, when judges specify the jurisdictional value of the action, indicating the value at stake and therefore the potential court cost the losing party must reimburse, the parties can better estimate the relevance and value of their dispute. Thus, according to Cremers and Schliessler (2012), deciding on a high jurisdictional value drives the costs of a trial, which renders a settlement more attractive (3). With regard to the strategic reasons (4), Duchêne and Serfes (2012) propose that a settlement between two incumbents and the disclosure of a high settlement amount might deter outsiders from potential market entry as the patent is seen to be strong and an entry will not pay off.[105]

3.4 Uncertainties in the Patent System

As indicated above, to fulfill its purpose—to promote innovation—the patent system needs to provide certainty. The patentee especially needs to be certain about the

[103] According to Meurer and Bessen (2005), settlement can be quite costly "because it sacrifices some of the monopoly profit" (Meurer and Bessen, 2005, p. 5).

[104] See also Harhoff et al. (2007).

[105] Assuming that the potential entrant can enter the market by infringing on the incumbent's patent (Duchêne and Serfes, 2012).

degree to which s/he can rely on his/her exclusion right. The possibility to enforce patents is therefore essential for the patent system to work. However, enforcement may fail because the focal patent is revoked. In fact, much infringement litigation is decided by invalidation of the patent in suit, an observation that Lemley and Shapiro (2005) aptly capture with their notion of "probabilistic patents." This uncertainty about a patent's legal robustness entails inefficiencies for a number of parties.

First and foremost, the *patentee* cannot fully rely on its patents.[106] S/he is uncertain about the extent to which his/her investment in an invention is protected and therefore the degree of which s/he might profit from the innovation.[107] Possible enforcement actions might further induce costs and will negatively influence the investments in case of an invalidation of the focal patent. Besides, *third parties* are facing more exclusion rights than should have legally been granted. This forces them to invent around specific patents, which causes increased R&D costs and might even lead to a complete avoidance of the focal inventions. Beyond that, making proper patent clearance more difficult, the high amount of exclusion rights—valid and latently invalid—further increases the risk for third parties to infringe on patents. Finally, *policy makers* might be concerned about an overall reduced incentive to innovate due to an avoidable amount of transaction costs and a high level of uncertainty—which is said to be one of the main determinants hindering innovative activities (Leifer et al., 2000).

The uncertainty about a patent's legal robustness is one of several uncertainties that contribute to the probabilistic nature of patents. Gans et al. (2008) classify these types of legal ambiguities as follows: patent grant uncertainty, patent scope uncertainty, patent pendency uncertainty, and patent enforcement uncertainty. The uncertainty related to patent grant and scope can best be described in a statement by Alison Brimelow, former president of the EPO: "If you spend several years waiting for a decision, you and others can play 'rich man's poker', taking a bet on what your rights are going to be […]."[108] Building, however, upon the findings of several studies analyzing the actual grant rate in different countries reveals that a large share of applications are at least granted in some form (Gans et al., 2008). According to this, patent grant rates reach roughly 90% at the

[106] From a patentee's point of view, valuable are only those property rights that really deliver what they promise (Ann, 2009).

[107] See Chapter 2.1 for further determinants of profiting from innovation.

[108] http://271patent.blogspot.de/2009/05/defensive-patenting-and-deferred.html, accessed July 06, 2015.

USPTO and approximately only 5%[109] of applications are refused at the EPO (Lazaridis and van Pottelsberghe de la Potterie, 2007; Quillen and Webster, 2009; van Pottelsberghe de la Potterie, 2011).[110] Due to the fact that the majority of patents are granted in some form, the uncertainty about the patent scope remains until "the last court speaks" (Gans et al., 2008, p. 984). Thus, even after a grant decision, the scope might be restricted in the course of an opposition or revocation action. Pending patents can cause a further source of uncertainty in the context of patent grant. Analyzing 443,988 applications at the German Patent Office, Henkel and Jell (2010) find that more than 50% show applicant induced delays before examination is requested. The results of a follow-up survey among inventors reveals that an important reason for delaying the granting process is to expose competitors to a longer period of uncertainty about the possible scope of the focal patent protection (Henkel and Jell, 2010). Yet even after a successful patent grant, uncertainty remains regarding the possibility to enforce a patent; the validity of the patent claims especially involves a high degree of uncertainty. In this context, Lemley and Shapiro's (2005) notion of "probabilistic patents" as property rights include a "substantial" risk of being revoked. "When a patent holder asserts its patent against an alleged infringer, the patent holder is rolling the dice. If the patent is found invalid, the property right will have evaporated." (Lemley and Shapiro, 2005, p. 75). It happens quite frequently that inventions illegitimately receive patent protection. This phenomenon is closely linked to the high grant rates indicated above. In line with this, Jensen and Webster (2004, p. 421) refer the "acceptance of bad patents" as a "type II error," whereas Meurer (2009, p. 682) describes this examination error as a "false positive"—referring to a positive grant decision even though the proper outcome would have been a rejection or at least a narrowing of the application. Palangkaraya et al. (2011) examined this type of error by analyzing the examination decision for one and the same invention at different patent offices.[111] Their findings reveal that "misclassifications" between patent offices exist, indicating that there are challenges related to a proper validity assessment of an

[109] According to Lazaridis and van Pottelsberghe de la Potterie (2007) 30% of the applications are withdrawn. Their analysis reveals that 54% of the withdrawals might be examiner induced. Refusals and examiner induced withdrawals therefore add up to 23%.

[110] In addition, surveying more than 300 SMEs, Harhoff and Hoisl (2010) identified an average grant rate of 80% in Germany. Besides, analyzing a cohort of patents claiming a 1977 priority date, Harhoff et al. (2003) identified a grant rate of 42% at the DPMA.

[111] Analyzing roughly 25,000 identical inventions granted by the USPTO, with an application and final grant decision at the EPO as well as Japan Patent Office (JPO), Palangkaraya et al. (2011) showed that the probability of a type II error—incorrect grant of a true refusal—is roughly 10%.

application, accompanied by a high uncertainty of the actual validity of already granted patents.[112]

The uncertainty about patent validity can be regarded as particularly serious for several reasons. Unlike the patent grant or scope induced uncertainty, uncertainty originating from patent validity ends only with the expiration of the patent or with a final judgment in a legal action. Furthermore, the assessment of validity can be regarded as more difficult and cost intensive than the identification of a patent infringement. The former mostly depends on an extensive global search for prior art, whereas the latter relates to a given patent and a known product. Furthermore, the degree of uncertainty related to patent validity is likely a financial matter. Since searching for prior art is easier for those parties that can invest more money in searching for novelty destroying prior art, the uncertainty issue might be more severe for smaller parties with fewer resources. Lastly, this kind of uncertainty not only affects individual products but also every third party and should, in principle, be avoidable ex ante through a proper examination.

3.5 Research Question

Based on the high rate of (partial or full) invalidation rulings in patent revocation actions demonstrated in Section 3.2.2, a large number of once granted patents seems to be "latently invalid"—i.e., are valid but would be invalidated if challenged in court. As has been mentioned in the previous chapter (3.4), these patents create an undue uncertainty leading to inefficiencies for the patentee, third parties, and policy makers. Thus, it is important for IP policy makers and management to recognize the degree of the severity of this problem.

Only a small fraction of all patents are litigated, and this fraction is not a random selection. Drawing from Chapter 2.4, several selection stages and mechanisms occur within the process of initiating a potential patent infringement to the final revocation ruling. Moreover, the parties have the opportunity to settle their dispute throughout the procedure (see Chapter 3.3), which further influences the selection process. It may be that those patents that lack legal robustness are litigated, in which case the problem of probabilistic patents would be less severe for the universe of all patents. But it may also be that patents in suit are more robust than the average patent as invalidity decisions are mostly triggered by infringement proceedings, and given the choice, a patentee is more

[112] The authors build their model on the misclassification model developed by Hausman et al. (1998). In the context of their study, misclassification "occurs when a true grant is refused or a true refusal is granted" (Palangkaraya et al., 2011, p. 1064).

likely to enter these with robust patents.

With this study, I address a rather simple, yet quite important question: What would be the odds of being invalidated, if a randomly picked patent underwent a revocation proceeding? Put differently, what share of all patents would, if they went through invalidation proceedings, be ruled invalid? Are these prospects higher or lower than the share of patents that, after being challenged in court and adjudicated, actually reach an invalidation decision? In other words, do the selection effects at work lead to patents whose validity is tested in court being more robust or less robust than the average patent? To address these issues, I analyze the question of what role certain determinants play in the revocation process. Would the theoretical rate of invalidation be even higher than the actual observed rate if specific characteristics influenced the outcome of the proceedings? Of particular interest in this case is the influencing nature of the parties involved, which has, to the best of my knowledge, not been analyzed in a comparable manner (see Chapter 3.2.2).

Miller (2013) addresses the question of a potential invalidation rate of a randomly picked patent for the U.S., analyzing 980 patents that received a court decision on innovation-based validity between 2000 and 2010. He finds that 37% of these patents were partially or fully invalidated due to either anticipation or obviousness, and estimates a share of 28% of partial or full invalidation for the entirety of all patents applied for on the same days as the adjudicated patents.[113]

While addressing largely the same question for the case of Germany—the difference being that I study validity in general rather than innovation-based validity—I build on and complement Miller's (2013) study in three respects. First, I applied multiple methods and data sources, which are further explained in Chapter 4. Moreover, I collected and analyzed more detailed data than Miller (2013) on the parties involved in the proceedings (see Chapter 4.2.2.1.2). Third, my analysis focuses on Germany, where the bifurcated system allows for a very thorough examination of the revocation proceeding because it is detached from the infringement action (see Chapter 2.3.3).

[113] Miller's (2013) focus on patents that received a decision on "innovation-based validity" rather than on validity in general implies that the numbers he reports cannot be directly compared to overall invalidation rates.

4 Research Approach and Data

To answer the aforementioned research question, the study builds on a combination of qualitative and quantitative research methods. Denzin (1970, p. 291) defined this *between-method triangulation* as "the combination of methodologies in the study of the same phenomenon." The benefit of combining methods of different types is that it "provide[s] a more elaborated understanding of the phenomenon of interest" (Johnson et al., 2007, p. 119) and therefore enhances the value and quality of the results (e.g., Eisenhardt, 1989; Greene et al., 2001; Jick, 1979; Punch, 2005; Rossman and Wilson, 1985).

The approach of the present study involves, in total, three methodological methods —one qualitative and two quantitative. Figure 3 illustrates the overall procedure followed in this study.

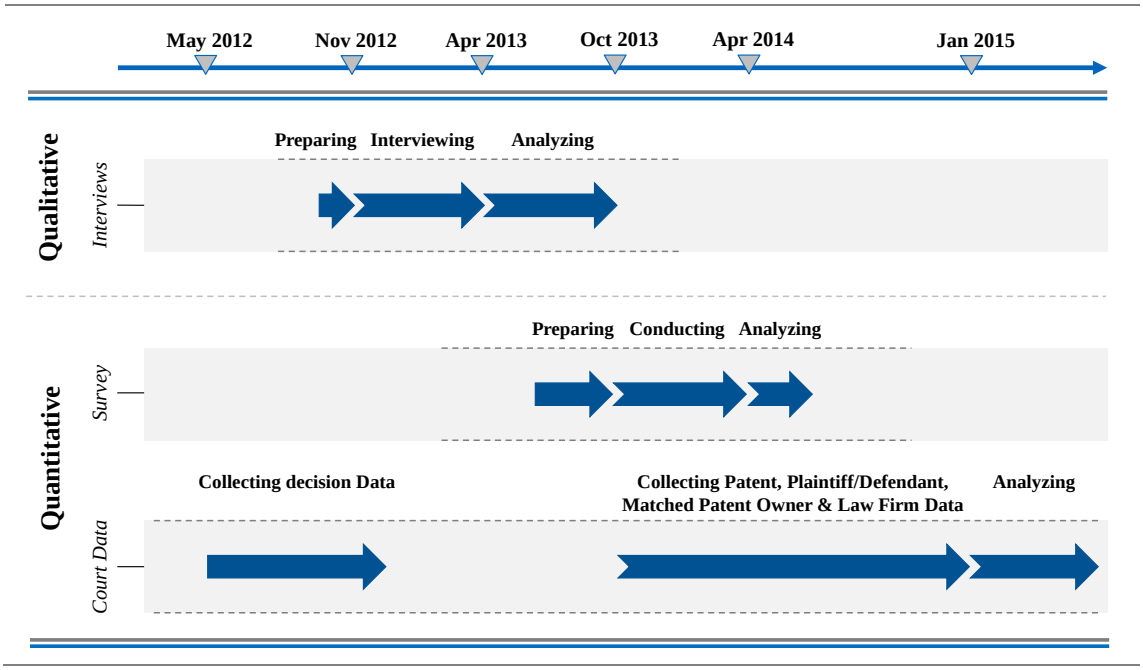

Figure 3: Research approach

The subsequent sections provide an overview of the qualitative (4.1) as well as the quantitative methods (4.2) applied.

4.1 Qualitative Study on German Patent Revocation Proceedings

Qualitative research methods are especially useful in the early stages of a research project as they allow for exploring a topic and increasing the researcher's knowledge base in the respective field of study (e.g., Bortz and Döring, 2002; Bryman, 1988; Creswell, 2013; Punch, 2005). Thus, to gain further insights into the nature of patent revocation

proceedings as well as the factors influencing these proceedings at the various stages of the process (see Figure 2), a qualitative research approach was chosen to initially enrich the theoretical background on patent invalidation (see Chapters 2 and 3) with practitioners' knowledge. In the following, I will provide an overview of the specific qualitative method used in the present study.

4.1.1 Data Collection through Semi-Structured Interviews

Differentiating by the degree of standardization, there are three types of interviews: unstructured (explorative), semi-structured, or standardized (e.g., Lamnek, 2005; Punch, 2005; Schnell et al., 2005). The correct choice of type depends on the stage and the aim of the research project. According to Lamnek (2005), semi-structured interviews—the prevailing form of qualitative interviews (e.g., Bortz and Döring, 2002; Flick, 2009)—is seen to be the most appropriate method for exploring the underlying field of research as well as developing propositions.

Semi-structured interviews rely on a loose structure including open-ended questions and, therefore, allow for enough room and flexibility to stimulate new issues as well as further questions during the course of the dialogue—increasing the likelihood of a more comprehensive view of the interviewee's experience and the focused field of study (e.g., Schnell et al., 2005). To guarantee comparability between the different interviews and to ensure that all important questions are asked, a guideline serves as a framework for the dialogue (e.g., Flick, 2009; Schnell et al., 2005; Stier, 1999). During a semi-structured interview, however, the interviewer might change the order of the questions, which increases the flexibility and enables the interviewer to adapt to specific interview situations.

Since the quality of the interview results closely relates to the interviewees' know-how in the respective field of study, the proper interview partners (experts) have to be identified (Flick, 2009). Furthermore, to achieve a comprehensive picture of the respective field of study, it is of particular importance that the interviewees' expertise contributes to the focal topic from various perspectives (Eisenhardt and Graebner, 2007). The interview partners were carefully selected based on the following criteria. First, the interviewees needed to be experienced in the underlying field of study, i.e., familiar with infringement and revocation proceedings and senior with respect to professional experience. Second, the interviews should provide a comprehensive view of the topic, thus, the interviewees were selected from different professions as well as different technological backgrounds. Among the interview partners are judges from the Federal

Patent Court and Federal Court of Justice, representatives of the patent office, lawyers and patent attorneys—both with and without former industry experience. Table 2 provides a list of the conducted interviews.

No.	Profession	Position	Type	Date	Duration
1	Judge	Presiding Judge	face-to-face	05.11.2012	01h 48min
	Judge	Judge			
2	Lawyer, Certified IP-Lawyer	Partner	face-to-face	06.11.2012	01h 47min
	Patent Attorney	Partner			
3	Judge	Presiding Judge	face-to-face	09.01.2013	01h 06min
4	Patent Attorney	Partner	telephone	10.01.2013	01h 07min
5	Lawyer	Vice President Legal / International Affairs	face-to-face	14.01.2013	01h 34min
	Lawyer	Directorate International Affairs			
6	Patent Attorney	Co-leader of a Chemistry Group	face-to-face	17.01.2013	02h 02min
7	Patent Attorney	Partner	face-to-face	21.01.2013	01h 03min
8	Judge	Co-presiding Judge	face-to-face	08.02.2013	01h 35min
9	Patent Attorney with former industry experience	Partner	face-to-face	06.03.2013	02h 06min
10	Patent Attorney	Managing Partner	face-to-face	15.03.2013	01h 28min
11	Patent Attorney	Partner	telephone	23.03.2013	01h 32min
12	Lawyer with former industry experience	Principal	telephone	27.03.2013	01h 22min

Table 2: List of interviews

Prior to the interviews, I sent out an e-mail to each identified interviewee that included sufficient information on the purpose and the background of the study as well as the expectations toward the upcoming interview. Due to this information, three of the 12 contacts invited another colleague to the appointment, as they believed that additional expertise could be valuable for certain issues. In total, 12 semi-structured interviews with 15 different experts were conducted between November 2012 and March 2013.[114] The interviews took between 1h 06min and 2h 02min, which resulted in 19 hours of interviews, corresponding to an average duration of 1h 35min. After assuring the interviewees a strict anonymous and confidential treatment of any personal data, all of the conversations were—as recommended by Creswell (2014) or Mayring (2002)—fully

[114] These included three phone and nine face-to-face interviews (see Table 2).

recorded and additional notes were taken.

As a framework, I used an interview guideline based on the invalidation process and the various selection stages (see 2.4). The interviews started with general questions related to infringement and revocation proceedings. With respect to the research questions, the interviewees were guided through the process and asked for determinants influencing each stage. The participants were further asked to assess the importance of these factors. The questions had an open form and often initiated lively discussions. As proposed by Eisenhardt (1989), I slightly adjusted the guideline after the first interviews as new information arose. The final version of the guideline can be found in Appendix A1.[115] To guarantee an optimal understanding of the interview questions, I presented several slides that included facts and figures related to the infringement and revocation process during the interviews.[116]

4.1.2 Data Analysis and Quality

4.1.2.1 Analyzing Interview Data

All of the recorded interviews were fully transcribed into written German and analyzed with QSR's Nvivo 10, using a structuring content analysis technique as described by Mayring (2002; 2004). Following Miles and Huberman (1994), a combination of deductive and inductive approaches were applied to develop the final coding scheme.[117] Bases on these procedural steps, the entire analyzing process can be divided into three parts (see Figure 4).[118]

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[115] The introductory questions and general questions on revocation proceedings are followed by questions on the determinants of patent infringement, patent infringement proceedings, selection into and outcome of patent revocation suits, the development and outcome of appellate proceedings, out-of-court decisions, and some concluding questions.

[116] For the phone interviews, I sent the slides via e-mail to the interview partners prior to the scheduled interview date.

[117] According to Bortz and Döring (2002), the deductive coding approach is theory driven, whereas the inductive approach does not rely on a preliminary structure and is therefore directly deducted from the source material (Glaser and Strauss, 1967). For the underlying study, I started with a deductive approach followed by an inductive coding procedure (see Figure 4).

[118] In the following "category," "codes," and "nodes" are used synonymously.

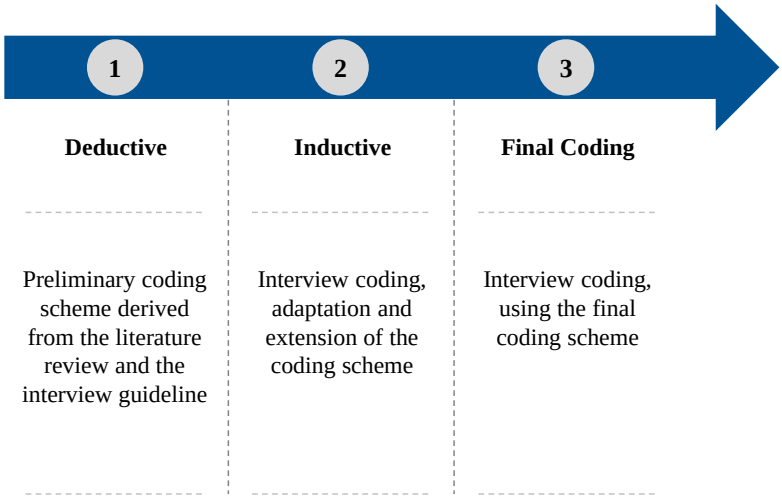

Figure 4: Qualitative data analysis procedure

Step one includes the creation of a preliminary coding scheme derived from the literature review and the interview guideline. This list of nodes served as a groundwork for *step two*, in which the interviews were stepwise analyzed. Whenever a statement fitted to one of the deductively derived codes, it was categorized respectively. If a valuable statement could not be matched with one of the existing nodes, the initial category scheme was extended with an inductively derived new code. After approximately two-thirds of the interviews, no new categories had to be added to the coding scheme. Controlling for logic and possible interferences, I modified the resulting list where necessary. In a *third step*, I used the final coding scheme to code all interviews in an iterative manner. The final list of codes includes 269 codes on five levels.[119]

4.1.2.2 Quality of Interview Data

Following Mayring (2002), the results of an empirical research approach have to be assessed using certain quality criteria. Among others, Miles and Huberman (1994) propose that the following classical criteria from quantitative research can be transferred to qualitative research: objectivity, reliability, and validity.

Objectivity—also referred to as "external reliability" in the qualitative context—stipulates intersubjective consistency. Thus, different scholars should be able to rerun the study with identical results by applying the same methods while analyzing the same research question (e.g., Flick, 2009; Miles and Huberman, 1994). A transparent documentation of the entire research approach, including a particular degree of standardization, is therefore essential. The use of a standardized interview guideline and

[119] See Appendix A2 for an excerpt of the final coding scheme.

the precise documentation of the entire qualitative approach—from interviewee selection to the data analysis—guarantees a high degree of transparency and standardization. The objectivity criterion can, thus, be considered fulfilled for this study.

Reliability generally "refers to the extent to which studies can be replicated" (LeCompte and Goetz, 1982, p. 35). In a qualitative research setting, however, the criteria is not easy to assess as the interview situation is characterized by a high degree of individuality—and therefore limited replicability—as well as context specificity (Bortz and Döring, 2002; Lamnek, 2005). Although, as for the objectivity, the standardized procedure applied allows for a high degree of repeatability as well as consistency and should therefore ensure the reliability of this study. The demonstration of additional information material during the interviews guaranteed a common understanding across all interview partners. While talking to different experts—covering a broad range of perspectives from different stakeholders (see 4.1.1)—highly consistent results could be achieved, which further supports the reliability of the applied approach.

Validity plays an especially important role in qualitative research settings. Thus, it is important to guarantee that the spoken data expresses what it is supposed to address (Bortz and Döring, 2002; Flick, 2009; Punch, 2005), guaranteeing that the researcher really measures what s/he intends to measure (LeCompte and Goetz, 1982). In general, two types of validity measures have to be considered when it comes to qualitative research: *validity of data collection* and *validity of data analysis* (e.g., Gibbert et al., 2008; Strauss and Corbin, 1990). Referring to the underlying study, v*alidity of data collection* is achieved by checking for and ensuring consistency within the same data source as well as in between the statements of different interview partners. In case inconsistent statements occurred, the respective interview partners were directly asked for possible explanations—or ex-post to review their statements. Furthermore, external data sources were used to verify the interview conclusions.

As to *validity of data analysis, internal and external validity* have to be reviewed (Bortz and Döring, 2002; Miles and Huberman, 1994; Punch, 2005). *Internal validity*—the credibility of interpretations—measures the degree of interpersonal consistency in terms of interpreting the data. In the present study, intercoder reliability (Miles and Huberman, 1994) could not be tested, as the coding has been done by only one researcher.[120] However, several interviews have been conducted by two researchers and

[120] The fact that every interview was coded twice, however, ensures a high degree of intrapersonal consistency.

a common understanding and interpretation of the results was directly clarified. Furthermore, the legal focus of the study and legal background of the participants resulted in clear-cut answers, minimizing the scope for ambiguous interpretations. I further integrated a wide range of perspectives from different stakeholders, including judges, lawyers, patent attorneys and employees from the patent office, to control for conformity of the results throughout different practical backgrounds. The interviewees agreed on all of the important questions. Moreover, the subsequent quantitative survey among patent attorneys and lawyers verifies the interview results on a larger scale. Summing up, the present study can be assumed to fulfill the criterion of internal validity.

External validity—the generalizability of interpretations—measures to what extend the findings of a study are transferable to another context (Bortz and Döring, 2002; Miles and Huberman, 1994). For the underlying study, transferability of the qualitative results, for example, to other legislations, can be assumed. As argued in Chapter 7, the findings regarding the selection effects (see Chapter 2.4) should carry over to other jurisdictions. Since the bifurcated German system can be regarded as a more "complicated" system (in terms of potential selection effects at work), the results should hold for legislations like the U.S. as well as for other countries with bifurcated court systems. In sum, I feel confident that the approach and findings ensure a certain degree of generalizability and therefore the present study complies with the external validity criterion.

4.2 Quantitative Study of German Patent Revocation Proceedings

While the qualitative approach enables an initial understanding of the different stages in the invalidation process and the possible factors driving patent revocation, combining these qualitative findings with quantitative methods helps to achieve a better understanding of the quantitative nature of these determinants (cf. Creswell, 2014). To gain a larger scale insight into the main factors influencing the patent revocation process at the various selection stages, I applied two quantitative methods. Section 4.2.1 provides a methodological overview of the survey conducted among patent attorneys and lawyers, followed by an overview of the data used for the multivariate analysis of German Patent Court decisions, including parties and patents involved (4.2.2).

4.2.1 Survey among Patent Attorneys and IP Lawyers

As a second source of triangulation, a large survey among patent attorneys and lawyers was conducted to verify and extend the results of the interviews and to test and answer the research questions derived from the literature and interviews (Creswell, 2014;

Greene et al., 1989; Jick, 1979; Snow and Thomas, 1994). The following sections describe the methodological steps of the survey procedure.

4.2.1.1 Designing the Survey

The survey was designed after the qualitative study had been completed (cf. Creswell, 2014, pp. 225–227). Based on the interview results and research questions, a five-page, paper-based questionnaire was developed to gain further insights into the proceeding's selection process. The survey is composed of four main parts and includes, among others, the following sets of questions (see Appendix A3 for the complete survey):

A. Personal Questions

The first part contains personal questions on the participants' professional career. Participants were asked for their experience with infringement and revocation proceedings as well as for the technical field on which their work is focused. Furthermore, this section contains questions on the participants' clients, including, for example, the size of the clients that participants usually represent in a revocation proceeding.

B. Influencing factors on infringement and revocation proceedings

The second part includes questions as to the factors that influence the likelihood that a patent might enter an infringement as well as a first instance revocation proceeding. Participants were asked for the impact of different determinants on the probability of an invalidation decision in case a patent becomes subject to a revocation action. In addition, this part includes a question on the hypothetical outcome of revocation proceedings that were withdrawn or settled out of court.

C. Influencing factors on appellate proceedings

The third part focuses on the appellate proceeding, including questions on the factors influencing the likelihood that a patent enters a second instance proceeding. A question referring to the share of withdrawals in appellate cases (and therefore an ineffective first instance decision) was also part of this section.

D. Questions regarding participants' employer

The survey concludes with questions related to the participants' employers, including the employers' size and the share of employees predominantly engaged in the field of patent revocation.

In total, the participants had to answer 22 questions, none of which was mandatory. The questionnaire was primarily based on closed-ended, as well as some open estimation, questions. In terms of questions related to the factors influencing the infringement/revocation proceedings, the participants were asked to indicate their assessment on a five-point Likert scale. For some of these questions I provided a "no answer possible" response option to avoid random replies (cf. Schnell et al., 2005).[121]

For reasons of quality and clarity improvement, I conducted several pre-tests preceding the final data collection (e.g., Backstrom and Hursh-César, 1963; Bortz and Döring, 2002; Churchill, 1976; Hunt et al., 1982; Schnell et al., 2005). In line with the recommendation by Tull and Hawkins (1976), the questionnaire was reviewed by five patent attorneys (targeted population) as well as two patent scholars before the launch. Among others, the experts were asked to review the survey for definition accuracy, clarity of questions and answers, logic, and lengths. The patent scholars primarily checked the types and order of questions, the wording, and the format. I received predominantly positive feedback by telephone or mail. Thus, the structure of the questionnaire remained unchanged and only minor rephrasing was needed to guarantee an optimal understanding. Based on the feedback, I further included an additional question referring to the role of the plaintiff's budget (in the revocation proceeding) on the likelihood of an invalidation ruling. The pre-testers indicated a reasonable average duration of 5-10 minutes for completing the survey.

4.2.1.2 Identifying and Selecting Appropriate Participants

As for the interviews (see section 4.1.1), it was essential to identify qualified participants for the survey, ensuring a certain degree of know-how in the field of patent infringement and revocation proceedings. The targeted population for the survey comprised patent attorneys and IP lawyers working for national and international law firms with offices in Germany. There are currently 3,444 accredited patent attorneys in Germany (Deutsches Patent- und Markenamt, 2015b) and a considerably smaller number of IP-related lawyers. However only a fraction of them is involved in patent infringement and/or revocation proceedings and therefore the appropriate focus group for the survey. To reach this target group, I applied a two-step identification process: (1) *identification of the suitable law firms* and (2) *identification of the suitable attorneys.*

[121] In this context Schnell et al. (2005, p. 337) define the "no answer possible" options as a "non-attitude" option.

Fundamental for the (1) *identification of the suitable law firms* was a list of patent law firms in the field of patent litigation as well as a list of further recommended patent law firms, both provided by the JUVE publishing house's *JUVE Handbook German Commercial Law Firms 2013*.[122] Based on a large amount of interviews and a survey among lawyers and clients, JUVE identified the law firms and attorneys with a certain degree of reputation in the respective field of law.[123] These lists served as a starting point for the (2) *identification of the suitable attorneys*. By thoroughly searching for and analyzing the listed law firms' websites and by individually examining every listed employee profile, I was able to identify patent attorneys and lawyers engaged in infringement and, in particular, revocation-related proceedings—the target group.[124] This approach resulted in a list of 1,165 potential participants (74% patent attorneys and 26% lawyers) working for 100 different national and international law firms with offices in Germany. For these contacts I gathered all available and relevant information. In addition, I derived missing contact information from the German patent attorney register.[125]

4.2.1.3 Conducting the Survey

To maximize the survey's response rate, I followed the suggestions by Dillman (1978, p. 12): "minimize the costs of responding, maximize the rewards for doing so, and establish trust so that those rewards will be delivered." According to these recommendations, I tried to *minimize the costs of responding* by providing the participants a choice of medium. The 1,165 potential participants received a paper-based questionnaire including a personalized cover letter, the survey, and a postpaid envelope.[126] Thus, they were able to reply using the provided envelope,[127] returning the survey by fax, or by scanning and mailing the completed questionnaire to the given e-mail address. Further, the cover letter included a short link (http://bit.ly/nichtig) to an

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[122] See http://www.juve.de/handbuch/de/2013/ranking/24450#ranking-24450; http://www.juve.de/handbuch/de/2013/weiterekanzleien/24450#weiterekanzleien-24450, accessed May 31, 2013.

[123] See http://www.juve.de/handbuch/recherchekriterien (accessed July 05, 2015) for a detailed explanation of JUVE's identification process.

[124] I did not include those patent attorneys and lawyers in the list of potential participants who are obviously not engaged in patent infringement and/or revocation-related issues. In cases where the law firm's website indicated no clear job description, I included all specified patent attorneys and IP lawyers—assuming that they are familiar with all of the firm's activities, including patent revocation.

[125] See http://www.patentanwaltsregister.com/Default.aspx?AspxAutoDetectCookieSupport=1, accessed June 06, 2015.

[126] See Appendix A4 for cover letter.

[127] Following Ferris (1951) and Fox et al. (1988), a postpaid and addressed return envelope positively increases the response rate.

online version of the questionnaire, enabling an easy online participation, without the need of any further registration.[128] In order to *reward for participation*, the respondents were promised an exclusive report of the survey results. In addition, there was a chance to win 20 bottles of the champagne-style beer "Infinium."[129] Finally, *trust was established*, by placing an announcement in the newsletter of the chamber of patent attorneys in Germany (PAK),[130] one week prior the survey launch (see Appendix A5 for the announcement).[131]

The survey was launched in October 2013 and remained in field until April 2014. I reminded the non-respondents with two follow-ups (four and seven weeks after the initial distribution) by sending out personalized e-mails including a link to the online version as well as an attached digital version of the questionnaire. The survey results delivered to the participants via e-mail, included a link to an additional question, including a supplement to the question regarding the hypothetical outcome of the revocation proceedings withdrawn or settled out of court (see 4.2.1.1).[132] Due to the high effort put into identification and contacting the participants, 323 questionnaires were returned, resulting in an overall response rate of 28%.

To control for possible differences among the group of respondents and the group of contacts that had not answered the survey, I performed a late-response analysis. Following Armstrong and Overton (1977) as well as Kanuk and Berenson (1975), those participants answering the survey with a large delay are more similar to those contacts that have not answered the survey at all than to those who responded early and needed "less prodding" (Kanuk and Berenson, 1975, p. 449). For the purpose of the late-response analysis, the study differentiates between the early and late respondents, using the date of the first follow-up message. All of the survey variables were tested on the null hypothesis that there is no difference between the two groups. The results (see Appendix A7) indicate

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[128] Using QuestBack's Unipark online survey platform.

[129] Among others, possible measures to maximize the reward for participation is to offer tangible rewards or to ensure that the questionnaire is interesting (Dillman, 1978).

[130] This is a bi-monthly newsletter sent out to all patent attorneys registered in Germany.

[131] According to Fox et al. (1988), survey prenotification and a university sponsorship—in this case the Technische Universität München—positively influences the response rate. Further, trust among the target group could be established with the support of the PAK, enabling the distribution of the survey announcement.

[132] The respondents were asked to assess (on a five-point Likert scale) to what degree a partial as well as a full invalidation might occur for patents involved in cases that were withdrawn or settled out of court, compared with those proceedings that reached a final judgment (see Appendix A6 for the additional question).

that early respondents are significantly more experienced in terms of the number of years they have been working in the field of patent revocation (p=0.009) as well as in the number of already experienced second instance revocation proceedings (p=0.006). Thus, it is possible to argue that the responding survey participants seem to be more experienced in the respective field of study than those who have not answered. This outcome further increases the value and explanatory power of the survey results. Moreover, lawyers seem to have answered the survey earlier than patent attorneys (p=0.004) and participants from smaller law firms responded before contacted persons working for larger law firms (p=0.018).[133] This finding should not negatively affect the quality of the results, since the responding lawyers have, on average, been involved in significantly more cases than the participating attorneys (p=0.001), although they are at an average less experienced with revocation proceedings in terms of years (p=0.047). A possible non-response bias can therefore be regarded as neutral. Furthermore, there seems to be no significant difference as to law firm size and revocation suit experience (years and number). Finally, the early respondents estimate the value of the patents in the second instance revocation decision higher than the late respondents (p=0.088). As the early respondents are found to be more experienced in second instance revocation proceedings than the late respondents, the survey finding can be regarded as an accurate estimation of patent value in the second instance.

4.2.1.4 Survey Demographics

In the following, descriptive data is provided on the survey participants as well as the law firms they worked for at the time of the survey.[134]

Personal descriptives: The demographics show that 64% of the respondents are patent attorneys, whereas 36% are lawyers by profession (see Figure 5).

[133] Possibly a result of leaner firm structures.

[134] To preserve anonymity, all the variables were asked as categories.

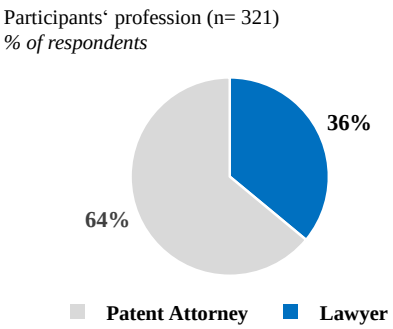

Figure 5: Participants' profession

In addition, participants were asked to assign their field of work to one or more technical sectors.[135] According to Figure 6, the respondents are almost equally engaged in the fields of mechanical engineering and electrical engineering and IT. The chemistry and biotechnology industry is represented to a slightly lower degree, whereas the fewest respondents affiliate themselves with the instruments sector.[136]

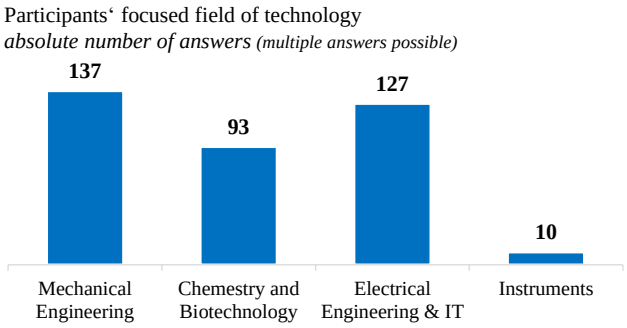

Figure 6: Participants' focused technical field

Concerning the respondents' professional expertise in the respective field of study, Figure 7 illustrates that the median participant was involved in 11-20 infringement proceedings, 6-10 revocation proceedings, and has 11-15 years of revocation suit experience. Moreover, the participants indicated a median experience with revocation proceedings of 11-15 years. Fifty-five percent have been dealing with revocation proceedings for more than 10 years. These figures reflect a high degree of expertise

[135] The classification of the technical fields is based on the World Intellectual Property Organization (WIPO) IPC-Technology concordance as revised in January 2013 (Schmoch, 2008).

[136] Subordinated industries of the instruments sector are: Optics, Measurement, Analysis of biological materials, Control, Medical technology (Schmoch, 2008).

among the survey respondents, suggesting valid results for the study.[137]

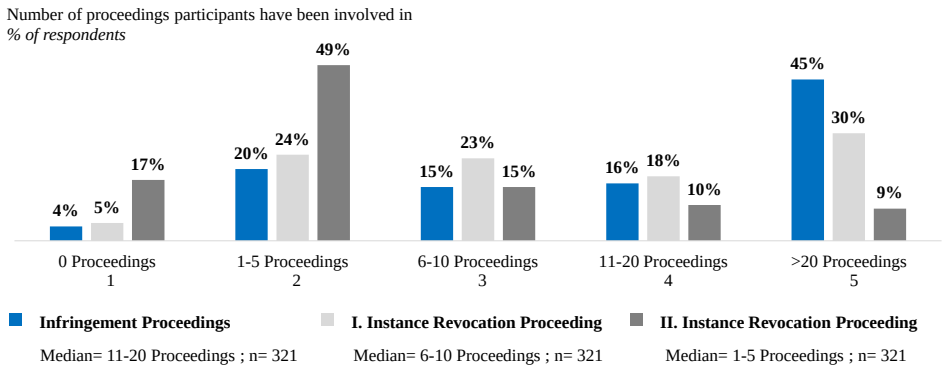

Figure 7: Participants' experience

Furthermore, the participants disclosed that they equally represent defendant and plaintiff (71%) and the majority do not focus on a specific size of client (48%) in a revocation proceeding. However, 36% of the respondents indicated they predominantly represent clients employing more than 1,000 employees (see Figure 8).

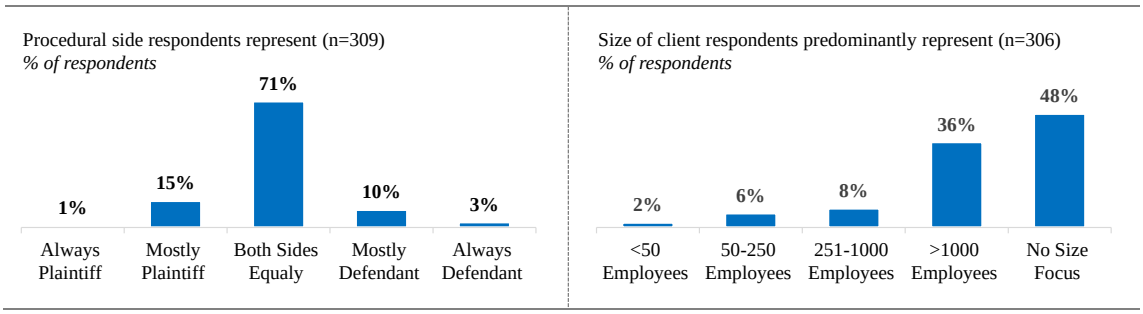

Figure 8: Client side and size

Employer descriptive: 98% of the respondents work for law firms with at least 10 employees. In addition, the data shows that 41% are employed in law firms with more than 150 employees (see Figure 9).

[137] With roughly 250 filed suits p.a., 3,000 registered patent attorneys in Germany, and the assumption that on average two patent attorneys are involved in one suit, a single patent attorney might on average be involved in 1/6 case each year. Assuming a professional life of approximately 30 years, each patent attorney might deal with five cases until his/her retirement. This is, of course, a rough estimate, assuming that every patent attorney is involved in revocation proceedings and that only one attorney represents each litigant. It indicates, however, that the experience of the survey participants with respect to invalidation proceedings is quite high.

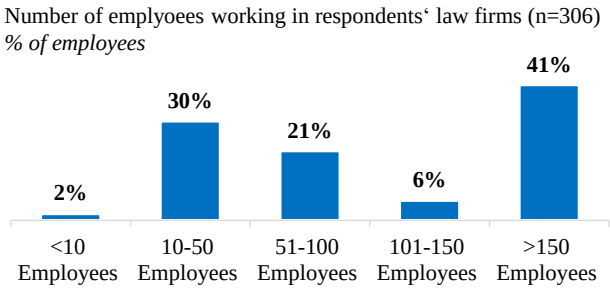

Figure 9: Law firm size (number of employees)

Finally, the respondents specified that the share of employees of the law firm for which they work, focused on patent infringement, averages 28% (see Figure 10).

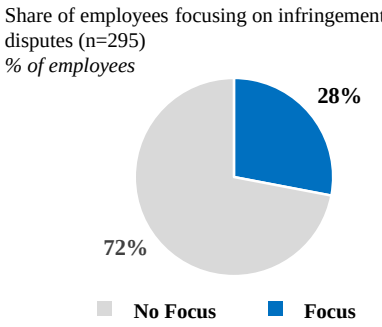

Figure 10: Share of employees focusing on infringement disputes

4.2.2 Multivariate Analysis of Court Decisions in Revocation Proceedings

The third and last methodological approach in this study is a multivariate analysis of court rulings at the BPatG and BGH (see Figure 3). The object of investigation is a unique dataset of all decisions connected to patent validity by the Federal Patent Court between 2000 and 2012 as well as the corresponding appellate decisions by the Federal Court of Justice from 2003 until 2015. The multivariate analysis aims at a verification of the interview and survey results as well as a large-scale identification of factors influencing the selection in and the outcome of a revocation proceeding for the years 2010 until 2012. In the next section, I elaborate on the underlying dataset and its creation (4.2.2.1), followed by a description of the variables derived and used in the further analysis (4.2.2.2).

4.2.2.1 Dataset on Court Rulings and Involved Stakeholders

Just as the research done by van Zeebroeck and Graham (2014) on “Patent Litigation Across Europe” the unit of observation of the present study comprises rulings issued by a court. Thus, the collected dataset only allows for analyzing the final court

decisions of first and second instance revocation actions. Proceedings that settled or were withdrawn before reaching a final judgment were not further examined.

4.2.2.1.1 Collecting Data on Revocation Decisions

Information on the first instance rulings between 2000 until 2012 was sourced from the Federal Patent Court's decision database, which provides online access to all its decisions since 2000.[138] Only those cases that included a ruling on patent validity were selected.[139] The identified judgments were carefully analyzed and a wide range of information was extracted. Among others, data such as file number, decision date, involved patent, plaintiffs' claims, and information on the judgment were identified and included in the dataset.

The first instance data was complemented with the related second instance decisions (if applicable) using the online judgment database of the Federal Court of Justice providing access to all its decisions (by the X. Senate) since 2000.[140] Again, the court rulings were analyzed and relevant information extracted.

The findings were verified by comparing them with a list of all patent validity cases (including their outcomes) filed at the Federal Court of Justice within the last two centuries, which was provided by the Federal Court of Justice's X. Senate. This information allowed for identifying the appellate cases without a final decision on the merits, yet with out-of-court settlements or withdrawals. A detailed view on the descriptives of the dataset is provided in Section 6.1.

4.2.2.1.2 Collecting Data on Parties Involved in the Proceedings

To analyze the influencing nature of the parties involved in the revocation proceedings, it was necessary to identify plaintiff and defendant characteristics. Unlike in other countries (e.g., the U.S.), the German court procedure implies an anonymization of the decisions, not providing any party-specific information within the judgments. Thus, the identification of plaintiff and defendant names was the first step toward collecting party-specific information.

The defendant in a patent revocation proceeding is the registered owner of the

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[138] See: http://www.bundespatentgericht.de/cms/index.php?option=com_wrapper&view=wrapper&Itemid=77&lang=en, accessed July 05, 2015.

[139] The database also includes several other decisions not related to a judgment on patent validity.

[140] See: http://juris.bundesgerichtshof.de/cgi-bin/rechtsprechung/list.py?Gericht=bgh&Art=en&Datum=Aktuell &Sort=12288, accessed July 07, 2015.

patent at time of the case filing (e.g., van Hees and Braitmayer, 2010).[141] To gather this information, the EPO Worldwide Patent Statistical Database (PATSTAT) as well as the International Patent Documentation Center (INPADOC) as of October 2013 were used as data sources.[142] For every patent involved in one of the examined proceedings the patent owner was extracted from PATSTAT. Since the owner of the patent at its grant is not always the owner of the patent when a case is filed (cf. Allison et al., 2009), the INPADOC served as a source to control for a possible owner change prior to the case filing. In cases where an owner change occurred, the reported new owner was considered as the defendant in the proceeding.[143] This approach resulted in an identification of all the defendant names involved in the dataset's cases.[144]

Considerable resources were spent on discovering the corresponding plaintiff in each decision between 2010 and 2012, applying a systematic procedure (Figure 11).[145]

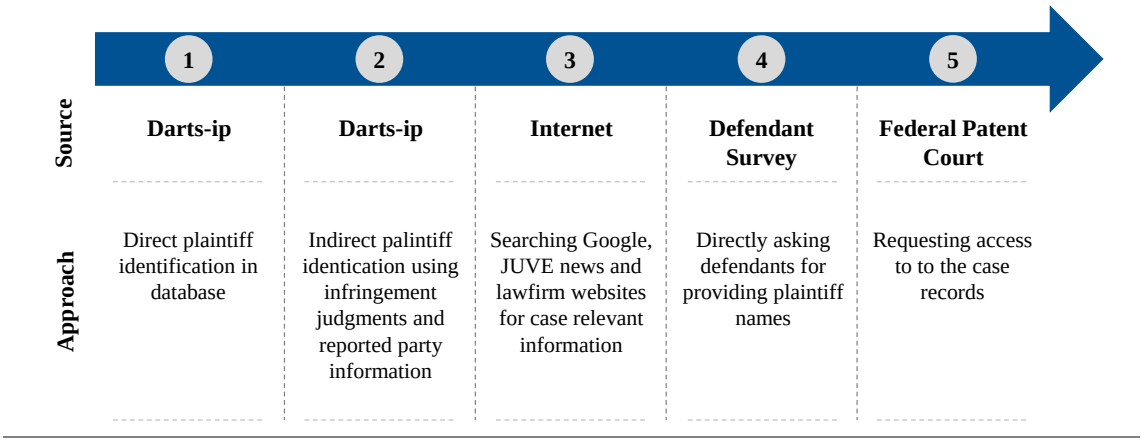

Figure 11: Procedure applied to identify plaintiff names

The global IP case law database *darts-ip* served as a first data source.[146] *Darts-ip* provides almost two million decisions on IP-related cases, including roughly one million patent-specific rulings. Among others, the database enables users to search for decisions

[141] See Section 81(1), second sentence, PatG.

[142] INPADOC is an EPO database, containing legal status information on patents worldwide.

[143] In 14% of the cases considered in the analysis of judgments between 2010 and 2012, an owner change prior to the filing of the case could be identified. No owner change occurred between case filing and decision.

[144] The findings could also be verified by using different data sources explained in the following steps.

[145] Due to a relative complex and time-consuming procedure to identify plaintiffs and the limited availability of company-specific data for earlier periods of time, this study focuses on the years 2010 to 2012 for a more detailed view on the parties involved in revocation proceedings.

[146] http://www.darts-ip.com.

on opposition, infringement, or revocation proceedings. For most opposition and infringement proceedings, plaintiff as well as defendant names are included in the database. However, for the overwhelming majority of revocation proceedings, *darts-ip* only provides the defendant's name and therefore no additional information compared with the initial dataset of the present study. In a *first step,* the *darts-ip* database was used to analyze information connected to the case file numbers of the dataset cases. Thereby, for a small number of proceedings (3%), the plaintiff names could be taken directly out of *darts-ip* and included in the dataset. For the majority of cases, no additional information could be extracted.[147] In a *second step* using *darts-ip,* I analyzed entries connected to the patents involved in the considered revocation proceedings. The IP case law database unveiled that several patents were also subject to infringement proceedings—related or not related to the revocation actions under consideration. In cases where a judgment on infringement was delivered within a few years before or after the decision on revocation, the infringement rulings were carefully analyzed. In several infringement decisions, I was able to determine information on whether the defendant (infringement) has filed for revocation (including the case file number) of the potentially infringed patent. If the identified revocation case file number (in the infringement judgment) matched the one in the dataset, the defendant (infringement) was assumed to be the plaintiff in the revocation proceeding and included in the dataset respectively. Due to this procedure, 24% of the plaintiffs could be identified.

An Internet search served as a *third step* toward a complete list of plaintiff names. This step included searching Google and Google News for different combinations of patent infringement and revocation-related keywords as well as case-specific information such as the case filing number and/or the patent number under consideration.[148] A systematic analysis of the JUVE news as well as the news sections of several law firm websites complemented this approach.[149]

Cases for which I was not able to identify the relevant plaintiff information using the aforementioned methods became subject to a *defendant survey*. In line with this method, defendants were directly contacted and asked to provide the name of the plaintiff

[147] However, a verification of defendant names was possible by comparing the defendants provided by *darts-ip* with the defendants in my dataset of revocation cases.

[148] Among others, "Patentnichtigkeit," "Patentverletzung," "patent infringement," "patent revocation," "patent invalidation,", "nichtig," "invalid," and "Bundespatentgericht" were used as keywords.

[149] For the JUVE news search (see http://www.juve.de/), I primarily used the keywords "patent," "nichtig/valide," "Bundespatentgericht," and the patent and case numbers.

for the respective proceeding.[150] If possible, defendants were directly called and requested to support the study by revealing the desired information. The majority of companies was contacted by phone. I used a general contact number and asked for an employee dealing with patent infringement/revocation issues within the company.[151] In several cases, a personalized cover letter including a description of the study as well as a response form were sent out via e-mail to proof the request as "official" and to enable an internal distribution. The same documents were e-mailed to the parties where no initial telephone contact was possible. All non-respondents were kindly reminded with two follow-ups. I received the majority of responses through e-mail, some directly on the telephone, and some via fax. While 38% of the contacted defendants were willing to share the requested information, 21% were not willing or able—because of firm policy reasons—to share the name of the plaintiff, whereas the remaining 41% did not provide any final feedback.[152]

Obviously, the approaches mentioned above were not successful for all of the considered proceedings. Thus in a last step, a request to be granted access to the court records was filed at the Federal Patent Court for the remaining cases.[153] This procedure provided the names of the missing plaintiffs.[154] Due to a combination of these approaches, all plaintiff and defendant names in the respective cases with decisions between the years 2010 and 2012 could finally be identified.

The availability of the involved parties' names now allowed for collecting a variety of company-specific information to construct a profile for each plaintiff and defendant.[155] Again, I followed a systematic approach involving a combination of different databases. Bureau van Dijk's *Orbis* database was used as an initial data source.[156] In cases where no information on the considered party could be derived from *Orbis*, alternative sources were

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[150] In cases where a defendant was involved in several proceedings in the dataset, s/he was asked to provide information for all of these proceedings.

[151] In several cases, the initial contact directly declined the request. Others facilitated a transfer to the respective contact and yet others asked for an "official" project description prior to any assistance.

[152] The whole approach also allowed for verifying the identified defendants in the dataset cases—at least for those defendants who replied to the request.

[153] See Section 99(3) PatG in conjunction with Section 31 PatG for the legal requirements.

[154] Including the names of the involved defendants, allowing for another verification of the defendants in the dataset.

[155] In the following "company" is used for "plaintiff" or "defendant."

[156] Orbis covers 130 million both listed and unlisted companies around the world, providing among others financial and industry-related information in a standardized format.

used:

For *international companies,* Thomson Reuters's *Thomson ONE* served as a second data source, followed by LexisNexis's *Nexis* database.[157] In the latter, I not only searched the firm data file but also the press archives—if the firm database did not deliver any results. In a final step, an Internet search was conducted, using Google. In this context, I used different keywords such as "revenue," "sales," "employees," etc. in combination with the respective company name.

For *German companies*, Bisnode's *Hoppenstedt Firmendatenbank für Hochschulen* served as an alternative data source, providing information on the 300,000 most important companies in Germany.[158] Supplementarily I draw from the *German Federal Gazette*—issued by the Federal Ministry of Justice and Consumer Protection—for the missing cases.[159] As for international parties, the last two steps involved LexisNexis's *Nexis* as well as a Google search.

Since I predominantly accessed the databases simultaneously, the identified company information could be compared—if at least two delivered a result—and in case of any discrepancy reviewed on plausibility. Following this approach, the dataset was extended with company-specific information on financials such as annual sales, earnings before interest and taxes (EBIT), results from ordinary business activity (EGT), total assets, equity, and further information like number of employees, line of business, legal status, whether the company is private or public, founding year and country of the headquarter. To guarantee comparability between the parties at time of the revocation proceeding, I extracted all information for the year, or at least the closest available year, the case was filed.[160] Due to the high volatility of the ratios EBIT and EGT, a mean was calculated including a period of two years around the case filing year.[161] If individuals were listed as plaintiff or defendant, I conducted an online search in order to reveal possible affiliations with a company. Furthermore, the ownership structure of the companies around the case filing year and the subsequent years was considered. In the case that a company was found to be a subsidiary of a larger corporation, information on

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[157] Nexis sources company profiles from a variety of databases. Furthermore, it allows one to search in a wide range of international press releases and news.

[158] The database includes companies with a yearly revenue of at least €1 million or at least 10 employees.

[159] The *German Federal Gazette* includes all information on German enterprises subject to the publication requirements (e.g., balance sheet, cash flow statement).

[160] See (Ball and Kesan, 2009), who also determined the company's annual sales for the year in which the case was filed.

[161] Therefore, EBIT and EGT were collected for five years total—if available.

the parent company was likewise searched for and included in the dataset. This approach resulted in a comprehensive dataset of all revocation proceedings between 2010 and 2012, including case-specific information as well as a wide range of plaintiff and defendant data.

4.2.2.1.3 Collecting Data on Law Firms Involved in the Proceedings

The court records further revealed the names of the law firms involved in each case. In order to control for a possible impact of law firm characteristics on the proceedings' outcomes, additional information on each firm was collected. Analyzing the law firms' homepages as well as the JUVE publishing house's list of patent law-related law firms revealed characteristics such as employee count, specialization, and possible awards such as a nomination in the JUVE publishing house's *JUVE Handbook German Commercial Law Firms 2015* (Griffiths et al., 2014). A more detailed description of the used law firm-related variables is part of Chapter 4.2.2.2.4.

4.2.2.1.4 Collecting Data on Patents Involved in the Proceedings and Matched Patents

The dataset was finally complemented by information on the patents involved in the revocation proceedings. As for the identification of the defendants' names, both the PATSTAT database and the INPADOC were used to extract a wide range of patent-specific data, based on the German and European publication numbers given in the judgments. To test possible differences between challenged patents and patents not involved in a revocation proceeding, I constructed a control group. To every patent in the dataset of challenged patents, a randomly selected granted patent—which has never been part of a revocation proceeding—was matched using filing year and month as a matching criterion.[162] A more detailed view on the patent-specific variables used and tested in the multivariate analysis are the subject of Section 4.2.2.2.2.

4.2.2.2 Variables Used in the Analysis

The following sections include information on the variables derived from the collected data on patents, parties, and law firms involved in the examined revocation proceedings that reached a final first instance decision between 2010 and 2012. I will start with describing the dependent variables used in the multivariate regressions as well as out-of-sample predictions (see Chapter 6.2), followed by a discussion of the explanatory

[162] To be able to control for technology as well as patent office-specific differences, I neither matched the control group on a technology level nor whether the patent originates from an EP or DE application.

patent (4.2.2.2.2), company (4.2.2.2.3), and law firm-specific variables (4.2.2.2.4). An overview of all the variables used in the forthcoming analyses is included in Table 3.

4.2.2.2.1 Dependent Variables on Case Outcome

To study the factors influencing a selection to pursue a revocation proceeding, I use a dummy variable that takes the value 1 if a patent entered an invalidation action and 0 otherwise.

With respect to the correlates of the revocation likelihood for the adjudicated patents (see 6.2.2) in the first (Table 18) and final instance (Table 19), models Ia/b in Table 18 and Table 19 employ an ordinal dependent variable that equals 0 when the patent was fully upheld, 1 if it was ruled partially invalid, and 2 if it was fully invalidated. The dependent variable in models IIa/b equals 1 if the patent was ruled fully invalid and 0 otherwise. In models IIIa/b the dependent variable equals 1 if the court decided on partial or full revocation. I will now discuss the independent variables.

4.2.2.2.2 Patent-Specific Variables

I use several patent-specific characteristics that possibly influence the likelihood that a patent enters an invalidation proceeding and the final outcome of such a proceeding. Most of these indicators relate to the economic value of a patent. These measures have been examined in several empirical studies (e.g., Harhoff et al., 2003; Putnam, 1996). According to Fischer and Leidinger (2014), among others, the most often analyzed correlates of patent value are the number of citations a patent receives (forward citations), the number of family members (family size), and the number of International Patent Classification (IPC) classes to which a patent is assigned, as well as the number of claims (breadth or scope) (e.g., Gambardella et al., 2008; Harhoff et al., 1999; Harhoff et al., 2003; Lerner, 1994; Putnam, 1996; Trajtenberg, 1990). In the following, I will discuss the variables included in the underlying study, drawing on an indicator classification used by Fischer and Leidinger (2014): *Patent's technological quality, patent's economic relevance and patent scope*.

Patent's technological quality. Existing research shows that a patent's legal robustness positively correlates with its technological quality (e.g., Bessen, 2008; Reitzig, 2003). A patent's technological quality correlates with the number of citations it receives from subsequently granted patents (e.g., Harhoff et al., 1999; Trajtenberg, 1990). These references are referred to as *forward citations*. Several studies show that the number of forward citations significantly correlates with the referenced patent's technological importance (e.g., Carpenter et al., 1981). As cited patents are relevant prior art for the

citing patents, forward citations serve as an indicator for a patent's contribution to a certain technological field as well as its monetary value (e.g., Albert et al., 1991; Harhoff et al., 1999; Harhoff and Reitzig, 2004; Trajtenberg, 1990). To account for the fact that younger patents have a shorter period of time in which to receive citations, I use the five-year truncated number of forward citations to allow for a comparison of forward citations received by patents of different ages (cf. Hall et al., 2001; Marco, 2007). I calculate citation-specific data using the PATSTAT database.[163]

Patent's economic relevance. Besides their technological quality, patents can be classified according to the economic relevance of the invention they protect (Fischer and Leidinger, 2014). In line with several earlier studies, patent family size is a frequently used indicator quantifying the economic relevance of the IPR (e.g., Guellec and van Pottelsberghe de la Potterie, 2000; Harhoff et al., 2003; Lanjouw et al., 1998; Putnam, 1996). First introduced by Putnam (1996), family size is defined as the number of jurisdictions or countries in which a patentee files patent protection for one and the same invention (Lanjouw et al., 1998). Similar to this definition, literature shows that an increase in a patent's family size is closely connected to an increase in the costs related to patenting activities—for example, to file and maintain the patent—and therefore highly correlates with a patent's economic value, in particular as perceived from a patentee's point of view (e.g., Fischer, 2011; Guellec and van Pottelsberghe de la Potterie, 2000; Harhoff et al., 2003; Lanjouw et al., 1998; Putnam, 1996). To derive the number of family members for the considered dataset patents, I draw on Martinez (2010, p. 15) and use the stricter "examiners' technology-based family" definition (DOCDB)[164] according to which a DOCDB family includes all patent documents protecting the same invention in different jurisdictions. Thereby all family members share exactly the same set of priority applications (Martinez, 2010).[165] For every patent in the dataset, the family size variable at hand includes the number of patents sharing a unique family identification number. This information is extracted from the PATSTAT database and the variable is logarithmized to account for its skewed distribution.

Patent scope. According to earlier studies, patent breadth or scope is supposed to

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[163] In line with Harhoff et al. (1999) I logarithmize the variable to account for its skewed distribution.

[164] "DOCDB is the master database of the European Patent Office. It is regularly fed with information from national patent offices on published documents. It is used by patent examiners to search prior art, and is the source of raw patent data for other EPO databases, included PATSTAT" (Martinez, 2010, p.15).

[165] The second family measure included in the PATSTAT database is the extended family definition (INPADOC), assigning all patents to one and the same family if they protect the same or a related technology (Martinez, 2010).

positively correlate with the underlying patent's value (e.g., Gambardella et al., 2008; Lanjouw and Schankerman, 2001; Reitzig, 2003; van Zeebroeck et al., 2009). The authors argue that broader patents affect a wider range of products and processes (Merges and Nelson, 1990; van Zeebroeck et al., 2009) and therefore raise the bar for possible "invent-arounds" by competitors (Fischer and Leidinger, 2014), which positively influences a patent's importance. Widely accepted methods to operationalize breadth/scope of a patent are to use the number of patent claims (e.g., Lanjouw and Schankerman, 1997; Reitzig, 2003; Tong and Frame, 1994) or the number of distinct IPC classes (Lerner, 1994). I test for both indicators in the multivariate analysis. Besides measuring the breadth of a patent, the number of claims is supposed to account for a patent's legal robustness (Bessen, 2008; Lanjouw and Schankerman, 2000; Reitzig, 2003; van Zeebroeck et al., 2009). To this end, the applicant can increase the probability that some claims survive a possible validity challenge by including a higher number of claims in the patent specification (Bessen, 2008).[166] As PATSTAT only provides information on claims for EP patents, I manually collect the number of claims for all the German national patents in my dataset, using DPMA's DEPATISnet database as well as the Google Patent Search. Information on the number of patent claims of the considered EP patents is retrieved from the PATSTAT database.[167]

I use the number of distinct four-digit IPC classes as an additional proxy for the scope of the analyzed patents. This variable was introduced by Lerner (1994) and is a widely used measure in patent-related research. According to this, a greater number of different IPC classes a patent is assigned to is seen to be a predictor of a broader application range for the patented technology and thus a proxy of the technological diversity of a patent (e.g., Cremers and Schliessler, 2012; Guellec and van Pottelsberghe de la Potterie, 2000). The relevant information on the different IPC classes of each dataset patent is collected from the PATSTAT database.

A further widely used patent value and scope correlate is the number of backward citations to patent literature (Harhoff et al., 1999; Harhoff et al., 2003).[168] In line with forward citations, backward citations are the references a patent makes to previously

[166] As the examiner assigns a patent to different IPC classes, the claims indicator is less objective as it might be influenced by the applicant in the way s/he drafts the claims (Fischer and Henkel, 2012; Lanjouw and Schankerman, 2001; Reitzig, 2004a; van Zeebroeck et al., 2009).

[167] Again, the variable is logarithmized to account for its skewed distribution.

[168] Practitioners estimate that during the examination process a higher number of backward citations to patent literature is assigned to those patents that protect technologies defined by a broad scope (Harhoff et al., 2003).

patented inventions. These citations thus reveal the relevant prior art on which the focal patent builds, as well as the development status of the considered patent's field of technology. This indicator, however, is controversially discussed in extant literature. Some scholars argue that a greater number of backward citations indicates the presence of a larger amount of novelty destroying documents and therefore a reduced importance of the focal patent (Hall et al., 2007; Lanjouw and Schankerman, 2001, 2004a). Other scholars suppose that a greater amount of referenced patent documents indicates a new combination of present technologies and therefore a higher degree of technological novelty and value of the patent under consideration (Hall et al., 2007; Harhoff et al., 1999; Reitzig, 2003). Despite its ambiguous nature, I include the number of backward citations in the following analysis. The relevant data is calculated according to information taken from the PATSTAT database and logarithmized to account for its skewed distribution.

Further independent variables. I further control for other factors typically used in research on patent valuation. Besides the references to patent literature, patent documents also include citations to non-patent literature (NPL) (Narin and Noma, 1985). According to the studies by Harhoff et al. (2003) and Callaert et al. (2006) the majority of NPL references refers to scientific or technical journals[169] and can thus be seen as a proxy for the scientific nature as well as the novelty of a patent (Harhoff et al., 2003; Meyer, 2000; Narin et al., 1987; Narin and Noma, 1985).[170] To account for the role that the scientific background of a patent may play in the involvement and outcome of a revocation proceeding, I calculate the number of NPL citations of each patent using citation data from the PATSTAT database.

The time elapsed between the filing and grant date—also referred to as grant lag—is also supposed to be an indicator of patent value. The studies by Harhoff and Wagner (2009) as well as Regibeau and Rockett (2007) show that more valuable patents are characterized by a smaller grant lag than less valuable ones.[171] To account for possible influences of the time a patent spent in the examination process on the involvement in and outcome of a revocation proceeding, I include the variable grant lag into my analysis. I derived the variable using relevant data from the PATSTAT database and again logarithmize its values.

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[169] Analyzed for German and European patents.

[170] Harhoff et al. (2003) further argue that NPL citations are of greater relevance in science-orientated fields—such as chemistry or pharmaceuticals—than in less scientific industries.

[171] Harhoff and Wagner (2009) argue that owners of more valuable patents try to speed up the examination process to reach early patent grants.

I further extend my models by inserting a dummy variable that captures whether a patent has already survived an opposition procedure (partially or fully). During an opposition at the respective patent offices, a patent is re-examined directly after the grant decision (see Chapter 2.3.2). Theoretically, a survival of this "second examination" should indicate a higher degree of legal robustness as the stability of the remaining claims has been affirmed. Furthermore, the probability that newly found prior art is introduced during a potential revocation proceeding will likely decrease, as the opponent might already have advised the patent office—during an opposition procedure—of prior art not considered in the examination process (Fischer, 2015). I use the INPADOC database in combination with the PATSTAT database to derive information on oppositions and their outcomes. The resulting variable equals 0 if the focal patent's validity has not been tested during an opposition proceeding,[172] and 1 if a patent was fully or partially upheld in such an action.[173]

I also test for the period of time between the application date of the patent and the case filing date ("Patent Age at Case Filing"). As the renewal fees of patents increase with the age of a patent, older patents are said to be of higher value than younger patents—at least from a patentee's point of view (e.g., Lanjouw et al., 1998; Pakes, 1986; Schankerman and Pakes, 1986).[174] Besides, the chance that the protected technology gains in market importance positively correlates with its age (Fischer and Leidinger, 2014).[175] I calculate the age of each patent as of the case filing date (in days) by subtracting the application date of each patent—taken from the PATSTAT database—from the case filing date. For simplicity, I divide the variable's values by 1,000.

To account for any industry-specific effects, I include several industry dummies in the analysis (cf. Giuri et al., 2007). The technology-related classification of the patents builds on the ISI-INPI-OST classes developed by the German Fraunhofer Institute of Systems and Innovation Research (ISI), the French Patent Office (INPI), and the Observatoire des Sciences et des Techniques (OST) (Hinze et al., 1997; Schmoch,

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[172] For those six cases (adjudicated & matched patents), where an opposition was filed but refused, I assume that de facto no opposition proceeding occurred as the validity of the patent has not been re-examined.

[173] Fifteen cases (adjudicated & matched patents), for which no final opposition outcome could be identified, were classified as having survived the opposition. I assume that the patent office did not continue those cases (ex officio) due to the fact that the focal patent was perceived as legally very robust.

[174] Economically, a renewal can only be justified if the cash-flows generated by the patent can outweigh the costs associated to keep the patent in force.

[175] Yet to a certain degree the underlying technology might become out-of-date with an aging patent (Fischer and Leidinger, 2014).

2008).[176] According to the classification by Schmoch (2008), I control for five different industry sectors including electrical engineering, instruments, chemical engineering, mechanical engineering, and other fields, by introducing five dummy variables. Information on the analyzed patents' IPC classes is provided by the PATSTAT database. If a patent has been assigned to more than one four-digit IPC class, I identify the most prevalent category and classify the patent accordingly.[177] Based on the ISI-INPI-OST classes, I construct an additional binary variable that bisects the technological fields into complex and discrete industries (Cohen et al., 2000; Merges and Nelson, 1990). Following Cohen et al. (2000, p. 19) "the key difference between a complex and a discrete technology is whether a new, commercializable product or process is comprised of numerous separately patentable elements versus relatively few." Drawing on Graevenitz et al. (2013) and the World Intellectual Property Organization (2011), I assign the analyzed patents to a complex or discrete technology field according to their IPC classification. The dummy variable "IPC: Complex industry" takes the value 1 if the patent can be assigned to a complex industry sector and 0 otherwise.[178]

Finally, I control for the fact of whether a patent is a DPMA-direct filing or the German part of a European patent. For those patents obtaining a final decision in a revocation proceeding, this information can be taken directly from the written judgments. For the matched patents, I gather this information from the DPMA register. The resulting dummy variable "German Part of EP Patent" equals 1 if the analyzed patent is the German part of a European patent and 0 otherwise.

4.2.2.2.3 Company-Specific Variables

To control for influences the involved parties might have on the selection to pursue and the outcome of a revocation proceeding, I consider several party-specific characteristics.

As mentioned in Chapter 4.2.2.1.2, considerable resources were used to identify the litigants in the underlying proceedings as well as party-specific information. If more than one plaintiff/defendant was involved in a proceeding, I assume the plaintiff/defendant

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[176] The ISI-INPI-OST classification summarizes the IPC classes (on a four-digit level) according to 30 major technological fields.

[177] For instance, a patent might be assigned to the IPC classes B62D 55/06, B62D 55/08, B62D 55/104, H01R 13/514, H01R 13/629. On a four-digit level, the IPC class B62D is the most prevalent one. Therefore, the patent is assigned to the class B62D and a classification into one of the six industry sectors is derived accordingly.

[178] It is not collinear with the industry dummies used.

with the "deepest pocket" (Ball and Kesan, 2009, p. 15) has the greatest influence on the case and therefore expect the largest litigant to take on the dominating role in the respective proceeding (Ball and Kesan, 2009).[179] I further analyze the cases on an enterprise level. Thus, in proceedings where the denoted litigant is found to be a subsidiary of a larger enterprise around the case filing date, I assume the parent company to be the litigant in the respective case.[180] Based on these assumptions, I control for the size of the plaintiff/defendant as a proxy for the ability to spend a certain budget on a proceeding. In line with earlier studies, I take the involved companies' annual sales in the year of the case filing date or the closest available year as a size measure (cf. Ball and Kesan, 2009).[181] I derive three revenue dummies each for the plaintiffs and defendants involved in the proceedings as well as for the owners of the matched patents (MP) from these sales figures by dividing the plaintiffs', defendants', and owners' revenue range (given in € Mio) into terciles.[182] The variable "Plaintiff Size Large (revenue)" thus equals 1 if the annual sales figures can be assigned to the third and largest tercile of the revenue range and 0 otherwise. The dummy variables "Plaintiff Size Medium (revenue)" and "Plaintiff Size Small (revenue)" are derived accordingly for the remaining terciles.[183] The same categorization was used for the defendants and the owners of the matched patents (MP).

Besides the size-related variables, I include additional correlates capturing further possible company-specific influences. The variables "Plaintiff Individual," "Defendant Individual," and "Owner (MP) Individual" control for the fact of whether the involved parties (as well as owners of the matched patents) can be characterized as individuals or legal entities. They equal 1 if the respective litigant can be classified as an individual and

[179] If companies A and B are involved as plaintiffs in a case and A is larger than B, I consider A as the dominant plaintiff in the action and use his/her characteristics (revenue, country of headquarter, etc.) as the plaintiff-specific attributes in the respective proceeding. This selection, however, is only necessary in 8% (2%) of the cases on the plaintiff (defendant) side. Moreover, the companies in the particular cases are almost of the same size.

[180] If company A is involved as plaintiff in a case and found to be subsidiary of C, I consider C as the plaintiff in the case and use its characteristics (revenue, country of headquarter, etc.) accordingly. This approach is based on the assumption that the parent company very likely supports its subsidiary, in this kind of case.

[181] If no revenue-specific information for a company could be identified—following the comprehensive approach presented in chapter 4.2.2.1.2—I assume the respective company to be of a small revenue size (cf. Ball and Kesan, 2009).

[182] As the litigating companies in the considered cases and the owners of the matched patents show different revenue distributions, the terciles' thresholds are different for these groups as well.

[183] I follow the same approach for the number of employees as well as the EBIT.

0 if not.[184] In addition, I test for possible procedural advantages or drawbacks related to a company's country of headquarter.[185] I insert the dummy variables "Plaintiff Headquarter not Germany," "Defendant Headquarter not Germany" and "Owner (MP) Headquarter not Germany," which are equal to 1 if the plaintiff, defendant, or owner of the matched patent is not domestically headquartered and 0 otherwise. Finally, the dummy variables "Plaintiff NPE," "Defendant NPE" and "Owner (MP) NPE" determine if the patent owner can be classified as a non-practicing entity (NPE). This classification is based on the respective company's SIC code and additional Internet research.[186] In cases where the respective party can be identified as an NPE, the variable's value is set to 1.

4.2.2.2.4 Law Firm-Specific Variables

I introduce the variables "Plaintiff Law Firm: Total Attorney Count" and "Defendant Law Firm: Total Attorney Count" to control for the size of the involved law firms, approximated by the total number of attorneys each law firm employs in Germany.[187] I gather this information by analyzing the law firms' websites and counting the named attorneys. As some of the law firms do not specialize in patent-related issues, I further specify this employee count by introducing the additional variables "Plaintiff Law Firm: Patent Related Attorney Count" and "Defendant Law Firm: Patent Related Attorney Count" accounting for the number of patent-related attorneys working in Germany. I therefore analyze the denoted attorneys on their specialization and only count those employees specialized in patent-related issues.

The variables "Plaintiff Law Firm: Law Firm JUVE Listed" and "Defendant Law Firm: Law Firm JUVE Listed" involves information on whether an analyzed law firm is either on the ranking of patent law firms in the field of patent litigation or on a list of

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[184] According to the approach described in Chapter 4.2.2.1.2, I carefully control for any possible relationship of the involved individuals to a legal entity. If the analysis reveals that an individual is closely connected to a company, I consider the identified company as the litigant.

[185] According to Webster et al. (2014), there seems to be a domestic inventor advantage in the patent grant process. This effect might be applicable to the patent revocation process as domestic litigants might be more familiar with the bifurcated system and the legal conditions than foreign parties. Furthermore, Lanjouw and Schankerman (2004b) argue that foreign litigants might suffer from higher proceeding-related costs.

[186] The SIC Codes are part of a four-digit industrial classification code system established in the U.S. It divides the industries into 99 major groups that are summarized in 10 different divisions. Drawing from this classification, NPEs in my dataset are assigned to the group "Patent Owners and Lessors" (SIC 6794).

[187] If more than one law firm per litigant is involved in a case, I consider the law firm with the highest number of patent-related attorneys as the representing law firm of the respective party. More than one law firm was involved in 5% (14%) of the cases on the defendants' (plaintiffs') side.

further recommended patent law firms, both provided by the JUVE publishing house's *JUVE Handbook German Commercial Law Firms 2015* (Griffiths et al., 2014). As JUVE selects the law firms based on a specific approach and only lists reputable firms in a certain field of activity (see Chapter 4.2.1.2), I consider a possible listing as a quality criterion for the respective law firms. According to this, the dummy equals 1 if a law firm is recommended for patent litigation issues by the JUVE publishing house and 0 if not.

I further define the variables "Plaintiff Law Firm: Revocation Success Rate" and "Defendant Law Firm: Revocation Success Rate" as a measure for the revocation proceeding-related success rate of a law firm. A case is considered successful for the plaintiff when a fully challenged patent has been completely revoked or when a partial revocation claim has reached a partial invalidation decision (the analog logic holds for the defendant side). I further consider a case a 50/50 success if the plaintiff claimed a full invalidation but only some claims were finally revoked.

Table 3 includes an overview of all the variables used in the quantitative analysis.

Table 3: Description of the variables used in the empirical study

Variables	Description
Patent characteristics	
IPC: Electrical Engineering	Dummy variable=1 if patent can be assigned to the electrical engineering industry (based on IPC -class)
IPC: Instruments	Dummy variable=1 if patent can be assigned to the instruments industry (based on IPC -class)
IPC: Chemical Engineering	Dummy variable=1 if patent can be assigned to the chemical industry (based on IPC -class)
IPC: Mechanical Engineering	Dummy variable=1 if patent can be assigned to the mechanical engineering industry (based on IPC -class)
IPC: Others	Dummy variable=1 if patent cannot be assigned to one of the industries mentioned above
IPC: Complex Industry	Dummy variable=1 if patent can be assigned to a complex industry (based on IPC -class)
IPC4 Class Count	Number of different IPC subclasses on a four-digit level (logarithm)
Number of Claims (log)	Number of patent claims (logarithm)
Family Size (log)	Number of the patent's docdb-family members (logarithm)
German Part of EP Patent	Dummy variable=1 if patent is German part of an European patent
Grant Lag (log)	Number of days between the application and the grant date (logarithm)
Opposition	Dummy variable=1 if patent was restricted or fully upheld during an opposition procedure
Forward Citations, five years (log)	Number of citing patents until five years after publication (logarithm)
Backward Citations (log)	Number of references to patent literature (logarithm)
Backward Citations to NPL (log)	Number of references to non-patent literature (logarithm)
Patent Age at Case Filing (1000 days)	Patent age at date of the case filing (divided by 1000)
Company-specific characteristics	
Plaintiff/Defendant/Owner (MP) Size Large (revenue)	Dummy variables=1 if plaintiff/defendant/owner (MP) revenue (at date of case filing) can be assigned to the largest tercile
Plaintiff/Defendant/Owner (MP) Size Medium (revenue)	Dummy variables=1 if plaintiff/defendant/owner (MP) revenue (at date of case filing) can be assigned to the middle tercile
Plaintiff/Defendant/Owner (MP) Size Small (revenue)	Dummy variables=1 if plaintiff/defendant/owner (MP) revenue (at date of case fil ing) can be assigned to the smallest tercile
Plaintiff/Defendant/Owner (MP) Individual	Dummy variables=1 if plaintiff/defendant/owner (MP) is an individual
Plaintiff/Defendant/Owner (MP) Headquarter not Germany	Dummy variables=1 if plaintiff/defendant/owner (MP) country of residence (headquarter) is not Germany
Plaintiff/Defendant/Owner (MP) NPE	Dummy variables=1 if plaintiff/defendant/owner (MP) can be classified as a non-practicing entity
Law firm-specific characteristics	
Plaintiff/Defendant Law Firm: Total Attorney Count	Total number of attorneys working for the respective law firm in Germany
Plaintiff/Defendant Law Firm: Patent-Related Attorney Count	Total number of attorneys, specialized on patent-related issues, working for the respective law firm in Germany
Plaintiff/Defendant: Law Firm JUVE Listed	Dummy variables=1 if the respective law firm is named in the JUVE publishing house 's *JUVE Handbook German Commercial Law Firms 2015* with a particular reputation in the field of patent litigation.
Plaintiff/Defendant Law Firm: Revocation Success Rate	Percentage of successful cases: Number of successful cases/total number of cases by respective law firm. A case is considered as partly successful (=0.5) if a full revocation claim resulted in a partial revocation decision.

5 Interview/Survey Results: Selection in and Outcome of Revocation Proceedings

In order to draw conclusions for the population of all patents from the observed invalidity decisions, I need to identify the selection effects at work (see Figure 2). I therefore follow a between-method triangulation, using different empirical methods (see Chapter 4). The following sections highlight the results derived from the semi-structured interviews (see Chapter 4.1) and the survey (see Chapter 4.2) among revocation proceeding experts.

5.1 Legal Stability of Patents in Revocation Suits

As discussed earlier (see Section 3.1.2), economic reasoning suggests that patents involved in infringement cases should be more robust than the average patent. An indicator for this reasoning is that patents that have already survived an opposition are seen to be more likely involved in infringement proceedings (Cremers, 2004; Harhoff et al., 2003). Moreover, in cases where a patent owner perceives the allegedly infringed patent as robust, s/he will more likely file an action. However, the subsequent selection stage—in most cases the filing of an invalidity suit by the alleged infringer—should favor less robust patents. This reasoning is confirmed by the interviews, from which I report specific quotes for illustration:

"Make sure that a patent on the basis of which you file a suit is relatively legally valid." (Patent attorney)

"I wouldn't have proceeded on the basis of a non-robust patent [...]." (Patent attorney)

As expected, the interviews reveal that the positive selection at the first stage is counteracted by the next step leading to revocation proceedings, since the alleged infringer will be more likely to challenge the patent the less robust it is perceived to be (see Chapter 3.2.1):

"Well, I assume after all that there would have been some sort of tangential result, affecting the granted patent [...] And this in turn indicates to me that the suits which are filed are not without any prospect of success." (Patent attorney)

These findings are in line with the survey results. As Table 4 shows, survey participants perceive patents involved in infringement proceedings as slightly more robust than the average (mean on a scale from -2, "significantly less valid", to +2, "significantly more valid": 0.20; test median=0: p=0.000). The net effect of both selection stages is seen to be 0 (mean: 0.05; test median=0: p=0.206). That is, both interviewees and survey participants consider patents that enter invalidity suits to be of average robustness.

***Legal robustness**: Patents in infringement/ revocation proceedings, compared to average patent:*									
	significantly less valid (-2)	somewhat less valid (-1)	roughly same validity (0)	somewhat more valid (+1)	significantly more valid (+2)	N	Median	Mean	Wilcoxon signed-rank test
Infringement proceedings	3%	5%	66%	22%	4%	297	0	0.20	0.000
Revocation proceedings	2%	11%	70%	14%	3%	295	0	0.05	0.206
***Firm size/budget:** Influence of parties' size on likelihood of invalidation: The likelihood of invalidation …*									
	significantly decreases (-2)	considerably decreases (-1)	does not increase (0)	somewhat increases (+1)	significantly increases (+2)	N	Median	Mean	Wilcoxon signed-rank test
Size Plaintiff	0%	4%	76%	16%	4%	231	0	0.19	0.000
Size Defendant	0%	9%	82%	8%	1%	232	0	0.00	0.892
***Firm size/budget:** Influence of plaintiff's budget on likelihood of finding relevant prior art:*									
	significantly decreases with budget (-2)	considerably decreases with budget (-1)	does not depend on budget (0)	somewhat increases with budget (+1)	significantly increases with budget (+2)	N	Median	Mean	Wilcoxon signed-rank test
Plaintiff's budget	0%	0%	6%	47%	47%	296	1	1.41	0.000
***For cases that settle:** what would have been the outcome in case of a decision compared to proceedings ending with a decision?*									
	significantly less likely (-2)	somewhat less likely (-1)	roughly same probability (0)	somewhat more likely (+1)	significantly more likely (+2)	N	Median	Mean	Wilcoxon signed-rank test
Probability of partial inval.	0%	9%	39%	35%	17%	206	1	0.57	0.000
Probability of complete inval.	6%	15%	41%	33%	5%	206	0	0.18	0.002
***Newly found prior art vs. differing evaluation standards**: Reasons for invalidation by Federal Patent Court after grant by patent office:*									
	not at all important (1)	low importance (2)	somewhat important (3)	important (4)	very important (5)	N	Median	Mean	One-sample t test
Newly found prior art	0%	1%	2%	47%	50%	297	4	4.46	0.000
Differing Evaluation Standards	1%	4%	44%	46%	5%	285	4	3.49	0.000

Table 4: Main survey results

5.2 Influence of Firm Size and Budget

I now address the influence of two key characteristics—size and budget—of plaintiff and defendant on the outcome of revocation proceedings. Liedel (1979) reports estimates that the share of invalidations could be increased to up to 95% if the plaintiff sued without time and budget restrictions. While this is clearly a bold estimate, it is plausible that invalidation becomes more likely the more time and budget is spent on searching for prior art.

According to the interviews, firm size by itself does not have an influence, but—unsurprisingly—does correlate with budget spent on the case:

"The little guy has an even chance if he deploys equal means. And what is unfortunately observable time and again is that they do not do this. Either they are poorly represented or they're not willing to invest the money in decent research." (Patent attorney)

"Not necessarily. Well, size doesn't really confer any premium in itself." (Judge)

Budget spent is seen to matter, though and

"If you search long enough and with sufficiently large amounts of money that you put into the thing, you'll eventually find something." (Patent attorney)

"Well, as regards the success of revocation suits, I do think that the investment in good lawyers pays off to some extent." (Patent attorney)

Thus larger and smaller firms are supposed to have similar possibilities when they invest the same amount of money.

Survey results are mostly in line with interview findings (Table 4). Plaintiff size is seen to increase the probability of an invalidation ruling slightly (mean: 0.19; test median=0: p=0.000), whereas defendant size is considered to have no effect (mean: 0.00; test median=0: p=0.892). Regarding budget, survey participants clearly believe that a larger budget will strongly increase the probability of finding new prior art suitable to achieve an invalidation ruling (mean: 1.41; test median=0: p=0.000). Analyzing the different groups of respondents shows that participants less experienced in revocation proceedings (<11years/<11 cases) assume the effect of plaintiff size on the invalidation

likelihood to be stronger than more experienced participants (e.g., by years of experience: mean: 0.28 vs. mean 0.12; test median: 0.008). Moreover, less experienced participants (<11years)—compared with more experienced respondents (>10years)—expect the effect of plaintiff budget on the revocation probability to be slightly stronger (mean: 1.49 vs. mean 1.34; test median: p=0.043).

5.3 Revocation Suits that Settle

As has already been mentioned in the introduction, a large share of revocation suits settle (54% of the first instance proceedings). Economic reasoning suggests that these settlements would have ended with a high likelihood in (partial or full) invalidations had they been brought to a decision. By settling when invalidation is imminent, and the patent holder providing a free license to the plaintiff, the parties in suit save on costs while maintaining the patent as a barrier against outsiders.[188] In contrast, when a "valid" ruling is to be expected, the patentee improves its position vis-à-vis third parties by receiving the confirmation of validity of its patent.

Interview results are consistent with this argument:

"In my opinion, this means that behind these very high figures there are, in essence, potentially successful revocation suits." (Patent attorney)

"They would probably also all have been revoked, or many would have been revoked." (Judge)

"These certainly are the weak patents. If one's pretty sure of one's position, then one sees it through." (Patent attorney)

Survey participants confirm the interview results that settled proceedings would more likely have led to a partial revocation (mean: 0.57; test median=0: p=0.000) as well as a full revocation decision (mean: 0.18; test median=0: p=0.002) than proceedings that ended with a decision (Table 4). Analyzing the different groups of respondents indicates a significant difference between the participating patent attorneys and lawyers with regard

[188] Lemley and Shapiro (2005, p. 76) note in this context: "Indeed, virtually every patent licensing and cross-licensing agreement can be seen as the settlement of a patent dispute. However, the frequency or form of such private settlements may not serve the public interest, because litigating patent disputes to completion tends to generate positive externalities, by clarifying the limits of patent protection if the patent is upheld or encouraging wider use of the innovation if the patent is invalidated."

to their estimation of a potential full invalidation likelihood of the settled cases: patent attorneys estimate the probability to be significantly higher than the responding lawyers (mean: 0.27 vs. mean: -0.03; test mean: 0.015).[189] Besides, participants less experienced in revocation proceedings (<11years) assume a higher probability of a potential partial invalidation of patents in the settled cases compared with more experienced respondents (mean: 0.68 vs. mean: 0.39; test mean: 0.043).[190]

5.4 Newly Found Prior Art vs. Differing Evaluation Standards

Invalidation decisions on German patents are taken by the Federal Patent Court or the Federal Court of Justice, while the grant decision is taken by the EPO or the German Patent and Trademark Office. In order to suggest policy measures that could address the issue of latently invalid patents, it is important to understand if the large number of invalidations by the German courts is due to newly found prior art or to differing evaluation standards. According to our interviews, the former clearly matters:

"Well, in those cases I spontaneously recall now, new prior art was virtually always submitted." (Patent attorney)

"I do believe, however, that in most cases new prior art will be found or submitted." (Patent attorney)

Yet, differing evaluation standards also play a role:

"And here, the thing is that, in my view – this is just my personal estimation now – 50 percent of the decisions taken by the Federal Patent Court would have reached the opposite conclusion at the European Patent Office." (Patent attorney)

"That happens, too. That is, that prior art was not considered as relevant in the examination procedure by the EPO as it was before the Federal Patent Court in a revocation suit - that happens a lot." (Patent attorney)

The survey (Table 4) clarifies that newly found prior art is seen as the predominant invalidation reason at the Federal Patent Court (mean: 4.46, between "important" (4) and

[189] No significant difference is found for the estimation of a potential partial invalidation likelihood.

[190] No significant difference is found for the estimation of a potential full invalidation likelihood.

"very important" (5)), while differing evaluation standards (Federal Patent Court vs. DPMA/EPO) are considered as being between "somewhat important" (3) and "important" (4), with a mean of 3.49.

5.5 Further Results

In addition to the factors mentioned above, the qualitative and quantitative studies further reveal some patent-specific correlates of the selection likelihood to pursue a patent infringement and/or a revocation proceeding. In the following, I will present these findings with regard to patent value, patent breadth, and patent age.

5.5.1 Influence of Patent Value

As has already been shown in Section 3.1.2, a patent's commercial value is said to increase the likelihood of an involvement in an infringement proceeding. Thus, a promising and valuable invention attracts others to do research in the same field, presumably resulting in products or processes that infringe on the focal patent or even to deliberately infringe on this patent. Since most invalidation actions are triggered by infringement proceedings, it is very likely that more valuable patents—if the reference group is the universe of all patents—also enter revocation proceedings.[191] In line with this theoretical argumentation, the interview partners confirm the assumption that more valuable patents become involved in infringement and revocation proceedings:

"It's been my experience that the economic importance of patents that have been subject to a dispute has increased." (Patent attorney)

"Well, the economic dimension naturally plays a role—for me, it plays the decisive role." (Patent attorney)

The survey participants confirm the interview results. According to Table 5, patents that enter infringement and revocation proceedings are seen to be of higher value than the average patent (mean infringement: 1.47; mean revocation: 1.41; test median=0: p=0.000).

[191] See Chapter 3.2.1.

***Value**: Patents in infringement/ revocation proceedings, compared to average patent:*									
	significantly less valuable (-2)	somewhat less valuable (-1)	roughly same value (0)	somewhat more valuable (+1)	significantly more valuable (+2)	N	Median	Mean	Wilcoxon signed-rank test
Infringement proceedings	0%	1%	11%	28%	60%	304	2	1.47	0.000
Revocation proceedings	0%	1%	13%	28%	58%	299	2	1.41	0.000
***Breadth:** Patents in infringement/ revocation proceedings, compared to average patent:*									
	significantly less broad (-2)	somewhat less broad (-1)	roughly equally broad (0)	somewhat broader (+1)	significantly broader (+2)	N	Median	Mean	Wilcoxon signed-rank test
Infringement proceedings	0%	2%	72%	22%	4%	298	0	0.29	0.000
Revocation proceedings	0%	3%	68%	24%	5%	297	0	0.31	0.000
***Patent Age:** Patents in infringement/ revocation proceedings, compared to average patent:*									
	significantly younger (-2)	somewhat younger (-1)	roughly same age (0)	somewhat older (+1)	significantly older (+2)	N	Median	Mean	Wilcoxon signed-rank test
Infringement proceedings	1%	9%	63%	24%	3%	296	0	0.19	0.000
Revocation proceedings	1%	8%	64%	22%	5%	295	0	0.20	0.000

Table 5: Further survey results

5.5.2 Influence of Patent Breadth

In theory, the probability that broader patents become involved in an infringement proceeding should be increased compared to the average patent. A broader scope of protection increases the likelihood that someone infringes on this patent, raising the probability of an infringement dispute (see Chapter 3.1.2.). Furthermore, a defendant in an infringement suit will more likely choose to file an action against a broader patent, as a broader scope increases the likelihood that something novelty destroying can be discovered (see Chapter 3.2.1). This reasoning is confirmed by the interviews for the selection into infringement actions:

"An observable characteristic, which indicates that a patent will more likely end up in an infringement action, is that it is broad. That is, broad patent claims."(Patent attorney)

And also for a selection into revocation proceedings:

"In that sense, I do believe that there is the tendency that broader patents more likely end up in a revocation suit than very narrow ones." (Patent attorney)

"The broader the claim, the more likely it is that you'll still find something [novelty destroying]." (Patent attorney)

The survey results further confirm the interview statements. Therefore, broader patents are seen to be more likely involved in infringement (mean: 0.29.; test median=0: p=0.000) as well as revocation suits (mean: 0.31; test median=0: p=0.000) than average patents (Table 5).

5.5.3 Influence of Patent Age

According to earlier studies, the age of a patent is also seen to correlate with the likelihood of an involvement in an infringement proceeding and therefore a subsequent revocation action (Chapter 3.1.2). However, according to the interview results, I am not able to derive an unambiguous conclusion for the selection to pursue an infringement action:

"If a patent has almost expired […] you are certainly glad to claim for infringement—in case of its existence—including a preliminary injunction, which you can get granted in Düsseldorf in between 1-2 days." (Patent attorney)

"I would say that [one rather files an infringement suit based on a younger patent]. This is at least something that should be considered." (Patent attorney)

The same applies for the selection to pursue a revocation proceeding:

"[...] Filing a revocation proceeding is always reasonable if the [patent] has still a relatively long time until it expires." (Patent attorney)

"One could argue that older patents […] are more likely involved into revocation proceedings. […] If an 18 year old patent is still alive […] it must be connected to an interesting technology and this again increases the probability that [the patent] gets involved into a revocation action." (Patent attorney)

The survey results (Table 5) show that patents that enter infringement proceedings are supposed to be slightly older than the average patent (mean on a scale from -2,

"significantly younger", to +2, "significantly older": 0.19; test median=0: p=0.000). The same effect seems to hold for the selection to pursue a revocation suit (mean: 0.20; test median=0: p=0.000).

5.6 Conclusion

Overall, patents in first-instance invalidation proceedings that conclude with a decision should be more robust than the average patent: the net selection effect of patents in infringement suits, followed by the selection of a share of these patents (and very few others) to become involved in invalidation suits is seen to be neutral, while the selection into decisions by the Federal Patent Court (as opposed to settlements) favors more robust patents.

Since the subsequent selection into the second instance (see Figure 12) is fairly symmetric among the first-instance outcomes, and the second-instance decisions show largely the same distribution as those in the first instance, there is no indication of a selection bias in the step from first to second decision. However, the logic that settlements are more likely to occur if an invalidation appears imminent applies equally in the second instance. Again, patents in invalidation cases concluding with a decision should be more robust than the average patent.

Further results as to patent characteristics show that more valuable and broader patents become involved into infringement as well as revocation disputes. However, deriving unambiguous evidence from the results on the influencing nature of patent age is not yet possible.

Outcomes with regard to the litigants involved in the proceedings clearly show that the budget spent on the plaintiff's side significantly increases the likelihood of an invalidation ruling. This result is further supported by the fact that newly found prior art is seen to be the prevailing reason for a revocation judgment. Thus, spending more resources on finding relevant prior art is obviously a promising approach for the plaintiff to succeed in a revocation proceeding.

What do these findings tell us about the hypothetical invalidation rate of all patents? As more robust patents—as compared with the average patent—are seen to be involved in revocation proceedings concluding with a decision, it is very likely that the invalidation probability of a randomly drawn patent might even be higher than the invalidation rate found for adjudicated patents. Moreover, assuming that predominantly smaller companies, with smaller financial budgets, are found to be involved in the analyzed revocation proceedings, the hypothetical invalidation rate of all patents (assuming a large

budget) will probably be increased compared with the rate identified for the adjudicated patents. Smaller litigants, compared with larger (and probably financially stronger) parties, are less likely capable to afford a search for prior art that comes close to a hypothetically perfect, thorough search for prior art. Under the assumption of this perfect, thorough search for prior art—and thus the fulfillment of the (theoretical) requirement of absolute novelty—significantly more novelty-destroying publications will be identified, which, in turn, increases the likelihood that a randomly drawn patent is found to be invalid. To draw further conclusions on the hypothetical invalidation rate of all patents, the characteristics of patents and litigants involved in the proceedings have to be further analyzed. An econometric analysis of actual court decisions is part of the following chapter and will complement the analysis based on interviews, survey, and economic reasoning presented so far.

6 Quantitative Results: Correlates of Invalidation Rulings and Prediction

The last methodological step contributing to the overall approach of this study is a quantitative analysis of the first instance (and to some extent second instance) court decisions in German revocation proceedings. The following section (6.1.1) presents descriptive results on the proceedings that reach a final first instance decision in the years 2000 until 2012. Chapter 6.1.2 includes a descriptive analysis of the parties as well as the law firms involved in the suits the BPatG decided on between the years 2010-2012. This period is further examined by a multivariate analysis to identify the factors influencing the likelihood that a patent enters a revocation proceeding (6.2.1) as well as the main correlates influencing the outcome of such a proceeding (6.2.2). Based on these results, I run a set of out-of-sample predictions to identify the invalidation probability of a randomly drawn patent (Chapter 6.2.3).

6.1 Descriptive Analysis of Court Decisions and Stakeholders

In the following, I will give a descriptive analysis on the first and second instance judgments for the cases with a first instance ruling between 2000 and 2012 (Chapter 6.1.1). A more detailed examination of the cases decided during the years 2010 to 2012, including the parties involved, is part of Section 6.1.2.

6.1.1 Analysis of judgments between 2000 and 2012

The study is based on a descriptive analysis of all final decisions by the German Patent Court and the court of second instance (BGH) during the course of patent revocation proceedings in Germany between 2000 and 2012. In total, I analyze 1,125 different first instance decisions and 355 corresponding second instance rulings on 1,092 different German Patents.[192] Figure 12 illustrates the process of a German revocation action including first and second instance proceedings and statistics.

[192] This number includes 789 German parts of European patents. Ten decisions on supplementary protection certificates (SPC) and 10 decisions on patents granted under the German Democratic Republic (DDR) have already been excluded from this number and are not further examined.

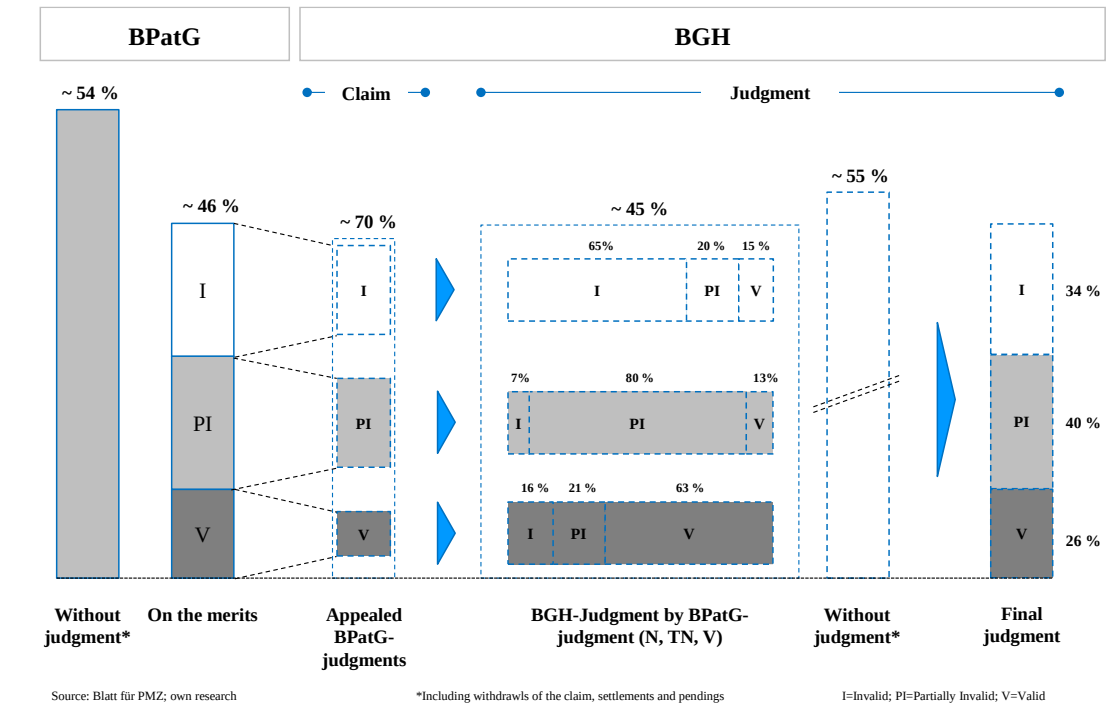

Figure 12: Process and statistics of German revocation actions

6.1.1.1 Final Outcomes of the First and Second Instance

Due to data restrictions, I only consider those proceedings that reached a judgment on the merits.[193] During the analyzed period, on average, roughly 46% of the first instance revocation proceedings reached such a final ruling.[194] Fifty-four percent of the proceedings were concluded with a withdrawal of the revocation action, settlements between the parties, or other outcomes. Table 6 provides a more detailed view on the outcomes of the analyzed German Federal Patent Court rulings between the years 2000 and 2012.

[193] This is in line with Liedel (1979) as well as van Zeebroeck and Graham (2014).

[194] I calculated this number analyzing the yearly statistics of the Federal Patent Court on revocation proceedings reported in the respective March issues of the Blatt für Patent-, Muster- und Zeichenwesen (Blatt für PMZ).

	First instance decisions between 2000 and 2012 (in %)													
	00	01	02	03	04	05	06	07	08	09	10	11	12	**Ø**
Decision														
Fully Valid	30	30	21	30	31	19	27	23	23	29	25	22	17	**25**
Partially Revoked	48	35	45	38	35	38	41	36	36	35	32	38	32	**37**
- As filed	49	43	32	55	37	44	41	53	45	47	55	47	42	**45**
Fully Revoked	22	35	34	32	35	43	32	41	41	36	43	40	51	**38**
N	73	80	76	77	78	85	82	90	87	91	92	100	114	**1125**

Table 6: BPatG decisions by year (2000-2012)

According to the Federal Patent Court decisions in my dataset, 25% of the cases were dismissed and the patent therefore upheld. The court partially revoked the patent in 37% of the cases and decided on a full revocation in 38%. Analyzing the partial revocations reveals that 45% of them conform to the plaintiff's claim. Effectively, thus, I can consider these rulings as full revocations in the context of the corresponding infringement suit, increasing the share of fully revoked patents from 38% to 55%.[195] Also, a certain share of those "partial invalid" decisions where the plaintiff had claimed a full invalidation may be tantamount to an effective full invalidation, though I cannot determine this share.

Sixty-nine percent of the first instance decisions on the merits are appealed at the Federal Court of Justice. The corresponding second instance decisions from 2003 until 2015 are reported in Table 7.[196] In total, 45% of these appellate proceedings reach a final decision (the split being 24% fully valid, 43% partially revoked, and 33% fully revoked).[197]

[195] See Section 2.3.3.

[196] I consider second instance cases that have reached a final decision until March 2015.

[197] Fifty-five percent of the cases did not reach a final decision due to the following reasons: 36% withdrawal of the appeal; 49% withdrawal of the claim; 4% settlements at court; 6% pending as of March, 2015; 5% other reasons.

	Second instance decisions between 2003 and 2015 (in %)													
	03	04	05	06	07	08	09	10	11	12	13	14	15	**Ø**
Decision														
Fully Valid	25	35	25	13	32	13	15	15	22	23	34	37	0	**24**
Partially Revoked	50	24	25	60	36	78	57	49	43	28	34	34	50	**43**
Fully Revoked	25	41	50	27	32	9	28	36	35	49	32	29	50	**33**
N	4	17	16	15	22	23	40	53	40	39	41	41	4	**355**

Table 7: BGH decisions by year (2003-2015)

The outcomes of the cases reaching their final judgment at the first or second instance can be divided into 26% "valid," 40% "partially revoked," and 34% "fully revoked." Revocation rates at the first, second, and first or second instance are roughly the same for patents granted by the EPO and for patents granted by the German Patent Office. Table 8 summarizes the decisions at each stage as well as the final decisions of the first or second instance.

	1. Instance			2. Instance			1. or 2. Instance		
	DE	EP	**Total**	DE	EP	**Total**	DE	EP	**Total**
Decision									
Fully Valid	25%	25%	**25%**	22%	24%	**24%**	24%	27%	**26%**
Partially Revoked	39%	36%	**37%**	43%	43%	**43%**	41%	40%	**40%**
Fully Revoked	36%	39%	**38%**	35%	33%	**33%**	35%	33%	**34%**

Table 8: Revocation rates across the instances

6.1.1.2 Case Duration

Analyzing the first instance case duration, the outcomes differ from the results of an earlier study by Liedel (1979). Whereas Liedel (1979) shows that roughly 45% of the cases are decided within one year and only 10% after two years (see 2.3.2), the outcomes are different in the analyzed period from 2000 until 2012. Table 9 shows that 17% of the first instance proceedings are decided within one year. Eighteen percent reached a final judgment after two years. The average first instance case duration is approximately 19

months.[198]

	1. Instance			2. Instance		
	Pre 09/2009	Post 09/2009	**Total**	Pre 09/2009	Post 09/2009	**Total**
Case duration (month)						
0-12	19%	7%	**17%**	2%	19%	**8%**
13-18	40%	44%	**41%**	5%	31%	**14%**
19-24	22%	36%	**24%**	9%	14%	**10%**
25-30	12%	11%	**12%**	7%	10%	**8%**
31-36	4%	2%	**3%**	15%	11%	**14%**
>36	3%	0%	**3%**	62%	14%	**46%**

Table 9: First and second instance case duration

The second instance case duration averages 34 months.[199] In total, 32% of the appeals are decided within 24 months, whereas 46% of the judgments are ruled after 3 years. The new regime for cases filed after September 2009 (see 2.3.3) seems to have a significant impact on the duration of second instance cases. The average length of cases changed from 40 months to 22 months and more than 50% of the cases were decided within 3 years (compared to 38% prior to 09/2009).[200] This finding matches the practitioners' estimates of current appellate case duration of approximately 2 years for each instance (Bardehle Pagenberg Partnerschaft, 2014b; Coster, 2012).[201]

6.1.1.3 Decisions by Senate and Technology

In view of the decisions' origin, Table 10 shows that more than 50% of the first instance judgments between 2000 and 2012 are ruled by the 3. and 4. Senate. Whereas the 3. Senate partially or fully revoked a patent in 84% of the cases, the likelihood of a partial or full invalidation ruling varies from 70% to 79% at the other Senates.

[198] The discrepancy to the period analyzed by Liedel (1979) is found for the pre and post 09/2009 period.

[199] For appellate cases filed before and after September 2009.

[200] Liedel (1979) shows that 15% of the second instance cases were decided within 2 years. In 51% of the cases, a decision was ruled after 3 years.

[201] See Chapter 2.3.3.

	Senates						
	1. Senate	2. Senate	3. Senate	4. Senate	5. Senate	10. Senate	**Total**
Decision							
Fully Valid	29%	26%	16%	30%	21%	29%	**25%**
Partially Revoked	34%	33%	42%	37%	38%	39%	**37%**
Fully Revoked	37%	41%	42%	33%	41%	32%	**38%**
Share	**12%**	**24%**	**25%**	**28%**	**7%**	**4%**	**100%**

Table 10: Decisions by BPatG-Senates (2000-2012)

According to Table 11, the majority of patents in revocation proceedings protect technologies of the mechanical engineering sector (35%), which finding is in line with Cremers et al. (2013). According to their study, the majority of litigants in patent disputes are associated with the machinery industry. A closer look at the outcomes for each industry reveals that the (partial or full) revocation rate is equal to or higher than 70% across all industries. The highest number of (partial or full) revocation judgments is pronounced in the Instruments and Chemistry sector (83%).

	Industries					
	Electrical engineering	Instruments	Chemistry	Mechanical engineering	Other fields	**Total**
Decision						
Fully Valid	24%	17%	17%	31%	29%	**25%**
Partially Revoked	32%	45%	40%	36%	34%	**37%**
Fully Revoked	44%	38%	43%	33%	37%	**38%**
Total	**18%**	**14%**	**18%**	**35%**	**15%**	**100%**

Table 11: Revocation rates across industries

6.1.2 Analysis of judgments between 2010 and 2012

Three hundred and five decisions are subject to the multivariate analysis between the years 2010 and 2012. During this period, the BPatG partially revoked the challenged patents in 33% of the cases and decided on a full revocation in 45% (Table 6). Sixty-nine

percent of the first instance decisions on the merits are appealed at the Federal Court of Justice, and 34% of these appellate proceedings reach a final decision (the split being 36% fully valid, 32% partially revoked and 32% fully revoked).

6.1.2.1 Characteristics of the Involved Litigants

As has already been described in Section 4.2.2.1.2, considerable effort went into the identification of plaintiff and defendant data for the cases that reached a final decision between 2010 and 2012 as well as of information on the patent owners of the matched patents.[202] Table 12 provides an overview of the size distribution (including number of individuals) of plaintiffs, defendants, and owners of the matched patents according to six revenue categories. Further information on company size-specific measures like the number of employees or EBIT can be found in Appendix A8.

Revenue	**Plaintiff**		**Defendant (Owner)**		**Matched Patent Owner**	
	%	Freq.	%	Freq.	%	Freq.
€ Mio.						
0-10	18%	55	22%	63	7%	21
10-100	21%	63	20%	59	10%	29
100-500	15%	46	13%	38	12%	33
500-1,000	4%	12	5%	14	6%	18
1,000-10,000	22%	67	23%	66	26%	72
>10,000	20%	62	17%	50	39%	109
Median	**€ 298 Mio.**		**€ 277 Mio.**		**€ 3,292 Mio.**	
Companies	**305**		**290**		**282**	
Individuals	**0**		**15**		**23**	
N	**305**		**305**		**305**	

Table 12: Categorization of plaintiff and defendant/patent owner according to revenue (€ Mio.)

According to Table 12, plaintiff and defendant revenues are more or less equally distributed among the different categories. Thus, more than 40% of the plaintiffs and defendants generate revenues above €1bn. The owners of the randomly drawn matched patents seem to be larger than parties involved in the revocation proceedings.[203]

[202] I matched a randomly selected granted patent—which has never been part of a revocation proceeding—to every patent in the dataset of challenged patents. See Section 4.2.2.1.4 for further information on the matching criterion.

[203] This result also holds for other size measures such as number of employees or EBIT (see Appendix A8).

Furthermore, no individual is involved on the plaintiff side whereas 5% of the defendants can be classified as individuals.

The industry classification is based on the primary SIC codes provided by the analyzed databases for each company. In line with Achleitner (2009), I use a slightly modified segmentation of the industry divisions taking the first digit of each code as the differentiation criterion.[204] According to Table 13, the overwhelming majority of plaintiff and defendant companies, as well as the owners of the matched patents, can be assigned to the heavy manufacturing industry (including electrical engineering), followed by the light manufacturing industry (including chemistry).[205]

Industry	**Plaintiff**		**Defendant (Owner)**		**Matched Patent Owner**	
	%	Freq.	%	Freq.	%	Freq.
Division						
Agriculture, Forestry, & Fishing	0	0	0	0	0	0
Mining & Construction	1%	3	1%	4	1%	3
Light Manufacturing	17%	52	18%	51	19%	53
Heavy Manufacturing	65%	198	63%	179	68%	189
Transportation & Public Utilities	3%	9	0%	1	2%	5
Wholesale/Retail Trade	8%	26	3%	8	3%	7
Finance, Insurance, & Real Estate	3%	8	12%	34	2%	6
Service	3%	2	3%	9	5%	13
Public Administration	0	0	0	0	0	0
Companies	**304**		**286**		**276**	
Individual	**0**		**15**		**23**	
N[206]	**304**		**301**		**299**	

Table 13: Industry categorization of plaintiff and defendant/patent owner

[204] Thus, the four divisions mining, construction, wholesale trade, and retail trade merge into two categories, whereas the manufacturing division is separated into two distinct industries (light and heavy manufacturing).

[205] Heavy (Light) manufacturing includes the SIC major groups 30-39 (20-29).

[206] The numbers are different from 305 as not all relevant industry information could be identified for some of the parties.

The relatively high share of finance-related companies (12%) among the defendants is caused by non-practicing entities (68%) and by producing companies classified as holdings (32%).[207]

In addition to each company's industry sector, I analyze the competitive relationship of the parties involved in the revocation proceedings.[208] Therefore, plaintiff and defendant in each case are categorized by two competitor measures. According to this, I identify competitors by using the first two digits of the SIC codes. In cases where both companies share the same digits, a competitive relationship is assumed. For an additional classification of the competitive relationship between two parties in a suit, I draw on Bergen and Peteraf (2002) as well as Chen (1996), and use the dimension of *market commonality*.[209] The results of the analysis (Table 14) indicate that a sole SIC code examination might generate incorrect results as the more elaborated approach results in a significantly higher number of competitors. Based on a market commonality classification, 86% of the revocation cases are seen to happen between competitors.

	SIC Code: digits 1-2		**Market commonality**	
	%	Freq.	%	Freq.
Competitor				
No	47%	136	14%	40
Yes	53%	153	86%	249
N	**289**		**289**	

Table 14: Competitor analysis

I further collect information on the defendant's/owner's country of residence (headquarter).[210] The countries are grouped into the five geographical regions suggested by the United Nations Statistics Division (Table 15).[211]

[207] Non-practicing entities are classified by the SIC code 6794, holding companies by SIC code 6719.

[208] According to Ann et al. (2010), it is likely that parties in know-how protection-related lawsuits are competitors.

[209] According to the definition of market commonality, Bergen and Peteraf (2002, p. 160) "sort competitors based on the degree to which they address similar customer needs." In line with this definition, I identify competitors by analyzing the parties' websites on products and targeted customer groups.

[210] If the involved company can be classified as a subsidiary, I take the enterprise location of the parent company.

[211] See http://unstats.un.org/unsd/methods/m49/m49regin.htm#europe*/, accessed July 05, 2015.

Geographical	Plaintiff		Defendant		Matched Patent Owner	
	%	Freq.	%	Freq.	%	Freq.
Region						
Africa	0%	0	0%	0	0%	0
Americas	14%	41	12%	34	26%	74
Asia	14%	43	9%	28	19%	53
Europe	72%	221	79%	228	55%	154
Oceania	0%	0	0%	0	0%	1
Not German	56%	135	57%	131	70%	214
Companies	**305**		**290**		**282**	
Individuals[212]	**0**		**15**		**23**	
N	**305**		**305**		**305**	

Table 15: Defendant's/owner's country of residence (headquarter)

The companies involved in German revocation proceedings are predominantly located in Europe (roughly 75%), followed by America, and Asia. In 55% of the cases, the owners of the matched patents are European based.[213] Thus, the randomly drawn patents seem to be more likely owned by non-European patent owners than patents involved in the invalidation proceedings under consideration (Table 15). Furthermore, almost half of the plaintiffs and defendants in the proceedings are headquartered in Germany, whereas the majority of the owners of the matched patents (70%) are not German.[214]

6.1.2.2 Characteristics of the Involved Law Firms

Besides the plaintiffs, defendants, and owners of the randomly drawn patents, I further examine the 240 different law firms involved in the considered revocation proceedings between 2010 and 2012. According to my findings, the majority of the

[212] Twelve of the 15 defendant individuals come from Germany, two from the U.S., and one is located in Spain. The majority of individuals owning the matched patents is German (17), followed by French (3), Italian (1), Japanese (1), and American (1).

[213] According to the EPO's 2014 Annual Report, 51% of the EP patents were granted to European applicants (European Patent Office, 2015a). The number is higher at the German Patent Office, where 77% of the DPMA-direct and DPMA-PCT filings are granted to European patentees (Deutsches Patent- und Markenamt, 2015a).

[214] Drawing from the annual reports of the German Patent Office (Deutsches Patent- und Markenamt, 2015b) and the EPO (European Patent Office, 2015a), 20% of all EP patents and 70% of all DPMA-direct and DPMA-PCT filings are granted to German applicants.

analyzed law firms have 1-10 employees and 12% have more than 50 people employed (Table 16).[215]

	Plaintiff/Defendant Law Firm	
	%	Freq.
Total number of employees (Germany)		
<11	64%	154
11-50	24%	59
51-100	6%	14
101-150	2%	4
>150	4%	9
JUVE listing		
Listed	31%	75
Not listed	69%	165
Number of cases (plaintiff and/or defendant side) among the considered cases		
1	53%	126
2-10	43%	104
11-20	3%	7
>20	1%	3
Number of successful cases relative to the number of cases each law firm was involved in		
0	27%	64
0.5-2	54%	130
2.5-5	13%	32
5.5-10	4%	10
>10	2%	4

Table 16: Law firm descriptives

Moreover, the law firms under consideration were, on average, involved in roughly three cases on plaintiff's and/or defendant's side. More than 50% participated in only one proceeding (Table 16). Whereas 27% of the analyzed law firms did not succeed in their case(s), the mean number of successful cases among all law firms is found to be 1.5.[216] Furthermore, the majority (69%) of the analyzed law firms are not mentioned in the JUVE

[215] I only consider employees working in Germany. Twenty-six of the considered law firms are individual patent attorneys.

[216] A case is considered successful on the plaintiff side when a fully contested patent is fully revoked or when a partial revocation claim reaches a partial invalidation decision (the analog logic holds for the defendant side). I further consider a 50/50 success if the plaintiff claimed a full invalidation but only some claims were finally revoked (see also Chapter 4.2.2.2.4).

publishing house's *JUVE Handbook German Commercial Law Firms 2015* (Griffiths et al., 2014).

6.2 Results of the Multivariate Analysis

Table 17 provides the descriptive statistics of the variables that I use in the multivariate analysis of decisions issued from 2010 to 2012. The observed patents are not a random sample of all patents, as only a small fraction is involved in revocation suits reaching a final decision and might thus be subject to sample selection. In order to control for potential correlation between the unobserved determinants of the selection to pursue a revocation proceeding and its outcome I run a set of Heckman regressions (Heckman, 1979).[217] For identification, I use the size of the defendant since (a) the respective variables are highly significant in the selection equation and insignificant in the outcome equation, and (b) based on economic consideration should have an effect in the selection stage (since in most cases the defendant had triggered the revocation proceeding by filing an infringement suit) but not in the outcome stage (where the plaintiff's ability to find additional prior art is critical). In none of the specifications did I find a significant effect of the Heckman correction, in line with Miller (2013).[218] I thus report separate models for the selection and the outcome stage (Table 18, Table 19).

I start with a probit model of the selection to pursue a revocation proceeding. Using various patent characteristics as well as patent owner attributes as explanatory variables, I compare patents that have entered a revocation action to a randomly drawn sample of matched patents that have not been involved in revocation proceedings (see 6.2.1).[219] In a second step, I analyze correlates of the revocation likelihood for the adjudicated patents (see 6.2.2) in the first instance (Table 18) and in the final instance (Table 19) using ordered probit and standard probit models.[220]

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[217] Specifically, I employ the STATA command "heckprob" if the outcome variable is binary (as in models II and III) and the "heckoprobit" command if it is ordinal (as in model I) (see Table 18 and Table 19).

[218] I test for the necessity of applying a Heckman selection model by interpreting the arc-hyperbolic tangent of the rho parameter (athrho). The insignificant value of athrho throughout all of the models indicates that there is no correlation between the residuals of the selection and the outcome equation.

[219] See 4.2.2.1.4 for the matching criterion applied.

[220] See Appendix A9 for summary statistics and correlations of the dependent and independent variables used in the regression models.

	I: Involved patents					II: Matched patents					p-values[1]
	Mean	*Median*	*Std. dev*	*Min*	*Max*	*Mean*	*Median*	*Std. dev*	*Min*	*Max*	*I vs. II*
Plaintiff											
Plaintiff size large	0.334	0	0.473	0	1						
Plaintiff size medium	0.334	0	0.473	0	1						
Plaintiff size small	0.331	0	0.471	0	1						
Plaintiff individual	-	-	-	-	-						
Plaintiff not German	0.557	1	0.498	0	1						
Defendant/Patent Owner											
Def./Own. (MP) size large	0.226	0	0.419	0	1	0.439	0	0.497	0	1	0.000
Def./Own. (MP) size medium	0.334	0	0.473	0	1	0.334	0	0.473	0	1	1.000
Def./Own. (MP) size small	0.439	0	0.497	0	1	0.226	0	0.419	0	1	0.000
Def./Own. (MP) individual	0.049	0	0.217	0	1	0.075	0	0.264	0	1	0.180
Def./Own. (MP) NPE	0.039	0	0.195	0	1	0.003	0	0.057	0	1	0.002
Def./Own. (MP) not German	0.570	1	0.496	0	1	0.702	1	0.458	0	1	0.001
Patent characteristics											
IPC: Electrical Engineering	0.262	0	0.441	0	1	0.180	0	0.385	0	1	0.015
IPC: Instruments	0.151	0	0.354	0	1	0.125	0	0.331	0	1	0.347
IPC: Chemical Engineering	0.164	0	0.371	0	1	0.249	0	0.433	0	1	0.009
IPC: Mechanical Engineering	0.292	0	0.455	0	1	0.334	0	0.473	0	1	0.256
IPC: Others	0.131	0	0.348	0	1	0.111	0	0.315	0	1	0.457
IPC: Complex industry	0.741	1	0.439	0	1	0.649	1	0.478	0	1	0.014
IPC4 class count	1.997	2	1.268	1	9	1.931	2	1.248	1	8	0.520
Number of claims (log)	2.495	2.485	0.616	0.693	4.143	2.392	2.398	0.622	0.693	4.234	0.039
Family size (log)	1.968	2.079	1.022	0	4.419	1.602	1.792	0.805	0	4.277	0.000
German Part of EP patent	0.734	1	0.442	0	1	0.705	1	0.457	0	1	0.417
Grant lag (log)	7.386	7.409	0.553	5.796	8.660	7.347	7.411	0.554	5.252	8.583	0.382
Opposition	0.190	0	0.393	0	1	0.043	0	0.202	0	1	0.000
Forward citations, fiveyears (log)	0.612	0	0.835	0	3.367	0.406	0	0.636	0	2.944	0.000
Backward citations (log)	1.570	1.609	0.596	0	3.258	1.452	1.386	0.574	0	3.219	0.013
Backward citations to NPL (log)	0.384	0	0.592	0	2.639	0.447	0	0.569	0	3.434	0.177
Patent Age at Case Filing (1k days)	4.273	4.038	1.505	0.675	8.56						
Observations			**305**					**305**			**610**

[1] t-test and test of proportions, respectively

Table 17: Descriptive statistics and test of equality of means/proportions

6.2.1 Correlates of Entering a Revocation Proceeding

Patent characteristics. With respect to the factors describing the patents' economic value, my findings are in line with Fischer's (2015). The selection models in Table 18 and Table 19 consistently indicate that a higher number of a patent's forward citations as well as family members go along with a higher likelihood of being challenged in a revocation proceeding. My findings further confirm that patents that had been subject to opposition proceedings (and were maintained in part or in full) are more likely to be subject to a revocation proceeding. The number of referenced non-patent literature is negatively correlated with the probability of being challenged in an invalidation proceeding, whereas broader patents (measured by their number of claims) more likely enter a revocation suit. Regarding technology fields, patents related to electrical engineering are more likely to enter invalidation proceedings.

Patent owner characteristics. I find a negative correlation ($p<0.01$) of company size and the probability of the patent being contested. In Table 18, but not in Table 19, I observe a negative correlation with foreign ownership ($p<0.05$), in line with Miller (2013).

	Selection		Ia – 3 stages		Ib – 3 stages		IIa – fully inv.		IIb – fully inv.		IIIa – partly/fully		IIIb – partly/fully	
	Coeff.	*S.E.*	*Coeff.*	*S.E.*	*Coeff.*	*S.E.*	*Coeff.*	*S.E.*	*Coeff.*	*S.E.*	*Coeff.*	*S.E.*	*Coeff.*	*S.E.*
Plaintiff														
Plaintiff size large			0.396**	(0.198)	0.450**	(0.187)	0.598***	(0.227)	0.640***	(0.214)	0.124	(0.260)	0.202	(0.250)
Plaintiff size medium			-0.047	(0.169)	-0.022	(0.165)	0.102	(0.202)	0.138	(0.198)	-0.218	(0.217)	-0.194	(0.216)
Plaintiff individual			-		-		-		-		-		-	
Plaintiff not German			0.171	(0.143)	0.166	(0.142)	0.138	(0.169)	0.129	(0.167)	0.184	(0.183)	0.171	(0.181)
Defendant/Patent Owner														
Def./Own. (MP) size large	-0.942***	(0.159)	0.161	(0.200)	0.119	(0.194)	0.079	(0.228)	0.037	(0.222)	0.336	(0.274)	0.293	(0.270)
Def./Own. (MP) size medium	-0.505***	(0.154)	-0.189	(0.180)	-0.210	(0.174)	-0.204	(0.203)	-0.210	(0.196)	-0.167	(0.219)	-0.227	(0.213)
Def./Own. (MP) individual	-0.431	(0.278)	-0.168	(0.384)	-0.168	(0.386)	0.142	(0.397)	0.169	(0.398)	-0.591	(0.425)	-0.655	(0.433)
Def./Own. (MP) NPE	0.226	(0.580)	0.215	(0.490)			0.075	(0.485)			0.310	(0.620)		
Def./Own. (MP) not German	-0.323**	(0.139)	0.199	(0.163)	0.174	(0.154)	0.117	(0.188)	0.085	(0.179)	0.265	(0.204)	0.279	(0.196)
Patent characteristics														
IPC: Electrical Engineering	0.502**	(0.209)	0.126	(0.255)	0.141	(0.243)	0.134	(0.269)	0.110	(0.261)	0.055	(0.301)	0.117	(0.286)
IPC: Instruments	0.198	(0.225)	0.229	(0.239)	0.215	(0.239)	0.010	(0.289)	-0.052	(0.286)	0.761**	(0.339)	0.830**	(0.337)
IPC: Chemical Engineering	-0.116	(0.280)	-0.102	(0.365)	-0.079	(0.364)	-0.350	(0.401)	-0.369	(0.403)	0.372	(0.451)	0.479	(0.436)
IPC: Mechanical Engineering	0.023	(0.201)	-0.279	(0.239)	-0.286	(0.238)	-0.350	(0.274)	-0.378	(0.274)	-0.146	(0.280)	-0.130	(0.272)
IPC: Complex industry	0.057	(0.188)	-0.410	(0.273)	-0.387	(0.275)	-0.533*	(0.296)	-0.460	(0.294)	-0.152	(0.309)	-0.193	(0.311)
IPC4 class count	-0.057	(0.051)	0.038	(0.054)			-0.015	(0.064)			0.140	(0.085)		
Number of claims (log)	0.156*	(0.092)	-0.090	(0.120)			-0.151	(0.139)			-0.053	(0.152)		
Family size (log)	0.495***	(0.088)	0.000	(0.085)			-0.010	(0.094)			0.014	(0.104)		
German Part of EP patent	-0.272	(0.166)	-0.271	(0.194)	-0.266	(0.168)	-0.128	(0.217)	-0.156	(0.188)	-0.527**	(0.255)	-0.473**	(0.228)
Grant lag (log)	0.143	(0.106)	0.241*	(0.138)	0.261*	(0.136)	0.250	(0.158)	0.251	(0.156)	0.236	(0.179)	0.291	(0.182)
Opposition	0.910***	(0.215)	-0.111	(0.198)	-0.133	(0.191)	0.133	(0.205)	0.109	(0.202)	-0.414*	(0.226)	-0.401*	(0.212)
Forward citations, five years (log)	0.239***	(0.078)	0.118	(0.084)	0.113	(0.082)	0.156	(0.096)	0.127	(0.093)	0.084	(0.108)	0.103	(0.105)
Backward citations (log)	0.050	(0.103)	-0.313***	(0.119)	-0.312***	(0.116)	-0.337**	(0.137)	-0.331**	(0.135)	-0.251	(0.172)	-0.257	(0.160)
Backward citations to NPL (log)	-0.210**	(0.106)	-0.068	(0.127)			-0.128	(0.144)			0.042	(0.157)		
Patent Age at Case Filing (1k days)			-0.161***	(0.058)	-0.161***	(0.058)	-0.154**	(0.065)	-0.146**	(0.065)	-0.183***	(0.071)	-0.193***	(0.070)
Constant	-1.650*	(0.846)					-0.153	(1.234)	-0.654	(1.154)	0.352	(1.391)	0.118	(1.342)
Constant cut 1			-0.650	(1.065)	-0.323	(0.995)								
Constant cut 2			0.369	(1.064)	0.693	(0.994)								
Observations	610		305		305		305		305		305		305	
F-Test	0.000		0.001		0.000		0.014		0.003		0.000		0.000	
Pseudo Likelihood	-343.9		-296.1		-296.8		-187.7		-188.9		-133.3		-135.1	
Wald's chi-squared	124.6		51.34		49.13		40.43		38.75		55.33		50.88	
Degrees of freedom	19		23		18		23		18		23		18	
Pseudo R-squared	0.187		0.079		0.077		0.107		0.101		0.156		0.145	

*** p<0.01, ** p<0.05, * p<0.1

Table 18: Correlates of selection into BPatG revocation proceedings with decisions, and of outcomes (2010-2012; probit/ordered probit)

	Selection		Ia – 3 stages		Ib – 3 stages		IIa – fully inv.		IIb – fully inv.		IIIa – partly/fully		IIIb – partly/fully	
	Coeff.	*S.E.*	*Coeff.*	*S.E.*	*Coeff.*	*S.E.*	*Coeff.*	*S.E.*	*Coeff.*	*S.E.*	*Coeff.*	*S.E.*	*Coeff.*	*S.E.*
Plaintiff														
Plaintiff size large			0.565**	(0.235)	0.598***	(0.212)	0.844***	(0.281)	0.898***	(0.260)	0.231	(0.270)	0.263	(0.260)
Plaintiff size medium			-0.077	(0.192)	-0.048	(0.186)	-0.041	(0.251)	0.007	(0.241)	-0.103	(0.235)	-0.064	(0.233)
Plaintiff individual			-		-		-		-		-		-	
Plaintiff not German			0.529***	(0.173)	0.505***	(0.170)	0.561***	(0.207)	0.538***	(0.204)	0.493**	(0.205)	0.472**	(0.200)
Defendant/Patent Owner														
Def./Own. (MP) size large	-1.049***	0.190	0.192	(0.241)	0.180	(0.240)	0.241	(0.284)	0.226	(0.285)	0.185	(0.249)	0.162	(0.297)
Def./Own. (MP) size medium	-0.617***	0.177	-0.186	(0.213)	-0.168	(0.208)	-0.081	(0.238)	-0.069	(0.237)	-0.282	(0.246)	-0.278	(0.239)
Def./Own. (MP) individual	-0.471	0.308	0.039	(0.463)	0.056	(0.452)	0.524	(0.495)	0.532	(0.484)	-0.444	(0.465)	-0.420	(0.455)
Def./Own. (MP) NPE														
Def./Own. (MP) not German	-0.198	0.160	-0.220	(0.183)	-0.224	(0.183)	-0.358*	(0.216)	-0.359*	(0.216)	-0.130	(0.221)	-0.138	(0.219)
Patent characteristics														
IPC: Electrical Engineering	0.685***	0.237	-0.558**	(0.280)	-0.551**	(0.271)	-0.318	(0.329)	-0.312	(0.323)	-1.024***	(0.368)	-1.015***	(0.365)
IPC: Instruments	0.416	0.260	-0.594**	(0.288)	-0.602**	(0.291)	-0.624*	(0.375)	-0.635*	(0.378)	-0.665*	(0.396)	-0.678*	(0.400)
IPC: Chemical Engineering	0.121	0.324	-0.416	(0.396)	-0.412	(0.392)	-0.407	(0.504)	-0.357	(0.498)	-0.663	(0.509)	-0.635	(0.514)
IPC: Mechanical Engineering	0.162	0.238	-0.799***	(0.268)	-0.808***	(0.269)	-0.781**	(0.346)	-0.778**	(0.349)	-1.032***	(0.377)	-1.032***	(0.378)
IPC: Complex industry	0.075	0.221	-0.404	(0.276)	-0.372	(0.276)	-0.579	(0.365)	-0.505	(0.360)	-0.322	(0.322)	-0.275	(0.319)
IPC4 class count	-0.076	0.059	0.095	(0.070)	0.090	(0.067)	0.014	(0.088)	0.008	(0.084)	0.225**	(0.098)	0.215**	(0.096)
Number of claims (log)	0.183*	0.110	-0.041	(0.141)			-0.114	(0.176)			-0.077	(0.181)		
Family size (log)	0.492***	0.104	-0.056	(0.115)			-0.046	(0.125)			-0.055	(0.133)		
German Part of EP patent	-0.242	0.196	-0.386	(0.249)	-0.437**	(0.202)	-0.375	(0.285)	-0.408*	(0.237)	-0.461	(0.301)	-0.522**	(0.252)
Grant lag (log)	0.135	0.120	0.131	(0.172)			0.155	(0.198)			0.063	(0.207)		
Opposition	0.826***	0.260	-0.390*	(0.234)	-0.384*	(0.231)	-0.037	(0.273)	-0.031	(0.267)	-0.758***	(0.256)	-0.744***	(0.252)
Forward citations, five years (log)	0.226**	0.088	0.030	(0.101)	0.012	(0.101)	0.084	(0.120)	0.053	(0.118)	-0.036	(0.117)	-0.050	(0.118)
Backward citations (log)	0.039	0.118	-0.292**	(0.129)	-0.291**	(0.127)	-0.482***	(0.174)	-0.487***	(0.166)	0.023	(0.171)	0.011	(0.166)
Backward citations to NPL (log)	-0.294**	0.122	-0.205	(0.149)	-0.208	(0.143)	-0.485***	(0.168)	-0.495***	(0.184)	0.131	(0.188)	0.128	(0.183)
Patent Age at Case Filing (1k days)			-0.103	(0.074)	-0.076	(0.065)	-0.110	(0.084)	-0.070	(0.074)	-0.093	(0.086)	-0.077	(0.071)
Constant	-1.724*	0.959					1.004	(1.471)	1.590**	(0.681)	1.809	(1.471)	1.954***	(0.664)
Constant cut 1			-1.624	(1.241)	-2.287***	(0.551)								
Constant cut 2			-0.614	(1.244)	-1.281**	(0.540)								
Observations	454		227		227		227		227		227		227	
F-Test	0.000		0.000		0.000		0.000		0.000		0.003		0.001	
Pseudo Likelihood	-259		-218.7		-219.3		-123.9		-124.6		-111.1		-111.4	
Wald's chi-squared	93.11		57.09		57.09		59.40		60.34		44.84		45.39	
Degrees of freedom	18		22		19		22		19		22		19	
Pseudo R-squared	0.177		0.111		0.109		0.191		0.187		0.153		0.150	

*** p<0.01, ** p<0.05, * p<0.1

Table 19: Correlates of selection into revocation proceedings with final decisions at BPatG or BGH, and of outcomes (2010-2012; probit/ordered probit)

6.2.2 Correlates of Patent Revocation Likelihood

Models Ia/b in Table 18 and Table 19 employ an ordinal dependent variable that equals 0 when the patent was fully upheld, 1 if it was ruled partially invalid, and 2 if it was fully invalidated. The dependent variable in models IIa/b equals 1 if the patent was ruled fully invalid and 0 otherwise. In models IIIa/b, the dependent variable equals 1 if the court decided on partial or full revocation.

Patent owner and plaintiff characteristics. As assumed, defendant size does not show any influence on an invalidation ruling. In contrast, models Ia/b and IIa/b show a highly significant effect of plaintiff size on the probability of a full revocation ruling, both in the first (Table 18) and in the final instance (Table 19).[221] The patent owner's country of residence has no significant effect. For the plaintiff, not being headquartered in Germany has no effect in the first instance, but interestingly, a highly significant positive effect in the final instance.

Patent characteristics. In line with Miller (2013), the analysis of the first instance decisions (Table 18) indicates a negative relationship between the number of backward citations and the probability of the patent being ruled fully invalid (models Ia/b and IIa/b). As in Miller (2013), none of my models reveals a significant correlation between the number of forward citations and the invalidation likelihood. The same holds for the number of claims, a result contrary to the work by Fischer (2015) and MacGahee (2011).[222] In contrast, examination at the EPO and having survived an opposition correlate positively, whereas the IPC class "Instruments" correlates negatively with the likelihood that the patent is fully upheld (models IIIa/b). Finally, all the models show that older patents are less likely to be ruled invalid, in line with Atkinson et al. (2009), MacGahee (2011), and Miller (2013).

The results on the final instance decisions (Table 19) are in line with those in Table 18 regarding backward citations, opposition and, partly, EPO examination. Differences exist mainly with respect to IPC classes, IPC4 class counts (in models IIIa/b), backward citations to NPL, and patent age.

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[221] Interestingly, this finding does not hold for the models IIIa/b (Table 18, Table 19) controlling for an influence on a (partial or full) invalidation. This result might be an indicator for the fact that an increase in plaintiff budget (approximated by revenue size) supports a full invalidation outcome, however, not a partial invalidation ruling.

[222] In line with Miller (2013), my findings indicate a negative, however not significant, relationship.

6.2.3 Predictions of Invalidation Likelihood

Based on my estimates (Table 18 and Table 19) I run out-of-sample predictions for the set of matched patents, setting plaintiff size variables to the average values of the adjudicated patents (which, by construction of the size categories, equal 0.33). Table 20 summarizes the predictions.

	I. Instance decision (BPatG)				I. or II. Instance decision (BPatG/BGH)			
	Out-of-sample prediction			Actual shares in-sample	Out-of-sample prediction			Actual shares in-sample
	Obs.	*Mean*	*Std. Dev.*		*Obs.*	*Mean*	*Std. Dev.*	
Ia -Full Model: 3 Stages								
Patent fully valid	305	0.188	0.113	0.213	227	0.213	0.132	0.265
Patent partially invalid	305	0.330	0.061	0.334	227	0.330	0.060	0.330
Patent fully invalid	305	0.482	0.163	0.453	227	0.457	0.179	0.405
Patent partially or fully invalid	305	0.812		0.787	227	0.787		0.735
Ib - Reduced Model: 3 Stages								
Patent fully valid	305	0.191	0.116	0.213	227	0.218	0.131	0.265
Patent partially invalid	305	0.329	0.061	0.334	227	0.332	0.058	0.330
Patent fully invalid	305	0.480	0.165	0.453	227	0.450	0.175	0.405
Patent partially or fully invalid	305	0.809		0.787	227	0.782		0.735
IIa - Full Model: Fully invalid								
Patent fully invalid	305	0.462	0.152	0.453	227	0.439	0.214	0.405
IIb - Reduced Model: Fully invalid								
Patent fully invalid	305	0.455	0.148	0.453	227	0.433	0.212	0.405
IIIa - Full Model: Partly/Fully invalid								
Patent partially/fully invalid	305	0.828	0.140	0.787	227	0.802	0.129	0.735
IIIb - Reduced Model: Partly/Fully invalid								
Patent partially/fully invalid	305	0.827	0.143	0.787	227	0.796	0.128	0.735

Note: Plaintiff size variables for matched patents are set to average values of litigated patents. In-sample predictions are identical (with differences below 0.004) to actual shares in-sample.

Table 20: Out-of-sample predictions of invalidation probabilities

For the first instance, I find the unconditional mean of the probability of a partial or full invalidation of a randomly drawn patent to be between 80.9% and 82.8%, corresponding to an increase of about 5% over the actual rate of 78.7% in 2010 to 2012. For the final decision, I find an unconditional mean of roughly 79% (between 78.2% and 80.2%). The average out-of-sample prediction for the probability of a full revocation in the first instance is around 47%, compared to a share of 45.3% in actual decisions. For the final instance, average predicted probabilities are around 45%, compared with the actual rate of 40.5%.

I further perform the same set of predictions by assuming to have only large plaintiffs in my regressions (Table 21), a situation that comes closer to the ideal of a perfect, thorough search for prior art and thus to fulfillment of the (theoretical) requirement of absolute novelty. In this alternative specification, the average predicted probability of a partial or full invalidation in the first instance increases to 87% (88% in model Ib, 86% in model IIIa, and 87% in model IIIb), while that of a full revocation becomes 59% (58% in model Ia, 59% in models Ib/IIb, and 60% in model IIa). For a final decision in the first or second instance, the average predicted probability of a (partial or full) invalidation increases to 86% (88% in models Ia/b, 85% in model IIIa, and 84% in model IIIb), and that of the full revocation to 62% (60% in models Ia/b, and 63% in models IIa/b).

	I. Instance decision (BPatG)				I. or II. Instance decision (BPatG/BGH)			
	Out-of-sample prediction			Actual shares in-sample	Out-of-sample prediction			Actual shares in-sample
	Obs.	*Mean*	*Std. Dev.*		*Obs.*	*Mean*	*Std. Dev.*	
Ia -Full Model: 3 Stages								
Patent fully valid	305	0.127	0.089	0.213	227	0.123	0.093	0.265
Patent partially invalid	305	0.290	0.077	0.334	227	0.277	0.087	0.330
Patent fully invalid	305	0.583	0.160	0.453	227	0.600	0.175	0.405
Patent partially or fully invalid	305	0.873		0.787	227	0.877		0.735
Ib - Reduced Model: 3 Stages								
Patent fully valid	305	0.124	0.089	0.213	227	0.124	0.092	0.265
Patent partially invalid	305	0.285	0.079	0.334	227	0.278	0.085	0.330
Patent fully invalid	305	0.591	0.161	0.453	227	0.598	0.171	0.405
Patent partially or fully invalid	305	0.876		0.787	227	0.876		0.735
IIa - Full Model: Fully invalid								
Patent fully invalid	305	0.595	0.150	0.453	227	0.631	0.209	0.405
IIb - Reduced Model: Fully invalid								
Patent fully invalid	305	0.594	0.146	0.453	227	0.632	0.208	0.405
IIIa - Full Model: Partly/Fully invalid								
Patent partially/fully invalid	305	0.860	0.123	0.787	227	0.845	0.110	0.735
IIIb - Reduced Model: Partly/Fully invalid								
Patent partially/fully invalid	305	0.867	0.121	0.787	227	0.842	0.109	0.735

Note: Plaintiffs are assumed to be large (Plaintiff size large=1; Plaintiff size medium=0). In-sample predictions are identical (with differences below 0.004) to actual shares in-sample.

Table 21: Out-of-sample predictions of invalidation probabilities assuming large plaintiffs

How do the predictions perform on the level of individual observations within the sample? I predict, for each observation, the most likely outcome and compare this prediction with the actual outcome in contingency tables (Table 20, Appendix A10).[223] Comparing the share of correct predictions with that of the null model (which predicts for all observations the most frequent outcome) shows that my model performs relatively well in predicting full invalidation: 13.8% (I. instance, Appendix A10.3) and 15.0% (final instance, Appendix A10.4) more observations are correctly predicted than by the null model. It performs badly in predicting "partial or full invalidation," with an improvement over the null model by only 0.7% (Appendix A10.5) and 0.9% (Appendix A10.6). As expected, the performance of the ordered probit model lies between those of the two probit models, with improvements over the null model by 5.9% (Appendix A10.1) and 11.9% (Appendix A10.2). Thus, my model is not particularly accurate in predicting individual outcomes. This comes as no surprise, however—given the complexity and diversity of legal cases the goal of making accurate predictions on the level of the observation would be presumptuous. I thus pursue the more modest goal of predicting average outcomes on an aggregate level.

6.3 Conclusion

The results of the descriptive analysis of revocation cases decided between 2000 and 2012 show that roughly 3/4 of the patents in these judgments are ruled partially or fully invalid—both in the first and second instance. The second instance amended the first instance decisions in 44% of the cases, the split between (partially or fully) invalid and valid, however, stays almost the same.[224] In both instances, roughly 45% of the proceedings reach a judgment on the merits, whereas the majority of cases is settled or withdrawn. Moreover, German parts of European patents and German patents are found to have a similar revocation probability. With regard to the case duration, the new regime for cases filed after September 2009 especially reduced the duration of the second instance cases from averaging 40 months to 22 months.

The litigants in the cases decided between 2010 and 2012 show a very similar median revenue and employee size. The median plaintiff, however, seems to be larger in

[223] Comparing the average predicted probability of each outcome with the actual frequency of this outcome in the sample is not informative since the two are, by construction of the estimator, identical (e.g., Train, 2003, p. 72).

[224] Whereas 37% of the first instance "valid" decisions changed from "valid" to "(partially or fully) invalid," only 28% of the (partial or full) invalidations changed from "(partially or fully) invalid" to "valid."

terms of earnings before interest and taxes. The owners of the randomly drawn matched patents are found to be significantly larger than the involved litigants in all size categories (revenue, employees, EBIT). The analyzed parties can primarily be assigned to the manufacturing industry and most of the litigants can be characterized as competitors (86%). Furthermore, 56-57% of the rivaling parties and 70% of the matched patent owners are not headquartered in Germany.

Sixty-four percent of the law firms involved in the analyzed proceedings employ less than 11 attorneys and 69% of them are not mentioned in the JUVE publishing house's *JUVE Handbook German Commercial Law Firms 2015 (Griffiths et al., 2014)*. Fifty-three percent of the law firms were only involved in one proceeding and 27% were not successful in any of their case(s).

The findings of the econometric analysis of court decisions from 2010 to 2012 support the conclusion drawn from the interview and survey results that a randomly picked patent would be invalidated, partially or fully, with a probability above that found for actual invalidation decisions. The regressions indicate that the plaintiff being in the top revenue tercile has the strongest and most highly significant effect on the likelihood of full invalidation both in the first and in the final instance decision, which are interpreted as an indication that the plaintiff's budget matters. While the actual shares of partially and fully invalidated patents in the first instance are 33.4% and 45.3%, respectively, totaling 78.7%, I obtain in out-of-sample predictions for randomly drawn patents point estimates of around 33% for partial, 46% to 48% for full, and 81% to 83% for either partial or full invalidation. Assuming, as a proxy for a very thorough search for prior art that all plaintiffs are large, increases the prediction for partial or full invalidation in the first instance to values between 86% and 88%. Predictions for final instance decisions are comparable.

7 Summary and Conclusion

The underlying dissertation is motivated by the high invalidation rates of challenged patents, not only in German but also in other legislations' revocation proceedings. The analysis for the case of Germany reveals that 75% of the patents that have reached a final decision in such a proceeding (between 2000 and 2012) should, by the standards of the patent system, not have been granted as they are, or not at all. Based on this high invalidation rate, the purpose of this dissertation was to analyze a rather simple yet very important question: What share of all patents would, if they went through invalidation proceedings, be ruled invalid?

In order to answer this question it is important to account for the fact that only a small fraction of all patents are ever litigated and that the selection to pursue a revocation proceeding as well as to pursue a final decision is subject to a number of selection mechanisms. Several empirical studies have addressed the factors influencing the selection into an infringement proceeding, which in most cases triggers a revocation action. Therefore, the selection effects at work for the former also come to bear for the latter if the reference group is the universe of all patents. Besides, only a few scholars have analyzed the determinants of revocation action outcomes with regard to the nature of patents and parties involved in these proceedings. The characteristics of parties in suit—especially concerning litigants' size or budget—have not been addressed as detailed as does this dissertation. Furthermore, with Fischer (2015) only one study exists which addresses the mentioned selection effects and determinants for the bifurcated German system, which is characterized by a separation of infringement and revocation proceedings.

To answer the aforementioned research question, the study builds on a combination of qualitative and quantitative research methods, including a descriptive analysis of all available decisions in revocation proceedings by the German Federal Patent Court and the court of second instance (the German Federal Court of Justice) from 2000 to 2012 (for the BGH decision until 2015). I used 19 hours of expert interviews, a survey among 323 patent lawyers, and an econometric analysis of first and second instance judgments issued between 2010 and 2012, accounting for several patent and litigants' characteristics.

According to the interviews and the survey, patents entering an infringement, and

therefore likely an invalidation proceeding,[225] are seen as more valuable, broader, and as legally robust as the average patent. Furthermore, since proceedings that end with a settlement would more likely have led to invalidation rulings than those that reached a decision, patents in first-instance invalidation proceedings that conclude with a decision should be more robust than the average patent. Besides, the plaintiff's budget (and size) are seen to positively affect the probability of a revocation ruling. This result is in line with the interviewees' and survey participants' opinion that newly found prior art is seen to be the primary invalidation reason.

On a descriptive level, my results are in line with studies analyzing more recent periods of German revocation proceeding outcomes (e.g., Stauder and Luginbuehl, 2009; Hess et al., 2014): The analysis of revocation cases decided between 2000 and 2012 shows that roughly 3/4 of the patents in these judgments are ruled partially or fully invalid. Analyzing the decision period from 2010 to 2012, patent owners involved in these proceedings are significantly smaller than those of the randomly drawn patents, which have never been challenged in court. The litigants in these cases are almost equally distributed among the revenue categories and show a very similar median revenue and employee size. Moreover, the overwhelming majority of litigants are found to be competitors (86%) and more than 55% of both plaintiffs and defendants are headquartered in Germany.

The findings of the econometric analysis of court decisions from 2010 to 2012 supports the conclusion drawn from the interview and survey results that the share of all German patents that are likely ruled (partially or fully) invalid would be even above the actual rate for adjudicated patents. Based on the regressions and the out-of-sample predictions, I can conclude that around 80% of all active German patents are latently invalid, either fully or partially. This share further increases to 84% to 88% if a deep purse of the plaintiff—and thus a more thorough search for prior art—is assumed.

While these numbers are specific to Germany, I conjecture—based on the qualitative study—that the finding of a higher invalidation rate out-of-sample than in-

[225] According to the conducted interviews, the overwhelming majority of infringement proceedings is seen to result in a revocation action. Not filing a revocation proceeding as a defense in an infringement suit is even said to be "malpractice." Obviously, there seems to be a discrepancy between the data derived number of one-third (e.g., Cremers et al., 2014) and practitioners' estimates. A possible explanation might be that several infringement suits brought against different alleged infringers (involving the same patent) are combined into one revocation action at the BPatG. Another possible explanation is that patents in infringement suits are still in a pending opposition procedure (or the opposition period has not yet expired) and can therefore not be challenged in a revocation action. This issue, however, deserves further examination in future research.

sample carries over to other legislations. In fact, in countries such as the U.S. where validity is tested within the infringement proceedings rather than separately as in Germany, the incremental robustness of patents whose validity is challenged over the average patent should be even higher since the counteracting selection effect that goes along with the filing of a revocation suit in Germany is largely absent.[226] And even if this is not the case—Miller (2013) predicts for innovation-based validity decisions an out-of-sample invalidation rate of 28% compared with 37% in-sample—latent invalidity rates are likely high in any country.

Are these findings worrisome? Lemley (2001) argues that patent offices are "rationally ignorant" of the objective validity of patents because examining each patent in detail would be far too costly: "Because so few patents are ever asserted against a competitor, it is much cheaper for society to make detailed validity determinations in those few cases than to invest additional resources examining patents that will never be heard from again" (Lemley, 2001, p. 2). In contrast, Gallini (2002) and Kesan and Ghosh (2004) argue that spending more on weeding out some latently invalid patents would be beneficial for society. Lemley's (2001) view has been further criticized by Farrell and Merges (2004) on the grounds that the incentives to challenge and defend issued patents are strongly skewed. I concur with their critique. While following Lemley's (2001) argument that a more detailed examination of each patent application would not solve the problem— even doubling the examiner's time[227] would not be sufficient by far —and an examination as thorough as in a court case would be unfeasible for patent offices, I do not consider "rational ignorance" a satisfactory explanation.[228] Also, latently invalid patents that are "never litigated or even licensed" and "will never be heard from again" (Lemley, 2001, p. 2) create inefficiencies for the economy and innovators in particular: they unduly deter third parties from using the patented invention resulting in costs for invent arounds, create a risk for others of being litigated, cause cost for their application, examination, grant, and monitoring, and obscure the patent system by their sheer quantity. Needless to say, the error of denying patents that would have deserved grant also occurs, and setting the priorities correctly between avoiding one or the other type of error is non-trivial

[226] For example, in the legal system of the U.S. or the UK, the same court decides on infringement and revocation, subject to the condition that the alleged infringer challenges the patent as a defense—which is seen to be a common practice (e.g., Cremers et al., 2013; Cremers et al., 2014).

[227] According to Lemley (2001), examiners at the USPTO spend, on average, a total of 18 hours on each application.

[228] Moreover, "even if the process for granting patents is improved, when a patent does enter litigation, considerable uncertainty will continue to exist about its validity and scope" (Lemley and Shapiro, 2005, p. 85).

(Meurer, 2009). Yet, the error of omitting relevant prior art can only work toward granting too many patents, and so it appears more relevant to me.

So how could the problem that the majority of German patents—and also large shares of all patents in other countries—are latently invalid be addressed? For the case of the U.S., various measures related to the examination and grant process have been proposed (e.g., Allison and Hunter, 2006; Devlin, 2008; Farrell and Merges, 2004; Farrell and Shapiro, 2008; Gallini, 2002; Lemley and Shapiro, 2005). For example, Allison and Hunter (2006) mention the "second pair of eyes" review according to which the application is assessed by more than one examiner before being allowed. However, I assume the effect size to be rather small. Only in the chance event that the second examiner knows off-the-cuff of some existing prior art can it be regarded as added value. In contrast, if s/he has to perform a search there would actually be a wasteful duplication of effort. Besides, increasing fees for examination and grant may also play a role in reducing the number of legally weak patent applications, though only to the extent that patent value as perceived by the applicant correlates with robustness. However, this measure would likely affect financially constrained applicants more than legally weak patents.

To address the issue that most patents are latently invalid, I suggest increasing the required inventive step in the examination procedure significantly (including, where applicable, potential opposition proceedings), while leaving the inventive step required for upholding a patent in later validity challenges unchanged or increasing it moderately. Essentially, I thus propose a strong "presumption of validity," but with a different rationale than the correspondent doctrine in U.S. patent law. That doctrine requires courts to regard a granted patent as valid unless the opposing party provides "clear and convincing evidence," a standard that favors the patentee in a validity dispute (e.g., Jaffe and Lerner, 2006, p. 50).[229] Lichtman and Lemley (2007) criticize the presumption of validity as inappropriate, given the patent office's resource and informational constraints. I concur with their view, and suggest a presumption of validity as a purely pragmatic mechanism: to ensure that most granted patents clear the intended inventive step hurdle of s even in the light of additional prior art found after grant, one stipulates a significantly larger inventive step for grant—say, $2s$—but maintains the original threshold of s for upholding patents in validity challenges.

[229] A parallel in German patent law is that a pending invalidity suit may be a reason to stay simultaneous infringement proceedings regarding the same patent only if invalidation of the patent in suits appears highly likely (see Chapter 2.3.1).

The proposed measure would reduce the likelihood of grant mainly for those patents that under the current system are latently invalid: since the main reason for invalidation is newly submitted prior art (Hess et al., 2014), patents that are latently invalid will, on average, have a smaller inventive step than other patents. Importantly, rejecting these patents on the grounds of an increased inventive step standard would be far simpler for examiners than finding the prior art that makes them latently invalid. A desirable side effect of the proposed measure would be a reduction in the overall number of patents. At the same time, requiring an inventive step significantly higher for grant than that required for upholding a patent in a validity challenge makes it harder to invalidate granted patents, thus providing much-needed legal certainty to patentees and other parties alike. While such double standards may be unsatisfactory from a dogmatic point of view, they would be an effective measure against the serious problem that most patents, certainly most German patents, are latently invalid.

This dissertation raises some issues that merit further exploration. Hence, future studies might want to address some of the following limitations.

The analysis focuses on German proceedings, characterized by a bifurcation of infringement and revocation. While it has been argued above that the findings should carry over to other legislations, it would be interesting to analyze the addressed question for other countries as well. Miller (2013) has already run an out-of-sample prediction for U.S. cases, limiting his analysis to innovation-based validity decisions. A cross-country study can therefore shed some additional light into country-specific differences.

Moreover, the econometric analysis focuses on the actual outcomes of the revocation proceedings. Due to data restrictions, it was not possible to include information on the cases that did not reach a judgment on the merits. Even though my interviewees and survey participants provided valuable estimations concerning these suits, it may be worth further investigating the proceedings that have not reached a final judgment. It would be especially interesting to know how the various litigant and patent-specific characteristics in these cases compare to those of the proceedings with a judgment. This might further enhance the prediction of latently invalid patents.

The high effort necessary for data collection only allowed for a thorough analysis of the judgments during a defined period of time and is therefore based on a limited number of cases. Moreover, relevant data on litigants and patents could not be identified for all of these cases, further reducing the sample size. Even though results should not change with introducing more decisions into the analysis, future studies might want to verify this assumption by expanding the dataset. Meanwhile, court data for additional

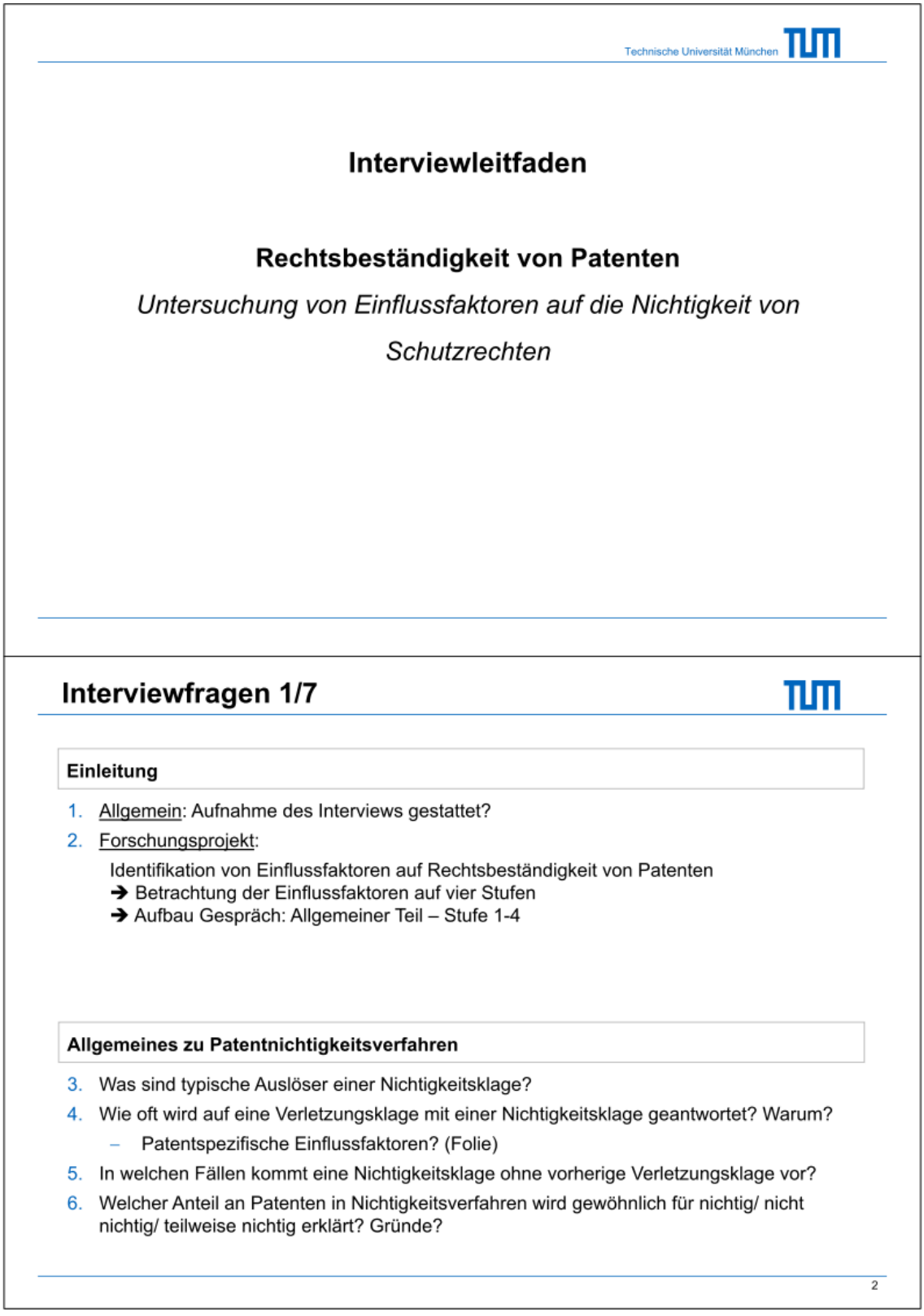
years will become available and identifying litigant-specific characteristics for more recent years is likely easier.

The plaintiff's budget is seen to be a major driver of success in a revocation proceeding. In the present study, the budget is approximated by the generated revenue at the case filing year. This is a valid assumption, as the revenue should positively correlate with the budget a company might be able to invest in such proceedings. Besides, further budget-related measures such as EBIT could only be identified for a limited number of litigants as this information is not available for smaller firms, which are not subject to the duty of public disclosure. Thus, future studies may include more precise budget figures. A possible approach to handle the lack of public available data might be to directly ask the involved litigants.

Finally, interviews with experts and litigants revealed that besides these tangible factors like budget, industry, etc. intangible determinants such as culture and personal characteristics of the persons involved in the litigation process may also contribute to the probability of a filing and the outcome of a revocation action. Especially for smaller companies, the latter are seen to be important. Thus, it may be worth investigating these factors, further supporting a comprehensive understanding of the nature of latently invalid patents.

Appendix

Appendix A1: Interviews—Interview Guideline



Technische Universität München

Interviewleitfaden

Rechtsbeständigkeit von Patenten

Untersuchung von Einflussfaktoren auf die Nichtigkeit von Schutzrechten

Interviewfragen 1/7

Technische Universität München

Einleitung

1. Allgemein: Aufnahme des Interviews gestattet?
2. Forschungsprojekt:

   Identifikation von Einflussfaktoren auf Rechtsbeständigkeit von Patenten
   ➔ Betrachtung der Einflussfaktoren auf vier Stufen
   ➔ Aufbau Gespräch: Allgemeiner Teil – Stufe 1-4

Allgemeines zu Patentnichtigkeitsverfahren

3. Was sind typische Auslöser einer Nichtigkeitsklage?
4. Wie oft wird auf eine Verletzungsklage mit einer Nichtigkeitsklage geantwortet? Warum?
   - Patentspezifische Einflussfaktoren? (Folie)
5. In welchen Fällen kommt eine Nichtigkeitsklage ohne vorherige Verletzungsklage vor?
6. Welcher Anteil an Patenten in Nichtigkeitsverfahren wird gewöhnlich für nichtig/ nicht nichtig/ teilweise nichtig erklärt? Gründe?

2

Appendix A1: Interviews—Interview Guideline (cont.)

Interviewfragen 2/7

Einflussfaktoren: Patentverletzung

7. Welche Faktoren haben einen Einfluss darauf, **ob ein Patent verletzt wird**? Warum?
   - *Patenteigenschaften: Breite*
   - *Patentinhaber/ potentieller Verletzer: Rechercheprogramme, Compliance*
   - *Markt/ Industrie: Pharma (bewusst, da Vertrauen auf fehlende Rechtsbeständigkeit) Unwissenheit*
   - *Sonstige*

Einflussfaktoren: Entstehung einer Patentverletzungsklage

8. Welche Faktoren haben einen Einfluss darauf, ob es zu einer **Verletzungsklage kommt**? Warum?
   - *Patenteigenschaften: Stabilität, Breite*
   - *Patentinhaber/ potentieller Verletzer: Strategisch (Drohung), wirtschaftliche Lage*
   - *Markt/ Industrie: Telekom, Pharma, Consumer Products*
   - *Sonstige*

3

Interviewfragen 3/7

Einflussfaktoren: Klageerhebung

9. Welche Faktoren haben einen Einfluss darauf, ob ein Patent in ein Nichtigkeitsverfahren kommt? Warum?
   - *Patenteigenschaften: Breite, ökonomische Wichtigkeit, Stabilität, Industrie, Land, Alter*
   - *Kläger/Beklagter: Branche, Individuum/Unternehmen/Uni , Größe, wirtschaftliche Lage, Land, Unternehmenskultur/ -typ, Inhaberführung*
   - *Markt/ Industrie: Standards, Asymmetrien*
   - *Klagespezifisch: Anwaltliche Beratung; Vorhersage des Ausgangs*
   - *Sonstige: Zeitpunkt, Bedeutung des Produkts*
10. Wie könnten die Einflussfaktoren der Bedeutung/ Stärke nach eingeordnet werden?
11. Was wären weitere mögliche Einflussfaktoren?
12. Im Durchschnitt: wie unterscheiden sich Patente, die in Nichtigkeitsverfahren kommen, von denen, die nicht in ein Nichtigkeitsverfahren kommen? Welche sind ökonomisch wichtiger, haben höhere Erfindungshöhe oder sind vor Gericht stabiler?

4

Appendix A1: Interviews—Interview Guideline (cont.)

Interviewfragen 4/7

Einflussfaktoren: Nichtigsprechung

13. Welche Faktoren haben einen Einfluss auf den Ausgang eines Nichtigkeitsverfahrens? Warum?
    - *Patenteigenschaften: ökonomische Wichtigkeit, Fundamentalität, Stabilität, vorangegangene Prozesse, Industrie, Alter, Eigenentwicklung, Prüfdauer*
    - *Kläger/Beklagter: Branche, Individuum/Unternehmen/Uni , Größe, wirtschaftliche Lage, Land, Erfahrung mit Patenten (Portfoliogröße), Erfahrung mit Klagen/ juristischen Prozessen, Streitkultur, IP-Organisation*
    - *Markt/ Industrie: Branchen mit hoher Klageaktivität*
    - *Klage: Senate, Richter, Dauer, Anwälte, Land*
    - *Sonstige: Zeitpunkt, Land*
14. Wie könnten die Einflussfaktoren der Bedeutung/Stärke nach eingeordnet werden?
15. Was wären weitere mögliche Einflussfaktoren?
16. Gibt es bestimmte Strategien in einem Nichtigkeitsverfahren (z.B. das Verfahren in die Länge zu ziehen etc.)? Werden diese auch ausgenutzt?

5

Interviewfragen 5/7

Einflussfaktoren: Berufung

17. Bei welchen BPatG-Entscheidungen (N, TN, V) kommt es eher zu einem Berufungsverfahren? Warum?
18. Welche Faktoren haben einen Einfluss darauf, ob eine Partei Berufung einlegt? Warum?
    - *Patenteigenschaften*
    - *Patentinhaber/ potentieller Verletzer*
    - *Markt/ Industrie*
    - *Sonstige*
19. Welche Faktoren haben auf dieser Stufe einen Einfluss auf das Ergebnis?
20. Was sind auf dieser Stufe Gründe für Klagerücknahmen?

6

Appendix A1: Interviews—Interview Guideline (cont.)

Interviewfragen 6/7

Einflussfaktoren: Außergerichtliche Einigung

21. Wie kommt es zu der hohen Zahl an Klagerücknahmen (siehe Folie)
22. Wie hoch ist die Wahrscheinlichkeit, dass es zu einer außergerichtlichen Einigung kommt?
23. Zu welchem Ausgang wäre es bei den Verfahren vermutlich gekommen, die außergerichtlich entschieden wurden (auch Klagerücknahmen)?
24. Welche Faktoren führen zu einer/ keiner außergerichtlichen Einigung?
    - Strategisch (Kein Eintrag), Monetär, Image, Streitkultur, Vorhersehbarkeit des Urteils
25. Ist eine Vorhersage des Ausgangs bereits vor dem Verfahren möglich?
26. Welche Faktoren können zu einer Einigung vor Klageerhebung (ex-ante) führen?
27. Kommt es tendenziell eher zu einer außergerichtlichen Einigung (ex-ante), wenn der Ausgang nicht vorhersehbar ist?

7

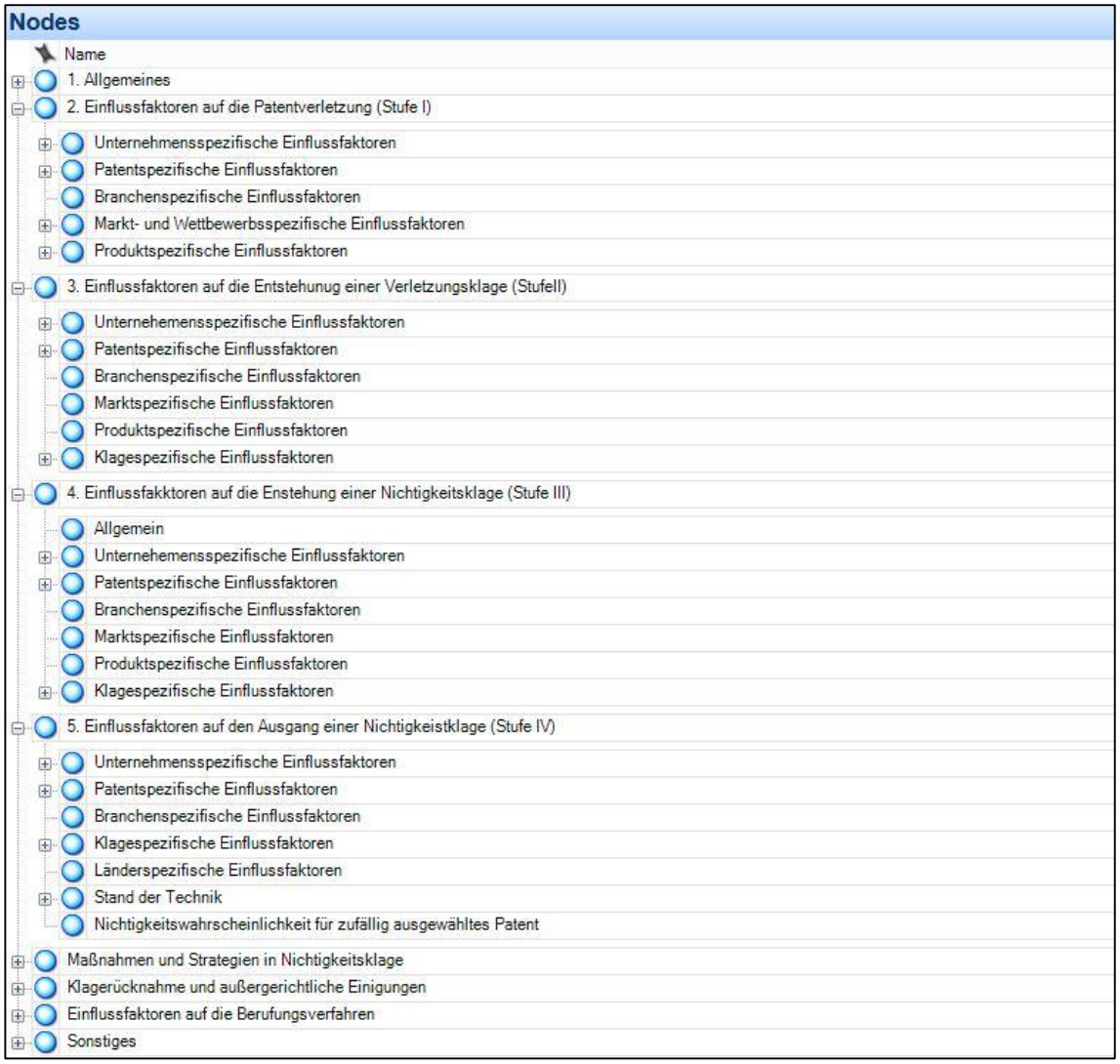
Interviewfragen 7/7

Abschliessende Fragen

29. Wie hoch schätzen Sie die Relevanz der angestrebten Untersuchung ein?
30. Gibt es noch weitere Punkte, die in diesem Zusammenhang wichtig wären?
31. Gibt es zu diesem Thema noch weitere interessante Gesprächspartner, die wir kontaktieren sollten?

8

Appendix A2: Interviews—Final Coding Scheme



Appendix A3: Survey—Complete Survey

Technische Universität München

Die folgenden Fragen beziehen sich auf Deutschland, also auf deutsche Patente und Nichtigkeitsverfahren in Deutschland.

A. Fragen zur Person:

A1. Seit wie vielen Jahren beschäftigen Sie sich mit Patentnichtigkeitsverfahren?

☐<3 ☐3-5 ☐6-10 ☐11-15 ☐>15

A2. In wie viele Nichtigkeitsverfahren waren Sie bisher involviert?

☐0 ☐1-5 ☐6-10 ☐11-20 ☐>20

A3. In wie viele Berufungsverfahren zu Patentnichtigkeitssachen waren Sie bisher involviert?

☐0 ☐1-5 ☐6-10 ☐11-20 ☐>20

A4. Welcher Profession gehören Sie an?

☐Rechtsanwalt ☐Patentanwalt

A5. Mit welchem Technikfeld befassen Sie sich schwerpunktmäßig? Auf dieses Technikfeld wird im Folgenden als „Ihr Schwerpunkt-Technikfeld" Bezug genommen.

☐Maschinenbau und Mechanik ☐Chemie und Biotechnologie ☐Elektrotechnik und IT
☐Instrumente

A6. In Nichtigkeitsverfahren vertreten Sie …

☐…immer die Klägerin ☐…meistens die Klägerin ☐…etwa gleich häufig Klägerin und Beklagte
☐…meistens die Beklagte ☐…immer die Beklagte

A7. In Nichtigkeitsverfahren vertreten Sie überwiegend Unternehmen mit…

☐<50 ☐50-250 ☐251-1000 ☐>1000 Mitarbeitern ☐kein Fokus auf bestimmte Größenklassen

A8. In wie viele Patentverletzungsverfahren waren Sie bisher involviert?

☐0 ☐1-5 ☐6-10 ☐11-20 ☐>20

Appendix A3: Survey—Complete Survey (cont.)

B. Einschätzungen: Einflussfaktoren auf Verletzungs- und Nichtigkeitsklage

*Bitte stellen Sie sich ein übliches **Verletzungs**verfahren in Ihrem Schwerpunkt-Technikfeld vor. Wie unterscheiden sich die **Klagepatente**, im Mittel, vom **Durchschnitt aller Patente** im gleichen Technikfeld, die nicht Gegenstand einer Verletzungsklage werden?*

B1. Klagepatente sind, im Vergleich zum **Durchschnittspatent**, das nicht Gegenstand einer Verletzungsklage ist, im Mittel…

☐ kommerziell deutlich wertvoller	☐ kommerziell etwas wertvoller	☐ kommerziell ungefähr gleich wertvoll	☐ kommerziell etwas weniger wertvoll	☐ kommerziell deutlich weniger wertvoll
☐ deutlich rechtsbeständiger	☐ etwas rechtsbeständiger	☐ ungefähr gleich rechtsbeständig	☐ etwas weniger rechtsbeständig	☐ deutlich weniger rechtsbeständig
☐ deutlich komplexer	☐ etwas komplexer	☐ ungefähr gleich komplex	☐ etwas weniger komplex	☐ deutlich weniger komplex
☐ deutlich breiter	☐ etwas breiter	☐ ungefähr gleich breit	☐ etwas weniger breit	☐ deutlich weniger breit
☐ deutlich jünger	☐ etwas jünger	☐ ungefähr gleich alt	☐ etwas älter	☐ deutlich älter

B2. Wie häufig passiert es **Ihrer Einschätzung nach**, dass in Ihrem Schwerpunkt-Technikfeld **auf eine Verletzungsklage** eine **Nichtigkeitsklage** gegen das Klagepatent **erfolgt**?

In ca. …… Prozent aller Fälle erfolgt auf eine Verletzungsklage eine Nichtigkeitsklage.

*Bitte stellen Sie sich ein **typisches Nichtigkeitsverfahren** in Ihrem Schwerpunkt-Technikfeld vor. Wie unterscheiden sich **Patente in solchen Nichtigkeitsverfahren** vom Durchschnitt aller **Patente** im gleichen Technikfeld, die **nicht Gegenstand einer Nichtigkeitsklage** werden?*

B3. Patente, die **in** ein **Nichtigkeitsverfahren** kommen, sind im Vergleich zum Durchschnitt aller Patente, die **nicht in** ein **Nichtigkeitsverfahren kommen**, im Mittel…

☐ kommerziell deutlich wertvoller	☐ kommerziell etwas wertvoller	☐ kommerziell ungefähr gleich wertvoll	☐ kommerziell etwas weniger wertvoll	☐ kommerziell deutlich weniger wertvoll
☐ deutlich rechtsbeständiger	☐ etwas rechtsbeständiger	☐ ungefähr gleich rechtsbeständig	☐ etwas weniger rechtsbeständig	☐ deutlich weniger rechtsbeständig
☐ deutlich komplexer	☐ etwas komplexer	☐ ungefähr gleich komplex	☐ etwas weniger komplex	☐ deutlich weniger komplex
☐ deutlich breiter	☐ etwas breiter	☐ ungefähr gleich breit	☐ etwas weniger breit	☐ deutlich weniger breit
☐ deutlich jünger	☐ etwas jünger	☐ ungefähr gleich alt	☐ etwas älter	☐ deutlich älter

Appendix A3: Survey—Complete Survey (cont.)

*Mehr als die Hälfte aller Nichtigkeitsverfahren beim BPatG werden **nicht durch ein Urteil** entschieden. Stattdessen kommt es zu **Vergleichen**, **Klagerücknahmen** und sonstigen Erledigungen.*

B4. Ihrer Einschätzung nach: **wie wären diese Klagen entschieden worden**, wenn es zu einem **Urteil** gekommen wäre?

……% nichtig	……% teilnichtig	……% aufrecht erhalten

*Wenn das **Nichtigkeitsverfahren** vor dem BPatG durch ein **Urteil** entschieden wird: Welchen Einfluss hat der Faktor **Unternehmensgröße** Ihrer Meinung nach auf die Wahrscheinlichkeit, dass ein **Patent für nichtig erklärt oder eingeschränkt** wird?*

B5. Ist die **Klägerin** ein **größeres Unternehmen**, wird die Wahrscheinlichkeit einer Nichtigsprechung/ Einschränkung…

☐	☐	☐	☐	☐	☐
…deutlich erhöht	…leicht erhöht	…gar nicht verändert	…leicht vermindert	…deutlich vermindert	Keine Aussage möglich

B6. Ist die **Beklagte** ein **größeres Unternehmen**, wird die Wahrscheinlichkeit einer Nichtigsprechung/ Einschränkung…

☐	☐	☐	☐	☐	☐
…deutlich erhöht	…leicht erhöht	…gar nicht verändert	…leicht vermindert	…deutlich vermindert	Keine Aussage möglich

*Wie wirkt sich das **Budget**, das die **klagende Partei** im Rahmen des Nichtigkeitsverfahrens aufwendet, auf die Wahrscheinlichkeit aus, dass **neuer Stand der Technik** gefunden wird, der eine **Nichtigsprechung** des Patents **wahrscheinlicher** macht?*

B7. Die Wahrscheinlichkeit, dass relevanter neuer Stand der Technik gefunden wird, ...

☐	☐	☐	☐	☐	☐
…nimmt mit dem Budget stark zu	…nimmt mit dem Budget etwas zu	…hängt nicht vom Budget ab	…nimmt mit dem Budget etwas ab	…nimmt mit dem Budget stark ab	Keine Aussage möglich

*Wenn Patente **vom BPatG für nichtig erklärt** oder eingeschränkt werden, **welche Rolle** spielen dabei die folgenden **Faktoren**:*

B8. Neuer Stand der Technik, der dem BPatG vorgelegt wurde, dem Prüfer am **Patentamt** aber **nicht bekannt war**

☐	☐	☐	☐	☐	☐
sehr große Rolle	große Rolle	geringe Rolle	sehr geringe Rolle	keine Rolle	Keine Aussage möglich

B9. Unterschiedliche **Bewertungsmaßstäbe** des BPatG und des Patentamtes

☐	☐	☐	☐	☐	☐
sehr große Rolle	große Rolle	geringe Rolle	sehr geringe Rolle	keine Rolle	Keine Aussage möglich

Appendix A3: Survey—Complete Survey (cont.)

*Unter der hypothetischen Annahme, dass **das BPatG exakt den gleichen Stand der Technik** berücksichtigen würde **wie der Patentprüfer**, im Verfahren also kein neuer Stand der Technik hinzukäme:*

B10. Welcher **Anteil an Patenten**, die das BPatG im normalen Verfahren (also **unter Berücksichtigung** von neuem Stand der Technik) für **nichtig** erklären würde, würde auch **unter dieser Annahme** (also allein aufgrund unterschiedlicher Bewertungsmaßstäbe) für **nichtig** erklärt werden?

Ca. …… Prozent

C. Einschätzungen: Einflussfaktoren auf Berufungsverfahren

*Bitte stellen Sie sich ein typisches **Nichtigkeits**verfahren in Ihrem Schwerpunkt-Technikfeld vor, in dem es zu einem **erstinstanzlichen Urteil**sspruch kam. Manche dieser Urteile führen zu einem Berufungsverfahren, andere nicht. Wie unterscheiden sich die **Patente**, die aus dem BPatG-Verfahren in ein **Berufungsverfahren** kommen, vom Durchschnitt derer, die nicht in ein Berufungsverfahren kommen?*

C1. Patente, die aus dem BPatG-Verfahren in ein **Berufungsverfahren** kommen, sind im Vergleich zu Patenten, die nur das erstinstanzliche Urteil erfahren aber keine Berufung, im Mittel…

☐ kommerziell deutlich wertvoller	☐ kommerziell etwas wertvoller	☐ kommerziell ungefähr gleich wertvoll	☐ kommerziell etwas weniger wertvoll	☐ kommerziell deutlich weniger wertvoll
☐ deutlich rechtsbeständiger	☐ etwas rechtsbeständiger	☐ ungefähr gleich rechtsbeständig	☐ etwas weniger rechtsbeständig	☐ deutlich weniger rechtsbeständig
☐ deutlich komplexer	☐ etwas komplexer	☐ ungefähr gleich komplex	☐ etwas weniger komplex	☐ deutlich weniger komplex
☐ deutlich breiter	☐ etwas breiter	☐ ungefähr gleich breit	☐ etwas weniger breit	☐ deutlich weniger breit
☐ deutlich jünger	☐ etwas jünger	☐ ungefähr gleich alt	☐ etwas älter	☐ deutlich älter

C2. In wie viel **Prozent** der Fälle kommt es Ihrer Erfahrung nach zu einer **Rücknahme der Nichtigkeitsklage** im Berufungsverfahren (d.h. das erstinstanzliche Urteil wird wirkungslos)?

In ca. …… Prozent aller Fälle

D. Fragen zur Kanzlei:

D1. Wie viele Mitarbeiter hat Ihre Kanzlei?

☐<10 ☐10-50 ☐51-100 ☐101-150 ☐>150

D2. Wie viele Mitarbeiter beschäftigen sich in Ihrer Kanzlei überwiegend mit Patentstreitigkeiten? (Angabe in Prozent)

Ca. …….. Prozent

Appendix A3: Survey—Complete Survey (cont.)

Abschließend möchten wir Sie noch um Ihre **Kontaktdaten** bitten, um Ihnen eine Zusammenfassung der **Ergebnisse übermitteln** zu können. Zudem erlauben uns diese Angaben, die Zugehörigkeit verschiedener Respondenten zur selben Kanzlei in der ökonometrischen Analyse zu berücksichtigen. Die **Auswertung** erfolgt, wie erwähnt, **völlig anonym**. Durch die Angabe Ihrer Kontaktdaten nehmen Sie automatisch an der Verlosung des Champagner-Bieres „Infinium" teil.

Name:	**Kanzlei:**	**Email:**
.....	.....	.....

Über Kommentare würden wir uns freuen:

.....

.....

.....

.....

Herzlichen Dank für Ihre Unterstützung!

Prof. Dr. Joachim Henkel

Dipl.-Kfm. Hans Zischka

Technische Universität München

Appendix A4: Survey—Cover Letter

Technische Universität München

TUM School of Management
Dr. Theo Schöller-
Stiftungslehrstuhl für
Technologie- und
Innovationsmanagement

Prof. Dr.
Joachim Henkel

Arcisstraße 21
80333 München
Germany

Tel +49.89.289.25741
Fax +49.89.289.25742

henkel@wi.tum.de
www.tim.wi.tum.de

Technische Universität München
TUM School of Management 80290 München

Herrn Dr. Max Mustermann
Mustermann & Partner
Postfach 123
12345 Musterstadt

Befragung zum Forschungsprojekt „Einflussfaktoren auf die Rechtsbeständigkeit von Patenten“

München, 29. Oktober 2013

Sehr geehrter Herr Dr. Mustermann,

wie in der Oktoberausgabe des Kammerrundschreibens der Patentanwalts-kammer angekündigt, führt mein Lehrstuhl für Technologie- und Innovations-management der Technischen Universität München im Rahmen eines wissenschaftlichen Forschungsprojektes eine Befragung zum Thema „Einflussfaktoren auf die Rechtsbeständigkeit von Patenten“ durch.

Ziel der Untersuchung ist es, Faktoren zu identifizieren, die einen Einfluss auf die Entstehung und den Ausgang eines Nichtigkeitsverfahrens haben.

Wir wären Ihnen sehr dankbar, wenn Sie sich ca. 10 min Zeit nehmen könnten, unser Forschungsprojekt mit Ihrer Erfahrung zu unterstützen.

Gern können Sie den ausgefüllten Fragebogen per Post – im beigelegten Umschlag – oder per Fax, 089-289 25742, an uns zurücksenden. Wenn Sie eine digitale Bearbeitung vorziehen, führt Sie folgender Link zur Umfrage: http://bit.ly/nichtig.

Ihre Angaben werden streng vertraulich behandelt. Die Analyse und die Publikation der Ergebnisse erfolgen in aggregierter Form und völlig anonym. Gern lassen wir Ihnen eine Zusammenfassung der Ergebnisse zukommen.

Als kleines Dankeschön verlosen wir unter den Teilnehmern 20 Flaschen des von Weihenstephan entwickelten Champagner-Bieres „Infinium“.

Für Rückfragen steht Ihnen Herr Hans Zischka unter zischka@wi.tum.de oder telefonisch unter 089 289 25744 jederzeit zur Verfügung.

Mit herzlichem Dank für Ihre Unterstützung und freundlichen Grüßen

Joachim Henkel

Prof. Dr. Joachim Henkel

Appendix A5: Survey—Announcement

Technische Universität München

TUM School of Management

Unterstützen Sie mit Ihrer Erfahrung das

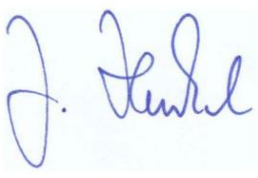
TUM-Forschungsprojekt zur Rechtsbeständigkeit von Patenten

Welche Patente werden Gegenstand von Nichtigkeitsverfahren?
Wovon hängt der Ausgang eines solchen Verfahrens ab?

Diese und weitere Fragen sind Gegenstand eines Forschungsprojekts des Dr. Theo Schöller-Stiftungslehrstuhls für Technologie- und Innovationsmanagement, Prof. Dr. Joachim Henkel, der Technischen Universität München.

Im Rahmen der Untersuchung führen wir im Oktober eine Befragung unter Patentrechtsexperten durch. Sollten Sie angeschrieben werden, bitten wir Sie herzlich, das Projekt mit Ihrer Erfahrung zu unterstützen. Alle Teilnehmer erhalten exklusiven Zugang zu den Ergebnissen.

Bei Fragen kontaktieren Sie gern Herrn Hans Zischka unter zischka@wi.tum.de.



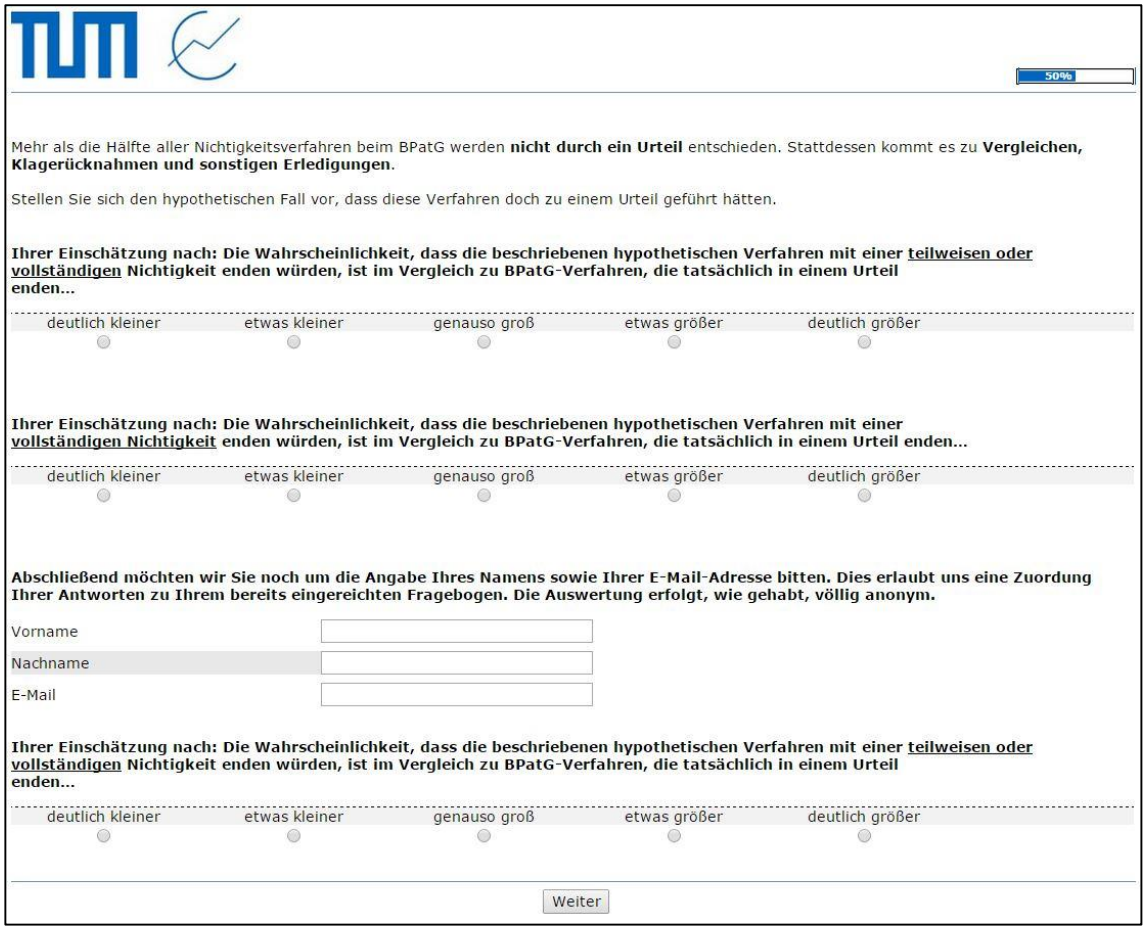
Prof. Dr. Joachim Henkel

Dipl.-Kfm. Hans Zischka

TUM School of Management
Dr. Theo Schöller-Stiftungslehrstuhl für Technologie- und Innovationsmanagement

Arcisstr. 21
80333 München
Tel +49.89.289.25741
Fax +49.89.289.25742
www.tim.wi.tum.de

Appendix A6: Survey—Additional Question



Appendix A7: Survey—Late-Response Analysis

			Mean		**n**	
	Values	p-Value	Early	Late	Early	Late
Variable						
Experience with first instance revocation proceedings (years)	1 to 5	0.009	3.818	3.409	215	105
Experience with second instance revocation proceedings (number)	1 to 5	0.006	2.569	2.171	216	105
Profession (1=lawyer; 2=patent attorney)	1 to 2	0.004	1.689	1.523	216	105
Size Law Firm (# of employees)	1 to 5	0.018	3.401	3.804	214	92
Value of Patent in second instance revocation proceeding	-2 to 2	0.088	1.419	1.272	198	88

Appendix A8: Party Size Classifications

Appendix A8.1: Party Size Classification (Number of Employees)

Employees	Plaintiff		Defendant		Matched Patent Owner	
	%	Freq.	%	Freq.	%	Freq.
Number						
0-10	3%	10	10%	27	2%	6
10-100	17%	49	17%	47	4%	10
100-500	16%	48	12%	34	9%	25
500-1,000	8%	24	4%	10	4%	11
1,000-10,000	17%	50	25%	71	22%	60
10,000-100,000	26%	75	22%	62	36%	98
>100,000	13%	38	10%	29	23%	61
Median	**1,751**		**2,018**		**18,800**	
n	**294**		**280**		**271**	
Individual	**0**		**15**		**23**	

Appendix A8.2: Party Size Classification (EBIT)

EBIT	Plaintiff		Defendant		Matched Patent Owner	
	%	Freq.	%	Freq.	%	Freq.
€ Mio.						
<0	8%	17	15%	31	13%	32
0-10	30%	66	20%	43	12%	30
10-100	14%	30	23%	49	15%	38
100-500	19%	42	20%	43	19%	46
500-1,000	7%	16	2%	4	5%	12
1,000-5,000	14%	31	10%	20	28%	68
>5,000	8%	17	10%	22	8%	21
Median	**93**		**46**		**251**	
n	**219**		**212**		**247**	
Individual	**0**		**15**		**23**	

Appendix A9: Summary Statistics and Correlations

Appendix A9.1: Selection into Proceedings (1st Instance Decisions) (Table 18)

Variables	Descriptive		Correlations																			
	Mean	*Std. dev.*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*VIF*[a]
Dependent Variable																						
(1) Selection in I. instance	.500	.500	1																			
Defendant/Patent Owner																						
(2) Def./Own. (MP) size large	.333	.472	-.226	1																		1.83
(3) Def./Own. (MP) size medium	.334	.472	.000	-.501	1																	1.66
(4) Def./Own. (MP) individual	.062	.242	-.054	-.182	-.183	1																1.39
(5) Def./Own. (MP) NPE	.021	.145	.125	-.104	-.081	-.038	1															1.22
(6) Def./Own. (MP) not German	.636	.482	-.136	.223	-.013	.195	-.171	1														1.46
Patent characteristics																						
(7) IPC: Electrical Engineering	.221	.415	.099	.009	-.026	-.088	.277	.034	1													2.45
(8) IPC: Instruments	.138	.345	.038	-.050	.019	.094	-.059	.114	-.213	1												1.93
(9) IPC: Chemical Engineering	.207	.405	-.105	.172	-.053	-.048	-.075	.117	-.272	-.204	1											4.13
(10) IPC: Mechanical Engineering	.313	.464	-.046	-.027	.038	.001	-.100	-.151	-.360	-.270	-.344	1										2.82
(11) IPC: Complex industry	.695	.461	.100	-.137	.039	-.006	.098	-.094	.353	.234	-.709	-.044	1									2.56
(12) IPC4 class count	1.964	1.258	.026	.029	.034	-.047	.067	.165	-.022	.015	.214	-.116	-.141	1								1.22
(13) Number of claims (log)	2.444	.621	.084	.069	.001	-.068	.012	.049	-.041	.004	.083	.008	-.110	.182	1							1.08
(14) Family size (log)	1.785	.937	.195	.123	.025	-.153	.090	.270	-.073	.074	.197	-.118	-.170	.309	.182	1						1.76
(15) German Part of EP patent	.720	.450	.033	.115	.102	-.171	.067	.233	.016	-.015	.129	-.067	-.104	.110	.118	.563	1					1.63
(16) Grant lag (log)	7.366	.554	.035	.051	.004	-.088	.072	.206	.059	.063	.083	-.118	-.071	.145	.024	.173	.217	1				1.13
(17) Opposition	.116	.321	.230	-.094	-.019	-.051	-.018	-.065	-.070	-.012	.042	.008	-.071	.059	.005	.122	.113	-.011	1			1.12
(18) Forward citations, 5 yrs (log)	.509	.748	.137	-.010	-.009	.028	.008	-.027	.006	-.047	-.021	.006	.052	.082	.076	.004	-.051	-.049	.114	1		1.06
(19) Backward citations (log)	1.511	.588	.100	-.101	.049	.040	-.032	-.025	-.083	.039	-.132	.130	.032	.015	.091	.049	.045	.013	.119	.099	1	1.15
(20) Backward citations to NPL (log)	.415	.581	-.055	.075	.018	-.068	-.003	.181	.045	-.005	.200	-.099	-.159	.181	.029	.184	.216	.125	.138	.050	-.219	1.23

Note: All correlations with absolute value above 0.080 are significant ($p<0.05$), N= 610; [a] VIF = variance inflation factor; the VIFs are calculated based on an OLS model with "Selection in I. instance" as the dependent variable

Appendix A9.2: First Instance Outcomes (Table 18)

Variables	Descriptive		Correlations																								
	Mean	*Std. dev.*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*VIF[a]*
Dependent Variable																												
(1) 3 stages	1.239	.781																										
(2) fully invalid	.452	.499																										
(3) fully/partially	.787	.410																										
Plaintiff																												
(4) Plaintiff size large	.334	.473	.263	.131	.237	1																						2.13
(5) Plaintiff size medium	.334	.473	-.086	-.089	-.102	-.502	1																					1.58
(6) Plaintiff not German	.557	.498	.107	.084	.113	.310	.030	1																				1.25
Defendant/Patent Owner																												
(7) Defendant size large	.226	.419	.075	.128	.115	.165	-.034	.056	1																			1.65
(8) Defendant size medium	.334	.473	-.100	-.106	-.120	-.002	.146	.072	-.383	1																		1.54
(9) Defendant individual	.049	.217	.037	-.030	.008	-.065	-.033	-.042	-.123	-.161	1																	1.28
(10) Defendant NPE	.039	.195	.121	.064	.111	.285	-.143	.112	-.109	-.143	-.046	1																1.51
(11) Defendant not German	.570	.496	.084	.098	.105	.194	-.017	.200	.216	.068	.197	-.233	1															1.53
Patent characteristics																												
(12) IPC: Electrical Engineering	.262	.441	.132	.019	.094	.272	-.138	.081	-.073	-.075	-.067	.339	-.025	1														2.65
(13) IPC: Instruments	.151	.358	-.015	.130	.059	-.027	.012	.007	-.075	.031	.116	-.085	.088	-.251	1													1.98
(14) IPC: Chemical Engineering	.164	.371	.042	.101	.080	.024	.043	.056	.226	-.051	-.060	-.090	.116	-.264	-.187	1												3.84
(15) IPC: Mechanical Engineering	.292	.455	-.134	-.159	-.169	-.165	.111	-.009	.015	.065	.021	-.130	-.084	-.383	-.271	-.284	1											2.69
(16) IPC: Complex industry	.741	.439	-.034	-.034	-.039	.038	-.120	.000	-.217	.023	-.039	.120	-.135	.353	.207	-.709	-.098	1										2.88
(17) IPC4 class count	1.997	1.268	.018	.138	.084	.090	.002	.029	.100	-.026	-.035	.054	.134	-.028	.001	.197	-.050	-.179	1									1.21
(18) Number of claims (log)	2.495	.616	-.105	.025	-.054	-.153	-.002	-.033	.131	-.006	-.041	-.021	.024	-.128	.058	.004	.114	-.107	.192	1								1.26
(19) Family size (log)	1.968	1.022	.021	.052	.040	.123	.025	.124	.258	-.003	-.134	.045	.236	-.167	-.004	.253	-.017	-.259	.303	.175	1							1.72
(20) German Part of EP patent	.734	.442	-.020	-.114	-.072	.064	.064	.062	.148	.127	-.138	.084	.198	-.030	-.099	.086	.076	-.135	.098	.066	.512	1						1.58
(21) Grant lag (log)	7.386	.553	.084	.073	.092	.179	.000	.087	.077	.077	-.099	.087	.220	.078	.036	.046	-.094	-.052	.105	-.099	.090	.104	1					1.41
(22) Opposition	.190	.393	-.004	-.156	-.084	.028	-0.042	-.056	-.062	-.025	-.072	-.055	-.052	-.099	-.017	.034	.075	-.095	.041	-.036	.059	.159	-.048	1				1.22
(23) Forward citations, 5 yrs. (log)	.612	.835	.029	-.021	.007	.003	.035	-.004	.034	.017	.003	-.004	.027	-.022	-.103	.063	-.010	.021	.120	.134	.039	.005	-.056	.118	1			1.19
(24) Backward citations (log)	1.570	.596	-.176	-.108	-.169	-.158	-.018	-.065	-.034	.094	-.061	-.092	-.023	-.104	.089	-.096	.072	.031	.004	.166	.000	.048	-.043	.135	.106	1		1.19
(25) Backward citations to NPL (log)	.384	.592	.018	.041	.033	.137	-.052	.064	.120	-.076	.008	-.001	.138	-.029	-.046	.250	-.039	-.248	.154	.032	.149	.169	.068	.224	.067	-.166	1	1.24
(26) Patent Age at case Filing (1k d)	4.273	1.505	-.012	-.046	-.032	.126	.032	.137	.089	.076	-.022	-.108	.240	.078	-.009	.192	-.130	-.206	.069	-.131	.040	-.006	.444	.063	.163	-.113	.150	1.58

Note: All correlations with absolute value above 0.111 are significant ($p<0.05$), N= 305; [a] VIF = variance inflation factor; the VIFs are calculated based on an OLS model with “3-stages” as the dependent variable

Appendix A9.3: Selection into Proceedings (1st or 2nd Instance Decisions) (Table 19)

Variables	Descriptive		Correlations																		
	Mean	*Std. dev.*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*VIF[a]*
Dependent Variable																					
(1) Selection in I. or II. instance	.500	.501	1																		
Defendant/Patent Owner																					
(2) Def./Own. (MP) size large	.330	.471	-.215	1																	1.89
(3) Def./Own. (MP) size medium	.330	.471	-.019	-.493	1																1.66
(4) Def./Own. (MP) individual	.068	.253	-.061	-.190	.190	1															1.49
(5) Def./Own. (MP) not German	.619	.486	-.104	.252	-.027	.212	1														1.50
Patent characteristics																					
(6) IPC: Electrical Engineering	.236	.425	.109	-.004	-.026	-.089	.030	1													2.50
(7) IPC: Instruments	.137	.344	.038	-.048	.021	.045	.101	-.221	1												1.99
(8) IPC: Chemical Engineering	.207	.406	-.087	.173	-.035	-.031	.132	-.284	-.203	1											4.23
(9) IPC: Mechanical Engineering	.304	.460	-.048	-.026	.055	-.008	-.152	-.367	-.263	-.338	1										2.99
(10) IPC: Complex industry	.676	.468	.089	-.154	.016	.019	-.097	.384	.248	.103	-.106	1									2.69
(11) IPC4 class count	1.923	1.168	-.013	.038	.038	-.034	.228	-.034	.076	.206	-.120	-.130	1								1.21
(12) Number of claims (log)	2.444	.615	.098	.062	.030	-.099	.077	-.018	-.038	.067	.026	-.146	.122	1							1.10
(13) Family size (log)	1.730	.954	.174	.190	.017	-.187	.296	-.064	.025	.228	-.095	-.203	.285	.19	1						1.95
(14) German Part of EP patent	.714	.453	.049	.124	.124	-.196	.225	.019	-.046	.131	-.058	-.126	.142	.125	.627	1					1.81
(15) Grant lag (log)	7.350	.564	.039	.037	.054	-.104	.210	.075	.061	.106	-.135	-.090	.175	.031	.152	.213	1				1.15
(16) Opposition	.104	.305	.195	-.085	-.023	-.092	-.016	-.104	-.030	.058	.027	-.105	.016	.024	.123	.135	.029	1			1.13
(17) Forward citations, 5 yrs (log)	.525	.754	.106	.000	-.022	.034	-.001	-.066	-.030	.014	.029	.019	.083	.085	.010	-.039	-.026	.089	1		1.06
(18) Backward citations (log)	1.503	.598	.109	-.138	.037	.065	-.029	-.098	.035	-.112	.151	-.018	.029	.147	.048	.033	.042	.145	.109	1	1.19
(19) Backward citations to NPL (log)	.415	.589	-.092	.152	-.009	-.107	.220	.056	-.041	.223	-.104	-.178	.214	.043	.219	.239	.152	.103	.050	-.210	1.27

Note: All correlations with absolute value above 0.094 are significant ($p<0.05$), N= 454; [a] VIF = variance inflation factor; the VIFs are calculated based on an OLS model with "Selection in I. or II. instance" as the dependent variable

Appendix A9.4: First or second instance outcomes (Table 19)

Variables	Mean	Std. dev.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	VIF[a]
Dependent Variable																											
(1) 3 stages	1.141	.808																									
(2) fully invalid	.405	.492																									
(3) fully/partially	.736	.442																									
Plaintiff																											
(4) Plaintiff size large	.330	.471	.237	.300	.103																						2.05
(5) Plaintiff size medium	.326	.470	-.122	-.134	-.073	--489																					1.55
(6) Plaintiff not German	.546	.499	.200	.212	.136	.320	.011																				1.27
Defendant/Patent Owner																											
(7) Defendant size large	.229	.421	.113	.084	.113	.197	-.044	.097																			1.74
(8) Defendant size medium	.322	.468	-.132	-.107	-.122	-.022	.085	.021	-.375																		1,48
(9) Defendant individual	.053	.224	.008	.046	-.037	-.040	-.038	-.022	-.129	-.163																	1.31
(10) Defendant not German	.568	.496	.009	.013	.002	.272	-.077	.242	.285	.029	.206																1.47
Patent characteristics																											
(11) IPC: Electrical Engineering	.282	.451	.036	.101	-.046	.205	-.102	.099	-.132	-.033	-.061	-.027															2.94
(12) IPC: Instruments	.150	.358	.003	-.045	.056	.046	-.029	.011	-.053	.028	.066	.017	-.263														2.22
(13) IPC: Chemical Engineering	.172	.378	.123	.100	.114	.053	.007	.063	.280	-.064	-.055	.138	-.285	-.191													4.08
(14) IPC: Mechanical Engineering	.282	.451	-.195	-.178	-.127	-.190	.170	-.039	.008	.093	.027	-.067	-.393	-.263	-.285												3.07
(15) IPC: Complex industry	.718	.451	-.036	-.021	-.043	.024	-.107	-.001	-.264	.012	.017	-.131	.393	.236	-.675	-.173											2.88
(16) IPC4 class count	1.907	1.123	.063	-.004	.120	.108	-.010	.067	.054	.023	-.051	.198	-.062	.057	.184	-.062	-.174										1.24
(17) Number of claims (log)	2.505	.603	-.080	-.130	-.002	-.124	-.046	-.016	.093	.067	-.085	.047	-.129	.026	-.008	.13	-.134	.175									1.31
(18) Family size (log)	1.896	1.066	-.006	-.010	-.001	.222	-.020	.242	.313	.001	-.144	.26	-.185	-.065	.247	.053	-.267	.291	.195								2.10
(19) German Part of EP patent	.736	.442	-.131	-.095	-.133	.124	.033	.096	.137	.156	-.126	.163	-.046	-.168	.088	.109	-.176	.164	.082	.588							1.83
(20) Grant lag (log)	7.373	.573	.052	.067	.020	.242	.011	.133	.066	.131	-.110	.211	.065	.006	.111	-.097	-.094	.181	-.110	.075	.132						1.53
(21) Opposition	.163	.370	-.166	-.097	-.200	-.006	-.002	-.053	-.070	-.023	-.104	.023	-.144	-.018	.02	.095	-.121	.047	.011	.081	.183	.021					1.24
(22) Forward citations, 5 yrs (log)	.605	.842	.001	.015	-.015	.040	-.019	.025	.003	.024	.017	.046	-.075	-.077	.064	.009	.012	0.100	.126	.053	-.002	-.045	.102				1.15
(23) Backward citations (log)	1.568	.614	-.172	-.235	-.052	-.178	-.031	-.059	-.054	.081	-.044	-.027	-.126	.098	-.138	.139	.01	.052	.214	.018	.006	-.044	.193	.098			1.26
(24) Backward citations to NPL (log)	.360	.585	-.015	-.061	.041	.185	-.027	.099	.204	-.081	-.039	.156	-.012	-.148	.309	-.046	-.283	.157	.089	.184	.189	.107	.154	.075	-.194		1.31
(25) Patent Age at case Filing (1k d)	4.257	1.472	-.01	-.026	-.048	.175	-.020	.131	.042	.093	.007	.222	.043	-.014	.233	-.098	-.243	.079	-.164	.048	-.038	.486	.066	.101	-.124	.161	1.65

Note: All correlations with absolute value above 0.130 are significant ($p<0.05$), N= 227; [a] VIF = variance inflation factor; the VIFs are calculated based on an OLS model with "3-stages" as the dependent variable

Appendix A10: In-Sample Predictions by Observation

Appendix A10.1: Ia – 3 stages: I. Instance Decision (BPatG)

Actual decision	Prediction				Correctly predicted…
	Valid	*Partially Rev.*	*Fully Revoked*	*Total*	
Valid	7	51	7	**65**	**by model: 51.1%**
Partially Revoked	0	69	33	**102**	**by null model: 45.2%**
Fully Revoked	2	56	80	**138**	**Improvement: 5.9%**
Total	**9**	**176**	**120**	**305**	

Appendix A10.2: Ia – 3 stages: I. or II. Instance Decision (BPatG/BGH)

Actual decision	Prediction				Correctly predicted…
	Valid	*Partially Rev.*	*Fully Revoked*	*Total*	
Valid	17	36	7	**60**	**by model: 52.4%**
Partially Revoked	8	54	13	**75**	**by null model: 40.5%**
Fully Revoked	2	43	48	**92**	**Improvement: 11.9%**
Total	**27**	**132**	**68**	**227**	

Appendix A10.3: IIa – fully invalid: I. Instance Decision (BPatG)

Actual decision	Prediction			Correctly predicted…
	Valid/Partially Revoked	*Fully Revoked*	*Total*	
Valid/Partially Rev.	131	36	**167**	**by model: 68.5%**
Fully Revoked	60	78	**138**	**by null model: 54.8%**
Total	**191**	**114**	**305**	**Improvement: 13.8%**

Appendix A10.4: IIa – fully invalid: I. or II. Instance Decision (BPatG/BGH)

Actual decision	Prediction			Correctly predicted…
	Valid/Partially Revoked	*Fully Revoked*	*Total*	
Valid/Partially Rev.	115	20	**135**	**by model: 74.4%**
Fully Revoked	38	54	**92**	**by null model: 59.5%**
Total	**153**	**74**	**227**	**Improvement: 15.0%**

Appendix A10.5: IIIa – partially/fully invalid: I. Instance Decision (BPatG)

Actual decision	Prediction			Correctly predicted…
	Valid	*Partially/Fully Revoked*	*Total*	
Valid	12	53	**65**	**by model: 79.3%**
Partially/Fully Rev.	10	230	**240**	**by null model: 78.7%**
Total	**22**	**283**	**305**	**Improvement: 0.7%**

Appendix A10.6: IIIa – partially/fully invalid: I. or II. Instance Decision (BPatG/BGH)

Actual decision	Prediction			Correctly predicted…
	Valid	*Partially/Fully Revoked*	*Total*	
Valid	12	48	**60**	**by model: 74.4%**
Partially/Fully Rev.	10	157	**137**	**by null model: 73.6%**
Total	**22**	**205**	**227**	**Improvement: 0.9%**

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