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Value capture on the market for technology - Strategic selection of patent licensing and litigation target in the value chain

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LIST OF ABBREVIATIONS

Abbreviation	Description
AIC	Akaike Information Criterion
AUC	Area under the curve
BIC	Bayesian Information Criterion
CDMA	Code Division Multiple Access
ETSI	European Telecommunications Standards Institute
EU	European Union
(F)RAND	(Fair), reasonable, non-discriminatory
FTO analysis	Freedom to Operate analysis
ICC	Inter-class correlation coefficient
ICT	Information and Communication Technology
IEEE SA	Institute of Electrical and Electronics Engineers Standards Association
IoT	Internet of Things
IP	Intellectual property
IPR	Intellectual property rights
IPO	Initial Public Offering
ITC	U.S. International Trade Commission
ITU	International Telecommunication Union
LTE	Long Term Evolution
MFT	Market for technology
NDA	Non-disclosure agreement
NFC	Near Field Communication
NIPO	Norwegian Intellectual Property Office
NPE	Non-practicing entity
OEM	Original Equipment Manufacturer
PACER ID	Public Access to Court Electronics Records ID
PAE	Patent Assertion Entity
ROC	Receiver-operating characteristic curve
R&D	Research and development
SDO	Standard Developing Organization
SEC	U.S. Securities and Exchange Commission
SEP	Standard-essential patent
SIC code	Standard Industrial Classification code
SIG	Special interest group
SSO	Standard Setting Organization
TCU	Telematic control unit
VIF	Variance Inflation Factor
Wi-Fi	Wireless Fidelity
WTO	World Trade Organization
W3C	World Wide Web Consortium

Abstract

Patent licensing represents an important path to participate and capture value from innovation on the market for technology (MFT). Scholars and practitioners have had a tempestuous debate on where in the value chain patent holders should license standard-essential patents (SEPs). As a result of intensive legal disputes, it became an established practice that patent holders can freely select on which level in the value chain to license their patents. Analogously, patent holders can file patent infringement suits against any party in the value chain downstream from the original infringer. Because of this flexibility, in practice, one can observe diverse choices of the licensing and litigation level. In this dissertation, I investigate the strategic selection of the licensing and litigation level beyond the realm of SEPs and shed light on the phenomena of bifurcated (vs. integrated) licensing and indirect (vs. direct) infringement suits.

In my first study – an exploratory, qualitative interview study comprising 35 semi-structured interviews complemented by public documents – I analyze patent licensing and litigation practices. Thereby, I detect six mechanisms that lead to bifurcated licensing and four aggregate motivations that result in indirect infringement suits.

In my second, quantitative study, I analyze 3,419 license agreements sourced from RoyaltySource, the Norwegian Intellectual Property Office (NIPO), and internet sources. I hypothesize predictors of bifurcated licensing, drawing on transaction cost and anchoring theory. I quantify the prevalence of bifurcated licensing to be overall relatively low (12%) but high in selected industries such as business services (50%). Furthermore, in multivariate analysis, I detect complex technologies, open standards covered by SEPs, product patents, and cross-licenses as predictors of bifurcated licensing.

In my third, quantitative study, I analyze a random sample of 500 patent infringement suits filed at US district courts between 2010 and 2016. I hypothesize predictors of indirect infringement suits, drawing on transaction cost and anchoring theory. I quantify the prevalence of indirect infringement suits as relatively high (34%), particularly in retail trade (65%) and transportation & public utilities (45%; e.g., communication). In contrast, it is relatively low in manufacturing industries (28%) with the exception of transportation equipment (57%) and electronics (47%). Besides, I detect complex technologies, open standards covered by SEPs, product patents, and patent assertion entities (PAEs) as plaintiffs as predictors of indirect infringement suits in multivariate analysis.

With this dissertation, I contribute theoretically to the research on profiting from innovation and value capture. Moreover, I identify and discuss managerial and policy implications.

Zusammenfassung

Die Lizenzierung von Patenten stellt einen wichtigen Weg dar, um Innovationen auf dem Markt für Technologie zu vermarkten und sich deren Wert anzueignen. Forscher und Praktiker führten eine heftige Debatte darüber, an welcher Stelle in der Wertschöpfungskette Eigentümer SEPs lizenzieren sollten. Infolge intensiver rechtlicher Auseinandersetzungen etablierte sich die Praxis, dass Patentinhaber frei wählen können, auf welcher Ebene der Wertschöpfungskette sie ihre Patente lizenzieren. Analog dazu können Patentinhaber Patentverletzungsklagen gegen jede Partei in der Wertschöpfungskette unterhalb des ursprünglichen Verletzers einreichen. Aufgrund dieser Flexibilität lassen sich in der Praxis unterschiedliche Entscheidungen zur Lizenzierungs- und Klageebene beobachten. In dieser Dissertation untersuche ich die strategische Entscheidung für die Lizenzierungs- und Klageebene über das Feld von SEPs hinaus und beleuchte die Phänomene der „bifurcated" (vs. integrierten) Lizenzierung und indirekten (vs. direkten) Verletzungsklagen.

In meiner ersten Studie – einer explorativen, qualitativen Interviewstudie, die 35 halbstrukturierte Interviews umfasst und durch öffentliche Dokumente ergänzt wird – analysiere ich die Patentlizenzierung- und Patentverletzungsklagepraktiken. Dabei identifiziere ich sechs Mechanismen, die zu einer „bifurcated" Lizenzierung führen, und vier Motivationsgründe auf aggregierter Ebene, die indirekte Verletzungsklagen zur Folge haben.

In meiner zweiten, quantitativen Studie analysiere ich 3.419 Lizenzverträge, die von RoyaltySource, dem NIPO und Internetquellen stammen. Basierend auf der Transaktionskosten- und Ankertheorie entwickle ich Hypothesen über die Einflussvariablen der „bifurcated" Lizenzierung. Insgesamt beobachte ich eine relativ geringe (12%) Verbreitung der „bifurcated" Lizenzierung, jedoch ist diese Lizenzierungspraxis in ausgewählten Branchen wie Unternehmensdienstleistungen weit verbreitet (50%). Weiterhin identifiziere ich in einer multivariaten Analyse komplexe Technologien, offene Standards, die von SEPs abgedeckt sind, Produktpatente und Kreuzlizenzen als Einflussvariablen der „bifurcated" Lizenzierung.

In meiner dritten, quantitativen Studie analysiere ich eine Zufallsstichprobe von 500 Patentverletzungsklagen, die zwischen 2010 und 2016 bei US-Bezirksgerichten eingereicht wurden. Ich entwickle basierend auf der Transaktionskosten- und Ankertheorie Hypothesen über die Einflussvariablen von indirekten Verletzungsklagen. Ich beobachte eine relativ hohe (34%) Verbreitung von indirekten Verletzungsklagen. Dies trifft insbesondere auf die Branchen

Einzelhandel (65%) und Transport & öffentliche Dienstleistungen (45%, z. B. Kommunikation) zu. Im Gegensatz dazu sind indirekte Verletzungsklagen in der produzierenden Industrie relativ wenig verbreitet (28%). Eine Ausnahme bilden die Branchen Transportausrüstung (57%) und Elektronik (47%). Zudem identifiziere ich in einer multivariaten Analyse komplexe Technologien, offene Standards, die von SEPs abgedeckt sind, Produktpatente und PAEs als Kläger als Einflussvariablen von indirekten Verletzungsklagen.

Mit dieser Dissertation trage ich theoretisch zur Forschung über die Monetarisierung von Innovationen und Wertschöpfung bei. Darüber hinaus identifiziere und diskutiere ich management- und politikbezogene Implikationen.

1 Introduction

1.1 Motivation

The Mercedes-Benz star is one of the most iconic symbols in the global automotive industry (Mercedes-Benz, n.d.), and Mercedes-Benz is one of the most valuable German brands with a market value of $23.6B (Thieme, 2024). Within a few weeks in 2020, German courts granted four injunctions against Mercedes-Benz, previously known as Daimler, based on the claims of the alleged infringement of SEPs on LTE (Long Term Evolution) by Conversant, Nokia, and Sharp (Klos, 2021; Lloyd, 2020; Richter, 2020a). If one of the three plaintiffs had decided to enforce the injunction by placing a deposit at the respective court, Mercedes-Benz would have had to immediately stop selling its cars in Germany, where it sold 335K cars in 2019 alone (Mercedes-Benz, 2020). At the heart of these patent disputes was the telematic control unit (TCU), which uses LTE and is an important component of today's connected cars for data transmission. On the one hand, Mercedes-Benz asserted that its suppliers are fully responsible for licensing because Original Equipment Manufacturers (OEMs) typically purchase supplies free of third-party rights (*Nokia v. Daimler*, 2020). On the other hand, Nokia declined to license suppliers and demanded that device makers such as Mercedes-Benz take licenses (Klos, 2021; Miller, 2021).

Despite Nokia's elemental opposition against upstream licensing, one can observe disputes involving parties on all levels in the value chain. For instance, upstream suppliers such as Cypress, a chip maker, or Huawei, among others, a component manufacturer, as well as downstream players such as Apple, a device maker, Deutsche Telekom, a merchant selling consumer electronics hardware, and an American coffee shop as a user of Wi-Fi (Wireless Fidelity) routers appeared as defendant or intervener of the defendant in infringement suits regarding patents implemented on a chip. Some of the allegedly infringed patents were essential to a standard such as Wi-Fi, others concerned non-essential functionalities and characteristics of a chip (Charles, 1990; Pentheroudakis & Baron, 2017; Richter, 2020b; Ericsson, 2022).

Even though the licensing of SEPs is subject to rules for antitrust reasons, a more structural framework is needed. In view of the heterogeneity in the litigation level in the cases above, there is a tempestuous debate among scholars and practitioners on where in the value chain SEPs should be licensed (Geradin, 2020; Klos, 2021; Pohlmann, 2017; SEPs Expert Group, 2021). Despite this debate, the strategy literature has focused only on the questions of if to license patents (e.g., Gans & Stern, 2003; Motohashi, 2008; Agrawal, Cockburn & Zhang, 2015; Ruckman & McCarthy,

2017) and when to license patents (e.g., Gans, Hsu & Stern, 2008; Allain, Henry & Kyle, 2016; Hegde & Luo, 2018; Min, Lee & Kim, 2022). However, the role of the strategic selection of the licensing and litigation level in capturing value from innovation via the MFTs remains unclear in the case of SEPs and, of no less importance, non-SEPs.

These fundamental issues are of high economic relevance. Cross-border payments for intellectual property (IP) licenses soared to $359B in 2015 (Neubig & Wunsch-Vincent, 2022) from $188B in 2009 (Athreye & Yang, 2011). The number of suits filed at US district courts for infringing at least one utility patent increased from 2,068 in 2003 to 3,820 in 2016 (Schwartz et al., 2019) and, from then on, moved sideways (Unified Patents, 2023). Litigation costs per suit are estimated to reach an average of $3.5M (Day & Udick, 2019), with damages and settlements potentially reaching a multiple. For instance, Research In Motion Ltd. (RIM), the Canadian BlackBerry manufacturer, settled an infringement suit on patents related to its e-mail service for $612.5M in 2006 (Mingis, 2006).

1.2 Research objectives and design

Patent licensing is an important means to access the MFT (Teece, 1986; Arora et al., 2001a) and a proxy for transactions on the MFT (Gambardella et al., 2007). As an alternative to commercializing an invention in-house, inventors can capture value from their innovation by accessing the MFT (Teece, 1986). The value capture approach depends on the type of technology and the access to complementary assets. Scholars distinguish “narrower discrete technologies” (Gambardella et al., 2021, p. 75) from enabling technologies (Bresnahan & Trajtenberg, 1995) such as cellular communication technologies. “Ongoing technical improvement” and “enable[ment] of complementary innovations in application sectors” (Teece, 2018, p. 1369) are typical for the latter. Given that inventors of enabling technologies often cannot own all complementary assets required to commercialize the innovation on the product market in-house (Gambardella et al., 2021; Teece, 2018), they depend on MFTs and licensing as the “default value-capture mechanism” (Teece, 2018, p. 1367). With respect to the difficulties resulting from commercializing enabling technologies (Teece, 2018), Gambardella et al. (2021) emphasize the importance of the horizontal scope, i.e., the number of applications into which an inventor licenses an innovation. The strategy of focusing on broadly licensing enabling technologies to downstream firms is called specialization in generality (Gambardella & McGahan, 2010; Conti et al., 2019; Gambardella et al., 2021). Even though the examples in 1.1 deal not exclusively with SEPs, they can be characterized as enabling technologies. In addition to confirming the strategic importance of the horizontal scope (e.g., consumer electronics vs. automotive vs. food and beverages), the licensing and litigation level seems no less important, given the selection heterogeneity.

For my research on the selection of the licensing and litigation level, I differentiate between bifurcated and integrated licensing (Henkel, 2022) and, conversely, indirect and direct infringement suits. The differentiation is based on Fischer & Henkel (2012), who view knowledge and underlying IP rights as two components that are independently traded on the MFT.

Integrated licensing and direct infringement suits describe constellations where the implementer of the patented knowledge licenses the patent or the original infringer is sued for infringing on the patent. On the contrary, bifurcated licensing and indirect infringement suits describe constellations where the licensee does not implement the patented knowledge or the defendant is not the original infringer of the patent. Both are typically positioned further downstream in the value chain. The original infringer is the first party to implement a patent, given a typical value chain structure in an industry, without the rights to use the respective patent.

The abovementioned cases involve both types of licensing and suit constellations. While the constellation of a smartphone maker taking a license on cellular patents, which a chip maker implements, corresponds with bifurcated licensing (or, in case of a suit, an indirect infringement suit), the constellation of a chip maker taking a license on the identical patent corresponds with integrated licensing (or in case of a suit a direct infringement suit).

How efficient patent license transactions on the MFT are, is directly linked to the licensing level. The degree of fragmentation on the licensees' level in the value chain and the licensees' familiarity with the patented inventions, the technology, and the licensing process affect MFT efficiency (Henkel, 2022). In addition, patent holders can, by and large, freely select where to license in the value chain (Kuehnen, 2019; SEPs Expert Group, 2021). Despite the relevance of the licensing level for market efficiency and the flexibility of patent holders in its selection, scholars have not yet systematically studied the licensing level except for the field of SEPs (e.g., Bekkers et al., 2014; Henkel, 2022). This observation applies to licensing as well as infringement suits. Therefore, I decided to start my research with a broadly framed research question:

Research question 1: Which level in the value chain do patent holders strategically select to license and litigate, respectively? To what extent do the choices differ across industries?

Building upon the findings from the first research question, I aimed to shed light on the underlying motivations in selecting a licensing or litigation level that corresponds with bifurcated licensing or an indirect suit.

Research question 2: Which motivations lead to bifurcated licensing and indirect infringement suits?

Regarding licensing, past research focused on specific industries and/or geographies and/or types of patents and/or types of licensors and licensees (e.g., Arora, 1997; Grindley & Teece, 1997; Anand & Khanna, 2000; Pitkethly, 2001; Collinson et al., 2005; Shrestha, 2010; Bekkers et al., 2014; Pentheroudakis & Baron, 2017; Lemley et al., 2018; Henkel, 2022; Love & Helmers, 2023). However, we lack a holistic understanding across industries on licensing practices.

Moreover, scholars have thoroughly investigated predictors of infringement suits in general. For instance, Lanjouw & Schankermann (1997), Lanjouw & Schankermann (2001), Cremers (2004), Allison et al. (2009), Chien (2011), Love (2012), and Marco et al. (2015) assessed which patent characteristics lead to patents being more likely to be subject to an infringement suit. Others focused on characteristics of plaintiffs (e.g., Bessen & Meurer, 2005; Chien, 2008a; Marco et al., 2015) or defendants (e.g., Bessen & Meurer, 2005), while targets of PAEs enjoyed particular attention (e.g., Cohen et al., 2016; Cohen et al. 2019; Huang et al., 2024). Also, scholars evaluated the role of jurisdictions (Cremers et al., 2017) and litigation strategies (Rudy & Black, 2018) in litigation outcomes. Despite the existing breadth in the literature, the predictors of the selection of the licensing and litigation level have not been researched yet. Therefore, I aimed to identify the predictors behind the strategic decisions of licensors and plaintiffs.

Research question 3: What are the predictors of bifurcated licensing and indirect infringement suits?

I followed a mixed-methods approach to accommodate for the novelty of the phenomena in focus (bifurcated vs. integrated licensing and indirect vs. direct suits), adequately address my research questions, and ensure methodological fit (Edmondson & McManus, 2007). Thereby, I conformed with the recommendation of Crewell & Plano Clark (2017): "In some research projects, the investigators may not know the questions that need to be asked, the variables that need to be measured, and the theories that may guide the study. These unknowns may be due to […] the newness of the research topic. In these situations, it is best to explore qualitatively to learn what questions, variables, theories and so forth need to be studied and then follow up with a quantitative study to generalize and test what was learned from the exploration" (p. 9). On the one hand, the applied methods allowed me to qualitatively analyze and thoroughly understand the rationale for the selection of the licensing and litigation level in the value chain since interviews provide scholars with the opportunity to "learn about settings that would otherwise be closed" (Weis, 1994, p. 1). On the other hand, the applied methods enabled me to quantitatively obtain a comprehensive picture through large cross-industry samples and test hypotheses.

The dissertation comprises three studies[1]: One exploratory, qualitative interview study consisting of 35 semi-structured interviews lasting 30 hours complemented by public documents such as reports as well as two deductive, quantitative studies analyzing 3,419 license agreements and 500 infringement suits, respectively. I followed a purposeful sampling approach based on an intensity sampling logic (Patton, 1990) in the qualitative study. As a result, the multi-country sample consists of firms from different geographies, industries, and levels in the value chain. In the quantitative study, I analyzed license agreements obtained from RoyaltySource, a commercial royalty rate benchmarking provider (RoyaltySource, n.d.b), and other publicly accessible sources as well as infringement suits filed at U.S. district courts and randomly sampled from the Patent Litigation Dataset published by the United States Patent and Trademark Office (n.d.a).

This dissertation contributes to the literature on patent licensing and litigation as well as profiting from innovation (Teece, 1986) and value capture theory (Gans & Ryall, 2017; Henkel & Hoffmann, 2019) by quantifying the prevalence of bifurcated licensing and indirect suits and, thereby, demonstrating the relevance of the selection of the level in the value chain, by exposing the underlying motivations, and by identifying their predictors.

1.3 Structure of the dissertation

I applied a mixed-methods approach combining one qualitative and two quantitative studies to ensure methodological fit (Edmondson & McManus, 2007). I selected this approach to deepen the understanding of the little understood phenomena of bifurcated licensing and indirect infringement suits. I applied an inductive approach in the qualitative and a deductive approach in

[1] The chapters 3, 4, and 5 of this dissertation build upon joint work with my co-author Prof. Dr. Joachim Henkel (TUM). We collaborate on two working papers with the titles "Value capture through patent licensing: Strategic selection of licensing target in the value chain" and "Suing upstream or downstream? A value chain perspective on defendant selection in patent infringement suits". For further information, see the signed declaration in Appendix C and D.

the quantitative studies. The dissertation is structured as follows: Chapter 2 lays the ground by illustrating the current state of research. In particular, Chapter 2 shows on which appropriation mechanisms firms rely and what inventions they patent (2.1). Subsequently, I introduce the role of MFTs and discuss the distinction between value creation and value capture (2.2). Then, I reflect on the special dynamics around Information and Communication Technology (ICT) patents and SEPs (2.3). Lastly, I present the existing research streams in patent licensing (2.4) and litigation (2.5) and discuss the role of the value chain in both patent licensing and litigation (2.6).

Chapter 3 aims at qualitatively identifying constellations of bifurcated licensing and indirect suits and deducing the underlying motivations. First, I introduce and motivate the chapter (3.1). Then I present the applied methods, in particular, my sampling and analysis approach (3.2) as well as my findings (3.3). To conclude the chapter, I discuss my findings and demonstrate my theoretical contribution (3.4).

Chapter 4 aspires to quantify the prevalence of bifurcated licensing with a differentiated cross-industry perspective as well as deductively identify predictors of bifurcated licensing. After introducing the research topic (4.1), I argue for a general preference of patent holders for bifurcated vs. integrated licensing and theoretically develop five hypotheses on predictors of bifurcated licensing (4.2). Subsequently, I demonstrate the applied methods focusing on the data collection, cleaning, and preparation process as well as the variable generation and model selection procedures (4.3). The chapter concludes with a presentation of results from descriptive and multi-variate regression analyses, the assurance of robustness (4.4) as well as a discussion of my findings and derivation of my theoretical contribution (4.5).

Following a similar structure as Chapter 4, Chapter 5 aims at estimating the prevalence of indirect suits with a differentiated cross-industry perspective as well as theoretically deriving and quantitatively testing predictors of indirect suits. First, I motivate the research topic (5.1). Afterward, I argue for a general preference of plaintiffs for indirect vs. direct suits and theoretically develop four hypotheses on predictors of indirect suits (5.2). I illustrate how I constructed the sample, generated case- or patent-level variables, and dealt with ambiguities (5.3). Lastly, I present my results from descriptive and multi-variate regression analyses, ensure their robustness (5.4), and discuss my findings and theoretical contribution (5.5).

2 Background

2.1 Appropriation mechanisms, patents, and propensities to patent

Firms apply different mechanisms such as patents, secrecy, learning, keeping qualified people, complementary sales/service activities, manufacturing activities, or lead time advantages to appropriate returns from innovation (Levin et al., 1987; Brouwer & Kleinknecht, 1999; Cohen et al., 2000; Arundel, 2001). The applied mechanisms tend to differ depending on whether a firm deals with a product or process innovation (Levin et al., 1987; Arundel, 2001). The research results on the importance of single mechanisms are broadly in line. However, the exact order of importance differs, and researchers might not analyze all specific mechanisms. Researchers found lead time and secrecy particularly important (Levin et al., 1987; Brouwer & Kleinknecht, 1999; Cohen et al., 2000; Arundel, 2001). With an increasing firm size, patents tend to become more relevant as appropriation mechanism relative to secrecy (Arundel, 2001). Logically, if one focuses on firms that actively file patents, the results look slightly differently. Blind et al. (2006) found that patenting is the second-most important appropriation mechanism after lead time among German firms who actively file patents. This happened to the detriment of secrecy, which turned out to be of medium importance. The results were robust across industries.

Even though other appropriation mechanisms exhibit a higher relevance, patents have noteworthy characteristics. A patent provides its owner the temporary exclusion right for the underlying invention at the cost of disclosing it to the public (Levin et al., 1987; Kash & Kingston, 2001). To be patentable, an invention must fulfill three requirements: The invention needs to be novel, have an industrial application, and be nonobvious to someone skilled in the subject matter (Mansfield, 1986; Kash & Kingston, 2001). However, being patentable does not necessarily mean that a patent is filed for an invention (Scherer, 1983; Mansfield, 1986). The propensity to patent varies across industries (Scherer, 1983; Bound et al. 1984; Mansfield, 1986; Levin, 1987; Brouwer & Kleinknecht, 1999). Industries such as pharmaceuticals or chemicals exhibit higher propensities to patent (Bound et al. 1984; Mansfield, 1986; Brouwer & Kleinknecht, 1999), and, thus, a lower share of unpatented inventions (Mansfield, 1986).

Disentangling the motives for patenting and reflecting on the effectiveness of patents to satisfy these motives provides an explanation for the heterogeneous propensities to patent. Firms cater to different motives when patenting (Cohen et al., 2000; Blind et al., 2006; Bekkers et al., 2011). While the quantified relevance of the respective motive varies between product and process innovations, the ordering of each motive by relevance is almost identical. For product inventions, the prevention of copies, blocking of competitors, prevention of suits, enhancement of one's reputation, use of patents as a currency in negotiations, and realization of licensing income are motives for patenting ordered by descending relevance. The order in the case of process innovations is identical except for the use of patents as a currency in negotiations and the enhancement of one's reputation, which swapped positions (Cohen et al., 2000). These results are broadly in line with the results of Blind et al. (2006) who focused on German firms. Besides the motives above, Blind et al. (2006) identified additional motives such as incentivization by motivating staff or using patenting as performance indicator or access to capital markets, e.g., by using patents as a collateral.

Besides the different types of patents, the motives for patenting vary between types of technologies and industries (Cohen et al., 2000; Kingston, 2001; Blind et al., 2006). Scholars applied different terms to refer to comparable technology types (Levin et al., 1987; Merges & Nelson, 1990; Kusunoki et al., 1998; Rycroft & Kash, 1999; Cohen et al., 2000; Kash & Kingston, 2001). For instance, Kusunoki et al. (1998) distinguished between material- (for example, chemicals or pharmaceuticals industry) and system-based industries (for example, machinery or electronics industry). To ensure consistency, I applied the terms complex and discrete technology (Cohen et al., 2000) in this dissertation.

While complex technologies comprise many patentable elements (Cohen et al., 2000), discrete technologies consist of a "discrete number of patentable elements" (Cohen et al., 2000, p. 19). Discrete technologies can be considered as stand-alone products, whereas complex technologies integrate multiple components into a product and exhibit a cumulative development path (Merges & Nelson, 1990). On the one hand, slight modifications in a discrete technology may have significant consequences, e.g., adjusting the chemical composition of a drug could result in a drug with contrary features (Kash & Kingston, 2001). On the other hand, discrete technologies are stable in the sense that even after transferring them to another party, they are reproducible (Rycroft & Kash, 1999).

To develop a complex technology, many individuals need to contribute (Kash & Kingston, 2001) and collaborate (Rycroft & Kash, 1999). They can select between a multitude of design options and, thus, engineer around (Kash & Kingston, 2001) if a development pathway is blocked. Not surprisingly, many different parties make incremental contributions toward advancing complex technologies. These incremental contributions expand on each other and are necessary for a fully operative product (Merges & Nelson, 1990).

In discrete technology industries, e.g., in pharmaceuticals, the motives for patenting depend on the effectiveness of the patents. Patent holders use effective patents to obtain and defend a monopolist status, whereas patent holders use patents that are less effective to block the development pathways of competitors "by creating patent fences" (Cohen et al., 2000, p. 23). In complex technology industries such as electronics, patent holders use patents to generate licensing income or to fortify their patent portfolios and strengthen their position in negotiations (Cohen et al., 2000). In line with Cohen et al. (2000), Kingston (2001) distinguished between offensive and defensive blocking and pointed out that patent holders of discrete technology patents predominantly use them for offensive blocking, i.e., preventing others from using the invention. In contrast, patent holders of complex technology patents predominantly use them for defensive blocking, i.e., to retain access to patented technologies and prevent being blocked by others.

Also, firms could deliberately decide not to patent an invention. Their main reasons were mainly doubts about the effectiveness of patent protection. Levin et al. (1987) and Cohen et al. (2000) found that firms were concerned about the ease for implementers to invent around an existing patent and the difficulty of showing the patentability and novelty of an invention in the first place and upholding the validity of a patent in the second place. In addition, they were hesitant to disclose sensitive information with the filing of a patent. Overall, firms tended to be more skeptical about patenting process innovations than product innovations (Levin et al., 1987).

Considering the heterogeneous reasons for (not) patenting illustrated above, scholars assessed the determinants affecting the propensity to patent (e.g., Brouwer & Kleinknecht, 1999; Cohen et al., 2000; Lerner, 1995; Mansfield, 1986; Scherer, 1983). The effectiveness of patents as appropriation mechanisms in general, as well as relative to alternative mechanisms, affects the propensity to patent (Cohen et al., 2000). In contrast, litigation costs deter firms from patenting and affect their patenting strategy by drawing them away from crowded subclasses (Lerner, 1995).

Besides these general factors, the propensity to patent seems to vary across firm sizes (Brouwer & Kleinknecht, 1999; Mansfield, 1986; Scherer, 1983). In general, larger firms and firms with higher research and development (R&D) spending tend to patent inventions more often (Brouwer & Kleinknecht, 1999; Scherer, 1983). This applies also to industries known to typically employ discrete technologies. For instance, Mansfield (1986) found that larger firms tend to patent their inventions more often than smaller ones in pharmaceuticals, petroleum, and chemicals. Also, firms refrain from patenting in areas where technology advances very fast, such that it becomes outdated before patent protection has been issued or such that imitating an invention is just too burdensome to pursue (Mansfield, 1986). This roughly boils down to distinguishing between complex and discrete technology industries.

Beyond industry and firm size, diversification, involvement in government-sponsored research, and R&D collaborations matter for the propensity to patent (Brouwer & Kleinknecht, 1999; Scherer, 1983). Firms conducting government-sponsored research are less likely to file patents for their inventions (Scherer, 1983). In contrast, firms conducting R&D through collaborations are more likely to file a patent at all and to file more patents (Brouwer & Kleinknecht, 1999). The former could be related to the contract structure defining who retains which IP rights (Scherer, 1983). Lastly, diversified firms might benefit from cross-fertilization or exhibit more skill in commercializing unconventional inventions. Thus, they are more likely to patent (Scherer, 1983).

As Cohen et al. (2000) established, some patentees patent their inventions to generate licensing revenues or use them as currency in licensing negotiations. While both motives regarded individually are of minor relevance, combining both motives substantiates the relevance of licensing for patenting decisions. Next, I illustrate how firms commercialize their innovations.

2.2 Market for technologies, value creation, and value capture

The MFTs comprise “transactions for the use, diffusion[,] and creation of technology”, including “transactions involving full technology packages (patents and other intellectual property and know-how) and patent licensing” as well as “transactions involving knowledge that is not patentable or not patented (e.g.[,] software or […] non-patented designs […])” (Arora et al., 2001a, p. 423-424). As a result, researchers considered patent licenses as an indicator for transactions on the MFTs (e.g., Gambardella et al., 2007).

Despite the various benefits that MFTs provide to market participants, especially the division of labor and specialization in the innovation process (Arora & Gambardella, 1994; Arora et al., 2001b), several contingencies constrain the use of MFTs. In general, appropriating and trading knowledge and information on the MFTs is associated with difficulties (Arrow, 1962). Transaction costs, e.g., resulting from small-number-bargaining, affect the use of the MFTs and the boundaries of the firm (Pisano, 1990) as well as the efficiency of the MFTs (Gambardella et al., 2007). High transaction costs associated with transactions on the MFTs result in increased internal R&D activities (Pisano, 1990). Besides transaction costs, further factors affect the boundaries of the firm such as considerations on tacit knowledge as well as imitability and replicability. Intangible assets such as tacit knowledge exhibit rather low tradability implying that a transfer may not always be possible and certainly not free of cost. Related to the imitability and replicability of an asset, market efficiency depends on the type of technology as well: Discrete technologies are associated with higher, complex technologies with lower market efficiency (Teece, 1998).

Even though patents promote the transfer of knowledge (Arora, 1997), one needs to distinguish the transfer of the knowledge required to implement a patented invention and the related patent license from the bare licensing of a patent (Henkel, 2022). This differentiation is needed because the recipient of the license rights, the licensee, could differ from the recipient of the knowledge. Consequently, scholars differentiated between the market for technologies on which participants transact knowledge and licenses and the market for patents on which participants transact patent licenses decoupled from knowledge transfers (Fischer & Henkel, 2012).

As established, patent licensing is a pathway to participate in the MFTs and capture value (Teece, 1986). Even though both terms are closely related, one needs to differentiate between value creation and value capture (Bowman & Ambrosini, 2000; Bowman & Ambrosini, 2001; Jacobides et al., 2006; Lepak et al., 2007). While value creation represents the "size of the pie" (p. 209), value capture stands for the "share of the pie" that is appropriated (Gulati & Wang, 2003, p. 209). The latter is particularly challenging for firms, as Pisano & Teece (2007) stated: "The challenge is not just creating value from innovation, but capturing that value […]" (p. 278).

Exogenous factors establish the value of a good or service (Bowman & Ambrosini, 2001). Building upon the classical economics lens and resource-based theory (e.g., Barney, 2014; Besanko et al., 2009; Brandenburger & Stuart, 1996; Peteraf & Barney, 2003), Bowman & Ambrosini (2000; 2001) introduced the distinction between use value, total monetary value, and exchange value to quantify the created and captured value. With use value, scholars described the "product or service value defined by customers" (Bowman & Ambrosini, 2001, p. 501) and emphasized the importance of the perceived and, thus, subjective usefulness of the product or service on offer for the customer relative to their needs for determining the use value (Bowman & Ambrosini, 2000; Bowman & Ambrosini, 2001). The perceived usefulness may result from, e.g., the design or the functionality of a product or service (Bowman & Ambrosini, 2000; Lepak et al., 2007), and depends on the available alternatives as well as the product's or service's novelty and appropriateness (Lepak et al., 2007). The total monetary value corresponds with the willingness to pay of a customer for a product or service, i.e., the sum of the paid price and the obtained consumer surplus. Lastly, the exchange value refers to the price paid at the moment of the transaction for the perceived use value (Bowman & Ambrosini, 2000; Bowman & Ambrosini, 2001). Except for the case of a monopoly with perfect price discrimination, the total monetary value typically exceeds the actual price paid, leading to the realization of a consumer surplus. The producer or provider of the good or service that is transacted generates a profit only if the exchange value surpasses the total of the prices and costs paid for inputs (Bowman & Ambrosini, 2000).

Scholars identified several approaches toward value creation, i.e., increasing the "size of the pie" (Gulati & Wang, 2003, p. 209). Individuals, organizations, or society at large can be the sources of value creation (Lepak et al., 2007). Bowman & Ambrosini (2000) argued that the creation of new value can be attributed to labor, and any differences in performance between competitors can be derived from the heterogeneity in labor performance across firms. In contrast, Nickerson et al. (2007) assumed a knowledge-based position and suggested problem identification, a building block within the problem-solving perspective, as a lever toward value creation. Moreover, scholars pointed to organizational learning, dynamic capabilities (Teece et al., 1997), and processes as additional perspectives on value creation (Nickerson et al., 2007). Grimpe & Hussinger (2014) showed how value can be created by acquiring targets exhibiting complementarity with the acquirer.

Other scholars simultaneously assessed the questions of value creation and capture. In this context, business models and their innovation took a prominent role. Teece (2010) described the core of a business model as "defining the manner by which the enterprise delivers value to customers, entices customers to pay for value, and converts those payments to profit" (p. 172). Thus, a business model "describes the design or architecture of the value creation, delivery, and capture mechanisms" (Teece, 2010, p. 172). In this context, Sjödin et al. (2020) analyzed business model innovation at industrial manufacturers. Essentially, the firms transitioned from selling products to providing outcome-based services. The scholars found how to successfully implement such a business model innovation from a value creation and value capture perspective (Sjödin et al., 2020). For innovation ecosystems, Ritala et al. (2013) identified mechanisms for value creation as well as value capture during the building and management phases of an innovation ecosystem. End-to-end involvement and management of the supply chain are characteristics of an ecosystem. Pitelis (2009) attended to strategy literature and accentuated the generic strategies of cost leadership and differentiation (Porter, 1985) as well as vertical integration and diversification strategies (Chandler, 1962; Penrose, 1959; Teece, 1986; Williamson, 1981). Also, both value creation and value capture attracted attention in the context of open innovation, yet multiple avenues for further research exist (Chesbrough et al., 2018).

Scholars identified several approaches and lenses toward value capture, i.e., the question of what “share of the pie” (Gulati & Wang, 2003, p. 209) a firm captures. For instance, Gans & Ryall (2017) elaborated on the role of strategic factor markets, social networks, and value chain frictions in their literature review on value capture theory. Moreover, they reflected on the role of vertical integration in capturing value. Thereby, they built upon the seminal work of Teece (1986) on the profiting from innovation framework. Teece (1986) analyzed the implications of the strength of the appropriability regime on selecting the value capture approach and emphasized the importance of complementary assets such as brands or access to distribution channels for capturing value. In-house commercialization (Teece, 1986), as well as participating in the MFTs through patent licensing, are important approaches toward value capture (Teece, 1986; Arora et al., 2001a). Besides the IP environment, the industry architecture affects value capture. Firms can change both and, thereby, support value capture (Jacobides et al., 2006; Pisano & Teece, 2007) and create an “architectural advantage” (Jacobides et al., 2006, p. 1200).

In addition to barriers to entry (Bain, 1956; Porter, 1980), Coff (1999) and Bowman & Ambrosini (2000) argued that power relationships between stakeholders, such as customers and suppliers, impact how the pie is split. The power relationship can be influenced in one's favor by applying isolating mechanisms (Lepak et al., 2007). These are “any knowledge, physical, or legal barrier that may prevent replication of the value-creating new task, product, or service by a competitor” (p. 188). Conversely, competition harms one's ability to capture value (Lepak et al., 2007).

In light of the emergence of internet-based businesses and changes in the competitive environment, Teece & Linden (2017) reiterated the relevance of the questions from the profiting from innovation framework (i.e., in-house commercialization vs. licensing). Moreover, Teece & Linden (2017) established the relevance of the business model design and the development of dynamic capabilities (Teece et al., 1997) for value capture. Despite those advances, Gans & Ryall (2017) highlighted the necessity for further empirical work on value capture theory.

2.3 Information and Communication Technology standards

One special type of IP that frequently attracts attention from stakeholders, such as regulators, is the IP related to standards (Bonadio & Pandya, 2023). Firms develop standards "to overcome the barrier to interconnection" (p. 560) in an environment where "technology must often be shared with others to be useful" (Weiss & Cargill, 1992, p. 560). A standard is a group of uniform technical guidelines (SEPs Expert Group, 2021). Consequently, standardization translates into the pre-selection of a dominant technical design through a non-competition-based approach (Kash & Kingston, 2001). Standardization offers benefits and costs (see Bekkers et al. (2014) for a comprehensive overview). On the one hand, buyers might benefit from network effects (Shapiro, 2001; Bekkers et al., 2014), lower risks of betting on the wrong horse (Funk & Mehte, 2001; Shapiro, 2001; Bekkers et al., 2014), lower switching costs, more suppliers (Bekkers et al., 2014), lower product costs (Funk & Mehte, 2001), and increased competition with open standards (Shapiro, 2001). On the other hand, buyers might incur disadvantages from biases toward larger market participants, increased entry barriers (Bekkers et al., 2014), or variety and innovation losses (Shapiro, 2001; Bekkers et al., 2014). Moreover, suppliers face a trade-off between less duplicative development activities and the costs of standard-setting activities (Bekkers et al., 2014).

Furthermore, standardization has implications for competitive dynamics and market structures (e.g., Weiss & Cargill, 1992; Bekkers et al., 2002; Bekkers et al., 2014). We move from "less competition early in product life cycle" to "more competition later in product life cycle" (Bekkers et al., 2014, p. 34). The center of competition shifts away from the technology itself to the value added beyond the technology (Weiss & Cargill, 1992). Also, Shapiro (2001) analyzed legal and anti-trust issues related to standardization and pointed to costs associated with "proprietary control over a closed standard (p. 138)". Moreover, non-market participants play a role: By selecting a standard, governments can significantly influence forecasted and actual demand for products based on a given standard (Funk & Methe, 2001).

Nowadays, standards have moved from being a harmonized set of "interface specifications enabling interoperability" to being "large technological platforms including critical technologies" (Bekkers et al., 2014, p. 29). Legislative processes (de jure standards), market processes (de facto standards), or – in most cases – "Standard Developing Organizations" ("SDOs"; formal standards) can shape standards (David & Greenstein, 1990; Belleflamme, 2002; Chiesa et al., 2002; Bekkers et al., 2014). Frequently, the term "Standard Setting Organizations" ("SSOs") is used as well (Bekkers, et al., 2014). For simplicity, I will use the term "Standard Developing Organizations" ("SDOs") and do not further differentiate between SDOs and SSOs. A discussion of the potential differences between SDOs and SSOs is beyond the scope of this dissertation.

The SDO landscape is fragmented (Genschel, 1997). Hundreds of SDOs exist, each with a different pursued business model, active geography, sector, and technology in focus. Well-known SDOs are, for example, the Institute of Electrical and Electronics Engineers Standards Association (IEEE SA; e.g., WiFi, Ethernet), the European Telecommunications Standards Institute (ETSI; e.g., 3G UMTS/W-CDMA), the International Telecommunication Union (ITU), or the World Wide Web Consortium (W3C; e.g., XML) (Bekkers & Updegrove, 2012; W3C, 2023). Bekkers et al. (2014) distinguished between three types of SDOs: formal recognized standard bodies, quasi-formal standard bodies, and standardization consortia. The latter type, also called special interest groups (SIGs; Bekkers et al., 2014), emerged in the second half of the 1980s and can be differentiated into implementation consortia, application consortia, and proof-of-technology consortia – Each with differing objectives. Implementation consortia aim at increasing the usability of existing standards, whereas application consortia target higher usage through modifications of existing system components. Lastly, proof-of-technology consortia aim at reducing development costs and increasing acceptance by fostering consensus already during the development of a technology, i.e., before setting a standard (Weiss & Cargill, 1992). Participation in a consortium is more restricted than in SDOs (Bekkers et al., 2014; Weiss & Cargill, 1992), e.g., due to significantly higher membership fees. While SDOs are more closely bound by rules promoting consensus and openness, consortia may compose their own rules, which must remain within the boundaries set by law (Weiss & Cargill, 1992). Often, consortia work on only a single topic (Bekkers et al., 2014). While regulators recognize the first type of SDO, they do not recognize the second type. Despite not being recognized, quasi-formal standard bodies have attained a standing comparable to formally recognized ones. Other than that, both types are comparable. ETSI is an example for type 1, IEEE SA for type 2, and the Bluetooth SIG for type 3 (Bekkers et al., 2014; Henkel, 2022).

SDOs are organized in an open fashion, allowing various stakeholders to participate in the standard development process (Baron et al., 2014). In particular, patent-intensive companies are more prone to participate in standardization efforts (Blind & Thumm, 2004). SDOs typically do not require ex-ante contracting. Standardization meetings serve as a forum to decide which technology developed before the meeting will be incorporated into a standard and which not (Baron et al., 2014). Such decisions are generally made by consensus among participants (Farrell & Simcoe, 2012; Simcoe, 2012). Due to its structure, the standard-setting process – "a wild mix of politics and economics" (Shapiro & Varian, 1999, p. 240) – could result in costly delays and redesign (Farrell & Simcoe, 2012; Simcoe, 2012). Frequently, standard contributors launch an ad-hoc consortium to complement the standard-setting process of SDOs (see the WiMAX Forum; Baron et al., 2014).

For antitrust reasons, intellectual property rights (IPR) policies of SDOs are frequently at the center of attention. One can differentiate between participation- and commitment-based IPR policies. The former means that members need to commit to license any patent essential to a standard (Bekkers et al., 2014) with essential referring to patents needed for the technical implementation of the standard (Bekkers et al., 2011; Bekkers et al., 2014; ETSI, 2022). The latter means that members are expected to disclose patents essential to a standard they own. They may or may not commit to licensing the disclosed patents (Bekkers et al., 2014). In short, members are required to offer licenses in some cases, while in others, they are not (Pohlmann & Blind, 2016). Typically, they are required to commit to licensing SEPs under (fair), reasonable, and nondiscriminatory ((F)RAND) terms (Lemley, 2002; Pohlmann & Blind, 2016; Bekkers et al., 2020; Henkel, 2022) and to disclose potentially essential patents (Bekkers et al., 2020). However, the reliability of information is questionable as patents declared essential are not necessarily so (Bekkers et al., 2014; Pohlmann & Blind, 2016; Bekkers et al., 2020). Considering a heterogeneous SDO landscape, disclosure policies affect the litigation frequency (Bekkers et al., 2023).

The patent landscapes underlying ICT standards are typically very complex and involve numerous patent owners, resulting in high degrees of fragmentation with increasing tendencies (Galetovic & Gupta, 2020). IPlytics (2022) reported 261 unique patent owners in 2021 who owned "over 50,000 active and granted patent families" (p. 1) essential for 5G in Q1 2022. In contrast, IPlytics reported only 99 unique patent owners in 2010, translating into a staggering increase in the number of patent owners by 164% over slightly more than 10 years. In 2020, Huawei, as the largest declarator, owned less than 15% of 5G patent families (IPlytics, 2020). The number of patents and patent families declared as essential for the 2G, 3G, and 4G standards is lower, but still in the thousands (Causevic et al., 2022; European Commission, n.d.). Pohlmann (2021) noted similar observations for the WiFi 6 (802.11ax) and WiFi 7 (802.11be) standards. The 25 most important declarators owned almost 7,200 granted and pending patent families essential to WiFi 6. Although the largest declarators Huawei and Qualcomm owned 34.1% of them, only six firms owned 300 or more patent families, i.e., 4.2% or more of the 7,200 patent families (Statista, 2022).

Despite or even because of the fragmentation, one should not underestimate the economic importance of standards, given the billions of Euros in licensing income generated each year (European Commission, n.d.). The aggregate royalty rate of the 4G standard alone is estimated to be between 6-8% (Ma, 2024), implying that the manufacturer of a 500$-smartphone needs to pay 30-40$ in royalties for integrating the 4G standard into its product.

Given the high degree of fragmentation and complexity, it comes without surprise that SEPs are more often litigated than non-SEPs (Bekkers et al., 2014; Bekkers et al., 2023) with an increasing tendency (Pohlmann & Blind, 2016) and in particular by upstream firms (Bekkers et al., 2023). A debate emerged among legal scholars regarding the licensing level in the value chain. Some argue that SEP holders need to grant a license to any party asking for one independent of their level in the value chain, whereas others argue that SEP holders can freely select the licensing level (i.e., license-to-all vs. access-to-all; e.g., Kappos & Michel, 2017; Rosenbrock, 2017a; Rosenbrock, 2017b; Kuehnen, 2019; Dornis, 2020; Geradin, 2020; Hovenkamp & Simcoe, 2020; Borghetti et al., 2021). The latter became a de facto accepted practice after the dispute between Nokia and Mercedes-Benz: SEP holders may freely select the licensing level in the value chain (Kuehnen, 2019; SEPs Expert Group, 2021).

2.4 Patent licensing

Regarding the commercialization of technologies, the literature on commercialization strategy distinguishes between three deployment modes: competition, cooperation, and co-opetition (Teece, 1986; Gans & Stern, 2003; Brandenburger & Nalebuff, 1996, p. 5). The decision for a deployment mode may be fixed or dynamically adaptable (Ghemawat & del Sol, 1998). Such flexibility is typically associated with increased value (Trigeorgis et al., 2022). Researchers identified determinants of the deployment mode, differentiating by demand- (e.g., Trigeorgis et al., 2022) and supply-side determinants (e.g., Gans et al., 2002). Relevant determinants are the market demand (Trigeorgis et al., 2022), the appropriability regime (Teece, 1986; Marx et al., 2014), the IP system (Gans et al al., 2008), the degree of control over IP (Gans et al., 2002), the level of competition (Arora et al., 2001a), the bargaining power of the innovator (Trigeorgis et al., 2022), the complementary assets and their costs (Gans et al., 2002; Arora & Ceccagnoli, 2006; Marx et al., 2014), the financing structure of the innovator (Gans et al., 2002; Hsu, 2006), and frictions (e.g., external regulatory shocks; Chatterji & Fabrizio, 2016). In addition, the nature of the innovation, i.e., whether the innovation is radical (Marx et al., 2014), as well as the business environment and changes in it (Gans & Stern, 2003) matter for the deployment mode selection. In particular, the radicalness of the effects of innovation on organizational and market structure affects the selection decision. E.g., an innovation is considered radical if it undermines an incumbent's complementary assets (Gans & Stern, 2003).

Following the selection of cooperation as the deployment mode, e.g., through patent licensing, scholars investigated the intensity and deployment execution. For instance, scholars researched the licensing propensity, the reasons for licensing, and the circumstances under which patent holders decide to license. Following the transaction cost theory (Coase, 1960; Williamson, 1975), Arora & Fosfuri (2003) confirm that lower transaction costs translate into higher licensing activity. However, licensing decisions are not only motivated by transaction costs but also by the competitive situation on the MFT and the product market and the effect of licensing on both markets. A patent holder might license the technology to build a de facto standard or respond to its inability to commercialize an innovation (Arora & Fosfuri, 2003). Previous research shows that analysts should not view the competitive situation on the MFT and the product market as independent but interdependent. Not surprisingly, the competitive situation on the MFT, as well as the product market, may affect licensing decisions and returns (Arora & Fosfuri, 2003; Fosfuri, 2006; Trigeorgis et al., 2022). Patent holders need to differentiate between the revenue and the profit dissipation effect to assess the effect of licensing on profits. While the former refers to the revenues realized through licensing payments net of transaction costs, the latter refers to the decline in profits resulting from lost sales due to increased competition in the product market (Arora & Fosfuri, 2003; Fosfuri, 2006). A varying number of incumbents in the product market leads to different conclusions regarding the licensing approach. As opposed to a monopoly, in a competitive situation with multiple incumbents, the burden of a loss in sales in the product market must be shared by multiple firms (Arora & Fosfuri, 2003).

Embedded in the theory of the firm and the literature on delegation, Bonanno & Vickers (1988) reason that delegation (i.e., vertical separation) – or more generally, a commitment to a certain behavior – prompts more friendly behavior of horizontal competitors. Building on Bonanno & Vickers (1988), Arora & Fosfuri (2003) draw parallels between committing to delegation and licensing, with the latter representing a commitment towards a shift or expansion of output capacities. They find that the propensity to license increases with less differentiated products comparing the technology holder's and the potential licensee's product portfolios. The rationale is that licensing technology to a competitor on the product market who offers differentiated products leads to fiercer competition and, thus, higher profit dissipation. Similarly, Fosfuri (2006) finds that the licensing propensity increases with increasing homogeneity in the product market. Moreover, researching entities are more prone to license because they face a lower profit dissipation effect than operating entities with product and commercial capabilities (Arora & Fosfuri, 2006). Katz & Shapiro (1986) analyze the profit-maximizing number of licensees and the pricing strategy for licensors who do not compete in the product market. Analogously, drawing on transaction cost and economic theory, Fosfuri (2006) shows that firms with lower market shares on the product market license more.

Besides the nature and intensity of competition in the product market, the level of competition on the MFT affects the licensing propensity. E.g., based on transaction cost theory, Huang et al. (2024) find that firms respond to PAE suits by focusing more on in-house technologies. This effect is even more accentuated in more competitive product markets. Moreover, Fosfuri (2006) identifies an inverted U-shaped relation between the licensing propensity and the number of patent holders.

Conversely, incumbents can license to affect the competition in the product market (Gallini, 1984; Shepard, 1987; Rockett, 1990; Arora & Fosfuri, 2003). They may deter competitors from conducting R&D into technology that could outperform the incumbent (Gallini, 1984), change "the initial conditions of the entry game" (Rockett, 1990, p. 170), deter competitors by crowding the market and, thereby, increasing competition (Rockett, 1990; Arora & Fosfuri, 2003), or increase demand for new technologies by increasing product quality and competition (Shepard, 1987) through licensing.

Other scholars linked licensing with organizational structure and firm strategy (Chandler, 1962), as well as access to complementary assets (Teece, 1986), arguing that both impact the boundaries of a firm. For instance, Arora et al. (2013) distinguish between centralized (corporate decision on licensing) and decentralized licensing (decision by business unit on licensing) and assess the effects on the licensing propensity. They observe that firms fail to capture value in a decentralized structure due to weak licensing incentives compared to profits on the product market. In addition, they detect heterogeneity across firms' licensing propensity and derive implications for the organizational structure. Expanding on Teece (1986), who recommends licensing in case of a lack of access to complementary assets, and the resource-based theory of the firm, Arora & Ceccagnoli (2006) analyze the relation between patenting, patent effectiveness, and licensing. On the one hand, a higher patent effectiveness corresponds with a higher patenting propensity. On the other hand, the share of patented inventions that are licensed declines with increasing patent effectiveness. Thus, a higher patent effectiveness results indirectly in a higher licensing propensity. This effect is stronger for firms lacking specialized complementary assets, which coincides with Teece (1986).

Also, psychological effects play a role in licensing. Building upon the halo effect (Thorndike, 1920), Sine et al. (2003) find that a higher prestige of universities translates into licensing rates above the level explainable by historical performance.

Patent licenses are mostly prevalent in manufacturing industries as shown by earlier studies. Anand & Khanna (2000) identify a noteworthy prevalence of licensing in the Chemicals and Allied Products (SIC 28), Industrial and Commercial Machinery and Computer Equipment (SIC 35), and Electronic & Other Electrical Equipment & Components (SIC 36) industries. Despite the use of different industry-level terms, Glachant et al. (2013) argue that international licensing is prevalent mostly in chemicals and drugs, electronics, and electrical equipment. Similarly, cross-licensing practices exhibit industry-level heterogeneity, as they are more common in complex technology industries (Grindley & Teece, 1997; Cohen et al., 2000; Hall & Ziedonis, 2001; Collinson et al., 2005). Also, universities as a research setting are of increasing importance: Patent licensing and patenting activities of universities have increased significantly since 1980 (Mowery & Shane, 2002).

Various motives for licensing exist. These exhibit a strong heterogeneity across industries and firms (Cohen et al., 2000). For example, Cohen et al. (2000) find that discrete technology-based industries use product and process patents more often with the intention to generate licensing revenues. With regards to cross-licensing, scholars identify the assurance of design freedom, the avoidance of patents blocking future development pathways (Grindley & Teece, 1997; Bekkers et al., 2014), the access to complementary technologies (Collinson et al., 2005), the avoidance of patent infringement (Collinson et al., 2005; Grindley & Teece, 1997), or the trading of technologies (in case of discrete technologies; Grindley & Teece, 1997) as motives.

Despite extensive research on the deployment mode selection, the propensity to license, and motives for licensing, we fail to comprehensively understand the rationale behind the selection of the licensing level in the value chain.

2.5 Patent litigation

The literature on patent infringement suits takes on different timing-related perspectives. One stream takes on an ex-ante, one an in-process, and one an ex-post litigation perspective. Ultimately, one stream covered overarching topics of a systemic nature. Allison et al. (2014) create transparency through descriptive statistics related to all three time-related dimensions such as venue selection, invalidity, or win rates. Within the ex-ante stream, one group of scholars and analysts aims at creating transparency on litigation frequency, involved parties, and relevant industries (e.g., Jeruss et al., 2012; Government Accountability Office, 2013; Cotropia et al., 2014; Barry et al., 2017), and PAEs (e.g., RPX Corporation, 2013).

As part of the ex-ante stream, another group of scholars investigates predictors of patent infringement suits. They assess patent-related, firm-related, jurisdiction-related, and strategy-related predictors. In addition, they discuss the "patent enforcement iceberg" (p. 801), the relation between the visible patent assertion attempts – the litigations – and the invisible patent assertion attempts – those that do not end in litigation (Lemley et al., 2018).

In general, one can predict based on ex-ante known variables whether a patent will be litigated or not (Marco et al., 2015). For instance, more valuable patents as measured by, e.g., forward citations, backward citations, continuations, or the survival of opposition (Lanjouw & Schankerman, 1997; Lanjouw & Schankerman, 2001; Cremers, 2004; Somaya, 2004; Allison et al., 2009; Chien, 2011; Allison et al., 2012; Marco et al., 2015) are more likely to be litigated. Also, securitized patents and patents experiencing ownership transfers are more likely to be litigated (Chien, 2011). Securitization is probably another indicator of value as financial counterparts will only securitize patents that they deem suitable, i.e., that have an intrinsic value. Similarly, a transfer of ownership validates the relevance of a patent on the MFTs. Moreover, patents with a broader scope, i.e., patents that comprise more claims (Allison et al., 2012; Marco et al., 2015), more general claims (Marco et al., 2015), or cover more technology classes (Somaya, 2004) as well as patents from new technology areas (Lanjouw & Schankerman, 1997; Lanjouw &

Schankerman, 2001) are more likely to be litigated. Also, software (Lanjouw & Schankerman, 2001; Allison et al., 2009) and internet patents (Allison et al., 2012) are more likely to be litigated. Interestingly, within internet patents, business model patents are more prone to litigation than business techniques (Allison et al., 2012).

Regarding firm-related predictors, scholars find individuals (Lanjouw & Schankerman, 1997; Lanjouw & Schankerman, 2001; Lanjouw & Schankerman, 2003; Chien, 2008a (only descriptive results); Allison et al., 2012), small firms (Lanjouw & Schankerman, 2001; Lanjouw & Schankerman, 2003; Cremers, 2004; Chien, 2008a (only descriptive results); Chien, 2011; Allison et al., 2012; Marco et al., 2015), and domestic patent holders (Lanjouw & Schankerman, 1997; Chien, 2011; Allison et al., 2012; Marco et al., 2015) to be more likely to be involved in litigation. However, contrary to U.S. results, Cremers (2004) observes that individual patent owners in Germany are not more likely to be involved in litigation. Moreover, public (especially small public) firms (Bessen & Meurer, 2005) and PAEs as patent holders (Chien, 2008a (only descriptive results); Allison et al., 2009), as well as plaintiffs who acquire more patents (Bessen & Meurer, 2005), are more likely to litigate. The patent age is interrelated with the plaintiff type. While operating firms typically enforce their patents early during the patent term, PAEs enforce their patents relatively late during the patent term. As a result, PAEs are the dominant type of plaintiff during the late years of the patent term (Love, 2012).

Moving on to predictors of defendants, firms that spend more on R&D are more likely to be the target of litigation (Bessen & Meurer, 2005). Allison et al. (2009) find the telecommunications industry litigious – an industry where standards play an important role.

Related to strategy, Rudy & Black (2018) distinguish between a proactive proprietary patent litigation strategy, typical for pharmaceutical firms, and a proactive defensive patent litigation strategy, typical for semiconductor firms.

Research on jurisdiction-related predictors shows that, compared to the UK, France, and the Netherlands, there is a higher caseload in Germany, even after controlling for macroeconomic indicators. Counterintuitively, outcomes in cross-jurisdictional parallel investigations diverge in the four jurisdictions in focus (Cremers et al., 2017). Not surprisingly, within the ex-ante stream, scholars investigate venue selection choices by analyzing forum shopping (Moore, 2001) and the role of the U.S. International Trade Commission (ITC) as an alternative venue to district courts (Hahn & Singer, 2007; Chien, 2008b; Cotropia, 2011).

Furthermore, scholars conduct research within the ex-ante stream on PAEs. E.g., they investigate litigation targets (Cohen et al., 2016; Cohen et al., 2019), privateering (Hervouet et al., 2023), their role on the MFTs (McDonough, 2006), and conduct work addressing multiple broader topics such as types of PAEs, litigation targets, patent portfolios, or the prevalence of PAEs (Risch, 2012; Feldman et al., 2013; Federal Trade Commission, 2016).

Within the in-process perspective on patent litigation, one research stream emerged on determinants of settlements and one on determinants of litigation outcomes. Furthermore, scholars investigated hold-up and hold-out behavior.

As part of the stream on determinants of settlements, Anand & Khanna (2000) quantify the licenses that resulted from a settlement. 3% of licenses are closed as part of a settlement of litigation. The share is even higher in the case of cross-licenses, where a large share is closed as part of a litigation settlement. In theoretical models, Priest & Klein (1984), Bebchuk (1984), and Rosenberg & Shavell (1985) describe the decisions for a settlement as opposed to litigation. According to the Priest & Klein (1984) model, determinants of a decision are the expected costs of an (un-) successful outcome, the expected likelihood of success at trial, and the direct costs of litigation and settlement. Divergent expectations theory predicts a case to proceed to trial if the plaintiff considers higher chances of success than the defendant (Priest & Klein, 1984). According to the Bebchuk (1984) model, determinants of a decision are the amount at stake, the litigation costs, and the existing information. Asymmetric information theory predicts a case to proceed to trial if the plaintiff expects to win (Bebchuk, 1984). Rosenberg & Shavell (1985) tailor their model to one particular type of suit: nuisance suits, i.e., “a suit in which the plaintiff is able to obtain a positive settlement […] even though the defendant knows the plaintiff's case is sufficiently weak that he would be unwilling or unlikely actually to pursue his case to trial” (p. 3). They argue that nuisance suits can occur because the defendant's litigation costs – if a suit goes to trial – surpass expected awards. Plaintiffs are incentivized to threaten to pursue a trial even if they will likely lose. Similarly, Lanjouw & Lerner (2001) develop a theoretical model to assess the benefits of preliminary injunctions. They test the model empirically and show that a preliminary injunction is an effective tool against weaker, i.e., capital-constrained, defendants as it increases the legal costs.

Somaya (2003, 2004) takes on a strategic lens on settlement decisions. Somaya (2003) distinguishes between using patents as a tool to protect strategic stakes and as a tool to gain “access to external technologies through mutual hold-up” (p. 17) and finds support for the strategic stakes perspective by an increased number of suits going to trial. In contrast, mutual hold-up only plays a role in computer patents – complex, system-based technologies – and not in pharmaceutical and medical biotechnology patents – discrete technologies. In a later study, Somaya (2004) finds additional support for the strategic stakes perspective: The strategic stakes of both the plaintiff and defendant are decisive for a suit to reach trial or not – Neither the plaintiff nor the defendant wants to forgo a decision affecting a strategically important area. This mechanism is more pronounced in the computer industry. Also, suits comprising older patents are likelier to be settled (Somaya, 2004). This could indicate that plaintiffs who file a suit for infringement of older patents are primarily driven by financial motives. Given the longer outstanding patent term, an injunction would be more effective with more recently filed patents. The support for the mutual hold-up perspective is weaker. Yet almost every dispute comprising countersuits is resolved, with both suits being withdrawn shortly after the filing. Also, firms with larger patent portfolios in the computer industry are more likely to settle, indicating the necessity of mutual access to patents (Somaya, 2004).

In contrast to the strategic, technology-oriented lens of Somaya (2003, 2004), Fournier & Zuehlke (1989) focus on the impact of financial stakes on settlement likelihood. They find that a higher financial stake, i.e., in the form of awards or damages, as well as the involvement of multiple parties, increases the likelihood of a settlement. Also, due to risk aversion, uncertainty about the financial stakes increases the likelihood of a settlement. In addition, Cremers & Schliessler (2015) focus their research on with-in-trial settlements, while Allison et al. (2010) concentrate on repeat patent plaintiffs. They detect a higher likelihood of settling cases for repeat plaintiffs.

Regarding the predictors of litigation outcomes, Waldfogel (1998) tests asymmetric information (Bebchuk, 1984) and divergent expectations (Priest & Klein, 1984) theories empirically by incorporating trial outcomes from federal civil cases. The research provides evidence for asymmetric information theory in pretrial adjudications and for divergent expectations theory (Waldfogel, 1998). In addition, Aoki & Hu (2003) assess the impact of time, i.e., in the sense of the duration of imitation and litigation, on litigation outcomes. They find the concept of time to be decisive. Further research is conducted on success factors of suits to which one of the involved parties appealed. I.e., Janicke & Ren (2006) analyze cases brought to the Federal Circuit. As noted earlier, Cremers et al. (2017) find that outcomes in cross-jurisdictional parallel investigations diverge.

As within the other research stream, PAEs receive additional attention. Mazzeo et al. (2013) identify lower win rates and awarded damages for cases with PAEs as plaintiffs, however, the distribution of awards does not significantly differ between PAEs and practicing entities. Moreover, scholars detect "substantial differences in litigation behavior, success rates, and award values among types of [PAEs]" (Mazzeo et al., 2013, p. 879-880). Following Mazzeo et al. (2013), PAEs can be differentiated into universities, individuals, and, more generally, PAEs.

Related to this very active group of plaintiffs, i.e., PAEs, Allison et al. (2010) and Miller (2012) research repeat plaintiffs. Patent litigation is expensive. Thus, economic theory predicts that plaintiffs should select comparatively strong patents to increase their expected return (Miller, 2012). However, Allison et al. (2010) find that repeat plaintiffs have comparatively poor trial win rates. This result seems to be related to the poor win rates of software patents and PAEs as plaintiffs (Allison et al., 2010; Miller, 2012). Building on this surprising result, Miller (2012) evaluates the quality of repeatedly litigated patents and finds them comparatively strong.

Also, patent quality is a core topic of research on the outcomes of patent invalidity litigation (e.g., Allison & Lemley, 1998; Miller, 2013; Henkel & Zischka, 2019). Based on U.S. data, Allison & Lemley (1998) find 46% of litigated patents to be invalid, and Miller (2013) estimates that a "surprising 28 percent of all patents would be found at least partially invalid if litigated" (p. 2). While Allison & Lemley (1998) observe only a few software patents to have reached a final judgment, Miller (2013) attributes this aforementioned finding in particular to software and business method patents, as well as to patents owned by PAEs. Those patents exhibit significantly higher invalidity rates. For Germany, the estimate is even higher. Based on data from the German bifurcation system, Henkel & Zischka (2019) estimate "the likelihood of (hypothetical) invalidation of a randomly picked patent to be in the same range as that for actually adjudicated patents" (p. 195): 45% fully invalid and 33% partially invalid patents. They detect incomplete prior art searches as the root cause. Risch (2015) aims at predicting invalidity decisions and finds neither patent-related characteristics such as patent quality nor the type of patent holder (i.e., PAE vs. non-PAE) to have significant predictive power. However, target-related characteristics of the foregoing infringement suit, such as the number of defendants, predict patent invalidity (Risch, 2015).

Lastly, scholars investigate hold-up and hold-out behavior within the in-process stream (e.g., Shapiro, 2010; Chien, 2014a; Love & Helmers, 2023; Love et al., 2023). In the context of SEPs, Love & Helmers (2023) and Love et al. (2023) investigate the prevalence of hold-out and hold-up. Hold-out describes “the practice of companies routinely ignoring patents and resisting patent owner demands because the odds of getting caught are small” (p. 1), whereas hold-up refers to patent holders “su[ing] a company when it is most vulnerable – after it has implemented a technology – and is able [to] wrest a settlement because it is too late for the company to change course” (Chien, 2014a, p. 1). In hold-up, the timing allows patent holders to enforce (unreasonably) higher royalties (Shapiro, 2001). Love & Helmers (2023) identify hold-out behavior in 66% of SEP assertions (vs. 32% of non-SEP assertions). In contrast, Love et al. (2023) detect hold-up behavior in 77% of SEP assertions (vs. 65% of non-SEP assertions) and find an association between hold-up behavior and case outcomes.

Within the ex-post stream, one group of scholars investigates awards and returns from patent litigation (e.g., Powers & Carlson, 2001; Moore, 2004; Henry, 2013; Kafouros et al., 2021). Henry (2013) assesses the impact of court decisions on firm value, and finds that not only the characteristics of a patent such as its validity but also its enforceability matter to investors. Powers & Carlson (2001) analyze the treble damages statute. With treble damages also being potential consequences of willful patent infringement, Moore (2004) provides empirics on willful patent infringement and its consequences. Kafouros et al. (2021) demonstrate the importance of effective patent litigation for profiting from innovation besides strong appropriability and access to complementary assets (Teece, 1986). In addition, they detect factors influencing the returns from patent litigation.

A further group of scholars assesses the consequences of infringement suits. They research (in-) direct costs resulting from infringement suits (Kesan & Ball, 2006; Bessen & Meurer, 2013a). Moreover, scholars show that patent litigation activity negatively impacts several dimensions. However, VC investment represents an exception (Kiebzak et al., 2016). While Kiebzak et al. (2016) propose “an inverted U-shaped relation between patent litigation and VC investment” (p. 218), others find a negative effect on the likelihood of market entry (Onoz & Giachetti, 2023), on R&D investments (Mezzanotti, 2021), and patenting of firms with high litigation costs in crowded subclasses (Lerner, 1995). Moreover, Kiebzak et al. (2016) detect a direct negative relation between PAE litigation activities and VC investment.

Lastly, another group of scholars concentrates on PAEs from an ex-post perspective. For instance, Bessen & Meurer (2013b) quantify the direct costs of PAE litigation and identify the cost bearer, i.e., mostly large firms. In addition, Bessen et al. (2011) estimate the wealth lost due to

PAE suits. Their analysis indicates that a small share of the direct costs and the loss resulting from PAE litigation is transferred to small inventors (Bessen et al., 2011; Bessen & Meurer, 2013b). Despite large firms bearing most of the costs, mostly small firms are targeted by PAEs and often face severe operational consequences, particularly relative to their size (Chien, 2014b). Chien (2014b) highlights the consequences for start-ups and small firms from PAE activity within the current legal system. Moreover, Huang et al. (2024) evaluate the strategic response of target and non-target firms of PAE-initiated litigations. They find that target firms avoid litigation risks and rely more on in-house technologies. In addition, non-target firms reposition their innovation efforts to areas less exposed to PAE litigation.

Overarching topics of a systemic nature investigated by scholars are related to fee schemes and their incentives (Rowe Jr., 1982; Polinsky & Rubinfeld, 1998; Aoki & Hu, 1999; Rhode, 2004; Helmers et al., 2013; Bernstein, 2014; Helmers et al., 2021) as well as the structure of the legal system (Schliessler, 2015; Cremers et al., 2016). E.g., Schliessler (2015) finds that defendants in general and small defendants in particular are disadvantaged in a bifurcation system where questions of patent infringement and validity are assessed in separate procedures. Consequently, the typical time lag between the infringement and the invalidity procedure could result in judgments that declare the patent infringed but invalid. This time lag favors plaintiffs and strengthens their negotiation position (Schliessler, 2015). In addition, defendants accused of patent infringement are less likely to challenge the validity of a patent in a bifurcated system (Cremers et al., 2016).

Despite the extensive existing literature, the role of the value chain in patent litigation has not yet been comprehensively analyzed. No empirical study has shed light on the strategic selection of the litigation level in the value chain. In *2.6*, I review the literature on the role of the value chain in patent licensing and litigation. Most literature focuses on the implications, e.g., on efficiency, instead of providing an empirical cross-industry analysis of the strategic selection of the litigation and licensing level in the value chain.

2.6 The role of the value chain in patent licensing and litigation

Transactions taking place on MFTs involve two elements: On the one hand, the knowledge or technology that the acquirer or licensee aspires to secure and, on the other hand, the intellectual property rights that protect the underlying knowledge or technology (Fischer & Henkel, 2012). Both elements are not only conceptually different but can also be exchanged independently. While the original implementer, i.e., the party who transforms the knowledge into a technical product, needs to be the recipient of this knowledge to conduct the implementation work, the patent holder may grant the usage right to the original implementer or a party further downstream in the value chain (e.g., Henkel, 2022). Accordingly, Henkel (2022) differentiates between bifurcated and integrated licensing. Integrated licensing describes a constellation where the recipient and implementer of the patented knowledge is also the licensee acquiring the underlying rights. In contrast, in bifurcated licensing, the patented knowledge does not go to the recipient of the IP rights (i.e., the licensee), typically but not necessarily a downstream firm in the value chain, but goes to the implementer, typically a firm further upstream in the value chain (Henkel, 2022).

A value chain represents a "sequence of productive (i.e., value[-]added) activities" conducted by firms through the division of labor "lead[ing] to end use" (Sturgeon, 2001, p. 6). Gereffi (1994) distinguishes between two archetypes: buyer-driven and producer-driven value chains. The former can be characterized by decentralized production, contract manufacturing, and product design by downstream firms and is typically observable in consumer goods and electronics industries. In contrast, the latter can be characterized by central control, integrated firms, and cross-border interrelations and is typically observable in capital- and technology-intensive industries. Nonetheless, industry value chain structures may change over time (Abecassis-Moedas, 2006), and the exact structure matters for the question of whether a licensing constellation is bifurcated or not.

For instance, bifurcated licensing does not necessarily correspond with licensing the firm positioned most downstream in a value chain of a given industry, and downstream licensing does not necessarily correspond with bifurcated licensing. E.g., it is common industry practice to license ICT SEPs downstream on a device-maker level (Bekkers et al., 2014; SEPs Expert Group, 2021). However, licensing a module maker for ICT SEPs, which are typically implemented on the chip-maker level (Continental & Denso, 2019), corresponds with bifurcated licensing as well. In addition, not every license on a device-maker level qualifies as bifurcated licensing, as the exact classification depends on the underlying technology and the licensee's capabilities and scope of operations. For instance, automotive OEMs frequently develop and manufacture engines for their cars as opposed to purchasing them from suppliers. If such an OEM in-licenses engine-related patents, the transaction can be described as an integrated license on the device-maker level. However, if a smartphone maker in-licenses coatings that prevent smartphone glasses from breaking after hitting the ground, the transaction can be described as a bifurcated license on the device-maker level – The patented knowledge would be implemented by the supplier of the coatings. In general, bifurcated licensing could take place on all levels of the value chain: Up-, mid-, or downstream (*Figure 1*).

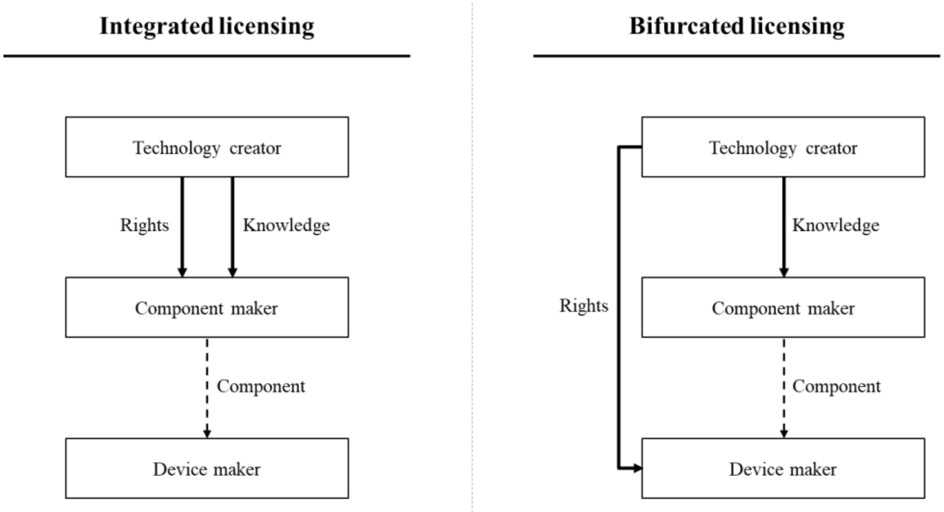


Figure 1: Integrated vs. bifurcated licensing (illustrative, based on Henkel, 2022)

I distinguish between direct and indirect infringement suits in line with this argumentation. While in direct suits, the defendant is the original infringer, i.e., the party who translates the patented knowledge into a technical artifact, in indirect suits, the defendant is further downstream in the value chain of the original infringer (*Figure 2*).

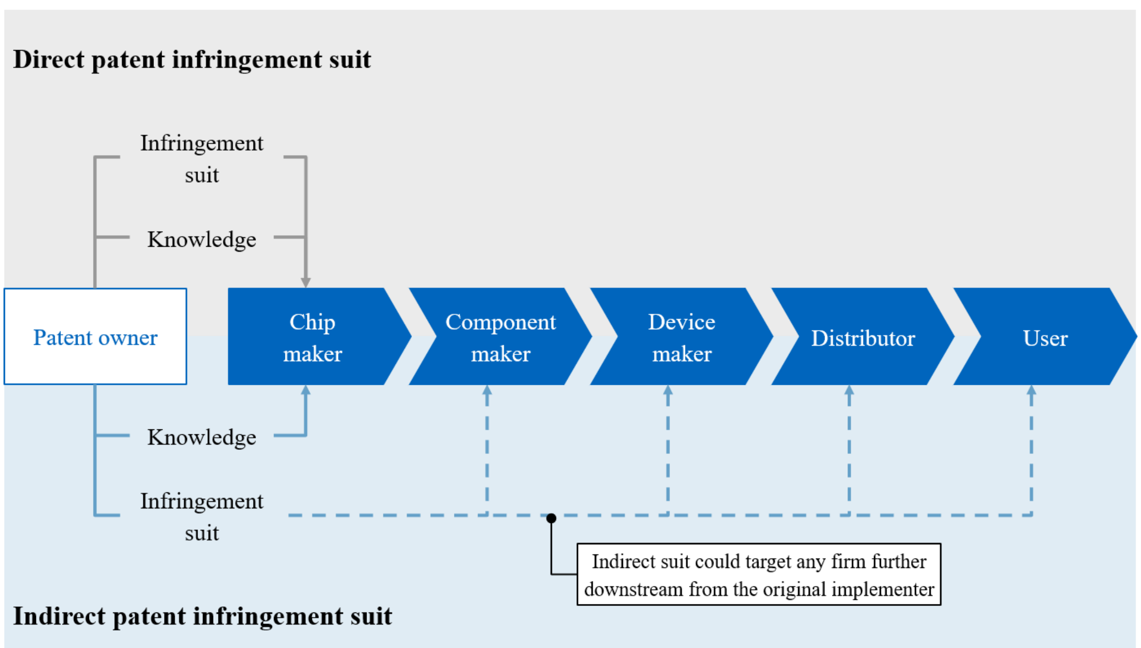


Figure 2: Direct vs. indirect patent infringement suits (based on Henkel, 2022)

In this context, I differentiate between the infringement itself and the type of suit, i.e., (in-) direct infringement vs. (in-) direct infringement *suits*. A direct patent infringer is "[…] whoever without authority makes, uses, offers to sell, or sells […] within […] or imports [any patented invention] into the United States" (35 U.S.C., 2023, § 271), whereas an indirect patent infringer is whoever is enabling and/or encouraging another party to directly infringe a patent (Singh, 2020; Karr, 2021). In contrast, we follow a narrower definition: The defendant in direct infringement suits is the original infringer and implementer of the knowledge underlying the patented invention. This implies that a suit naming as a defendant a direct infringer, i.e., "[…] whoever without authority […] uses, offers to sell, or sells […] within […] or imports [any patented invention] into the United States" (35 U.S.C., 2023, § 271) classifies as indirect suit when the defendant does not implement the underlying knowledge in such cases.

The licensing mode and, thus, the selection of the litigation level seem to have direct implications on MFT efficiency. Since uniform pricing results in welfare losses (Tirole, 1988), the "possibility for price differentiation" (p. 12) fosters MFT efficiency provided the cost of implementing it is not too high (Henkel, 2022). Uniform pricing sets the price level of some technologies too high to be profitably implementable in certain applications and too low for other highly profitable applications (Tirole, 1988). Thus, scholars (e.g., Teece & Sherry, 2016) argue that price differentiation is needed for a reasonable return on R&D investments. Practically speaking, price differentiation implies that patent holders demand a lower royalty in low-value applications (e.g., 4G implemented in an IoT sensor for consumer applications) than in high-value applications (e.g., 4G implemented in a car). Product heterogeneity and product complexity are contributing factors toward price differentiation (Henkel, 2022). It is argued that only some SEPs are implemented up- or midstream on a component level, whereas all are implemented downstream on an end-product level (SEPs Expert Group, 2021). Licensing each SEP on the value chain level where it is implemented, i.e., a chipset maker licenses the portion of SEPs implemented up to that value chain level, a module maker licenses the portion of SEPs implemented up to that value chain level less the SEPs licensed on the previous value chain level, etc., is not practicable due to issues such as double dipping, patent exhaustion (SEPs Expert Group, 2021), and elevated transaction costs. In response to these concerns, Henkel (2022) pointed out how patent holders can differentiate prices with upstream licensing.

In contrast to the ability to differentiate prices, transaction costs hamper the efficiency of MFTs (Gambardella et al., 2007; SEPs Expert Group, 2021; Henkel, 2022). Henkel (2022) distinguishes between dyad-level and industry-level transaction costs. Although the argument of lower transaction costs has been made for down- and upstream licensing (Geradin, 2020), arguments that bifurcated licensing is associated with increased transaction costs seem to outweigh contrary arguments in numbers and strength.

Henkel (2022) elaborates that industry-level transaction costs depend on the degree of fragmentation of the respective licensing level in the value chain. One can observe stronger downstream fragmentation, especially with the licensing of general-purpose technologies (Henkel, 2022). The connected cars value chain illustrates the dependence of the number of dyad-level licensing relationships on the degree of fragmentation of the licensing level in the value chain. A concentrated market landscape on a chipset level where the largest chipset supplier controls 80% of the market evolves into a more fragmented one on a module and car maker level. The top five module and car makers represent 71% and 50% of the market, respectively (Mandal, 2022; Siddiqui, 2022). In this case, bifurcated downstream licensing results in an increased number of licensing transactions and, thus, transaction costs. A fivefold increase in the number of licensees corresponds with a fivefold increase in the number of license agreements ceteris paribus. Consequently, post-licensing reporting requirements and, thus, transaction costs multiply.

As opposed to negotiating with licensees from different value chain levels, negotiating with just one group of licensees, e.g., device makers, could be advantageous for licensors (Borghetti et al., 2021). Negotiations could be prepared more efficiently and effectively due to accumulated experience and learning (Wright, 1936). Nonetheless, this logic does not necessarily favor one licensing model over the other but calls for a harmonized licensing mode.

Regarding dyad-level transaction costs, Teece & Sherry (2016) and Borghetti et al. (2021) argue that licenses not granted on a device-maker level are difficult to monitor and enforce. In contrast, Henkel (2022) elaborates that in bifurcated licensing "dyad-level transaction costs unambiguously rise, due to uncertainty and information asymmetry" (p. 2).

The former can result from uncertain potential licensing partners (Arora & Gambardella, 2010) or product liability, thereby, deterring firms from innovating (Galasso & Luo, 2022). Uncertainty can also occur in the form of price uncertainty (Henkel, 2022). Downstream licensing often takes place ex-post, i.e., after the decision to purchase components from a supplier.

Purchased components do not at all or only partially include licensed patents. The exact deliverables a supplier offers become blurred and untransparent in a context where some offerings do, and others do not contain patent licenses. Buyers can hardly calculate with fixed prices, and risk mitigation measures such as indemnification clauses might not be enforceable (Geradin, 2020). In addition, options for deterrence and defense in bifurcated licensing are limited for licensees due to a lack of own patents (Bekkers et al., 2014). This likely attracts patent holders to strictly enforce their patents, thereby, increasing the uncertainty regarding total cost and patent enforcement for the downstream firm.

The latter results from the fact that firms situated downstream relative to where the technology is implemented lack an understanding of the implemented technology (Geradin, 2020). However, licensors commonly have a good knowledge of their patent portfolios. For instance, a manufacturer of Internet of Things (IoT) devices such as smart meters lacks the knowledge of how and which ICT patents are implemented upstream on the chipset maker level and cannot navigate through this thicket of patents (Schneider, 2020; Henkel, 2022).

The strategic selection of the licensing and litigation level in the value chain has not been studied empirically in a cross-industry setting (e.g., outside of ICT SEPs). We neither know the motivations and predictors behind a selection nor the actual selections of the level in the value chain. I close the gap with a mixed-method approach: One qualitative interview study, presented in Chapter 3, and two quantitative studies, presented in Chapters 4 and 5.

3 Qualitative study on target selection in patent licensing and litigation

3.1 Introduction and motivation

There is limited transparency regarding patent licensing and litigation because involved parties have little obligation to report such events. For instance, in Norway, neither licensees nor licensors need to report the closing of a license agreement (WIPO, 2018). This is the case in many other jurisdictions as well. It is somewhat easier to obtain a more comprehensive picture of patent litigation as suits typically become public sooner or later. However, not all negotiation and enforcement attempts result in a license or an infringement suit. They often fail (Agrawal et al., 2015; Lemley et al., 2018). Lemley et al. (2018) pictured the situation as the patent enforcement iceberg as only the tip is visible, and most of the iceberg remains invisible under the water. They find that about one-third of enforcement attempts toward patent licensing resulted in litigation.

However, even a comprehensive dataset on patent licensing and litigation does not fully convey the motivations behind decisions. It conveys at most only the forceful (litigation) or successful attempts (licensing) but never, e.g., the unsuccessful ones. Besides being opaque, the rationale for selecting the licensing or litigation level may be contradictory and counterintuitive at times without further in-depth information. For instance, SEP holders followed diverse approaches regarding the licensing of LTE SEPs in the automotive industry. While Nokia and Sharp sued Mercedes-Benz, an automotive OEM, in Germany for infringement of several SEPs (Klos, 2021; Lloyd, 2020; Richter, 2020a), only Sharp litigated on a supplier level. In 2020, Sharp granted Huawei a SEP license ensuing infringement litigation (Richter, 2020c; Schindler, 2020). Contrary to Nokia, who declined to license suppliers and demanded that device makers such as Mercedes-Benz take licenses (Klos, 2021; Miller, 2021), Huawei was more flexible regarding the selection of the licensing level (Richter, 2020c; Schindler, 2020). Licensing Mercedes-Benz as a device maker corresponds with bifurcated licensing, whereas licensing Huawei corresponds with integrated licensing – in contrast to other suppliers, Huawei is a vertically integrated firm.

Such contradictions call for an explorative, qualitative study to, first, descriptively evaluate choices regarding the selection of the licensing and litigation level and, second, gain a deep understanding of the rationale leading to each decision. Ensuring methodological fit, I apply a mixed-methods approach and test theory quantitatively in Chapters 4 and 5 (Crewell & Plano Clark, 2017; Edmondson & McManus, 2007).

I organize the remainder of this chapter as follows: First, I explain the sampling process and the applied methods for analyzing the qualitative data. Second, I illustrate the results with a focus on, first, patent licensing and, second, patent litigation. Lastly, I summarize my findings and highlight my theoretical contribution.

3.2 Methods

3.2.1 Study setting and sampling approach

Across industries, I concentrated on the selection of the licensee in patent licenses and of the defendant in patent infringement suits as the unit of analysis. Patent licenses and infringement suits are of particular importance in manufacturing industries. Anand & Khanna (2000) identify a noteworthy prevalence of licensing in the Chemicals and Allied Products (SIC 28), Industrial and Commercial Machinery and Computer Equipment (SIC 35), and Electronic & Other Electrical Equipment & Components (SIC 36) industries. Similarly, Barry et al. (2017) detect consumer products, pharmaceuticals, and computer hardware/electronics to be the most important industries for litigation, and Glachant et al. (2013) argue that international licensing is prevalent mostly in chemicals and drugs, electronics, and electrical equipment.

Consequently, I concentrated on manufacturing and professional services firms, such as law firms specializing in patent licensing and litigation. Due to the advantages of geographic proximity, such as in-person interviews, I concentrated on European firms. To build a heterogeneous sample, I included firms headquartered in diverse countries and active on different levels in the value chain in various industries and geographies.

I employed purposeful sampling and followed an intensity sampling logic (Patton, 1990). As opposed to random sampling (Eisenhardt, 1989), I sampled interviewees "[…] because they are particularly suitable for illuminating and extending relationships and logic among constructs" (Eisenhardt & Graebner 2007, p. 27). I presumed that larger companies are more exposed to patent licensing and litigation ceteris paribus (e.g., Motohashi, 2008). Moreover, I expected them to have a more holistic view of the value chain. Thus, I concentrated on larger companies as "information-rich cases" (Patton, 1990, p. 182). I presumed interviewees in the Intellectual Property, Legal, R&D, or Procurement function in (senior) expert or managerial positions to be most knowledgeable in patent licensing and litigation. To identify potential interviewees, I relied on LinkedIn searches, professional contacts, or internet searches. I contacted interview candidates through personalized LinkedIn messages or e-mails and messaged 82 individuals from 80 companies. Once I reached theoretical saturation, I abstained from conducting further interviews (Glaser & Strauss, 1967; Corbin & Strauss, 2008; Flick, 2009).

3.2.2 **Data sources, coding, and analysis**

While all interviews dealt with patent licensing, only a subset explicitly dealt with patent litigation. In total, 46 (38 discussing patent litigation) individuals from 34 (28) different companies agreed to an interview, resulting in 35 (29) interviews with a total duration of 30:15 (26:45) hours. The minimum, maximum, and average interview duration amounted to 0:21 (0:27), 1:30 (1:30), and 0:51 (0:55) hours, respectively. Most interviewees worked for multinational manufacturing companies with headquarters in Germany. Their employers came from different industries and value chain levels. Also, the interviewees comprised lawyers and consultants active in patent licensing and litigation across various industries. I conducted 5 (5) interviews in person and 30 (24) via videoconference between October 2022 and October 2023. I recorded all interviews and received support from research assistants for the transcription of the recordings. *Table 1* illustrates the sample composition.

Geographies	**Licensing**	**Litigation**
France	1	1
Germany	21	16
Netherlands	1	1
Professional services	7	7
Sweden	1	1
Switzerland	2	2
United Kingdom	1	0
United States	1	1

Industries	**Licensing**	**Litigation**
Transportation equipment	8	6
Electronic & other elec. equip. & comp	6	5
Chemicals and allied products	5	3
Industrial and commercial machinery	4	3
Other manufacturing industries	5	5
Professional services	7	7

Level in value chain	**Licensing**	**Litigation**
Professional services	7	7
Researching entity	2	1
Supplier	10	8
OEM	16	13

Duration	**Licensing**	**Litigation**
Total (hours)	30:15	26:45
Minimum (hours)	00:21	00:27
Maximum (hours)	01:30	01:30
Average (hours)	00:51	00:55
Number of interviews	35	29

Table 1: Sample composition

I developed an initial interview guideline based on theory and literature and continuously refined it to incorporate emerging topics and industry specifics (Gioia et al., 2013). For the purposes of interview preparation and triangulation of findings during the analysis phase (Flick, 2009; Gioia et al., 2013), I consulted primary (e.g., press releases) and secondary sources (e.g., research reports).

I analyzed and coded the interview transcripts and supplementary documents (e.g., materials shared by interviewees) using the MaxQDA 2020 software package. I conducted the coding and analyses in two turns: the first turn with a focus on bifurcated licensing and the second turn with a focus on indirect infringement suits. The coding and analysis steps were identical in both turns. In the first round of coding, I applied structural coding (Namey et al., 2008; Saldana, 2013) to identify all constellations of bifurcated licensing and indirect infringement suits. To account for the explorative nature of the study, in the second round of coding, I applied inductive in vivo coding (Flick, 2009; Saldana, 2013) to derive first-order codes. I built second-order categories through focused coding (Charmaz, 2006) and derived aggregate dimensions by reviewing and aggregating the first-order codes.

3.3 Results from qualitative study

Within this chapter, first, I present the findings on patent licensing in the sub-chapters 3.3.1, 3.3.2, and 3.3.3. Subsequently, I display the findings on patent litigation in the sub-chapters 3.3.4 and 3.3.5. Due to the novelty of the concept of bifurcated licensing (Henkel, 2022), I present the interview-based assessment of the prevalence of bifurcated licensing in 3.3.1. Then, I identify mechanisms leading to bifurcated licensing (3.3.2) and show its consequences (3.3.3). With regards to patent litigation, I demonstrate motivations for the selection of the litigation level (i.e., indirect vs. direct) in 3.3.4 and 3.3.5.

3.3.1 Study on patent licensing – Prevalence of bifurcated licensing

The exact prevalence estimates of bifurcated licensing fluctuated to some degree. However, interviewees and assured that integrated licensing was the predominant licensing mode, leading to a consistent picture. Several interviewees estimated the prevalence of bifurcated licensing:

> *"Single cases of this type exist. […] It is indeed rare" (20 – I assigned a number to each interview to make transparent if statements were made in the same interview).*
>
> *"I can only make an estimate, […] the situation [of bifurcated licensing] is certainly an absolute exception. […] I would say 10% or maybe below" (9).*

Instead of gauging the share of bifurcated licenses, other interviewees approximated the share of integrated licenses:

> *"[…], you in-license in 70, 80% of all cases what you want to implement yourself" (17).*
>
> *"[…], there must be at least 75, 80 or maybe 90% of components which are licensed directly on the levels in the value chain at which the patents are implemented" (8).*

"I wouldn't put my hand in the fire for it to be 100%, but [integrated licensing] would be the case for the most part [of all licenses]" (27).

Not surprisingly, downstream firms stated that their upstream suppliers are responsible for providing a solution free of third-party rights, thereby, implying integrated licensing.

"[…] it is […] the case that we purchase components or systems from suppliers with a contractual agreement that the delivery is free of third-party rights." [12]

"[...] there is indeed a basic rule that everyone in the supply chain selling a component at a specific supply chain level ensures that this component [...] is actually licensed for the patents that are implemented in it" (8).

The expectation of delivery of products free of third-party rights is present on all value chain levels – an expectation towards suppliers and of customers.

"[...] we buy them from specialists who we also expect to provide us with patent-free solutions. It's very important for us that we stipulate this [...] in the sourcing contracts. My attitude to this is always that patent freedom should be guaranteed by the person who understands the technology best" (10).

"[…] customers also expect us to be responsible for a patent-free product. And if disputes break out, then, of course, we have to expect that they will approach us" (10).

However, upstream firms view their responsibility as limited to aspects they can influence. For example, one interviewee explicitly did not feel responsible for a downstream customer's usage behavior of the product beyond regular product use.

"As a rule, we guarantee that our products are free of third-party rights in the areas in which we can influence them. I do not know whether the product is being used as intended, I do not know what else the customer does. (15)"

As a result, firms need to in-license patents that cover their technologies. Horizontal licensing is a very common way to do so. It describes a license between a licensor and a licensee on the same value chain level. It typically corresponds with integrated licensing and occurs with and without litigation. This includes cross-licenses as well.

"It is the case that licenses are predominantly cross-licenses. […] this should apply in general for the whole industry, especially for machine builders […]" (20).

A legal professional illustrated:

"[…] the most [cases], which I am doing, [are] between direct competitors. Meaning less from upstream to downstream or somewhere on different levels in the value chains but […] mainly among competitors who are on the same level [in the value chain]" (32).

3.3.2 **Study on patent licensing – Mechanisms leading to bifurcated licensing**

In total, I identified six mechanisms leading to bifurcated licensing (*Figure 3*). While the mechanism "ICT SEPs" concerns the licensing of ICT SEPs, the two mechanisms "Higher return" and "Easier enforcement" exclusively comprise cases of patent litigation. Lastly, the three mechanisms "Second source", "Contract development/ manufacturing/ research", and "Freedom of 3rd party rights" lead to bifurcated licensing in the context of various sourcing approaches. Depending on the respective mechanism, patent holders select licensees on different value chain levels as target. For instance, patent holders pursue bifurcated licensing in the context of ICT SEPs and patent litigation ("Higher return", "Easier enforcement") by targeting downstream firms on OEM, user, or merchant level. In contrast, in sourcing-related mechanisms, licensees could be positioned more broadly on the value chain.

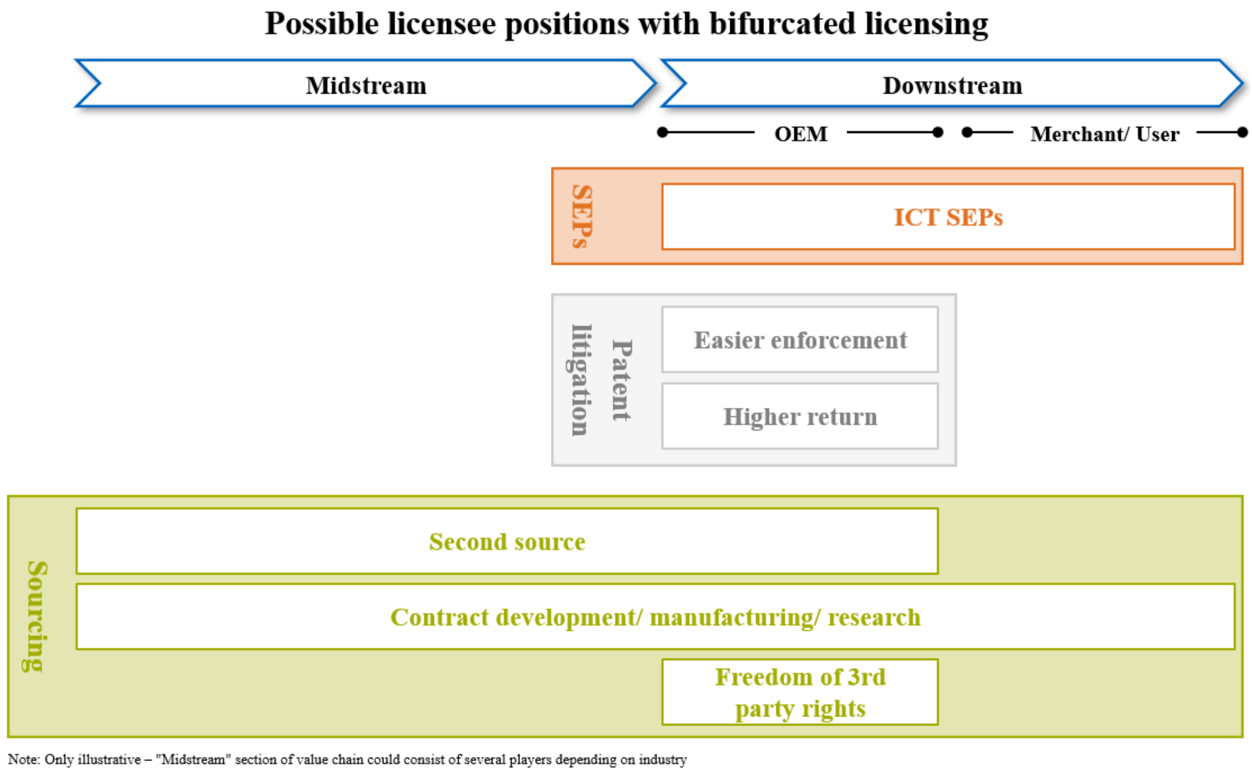


Figure 3: Mechanisms leading to bifurcated licensing

The first identified mechanism deals with ICT SEPs. Typically, licensees take a license on ICT SEPs ex-post, i.e., after the implementation of the standard. With ex-post licensing, patent holders can freely select the licensing level:

> *"[…] the patent owner has the right to approach any level in the value chain" (23).*

Patent holders commonly license ICT SEPs on a device level. This applies to various types of standards (e.g., audio codecs, video codecs, cellular standards, and short-range communication standards such as WiFi, Near Field Communication (NFC), or Bluetooth) as well as devices (e.g., mobile phones, televisions, cars). Interviewees argued that the reasons for device-level licensing are its nature as an established industry practice and the higher license base.

> *"Mostly it's the device maker. It does not always have to be it. That tends to be both a long-standing industry practice and somewhat convenient. There is an underlying question to this: How do you come up with the value? [...] the end-user device level, [...] that's basically where most of the time the value in the market is determined. That is also where the value to the consumer and also the value of sales is. Also, if you look at patent pools, for example, all of the pools right now license, so the audio, video codec, broadcasting pools, they all license at the end user device level. So, television, or the mobile phone, or a car with Avanci" (30).*

Despite the establishment of a common industry practice, deviations from this practice exist. Even though device-level licensing of IoT products still takes place, the IoT space represents an exception due to transaction costs. Bifurcated licensing further upstream on the module level is a practice to reduce transaction costs.

> *"[IoT] is typically a different market [...]. If we talk about television, mobile phones, cars, all of those things have a limited number of end-user device makers in that angle. In the IoT space you have indeed thousands. [...] the principles are still correct. Conceptually, the value of cellular communication also in IoT space is still determined at the level of sale between the end-user device maker and their customer or in the service that they provide. There is a practical problem in trying to license all those thousands of implementors" (30).*

However, outside the IoT space, patent holders largely remain consistent in the licensing level selection, even if upstream firms explicitly ask for a license.

“[...] there is indeed a basic rule that everyone in the supply chain selling a component at a specific supply chain level ensures that this component [...] is actually licensed for the patents that are implemented in it. This basic principle works flawlessly for most parts and technologies. Specifically, in the mobile telecommunications area, we have the problem that some patent holders say, "no, we only license on the level of the end product." It is also important to remember that there are only a few patent holders in the mobile telecommunications area who are willing to license at the preceding levels. On the one hand, we have this strange peculiarity, on the other hand, we will need some legislation to come to a more balanced, workable solution” (8).

The arguably easier detection of infringement is a further reason for device-level licensing. Some patent holders may not even conduct further reviews; the mere implementation of the standard is sufficient proof of infringement of the focal patent for them.

“[…] if one uses Bluetooth, then one is implementing by default the patent. That means they are not looking at our products at all, which they actually would need to do for claim charts, but one can see that it is a standard claim chart [...]” (6).

In theory, the license base should not matter when setting prices. The value of a patented technology should not depend on the licensing level and, thus, the value of the component or product where it is implemented because royalties could be passed through the value chain. A portfolio of SEPs should have the same value, no matter if it is licensed on the chip level or the device level, when the implemented chip has identical capabilities. However, experiences from practice show different underlying mechanics, with monetary prospects playing a role in licensing level selection. Psychological effects and relative royalty rates seem to mislead market participants. The same absolute royalty appears to be more acceptable with a higher license base.

“[…] they go in a very targeted fashion […] to the end of the value chain. Of course, with the hope that they benefit with similar […] royalty rates from a larger piece of cake. In theory, [...] how license fees are determined, this should not play a role. […] the larger the cake, the smaller the royalty rate should be [...]” (25).

“[...] you want larger numbers generally for the same product. So, if you're suing [...] on [...] screen technology/ If somehow you can link it to the phone, then you [...] can go after the entire phone. And that might be worth a $1,000. But if you just are [...] going after the screen manufacturer, that screen [...] only gonna cost [...] $10 for example [...].

And so, you can't really ask for $10 as a patent license for just your patent because everyone is gonna look at that and, "Oh well." Clearly, the market doesn't value that at that level" (34).

"I can hardly ask for a 3$ license fee on a chip which has a selling price of […] 5$. But I can ask without any problems for [a license fee of] 5$ or 10$ in case of a TV" (33).

Users of commercial nature, i.e., not consumers, represent a particularly attractive target for the licensing of SEPs. Depending on the nature of the presumably infringing device, users have limited or no alternative option than to take a license because of the high capital expenditures required, e.g., for replacing a production machine. Patent holders can leverage this fact.

"[...] in the manufacturing area, there is a strong emphasis on 5G technology. And now, in this area, the right holders are beginning to send letters [...] to the operators of the manufacturing facilities. This is because they see the greatest potential for extortion there" (2).

A particular type of infringement suit representing a bifurcated licensing constellation follows a similar rationale to the one above. The mechanism "Higher return" consolidates infringement suits focused on maximizing direct financial returns, i.e., licensing income. In contrast, the gain of additional business resulting from enforcing the temporary exclusion right, as the patent grants it, represents an indirect financial return. The latter type of return is not a core objective underlying this mechanism.

"[…] the companies will license where they think they can make the most money. […] It is not ultra-sophisticated from that perspective" (34).

To increase licensing income, plaintiffs aim to increase the pressure on defendants, e.g., by leveraging the number of patents-in-suit or looming litigation costs. Even in case of little merit, a defendant incurs significant litigation costs to repel a suit. Please note that I consistently use the term patent assertion entity (PAE) as opposed to non-practicing entity (NPE).

"[…] those non-practicing entities […] like to do this that they make the customers shy to first increase the stakes and the pressure to get an agreement. Even though the customer is not the one who is in the crossfire" (9).

"There are companies that get sued on a lot of [minor things] but, usually, those are not very professional. Those are more kind of just leveraging litigation costs [...]. And that is mostly in the US, like a patent troll type of thing. But that is really just leveraging not

kind of the underlying value of the IP in any way. It is most of the time just or like the number of patents. [...] there are other people who sue, want a couple of patents, and they really are suing just to get whatever number they can get" (34).

While practicing entities face severe downside risks from initiating litigation against the players on the customer level in the value chain, PAEs are more flexible in their selection of the value chain level because they do not need to fear damage to their reputation. Attacking a (potential) direct customer could severely harm a plaintiff's reputation as a reliable supplier as well as provoke countermeasures by direct competitors. Even though plaintiffs could comprise practicing entities, many interviews mentioned PAEs as plaintiffs. Based on past experiences, two interviewees specified the type of plaintiff, affected geographies, and underlying technology fields.

"[...] we have seen these before from particularly [...] non-practicing entities in the US who just buy a patent and then send you a letter and see if you cough up some money" (24).

"Particularly affected [from bifurcated licensing after litigation] are the [technology fields] where there are NPEs [...], which can buy up portfolios or develop in that direction and file patents accordingly" (25).

Most cases reported by interviewees involved downstream firms as litigation targets. Merchants or users were of minor relevance as defendants.

In contrast to the "Higher return" mechanism, within the "Easier enforcement" mechanism, plaintiffs focus particularly on considerations around the effectiveness of patent enforcement on a given level in the value chain, gaining or defending market shares, i.e., rather enforcing the temporary exclusion right a patent offers than licensing the patent, and the perception of downstream firms of the plaintiff's IP position.

"[In our industry,] value chains build up mainly in Asia. In Asia, it is relatively difficult to enforce IP. [...] At some point the end product reaches Germany, the US, where effective legal protection is possible. What could happen is that we skip multiple levels in the value chain and do not enforce the patent against our competitors and customers because we cannot reach them in Asia anyways, but directly against the OEM or end product maker and say: Clean up your value chain. Because if you do not do that, then we are thinking about a patent infringement suit, which would be critical for the end product maker" (9).

If a plaintiff cannot sue the original infringer, distributors represent a feasible target. However, most cases reported by interviewees involved manufacturing firms.

> *"[...] typically [...] in cases where the manufacturer cannot or hardly be targeted. [...] the distributors [...] are the ones who appear on the market and where there is proof of infringement, allowing for indirect pressure to be applied against the unlawful manufacturing or importing" (32).*

Despite the inherent risks, customers of direct competitors could become a target.

> *"[...] approaching the customers of respective competitors is something we rarely, if ever, observe. We only observe this if, for some reason, we can't reach the [...] direct competitors. This might be because proving infringements is very difficult in Germany, and we may not necessarily want to go to Poland to file a lawsuit. Especially in situations [...] with small products, closures, similar items, where you don't always know where they were manufactured. For instance, if I have a large machine, I know who the manufacturer is. [...] But say, with small closure products, for example, it's not indicated on them. [...] But this is the area where I also tell my people, sure, you can choose whoever you want. But your competitor is your direct competitor [...], think about whether you want to approach his customers, because that is obviously a very unfriendly act and you always meet twice in the market [...]. Secondly, the customers you would approach are typically also your own (potential) customers. They don't like it either" (32).*

Considering supply chain risks such as interruptions of supply routes or failure of manufacturing plants, firms can apply a multi-source sourcing strategy to mitigate such risks. This brings inherent conflicts of goals between down- and upstream firms to light. While downstream firms aim to obtain exclusive access to IP to remain independent, upstream firms aim to defend their position in IP, at least temporarily, through periodic exclusivity rights.

> *"So, when I can, I always try to keep IP under my control. [...] It's often the case that OEMs or parts suppliers try to develop tailored solutions [...] and then keep the IP. [...] you can say it's morally fair because they made the invention. If they are not making a purely commissioned invention for me, morally, the rights to the license also belong to them. This, however, puts me in a very, very difficult position. Therefore, I try in such*

cases to secure the IP for myself or at least a license [...]. But suppliers rarely agree to this, because by doing so, they give everything away" (17).

"[...] we develop a product with a supplier, [...] then we contractually secure the option to have a second source. Usually, there might be an initial exclusivity phase" (15).

Downstream firms implementing a multi-source sourcing strategy require a consistent level of quality and harmonized technical specifications across their supplier base. Thus, secondary suppliers in a multi-source sourcing strategy need usage rights for the IP of the primary supplier. The primary supplier can provide such access indirectly by granting have-made rights or sublicensing rights to the downstream firm, i.e., corresponding with bifurcated licensing, or directly by granting a license to the secondary supplier, i.e., corresponding with integrated licensing. Restricting and managing access to the IP as well as the levels of trust in an existing customer relationship are key concerns for patent holders because IP might be misappropriated. This is no surprise since secondary suppliers are direct competitors of the primary supplier.

"There are both possibilities. [...] if a good customer wants something from us, then we can give it to them [...], that would be a sublicense, or we can operate it under an extended workbench model [...]. That would be my preferred method, [...] because then [...] you have the license only for the area as you wish to use it, and for everything else, I can intervene directly. [...] if I've granted the [competing] suppliers a license, I can also restrict it in a certain quantity, location, or something else, but ultimately, enforcement in such a construct is more challenging because they have a license. I would essentially have to terminate a license, which is not always so straightforward" (7).

Another interviewee confirmed the commonality of granting have-made rights.

"[Regarding the licensing relationships,] I'm familiar with both situations, but usually, it's us. So, it's like an extended workbench, so to speak" (12).

Downstream firms incentivize patent holders to agree to a second source constellation by offering long-term business opportunities such as guaranteed purchasing volumes. In addition, patent holders aim to limit knowledge outflows to the secondary supplier.

"We inevitably have to license a competitor with our solution. In the best case, we would already have patents filed on it. We always call it a forced marriage, these second source licensing agreements. We have to educate a competitor, which we naturally prefer not to do" (4).

Even when introducing new products to the market, downstream firms proactively address the question of a second source to avoid becoming blackmailable.

> *"It often has this very practical aspect that you don't have a second source right at the beginning, so when you start producing products, you do a ramp-up [...]. Only after reaching a certain volume, you start with a second source. You wouldn't distribute a small quantity across two suppliers right away. This means the contract with the second supplier [...] is temporally subsequent. And of course, we want to have legal certainty at the moment we make the contract with the first supplier that they will give us this license, and not that, when we come back 2 years later, [...] they say: No, that would ruin my business" (23).*

One interviewee reported that the role of OEMs has changed, shifting more responsibility for conflict resolution to suppliers:

> *"[...] in the past [...] the resolution always involved the OEM [...]. Now, with all these various patent and IP risk issues, the OEM increasingly leaves it to the suppliers to [...] find an agreement at the same supplier level [...] and says: I don't want to be involved with this issue, you sort it out and come back only when you have reached an agreement" (13).*

In this context, another interviewee confirmed that large suppliers can resolve IP issues independently without the involvement of a downstream firm.

> *"The big companies can sort it out among themselves because they usually have mutual dependencies [...]. Smaller ones [...] without the market power, we sometimes still need to provide support" (12).*

Within the mechanism "Contract development/ manufacturing/ research" several distinct constellations could lead to bifurcated licensing. For instance, a downstream firm could in-license a patent to assure that the goods supplied by a contract or toll manufacturer are free of 3rd party rights. In this case, the in-licensed patents cover technologies implemented by the contract or toll manufacturer. Patent holders may grant such rights as have-made rights or as a right for sub-licensing. To restrict access to a technology, patent holders may restrict sub-licensing rights through further constraints.

> *"[...] [in this market segment] we partly let others manufacture for us, which would be a patent infringement against our licensor. There are two models here. Either we simply*

have the right in the contract for toll manufacturing [...] or, more commonly, we have sublicensing rights included [...]. These are sometimes also limited to allowing us to grant the sublicense to parties that work for us" (19).

In general, background and foreground IP are subject to negotiations between suppliers and their customers. Both want to retain control over the focal technology. The downstream firm aspires to have access to, e.g., foreground IP resulting from contract research to maintain its flexibility in supplier selection. I.e., a downstream firm with access to the IP could nominate another upstream firm to become the supplier. In contrast, the upstream firm aims to limit the downstream firm's access to the technology, e.g., through limiting exclusivity periods.

"In this case, the customer relationship on the licensing side is quite restricted. [...] we always try to arrange things so that we have as little interaction with customers as possible in terms of granting or entering into exclusivities. Sometimes it can't be avoided. [...] Especially when things arise from projects, we then try at least to obtain a timewise restricted exclusivity or a license. [...] It's actually seldom background IP, [...] it's mainly foreground IP. [...] And then it is differentiated according to the project and scope of the project, also differentiated by customers, and so on" (20).

As the mechanism "Freedom of 3rd party rights" shows, firms are concerned about their brand value and perception as a reliable supplier. Therefore, they also observe the patent landscape for technologies implemented further up- or downstream of their own level of the value chain. A firm could take a license for a patent that it is not implementing itself. One interviewee described a situation where the firm took a license for a patent that its direct customer implemented. Patent exhaustion represents another reason for this decision. It is more efficient if the supplier takes the license than all customers since they are covered by the it anyway due to patent exhaustion.

"[...] it was a license that we took, one that we didn't actually need directly, but our customers did. [...] where we also made sure as a precaution that our customers were indeed free. [...] there was a patent holder who actually had nothing to do with the industry and where you couldn't rely on the usual mechanism of saying: Okay, our customer won't be approached. Instead, it was someone, [...] who was very far away, and then had intellectual property rights [...] that we wouldn't have used directly, but rather [...] our customers would" (20).

Conversely, another interviewee explained that such a constellation could also occur with the downstream firm taking the license instead of the upstream firm. While in the first constellation, the customer could be sued, in the second case, the licensee could become a litigation target.

> *"[...] we do also clarify supplier intellectual property rights to some extent. And it really depends on the relationship and the supplier. [...] And in this case, again, my brand value is at stake. [...] Therefore, we assess in the [Freedom to Operate analysis] and [...] in license negotiations the risk of being supplied by a supplier who [...] is based somewhere in China. [...] I will make sure that I use technologies that I have a good FTO understanding or [...] I myself take a license from someone whom I believe I am dependent on" (17; FTO = Freedom to Operate).*

Besides the six previously presented mechanisms, I detected three further constellations of bifurcated licensing. However, interviewees rarely mentioned these three constellations and I was unable to generalize these findings such that I did not present them as a frequently occurring mechanism leading to bifurcated licensing. The first of the three constellations were sales licenses, i.e., the granting of rights to sell a product or service in a specified territory. In this context, the licensee was not the party assembling the technical artifact comprising the patented invention.

The second constellation comprised straw men, i.e., firms comparable with shell corporations who disguised their actual owners, and intermediaries, i.e., firms trading IP rights. These straw men pressure patent holders by, e.g., opposing patent applications. Thereby, they attempt to obtain a non-exclusive license comprising have-made rights, e.g., in return for withdrawing the opposition. Then, the straw man licensee forwards the have-made rights to the disguised owner of the shell corporation.

> *"In the background, there are also license negotiations where, interestingly, we have situations where there are straw man oppositions, where it's not actually clear who is the one being granted a license and at what level of the value chain they operate, and yet a license is still granted [...]" (28).*

The third constellation involved powerful suppliers who separated the sale of goods into two separate transactions: One to transfer the ownership and one to transfer the usage rights by forcing customers to take a patent license in addition to the purchase of supplies. Besides the rare occurrence, I excluded the constellation as it solely restructures the composition of the purchase price. For instance, Qualcomm, a US-based semiconductor company and SEP owner, sold chipsets to customers in one transaction and asked them to take a patent license in a separate transaction (Hollister, 2020; Hovenkamp & Simcoe, 2020).

Despite the identification and description of six mechanisms, the question of the relative frequency of each mechanism remains open. Due to the lack of precise quantification, I can only estimate the relative frequency. To ensure robustness, I applied two methods to quantify the frequency of each mechanism. First, I counted how many interviewees named each mechanism, implying a maximum number of mentions per interview of 1. With this method, I avoided overestimating the occurrence of a mechanism by being less sensitive to small variations in the interviewees' presentation of licensing constellations, e.g., differing types of licensors. In the second method, I accounted for multiple mentions of a mechanism in an interview.

Overall, 26 of 35 interviewees mentioned at least one mechanism (74%), with 4 being the maximum number of distinct mechanisms mentioned in one interview and 10 being the maximum number of mentions of a single mechanism in one interview. With the first method, I detected 59 mentions, and with the second method, 113 mentions.

Following the first method resulted in 17 mentions (in 49% of interviews interviewees mentioned this mechanism) for "ICT SEPs", 14 (40%) for "Second source", 10 (29%) and 8 (23%) for the litigation-related mechanisms "Easier enforcement" and "Higher return", respectively, 7 (20%) for "Contract development/ manufacturing/ research", and 3 (9%) for "Freedom of 3rd party rights". Applying the second method, I found "ICT SEPs" (53/47% of total mentions) and "Second source" (22/19%) as most frequently observed mechanisms followed by the litigation-related mechanisms "Easier enforcement" (14/12%) and "Higher return" (12/11%) as well as "Contract development/ manufacturing/ research" (6%/7) and "Freedom of 3rd party rights" (4%/5). Not surprisingly, the relative frequency changed. However, the ranked order of each mechanism by frequency did not differ between both methods. I found the high relative importance of "ICT SEPs" as mechanism to be confirmed by the qualitative statements of the interviewees as well. E.g., one interviewee concluded:

"I can say that the cellular topic is the only one, where we have that issue" (8).

The same interviewee added in an e-mail exchange in September 2024 that the interviewee observed similar friction in the value chain beyond cellular SEPs with licensing SEPs of other standards such as WiFi.

3.3.3 **Study on patent licensing – Consequences of bifurcated licensing**

Interviewees reported consequences of bifurcated licensing like the ones discussed in the literature (e.g., Bekkers et al., 2014; Geradin, 2020; SEPs Expert Group, 2021; Henkel, 2022; Love & Helmers, 2023). Licensees in bifurcated licenses felt increased uncertainty, e.g., around prices and legal questions, in particular in relation to the licensing of SEPs. These uncertainties affected not only device makers but also suppliers further upstream in the value chain.

> *"So overall, the problem is [...] with these SEPs and we are seeing such rapid changes. [...] ten years ago, we used to buy chips, including indemnification promises. This meant we could then sell to our customers at fixed prices including the license. If we don't get the licenses for components that implement certain standards, then we also have to tell our customers that we cannot offer a fixed price for uncertain licensing costs" (5).*

These issues are further amplified by the fact that patent holders can freely select the licensing level. As a result, some suppliers are unable to obtain a license and cannot assure their customers of a delivery free of 3rd party rights without incurring severe legal risks.

> *"A supplier who owns the patents essential to the standard usually can give an indemnification because it may have entered into cross-licenses. Another supplier not holding SEPs to the standard says: "I can't indemnify", especially if the supplier doesn't get licenses. Such license refusals exist. [...] even if I were willing to pay any price for the licenses, but don't get them, then I cannot offer you delivery free of third-party rights in this regard" (8).*

Related to the increased levels of uncertainty, interviewees elaborated on the elevated transaction costs associated with bifurcated licensing. The transaction costs resulted from a higher licensing frequency, administrative efforts, as well as risk management practices.

> *"As a licensee, regarding royalty reporting based on sales figures, it's not the case that you just find a button in your IT system which you can simply use for reporting under every new license. The processes are often extremely intertwined between purchasing, production and sales. If royalty reporting is based on sold end products it is nevertheless necessary to look from which supplier which part comes from and which of the parts are already licensed. Therefore, you need to investigate purchasing or production processes and data, because the sales data doesn't show that. Then it suddenly becomes quite*

complex [...].Of course, where a component is purchased which is already fully licensed, no further licensing is necessary, because the patent rights are exhausted" (8).

As a response to bifurcated licensing and higher risks for downstream firms, the allocation of IP-related risks within the value chain gained attention. Risks tended to emerge in particular for mid-stream suppliers.

"What is certainly very interesting is this sandwich position. There are companies that are neither end manufacturers nor upstream in the value chain. [...] They buy products but use them to build their own products that are incorporated into other products. [...] And I think there are incredibly high risks in this situation because, ultimately, the demands from both sides are high. As a rule, the supplier cannot guarantee freedom from third-party intellectual property rights. However, the buyer demands that the person in the sandwich position delivers free of third-party rights. And of course, the question now is, how do these sandwich companies in the middle deal with this?" (21)

A further implication of such a sandwich position is that downstream product values could be a multiple of the supplied components. Consequently, IP risks grow exponentially with the practice of bifurcated licensing.

"[…] we talk about how strong the exemption is [...]. We deliver to you [a component] [...], [which] is relatively cheap in relation to the [end device] [...], but afterwards, the delivery of the [end device] [...] can be interrupted because we have made an error in our clarifications regarding the patent-free nature of our materials. […] But there are different approaches. [The buyer] [...]need[s] an exemption from you [...] because I'm selling something, then I should assume liability for it. [....] Then you can also cap it. [...]many years ago [...] there was a problem with the turn signal and then cars couldn't be imported into Korea because there was a national protection law. Of course, the turn signal manufacturer cannot say: I take full liability […] because the indicator somehow costs €150 in purchase price and the car costs €60,000" (7).

Moreover, interviewees observed that more and more negotiation power is accumulated with patent holders. Reasons are, e.g., the imbalanced knowledge and complex patent landscapes.

"[...] if we take a [...] circuit, how are we supposed to check whether or not we are using a protected right, especially when there are I don't know how many thousand or hundred chips in a [product]. Apart from the fact that you can't even look inside. But just by the

number of them, it becomes difficult. So, proving non-infringement becomes very difficult" (12).

In addition, licensees noted an unlevel playing field for reasons that they cannot control such as luck or geographic presence. They feared being in a competitive disadvantage, as one interviewee explained:

"[...]it makes the business a bit of a lottery. [There is] a small company that is not even on the radar and the competitor that is approached by SEP holders for some reason [and then] suddenly has a completely different cost position" (5).

Figure 4 provides an illustration of first order codes, second order categories, and aggregate dimensions related to the consequences of bifurcated licensing.

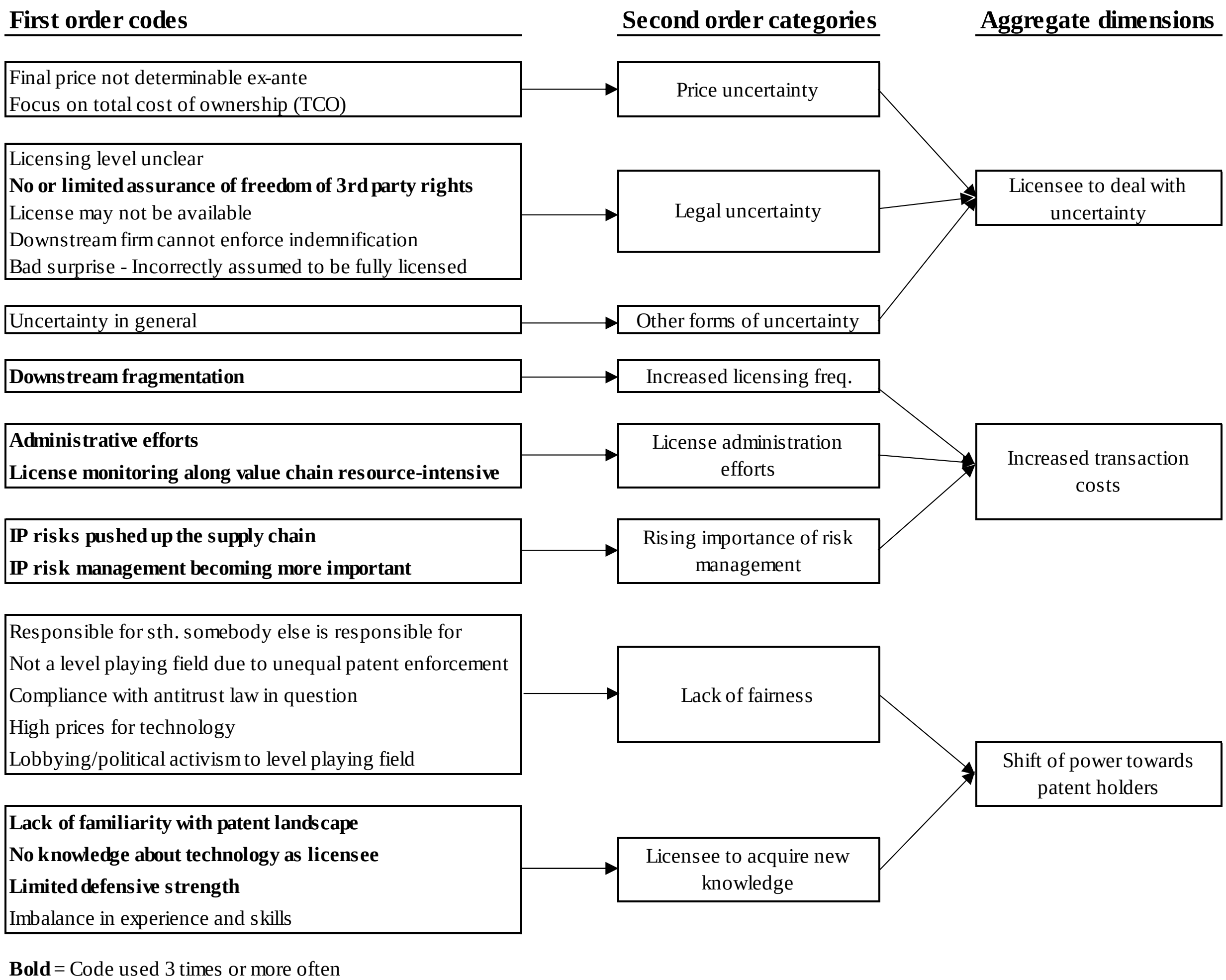


Figure 4: Main consequences (aggregate dimensions) of bifurcated licensing

3.3.4 **Study on patent litigation – Motivations for indirect suits**

This qualitative study confirms that patent holders flexibly select the litigation level in the value chain. This means that there is no dominant litigation level but heterogeneous sets of choices. Accordingly, two interviewees summarized their practical impressions as follows:

"[...] it's a bit like the Wild West" (26).

"[...] [the selection of the litigation level] is often very pragmatic and then driven by the respective situation" (28).

This heterogeneity increases the necessity to understand the motivations behind each litigation level selection even more. Overall, I discerned four distinct motivations, as illustrated in *Figure 5*.

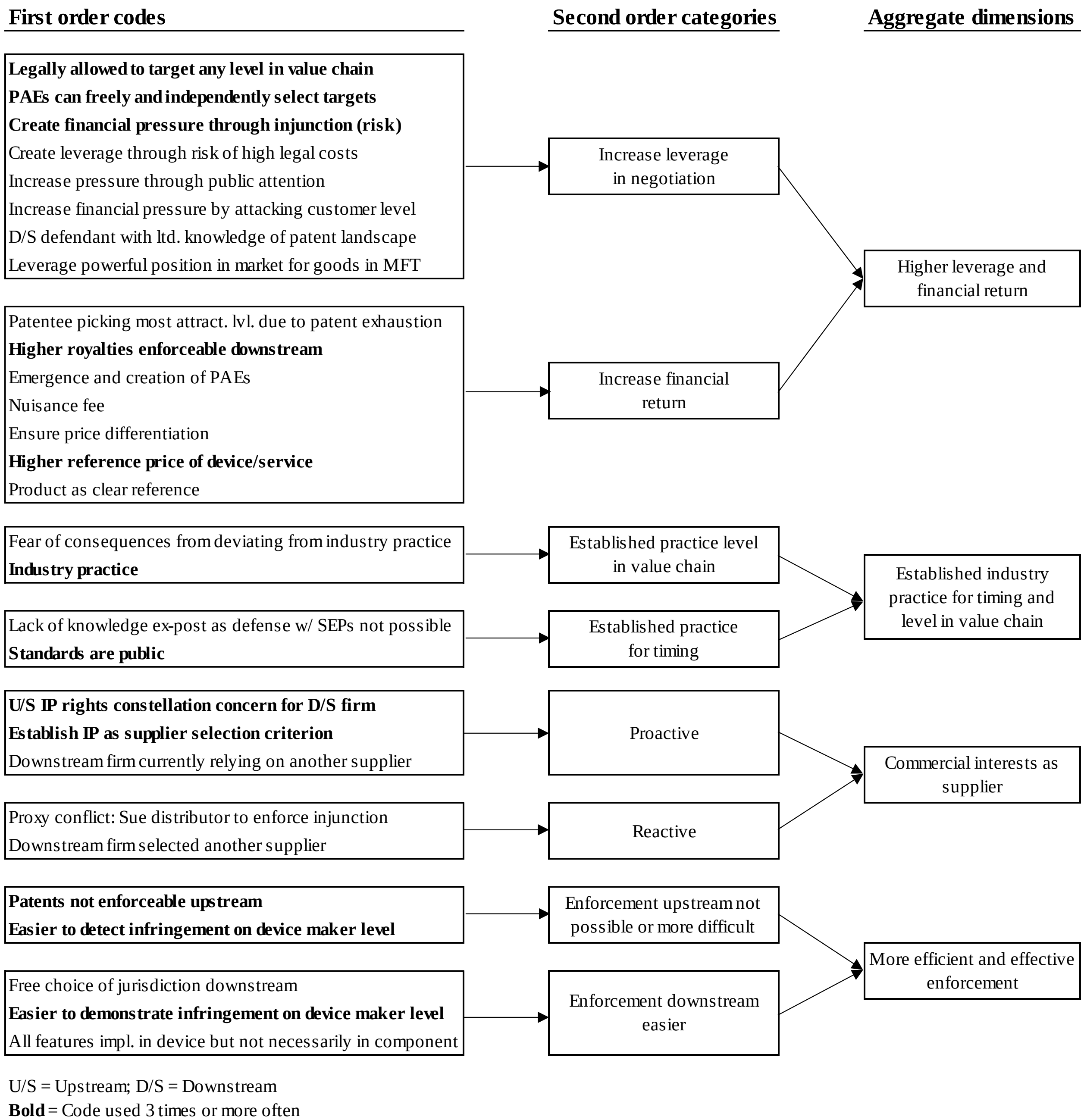


Figure 5: Main motivations (aggregate dimensions) for indirect suits

Each suit associated with each motivation names one or more different types of defendants. I distinguished between three different types of defendants in indirect infringement suits: manufacturers, merchants, and users. Given the nature of the suit, all three defendant types do not refer to the original infringer of the patented technology. This implies that manufacturers could be positioned on any level in the value chain. With merchants, I refer to trading businesses that are not manufacturing goods but only buying and selling them. With user I refer to the party who uses a product or service incorporating the patented technology. This could be, for example, a telecommunication services provider that uses cell towers that incorporate communication patents. Besides demonstrating the coding system itself, *Figure 5* illustrates in bold how often I used the respective code. Thus, *Figure 5* hints towards the importance of a particular motivation for a plaintiff in its selection of the litigation level.

The first motivation for plaintiffs to file an indirect suit are "Commercial interests as supplier". As opposed to enforcing a patent and securing license income, these interests could comprise defending or gaining market shares. The resulting suits deal with complex technologies and typically name manufacturers or merchants as defendants (*Figure 6*). Enforceability contemplations could influence the litigation level selection. Admittedly, they could also be fortuitous, as the country selection could depend heavily on the geographic profile of the (potential) customers in the focus of the patent holder. Patent holders could follow a proactive approach in which actions aim towards influencing future commercial decisions of (potential) customers. In contrast, patent holders could follow a reactive approach. This means that patent holders react after the infringement and aim at remedying past decisions of (potential) customers.

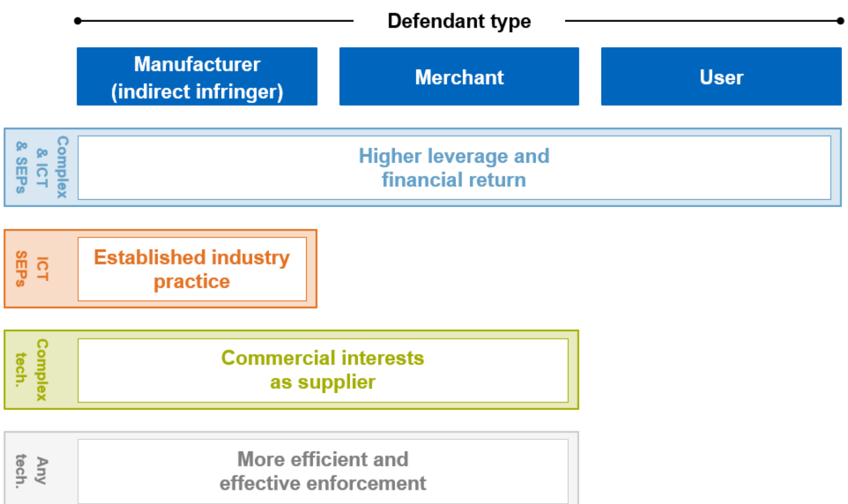


Figure 6: Main motivations for indirect suits and selected defendant types

In the proactive approach, patent holders substantiate the importance and strength of their IP portfolio towards the downstream levels. As a result, they are skeptical about licensing.

> *"[...] if we were to license to the end device manufacturer, we would have solved a very specific problem at a very specific moment with regard to a very specific product. What we would actually prefer, however, is for our immediate customers to perceive us as a reliable supplier who also has strong IP, so that in future cases, the customer would*

prefer to buy from us rather than from the Chinese, where they might expect to face delivery difficulties due to the patent situation" (9).

In addition, they aim to shape the purchasing decisions of firms further downstream or increase the pressure on the direct competitors indirectly through the customer level by creating a threatening backdrop. Such a backdrop does not necessarily entail suits, as the uncertainty associated with litigation risks could already influence such purchasing decisions.

"[Name of plaintiff] manufactures [the component] in Germany, with a lot of automation technology relatively expensively. There was always the question of whether one can use the alternative Asian component. A few companies did that [...]. [Name of plaintiff] sued those companies [...] and [the market] said: If I buy the [component] from the cheaper Chinese, then I will face a patent infringement suit in the US" (6).

"[...] the patent holding competitor approached the potential customer and said: [...] you buy from us because you cannot buy from the competitor because [the competitor] is a patent infringer, and if you do that and integrate [the component] you are off the market, and you surely do not want that to happen" (32).

Such infringement risks are a decisive concern for firms further downstream as one interviewee confirmed:

"[...] if, conversely, clients were to come to me and say, look, I need to install a component, is there patent infringement? Yes, or no? And if I can say, there's a residual risk, and they say, well, what should I do? Should I buy from the competitor? It costs the same, I really don't care. Or should I take the risk? [...] then I would say, [...] if there's a residual risk of 20% and you can eliminate it at no cost, yes, of course, go ahead" (32).

Even though such a strategy promises economic returns, it might backfire. Litigating against current or potential customers could frighten them, harm the patent holder's image as a reliable supplier, and endanger current or future business.

"[A company] tried to enforce a patent and sued [name of defendant], a well-known [name of city] company [...]. [...] [the plaintiff] did not have a single machine at the [defendant] and knew that he typically does not receive orders from [name of defendant]. [...] [the plaintiff] has burned its tongue and has never done it again" (20).

Besides targeting a downstream manufacturing company, targeting merchants to enforce an injunction could prove to be effective for patent holders. The reason for this is that an injunction translates into tangible, immediate consequences for the merchants and its customer. The affected merchant, in turn, likely increases pressure on the presumptive infringer.

> *"That [distributors are sued with the objective of obtaining an injunction] is correct. [...] It is often the case that the patent holder has an own product that one would deliver to them [the distributors] such that one would sweep away from the market the infringing product" (28).*

It seems that the effectiveness of a litigation level for pursuing commercial interests depends on the market share of the target.

The second motivation "More efficient and effective enforcement" leads to indirect suits to mitigate challenges associated with patent enforcement. Such challenges are related to the detection of infringement, the proof of infringement, the varying degrees of enforceability across jurisdictions, and the implementation status of patented features along the value chain. Consequently, in indirect infringement suits motivated by enforceability considerations, patent holders flexibly select manufacturers and merchants as litigation level alike.

Two interviewees illustrated how the lack of patent enforceability upstream affects the patent holder's choice to litigate further downstream in the value chain:

> *"[In our industry,] value chains build up mainly in Asia. In Asia, it is relatively difficult to enforce IP. [...] At some point the end product reaches Germany, the US, where effective legal protection is possible. What could happen is that we skip multiple levels in the value chain and do not enforce the patent against our competitors and customers because we cannot reach them in Asia anyways, but directly against the OEM or end product maker […]" (9).*
>
> *"[...] for IoT, you have major module players, largely Chinese at this point[...]. [...] If [...] the IoT products are made in China and then imported somewhere else by a downstream company, then someone with only European patents or someone who finds it difficult for any reason to litigate in China really has little choice but to enforce for downstream, right?" (35)*

For the reasons above, it is more promising for patent holders to target merchants operating in countries with strong IP regimes than upstream manufacturing companies operating in countries with weak IP regimes. Two interviewees described a scenario when to target a merchant:

"[...] in the case where the manufacturer can hardly or cannot be targeted. [...] the distributors, they are the ones who appear on the market and where you have the proof of infringement, where one can accordingly build indirect pressure against the illegal manufacturing or import" (28).

The interviewee further argued:

"[...] [This happens when the infringers] operate from China, where [...] one cannot serve a lawsuit because they operate through distributors here in the European market or in markets where patents exist or where their market activity takes place" (28).

In contrast to components which are sold to jurisdictions where manufacturing plants are located, devices are sold in many jurisdictions globally. Thus, litigating on a device maker level corresponds with increased flexibility in the selection of the jurisdiction as one interviewee argued:

"[...] devices were sold worldwide, which means that they could be legally pursued in every jurisdiction [...]" (22).

Besides the question of patent enforceability, patent holders need to consider how to most effectively, in a first step, detect infringement and, in a second step, proof infringement when selecting the litigation level. Regarding infringement detection, potential challenges could deal with transparency on component flows along the value chain.

"Also, there are various issues, especially at the beginning of the supply chain, [...] how to determine in which [end] product the component ends up [...]. But from my perspective, it is also the natural approach because we can identify these products in case of a patent infringement [...]. And then you have no other choice but to initially focus on the [end] products, or yes, you might have options, but those definitely involve more effort [...]. By way of example, the manufacturer of the end product could be requested to inform about its supplier(s) of the alleged infringing intermediate product." (14).

"And if you have licensed at the end product level, it becomes easy [...]. It is in a box. It is a certain type of product and it got [a company name] [...] on it, and you can see if there is a license for that product and job done. But if you have licensed at a component level then you have to buy the product, take it out of the box, see what is on the component [...]" (30).

Regarding proofing infringement, potential challenges could deal with understanding the exact functionalities of a component and transparently sketching license scopes. One interviewee illustrated these challenges based on the example of chips.

> *"The background is that there is a large variety of implementations of most open standards and a large variety of hardware the implementation may run on. It is usually difficult for the patent holder to determine which chips are inside and which chip runs the implementation. [...] many chip manufacturers [...] just say: Yes, I incorporate everything, but [...] it is my customer who decides which components in the chip are activated and which are deactivated. [...] It used to be simple, there were certified chips for every functionality. Today, these chipsets are all complex systems. It is significantly more difficult for the patent holder to determine which chip is inside or whether the functionality is even implemented." (31).*

As a result, proofing infringement of a patent or at least one of its claims upstream is very challenging. Another interviewee confirmed these challenges:

> *"[...] several components […] may not implement the invention as claimed in the patent. So, you need to show all the features. Yeah, this part is not in my component but is somebody else's component, but they come together in the end-user device" (30).*

The third motivation "Higher leverage and financial return" describes patent holders who adaptively deploy various maneuvers to increase the pressure on the defendant. The suits involved complex technologies predominantly related to ICT. Periodically, the patent holders, mostly practicing entities and PAEs, declared the patents in focus as essential to a standard. Ultimately, patent holders aim at maximizing financial returns as interviewees illustrated:

> *"[…] the companies will license where they think they can make the most money. […] It is not ultra-sophisticated from that perspective" (34).*
>
> *"[…] all these technical discussions are just shadow boxing, if we're being honest. It's really about gathering objective arguments to ultimately lower or raise the price" (26).*

Adaptively selecting the litigation level within the boundaries of indirect suits could augment financial returns. Especially, users and merchants could represent attractive proxy targets. A proxy suit could attract a lot of public attention, thereby, causing pressure on the upstream firm. At the same time, the plaintiff faces limited financial risks, e.g., due to manageable security deposits required for enforcing an injunction. Despite the publicity, the absolute business volume with the infringing product is likely lower with indirect suits on a user or merchant level as compared to the device maker level.

"[...] It belongs to the repertoire of a few patent holders that [...] one attacks the customers to increase the pressure on the party that should take the license. That happened in the automotive industry when car dealers and vehicle fleet providers were sued for patent infringement in addition to the OEM" (25).

"One attacks the user mostly to increase the pressure on the one whom one actually targets. [...] They often started suing car dealers such that the car dealers make noise at the OEM. Plus, they can enforce the judgment with lots of publicity without a too high risk of damages" (26).

It essentially is about creating leverage:

"[...] I mean, generally speaking, in most cases you want to create the most amount of leverage. And to create leverage, you want to, you know, create the most risk for the other side. That's generally what leverage is" (34).

Particularly, PAEs flexibly select the litigation level given that they are independent of long-term commercial considerations such as existing customer relations.

"[…] there were simply fewer restrictions for PAEs in enforcement […]" (22).

By suing a downstream defendant in an indirect suit, a plaintiff could realize further advantages. Due to anchoring, a given per unit royalty seems more bearable ceteris paribus.

"[…] if you have a $50,000 car, then $10 doesn't seem unreasonable. But if you have a $10 [royalty] on a $100 component in that car, then it does not seem as reasonable anymore most of the time, even though the volumes have not changed" (34).

"I can hardly ask for a 3$ license fee on a chip which has a selling price of […] 5$. But I can ask without any problems for a [license fee] of 5$ or 10$ in case of a TV" (33).

Moreover, by deploying this strategy, a plaintiff could enlarge the license base.

"[...] One sues operators because of the infrastructure. Not because of the mobile devices. Because mobile devices are not of interest for them [the operators], there are sufficient providers. They simply kick those out of the portfolio that are forbidden. But they are very sensitive with the infrastructure. [...] it is very thrilling to have the revenues from the services of operating a telecommunication network as license base as compared to the price of a base station" (26).

For these reasons, the license base is subject to debate between plaintiffs and defendants even though, in theory, the absolute royalty should be the same – independent of the selected license base and the royalty rate.

> *"[...] the USA have [...] this Smallest Saleable [Patent Practicing] Unit [...] but the owner will typically say: I want the whole product because that is the highest licensing base that exists [...]" (1).*
>
> *"[...] purely from a theoretical perspective [...], how licensing fees are determined, it shouldn't actually matter. I mean, the bigger the pie, the smaller the royalty rate should be [...]" (23).*

Lastly, the motivation for "Established industry practice" is solely related to ICT SEPs and, thus, complex technologies because the licensing of SEPs is subject to FRAND conditions. As indicated by the term "industry practice", the associated indirect suits have in common that they consistently target the same type of defendant: manufacturers of devices such as smartphones positioned toward the end of the value chain.

Device-level licensing of SEPs appears to be the established licensing practice accepted by market participants and courts. The practice and, therefore, indirect suits targeted at device makers arose with mobile devices.

> *"It was established that devices - at least in case of mobile devices - are licensed. […] There are also litigation actions around base stations. […] But there were less. I believe that this [practice] has been established in the market for mobile devices […]" (22).*
>
> *"What is industry practice, plays a very large role. [The licensing level] is mostly at the end of the value chain, which was confirmed by the Mannheim Regional Court in the case Nokia vs. Daimler. But this is no iron rule" (14).*

Also, for audio codecs, patent holders have established the practice of device-level licensing as confirmed by an interviewee:

> *"These technologies are usually licensed on the end user device level. […] This is general industry practice which has been established in the market and which all market participants accept." (31).*

FRAND considerations play a major role in the selection of the litigation level. Showing inconsistencies in one's practices of selecting the value chain level could potentially undermine one's negotiation position and result in licensing demands from players on other value chain levels:

> *“[...] I believe what [patent holders] will tell you [...] [that] they are concerned that if they license modules for IoT, then the handset makers [...] will use that against them in the franchise for handsets” (35).*
>
> *"We need to be careful [...] when it comes to standard essential patents. If we deviate from the industry practice once and license at a different level of the value chain, then we will be obliged to license also everyone else who wants a license at that level to avoid any discrimination." (14).*

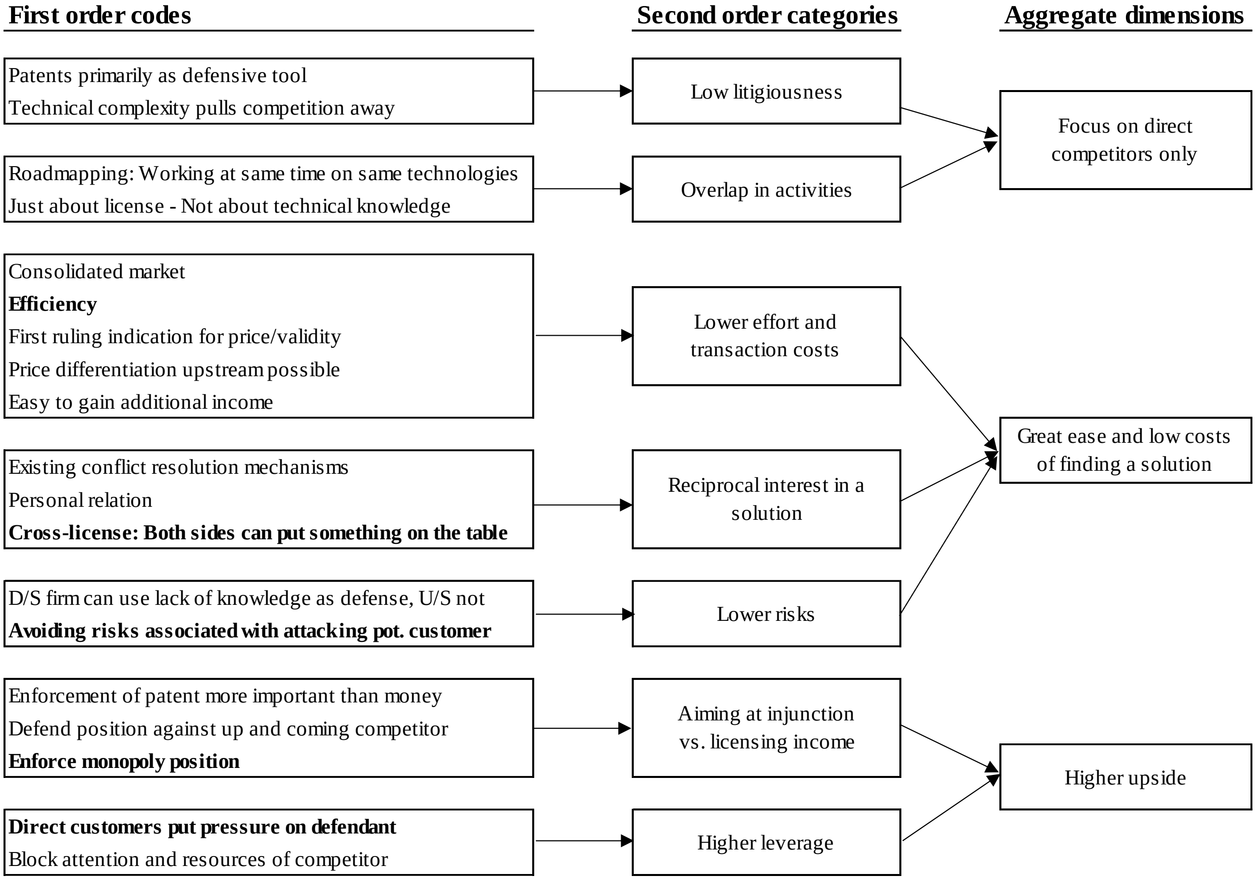
Nonetheless, observing the presence of established industry practices does leave the question of their emergence unanswered. The fact that specifications of open standards are public and, thus, easily accessible facilitates downstream licensing of technologies implemented further upstream. If standard specifications are not public, downstream firms could claim a lack of knowledge of the standard specification and the underlying patents in their defense. Downstream firms cannot use this argument convincingly with open standards, one interviewee elaborated. Moreover, firms may acquire the relevant knowledge through external partners:

> *“[...] information is accessible, I can inform myself about standards. […] [for] telecom standards, I can hire additional partners such as technology consultancies and get that” (1).*

In the context of cellular SEPs, one interviewee pointed to the exit from device manufacturing activities of some patent holders. New entrants such as Samsung, Research in Motion, and Apple replaced incumbents, such as Nokia, Ericsson, and Siemens. As a result, once fully integrated technology and equipment vendors players disintegrated their activities along the value chain (Bekkers et al., 2014) and focused on patent monetization. I.e., technology vendors sold portfolios to specialized PAEs or out-licensed patents on their own. Pure patent monetization players have the advantage that they do not need to consider customer relations or enter cross-licensing agreements. As a result, they are more flexible in the selection of the litigation level, contributing to the establishment of the industry practice of device-level licensing of ICT SEPs (Geradin, 2020; SEPs Expert Group, 2021).

3.3.5 Study on patent litigation – Motivations for direct suits

A patent holder can freely select the litigation level if the patent has been infringed on the respective level or further upstream. In contrast, in the case of licensing, the degree of flexibility in selecting the licensing level depends on the timing. Contrary to an ex-post license, an ex-ante license might not be at all or hardly enforceable. Despite my focus on indirect suits, the flexibility in the selection of the litigation level calls for further analysis of the motivation to file a direct suit. Overall, I identified three motivations for pursuing a direct suit (*Figure 7*).



U/S = Upstream; D/S = Downstream
Bold = Code used 3 times or more often

Figure 7: Main motivations (aggregate dimensions) for direct suits

Plaintiffs expressed that, as a motivation for a direct suit, they focused on direct competitors as opposed to firms further downstream in the value chain. In addition, the net expected benefits motivate plaintiffs. Plainly speaking, patent holders watch out for the delta between the ease and low costs of finding a conflict solution as well as the upside from the conflict. In certain situations, a direct suit might represent a higher net expected benefit than an indirect suit (contrary to my derivation of a general preference for indirect suits in *5.2*).

A focus on direct competitors resulted, e.g., from parallel development activities on the same technologies. In some discrete and complex technology industries, technology roadmaps are barely distinguishable between competitors and, consequently, interfering with each other is hardly avoidable. One interviewee observed this crowding of technology fields in pharmaceuticals:

> *"[...] the pharmaceutical companies used to stay out of each other's way. So that means you largely avoided each other's home research area, so to speak. But there were still enough fields for everyone. The [white spots are] [...] shrinking more and more, more and more has already been researched. Then there are the big hotspots [...] where they all want to go. There's still a lot to find there [...]. And then you just collide more" (19).*

In addition, interviewees emphasized that lower transaction costs, reciprocal interests in conflict resolution, and lower risks simplify the finding of a solution. One interviewee pointed to the importance of transaction costs for the litigation-level selection:

> *"If you have […] greater concentration, you're […] enjoining a bigger business upstream" (35).*

The fact that price differentiation is typically also possible upstream – confirmed by one interviewee – as well as the tendency towards fragmentation further downstream in the value chain further support the notion of transaction costs. Moreover, direct suits allow for equal arms of plaintiffs and defendants and, thus, easier conflict resolution. For example, one interviewee argued with regard to conflicts taking place horizontally on the value chain that the available weapons are more similar among the conflicted parties.

Besides, the optionality of cross-licensing is more important in direct suits. It has direct implications on suit preparations, as well as the patenting strategy.

> *"[...] if we were to attack [a firm], we need to know exactly, does it have something that it could also throw back at us? If that is the case, one naturally tries to settle into a cross-license from the outset. So cross-licenses do occur, and they are also partly a tactic in patent strategy" (23).*

One interviewee argued that even cross-licensing may represent an income stream.

> *"[...] some of our competitors that play in the same market may also have some patents. You want to at least make sure that that is handled in some kind of cross-licensing with the balance payment to us preferably. But you need to handle that risk as well" (30).*

If hypothetical risks materialize, plaintiffs face actual costs with risks impacting the net benefits equation. One of these risks results from attacking direct customers. The frequent use of this code showed that patent holders were particularly concerned with this risk. An interviewee elaborated:

> *"[...] when I think about operating companies [...] that hold most of the rights for various components, they want to sell their products. If that's their goal, it's always unattractive to target the end customer, i.e., the manufacturer of the final device, because it alienates a customer. [...] that was the classic case in the automotive supplier industry. There, the suppliers frequently clashed. And [...] when one won, the case typically settled. [...] Anyone in the market, who wants to sell and holds patents for that purpose, will never go after a potential or actual customer; instead, they will always try to litigate on the same level with the supplier to avoid destroying their business." (1).*

Lastly, plaintiffs pursued direct suits as they expected a higher financial return – not necessarily directly through higher license income but also indirectly. An example through direct benefits is that plaintiffs could develop high leverage versus defendants indirectly through the pressure that emerges from fearful customers of the defendants. An example for indirect financial benefits is that patent holders could enforce the temporary exclusion right coming along with the patent and, thereby, realize more sales. In this regard, one interviewee specified:

> *"I have to say, in my area, [the motive that patent holders license to make money] is almost nonexistent; instead, these are all, as one might nicely say, practicing entities, who would actually prefer to do business by selling their products and are happy if they can sell them as exclusively and with as little competition as possible" (32).*

Demonstrating as a patent holder one's willingness to enforce a patent might lead to further advantages that one can reap in the future. Logically, plaintiffs file such suits motivated by this consideration whenever they face the lowest costs as the materialization of the resulting benefits is uncertain.

> *"There are other considerations, again with a view to the larger economic context, for which one might say: Okay, then I'll forego a maximum license, to say, then I'll take what I can get and often it's actually the case that maximizing what one can get is perhaps secondary to firstly ensuring that patents are respected, that one gets something for them at all" (28).*

3.4 Discussion and conclusion

3.4.1 Discussion

The estimates of interviewees on the prevalence of bifurcated licensing varied significantly from rarely to 30%. Also, interviewees reported that licensors selected different types of licensees corresponding with bifurcated licensing, i.e., manufacturing companies, merchants, and users on different value chain levels. I observed equally diverse choices in the case of indirect suits. Despite these heterogeneous results, the study shows that bifurcated licensing and indirect suits are widely applied by patent holders confirming the strategic importance of the licensing as well as the litigation level selection in the value chain for capturing value from innovation. I extend the literature on profiting from innovation (Teece, 1986; Gambardella et al., 2021) by suggesting that the licensing and litigation level selection in the value chain and, accordingly, the licensing (integrated vs. bifurcated) or litigation mode (direct vs. indirect) represent a further dimension of value capture. In litigation, I find that patent holders can capture value directly through compensatory damages or indirectly through enforcing the temporary exclusion right on a patented technology or gaining market shares.

I identified six mechanisms that lead to bifurcated licensing: “ICT SEPs”, “Easier enforcement”, “Higher return”, “Second source”, “Contract development/ manufacturing/ research”, “Freedom of 3rd party rights”. Most constellations of bifurcated licensing happened after the implementation of the patented technology, i.e., ex-post, with two mechanisms explicitly comprising infringement suits (“Easier enforcement”, “Higher return”). In addition, bifurcated licenses were typically of a non-exclusive nature, consisted of portfolio licenses, and involved complex technologies, often even ICT patents or SEPs. Also, PAEs and patent pools appeared regularly as licensors. Despite the limitations, I was able to provide a first indication of the prevalence of each mechanism and ensured robustness by applying two counting methods. While the absolute frequency of each mechanism needs to be interpreted with caution, interpreting the relative frequency seems more adequate. In both methods, “ICT SEPs” and “Second source” emerged as the most relevant mechanisms, followed by the litigation-related mechanisms “Easier enforcement” and “Higher return” as well as “Contract development/ manufacturing/ research” and “Freedom of 3rd party rights”.

With regards to pursuing indirect suits, I detected four main motivations: “Commercial interests as supplier”, such as gaining or defending market shares, “More efficient and effective enforcement”, e.g., due to easier detection and proof of infringement, “Higher leverage and financial return”, e.g., by benefiting from a higher anchor due to higher product values downstream, and “Established industry practice for timing and level in value chain”, e.g., due to antitrust considerations around FRAND.

Interestingly, the latter motivation on established industry practices illustrates only why patent holders continue to comply with the established practices. However, it does not shed light on the development of such practices. The disintegration of value chains, i.e., the separation of once integrated firms holding patents and manufacturing devices (Bekkers et al., 2014) into patent-holding and manufacturing firms as well as the disposal of patent portfolios to PAEs, contributed to the establishment of device-level licensing of ICT SEPs as industry practice (Geradin, 2020; SEPs Expert Group, 2021).

Moreover, motivations for direct and indirect suits are partially comparable, implying that the ultimate objectives of patent holders are well-defined. However, the selection of the pathway towards achieving the objective is subject to contingency factors. For example, patent holders are concerned about the efficiency and transaction costs associated with a suit as well as the effectiveness of enforcement actions and the ease of resolving a dispute. While considerations around cross-licensing opportunities are associated with the effectiveness of direct suits, enforceability considerations related to IP regimes are associated with the effectiveness of indirect suits. In addition, the importance of the comparable motivations varies across direct and indirect suits as indicated by the count of codes. Consequently, contingency factors such as the type of technology or the type of plaintiff could affect the plaintiff’s selection of the litigation level.

Scholars debated about the impact of bifurcated licensing on MFT efficiency and came to different conclusions (e.g., Teece & Sherry, 2016; Borghetti et al., 2021; Henkel, 2022). My qualitative study provides a differentiated perspective on the impact of both bifurcated licensing and indirect suits on MFT efficiency. On the one hand, some mechanisms leading to bifurcated licensing, such as the facilitation of the establishment of a 2nd source, and motivations for indirect suits, such as a “More efficient and effective enforcement”, limit transaction costs and, thereby, contribute towards MFT efficiency. On the other hand, bifurcated licensing and indirect suits in other contexts (e.g., driven by return considerations) likely hamper MFT efficiency. Generally speaking, for instance, user- and merchant-level licensing and litigation is related to downstream fragmentation and higher uncertainty for downstream firms. A manufacturing firm typically sells through several channels to many customers, corresponding with a higher degree of fragmentation further downstream. Depending on the product and industry context, the implications of device maker-level licensing and litigation are more ambiguous. Nonetheless, one cannot generalize that licensing or litigating further upstream translates into MFT efficiency because this activity could still correspond with bifurcated licensing or indirect suits. As a result, uncertainty for firms and, thus, transaction costs could remain high. According to my analysis, bifurcated licensing and indirect suits translate, in general, into higher transaction costs and, thereby, hamper MFT efficiency.

3.4.2 Contribution

Through an exploratory, qualitative approach, my study illuminates the selection of the licensing and litigation level in the value chain and fills a research gap. It shows which mechanisms lead to bifurcated licensing and describes who is involved under which circumstances within each mechanism. Building upon the concept of the licensing mode (integrated vs. bifurcated licensing; Henkel, 2022), I introduce the concept of direct vs. indirect infringement suits and present motivations for pursuing one or the other litigation approach. I contribute to the literature on profiting from innovation (Teece, 1986; Gambardella et al., 2021) by identifying the need to consider the licensing and litigation level when devising a value capture strategy on the MFTs.

4 Quantitative study on target selection in patent licensing

4.1 Introduction and motivation

In 2020, four injunctions granted by German courts against Mercedes-Benz due to the alleged infringement of LTE SEPs owned by Conversant, Nokia, and Sharp shocked the automotive industry (Klos, 2021; Lloyd, 2020; Richter, 2020a). On the one hand, Mercedes-Benz asserted that OEMs typically purchase supplies free of third-party rights and, thus, its suppliers are fully responsible for licensing (*Nokia v. Daimler*, 2020). On the other hand, Nokia declined to license suppliers and persisted that device makers take licenses (Klos, 2021; Miller, 2021).

The *Nokia v. Daimler* (now Mercedes-Benz) case was part of a larger debate on the licensing level of SEPs (Geradin, 2020; Klos, 2021; Pohlmann, 2017; SEPs Expert Group, 2021). Patent licensing is an important alley to participate in the MFTs (Teece, 1986; Arora et al., 2001a). The licensing level has an impact on the efficiency of MFTs through the fragmentation of the licensing level, the experience of the licensees with the patented technologies, and the way the licensees make use of the technologies (Henkel, 2022). Yet, scholars have not comprehensively investigated the selection of the licensing level outside the SEP domain, the relevance of the licensing level for value capture via licensing on the MFT, and the predictors influencing the licensing level.

For example, studies on patent licensing concentrated selectively on industries and/or geographies and/or types of patents and/or types of licensors and licensees. For instance, Collinson et al. (2005) investigated patent licensing in the electronics and pharmaceuticals industries in Japan, Pitkethly (2001) compared licensing practices of Japanese and British firms, Anand & Khanna (2000) focused on U.S. firms, Grindley & Teece (1997) examined the electronics and semiconductors industries, Arora (1997) concentrated on the chemicals industry, Shresta (2010) shed light on PAE licensing practices, Lemley et al. (2018) investigated the role of timing, i.e., ex-ante vs. post-litigation licensing, and Kamien (1992) analyzed pricing models. In addition, scholars conducted studies on SEPs, e.g., on licensing terms (Pentheroudakis & Baron, 2017), on market prices (Love & Helmers, 2023), and on licensing in the IoT (Henkel, 2022).

For SEPs and non-SEPs alike, device-level licensing is not unusual. It ultimately became the established practice for SEPs (Geradin, 2020; SEPs Expert Group, 2021). Similarly, in the case of non-SEPs, carmakers may gain access to engine technologies through licensing each other (e.g., Hyundai Motor Group, 2018). Thus, it is not the vertical level, i.e., upstream vs. downstream, in the value chain that is of interest but the vertical position of the licensing level relative to the original implementer's level in the value chain. Building upon Henkel (2022), I distinguish between integrated licensing and bifurcated licensing.

I argue that licensors should, in general, prefer bifurcated licensing. Anchoring theory (Tversky & Kahneman, 1974) explains how a higher product value makes a royalty appear more reasonable (Teece & Sherry, 2016; Gautier & Petit, 2019). For instance, a 25$ royalty on a 30,000$ car appears to be more acceptable than a 25$ royalty on a 10$ chip even if the licensed technologies are identical. Patent holders can establish a higher product value by licensing further downstream. Ceteris paribus, the higher product value downstream corresponds with a more powerful injunction since more capital is tied to inventories. As a result, the cost of capital and obsolescence are higher. Moreover, patent holders have a deeper knowledge of the technology implemented upstream in comparison with downstream firms (Geradin, 2020) and face lower risks of being countersued with bifurcated licensing (Bekkers et al., 2014). Lastly, with the patent itself and the good incorporating the patented technology being complementary goods, patent holders tend to achieve better results when they negotiate both goods separately instead of selling them as a bundle (Henkel & Hoffmann, 2019). This upside arising from the separation calls for bifurcated licensing.

Contrary to patent holders, downstream firms (typically but not necessarily OEMs) should prefer integrated licensing for the reasons discussed above as well as to reduce transaction costs, e.g., resulting from license reporting requirements.

Given that patent holders can freely select the licensing level (Kuehnen, 2019; SEPs Expert Group, 2021), I argue that patent holders enforce bifurcated licensing whenever they can. This is the case with ex-post licensing (Green & Scotchmer, 1995), namely in six situations: after (unintentional) patent infringement, with more easily detectable infringement, in absence of ex-ante licensing (e.g., due to low attractiveness in case of high fragmentation among licensors or due to little need in case of options to invent around), with ex-ante publicly accessible standard specifications, in absence of competition between substitutive technologies, and, lastly, with the establishment of ex-post licensing as common industry practice.

By drawing on anchoring (Tversky & Kahneman, 1974) and transaction cost theory (Coase, 1960; Williamson, 1975), I discerned the predictors of bifurcated licensing. As hypothesized, my regression analysis indicated that complex technologies, SEPs, and product patents are positively associated with bifurcated licensing. I tested for robustness. In addition, I added to value capture theory by showing how the licensing level in the value chain affects value capture (Gans & Ryall, 2017; Henkel & Hoffmann, 2019).

I contributed to the literature on patent licensing (e.g., Kamien, 1992; Arora, 1997; Grindley & Teece, 1997; Anand & Khanna, 2000; Pitkethly, 2001; Fosfuri, 2006; Shrestha, 2010) and more generally on profiting from innovation (Teece, 1986) and capturing value on the MFTs (Arora & Gambardella, 1994; Arora et al., 2001a). By quantifying the prevalence of bifurcated licensing across industries, I demonstrated the strategic relevance of the selection of the licensing level in the value chain.

I structure the remainder of this chapter as follows: First, I derive hypotheses on predictors of bifurcated licensing. Next, I explain the sampling process, describe the hypothesized and control variables, and discuss how I dealt with multicollinearity and how I selected the applied regression models and interaction terms. Third, I illustrate the results from descriptive and regression analyses and test for robustness. Lastly, I summarize my findings and highlight my theoretical contribution.

4.2 Hypotheses development

In general, patent holders are free to select the licensing level in the value chain independent of whether a patent is essential to a standard or not (Kuehnen, 2019; SEPs Expert Group, 2021). I argue that downstream firms should prefer integrated licensing, i.e., typically upstream, whereas patent holders should prefer bifurcated licensing, i.e., typically downstream at the OEM level. Considering these contrary preferences, I first establish the rationale for the respective preference and, second, develop the hypotheses by deriving how patent holders can enforce bifurcated licensing against contrary preferences of licensees.

To decrease complexity, a downstream firm (typically but not necessarily the OEM) should prefer integrated (upstream) licensing. License reporting is simpler as it likely requires fewer data sources. While production data is probably sufficient to satisfy reporting requirements in the case of integrated licensing, license reporting in the case of bifurcated licensing probably requires merging procurement, production, and sales data. With integrated licensing, downstream firms do not need to develop expertise around patented technologies, e.g., expertise in assessing the validity or value of patents, that are typically implemented further upstream in the value chain (Geradin, 2020). As opposed to bifurcated licensing, integrated licensing reduces price and legal uncertainty. The former results from heterogeneous licensing scopes offered by upstream suppliers, untransparent price competition, and unexpected licensing requests. The latter results from enforceability risks related to indemnification clauses granted by suppliers (Geradin, 2020). As a result, integrated licensing allows the downstream firm to procure components from suppliers at a fixed, predictable price.

Despite the discourse on transaction costs and market efficiency implications (e.g., Teece & Sherry, 2016; Geradin, 2020; Borghetti et al., 2021; SEPs Expert Group, 2021; Henkel, 2022), I reason that integrated licensing is linked with lower transaction costs and higher efficiency. The connected cars industry shows that markets can be substantially more fragmented further downstream in the value chain. For instance, the largest five car makers combine 50% of the market compared to 87% market share of the largest five chipmakers (Mandal, 2022; Siddiqui, 2022). Related to the IoT device market, Henkel (2022) concluded that the market fragmentation increases with each value chain level further downstream. Higher fragmentation implies more licensing relationships and, thus, higher transaction costs (Henkel, 2022). In addition, transaction costs are likely higher downstream because of larger information asymmetries between licensors and licensees (Bekkers et al., 2014; Henkel, 2022).

Price differentiation leads to market efficiency (Henkel, 2022). Uniform pricing sets the price level of some technologies too high to be profitably implementable in certain applications, resulting in welfare losses (Tirole, 1988). Thus, scholars (e.g., Teece & Sherry, 2016) argue that price differentiation is needed to achieve a reasonable return on R&D investments. Practically speaking, price differentiation implies that patent holders demand a lower royalty in low-value applications (e.g., 4G implemented in an IoT sensor for consumer applications) than in high-value applications (e.g., 4G implemented in a car). However, patent holders may ensure price differentiation and, thereby, market efficiency by integrated licensing upstream as well (Henkel, 2022). Also, price differentiation may come at a cost, ultimately resulting in welfare losses: Patent holders need to account for the implementation costs of price differentiation (Leeson & Sobel, 2008) which are arguably higher in the case of bifurcated listening due to the more heterogeneous licensee landscape.

Contrary to downstream firms, bifurcated licensing is appealing to patent holders since a higher product value makes a royalty “look” smaller (Teece & Sherry, 2016; Gautier & Petit, 2019). This is caused by a psychological effect linked to biases (Tversky & Kahneman, 1974). To make royalties look more justifiable, patent holders can set a higher anchor by licensing downstream as the value added cumulatively by each contributing firm and, thus, the focal product value increases with each level further downstream in the value chain. Even if a 4G license covers the same technology, a 25$ royalty on a 30,000$ car appears to be more acceptable than a 25$ royalty on a 10$ chip. Englich & Mussweiler (2001), Hastie et al. (1999), and Marti & Wissler (2000) demonstrated that setting anchors is also an effective method during a trial. Prosecutors can influence the judgment even of experienced judges by demanding a severe punishment. Anchoring matters particularly for firms that focus on out-licensing to profit from and commercialize their innovation (Teece, 1986).

In line with high product values, patent holders can increase leverage stemming from an injunction. Even though the power of an injunction depends on multiple factors (e.g., ease of switching the technology), the higher product value downstream makes an injunction granted on a downstream value chain level more powerful ceteris paribus. For instance, a higher product value corresponds with more capital tied in inventories and, thus, higher cost of capital or obsolescence.

In addition, licensors presumably benefit from their strong technical position and fewer legal risks associated with bifurcated licensing. The downstream firm typically has little knowledge of the technology that is implemented further upstream (Geradin, 2020). While such knowledge can arguably be accumulated over time by collecting experiences or collaborating with external experts, such actions are very costly. Moreover, the downstream firm is less likely to countersue for two reasons. First, because the downstream firm's patent portfolio is likely focused on technologies directly implemented by it (Bekkers et al., 2014). Thus, the licensor is less likely to infringe on one of the downstream firm's patents. Second, because the downstream firm has little incentive to undertake defensive measures in fragmented downstream markets. Direct competitors would over-proportionally gain in case of a victory of the downstream firm as they are able to obtain at least the same benefits (e.g., ensuing an invalidation of a patent) at no costs.

Due to the reasons above, I expect patent holders to pursue bifurcated licensing whenever they can enforce it, i.e., with ex-post licensing. Ex-post licensing occurs when the patent holder licenses a patent to a licensee after the patented invention has been implemented. This timing leaves licensees with limited options: Either they stop using the invention and switch to an alternative, or they take a license. As a result, licensors gain leverage relative to licensees whose negotiation position is severely impacted by the limited options for action (Green & Scotchmer, 1995; Shapiro, 2010).

4.2.1 **Hypotheses**

I drew on value capture through profiting from innovation (Teece, 1986), transaction cost theory (Coase, 1960; Williamson, 1975), and anchoring theory (Tversky & Kahneman, 1974) to develop six hypotheses on predictors of bifurcated licensing: three related to the licensed technology, one to the type of licensor, one to the nature of the license agreement, and one to the market structure (*Figure 8*).

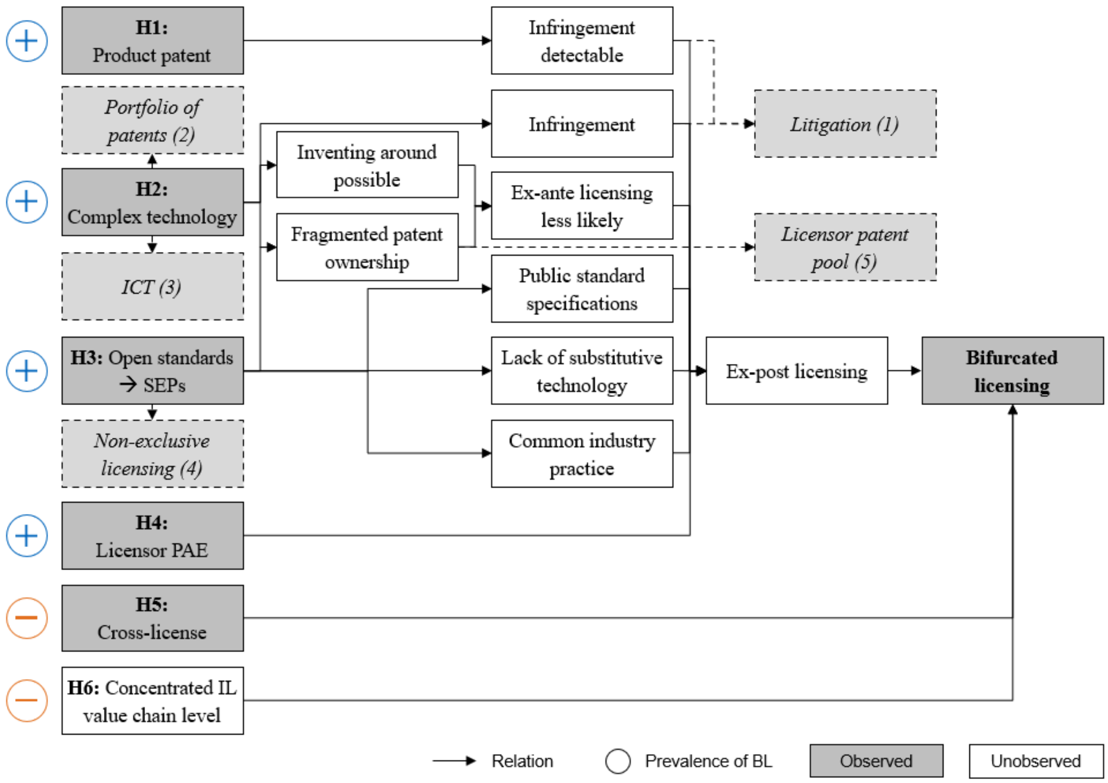


Figure 8: Argumentative chains and hypotheses – Bifurcated licensing

In contrast to ex-ante situations where the licensee can convincingly pursue the strategy of not using or inventing around a technology, it is far more difficult to stop using a technology in ex-post situations (Green & Scotchmer, 1995). Patent holders can pursue ex-post licensing after the (un-) intentional infringement of one of their patents. Comparing the strength and enforceability of product and process patents, Lunn (1987) concluded that "the strength of the property rights provided by a patent on a new product is generally greater than that provided by a patent on a new process" (p. 744) and Cohen et al. (2000) argued that process patents are less effective in protecting IP. "Given that [processes] are less public" (Cohen et al., 2000, p. 10), it is more difficult to detect the infringement of process patents. With bifurcated licensing, this difficulty is even more accentuated. For instance, in the case of a patent on a manufacturing process, the patent holder needs to demonstrate that a downstream firm has sourced supplies that were manufactured by applying the patent-protected process. As a result, it is, in general, easier for a patent holder to enforce bifurcated licensing with a product vs. a process patent. Therefore, I hypothesize:

Hypothesis 1: Product patents are associated with bifurcated licensing.

Complex technologies consist of many patentable elements (Cohen et al., 2000) and incremental technical advancements reciprocally depending on each other (Merges & Nelson, 1990). As a result, the patent holder landscape is more fragmented in the case of complex technologies (Cohen et al., 2000) such as in ICT (IPlytics, 2020; IPlytics, 2022; Causevic et al., 2022; European Commission, n. d.).

From a licensee perspective, a fragmented and, thus, sizeable patent holder landscape translates into significant efforts required to license all relevant patents ex-ante. Therefore, transaction costs for licensees are higher (Shapiro, 2001), and according to transactions cost theory (Coase, 1960; Williamson, 1975), ex-ante licensing is less attractive.

In addition, ex-ante licensing of complex technologies is less enforceable and, thus, less attractive for licensors due to the existence of multiple design options and the opportunity for the implementer to invent around (Kash & Kingston, 2001). In contrast to complex technologies, firms typically are less able to invent around discrete technologies. Therefore, they are technologically dependent and forced to license ex-ante to avoid the risk of an injunction, as opposed to waiting for ex-post licensing. Such licenses are of an integrated nature since firms license only technologies ex-ante they consider implementing at some point. Otherwise, such a license is hardly economically attractive.

From a licensor perspective, infringement is generally more likely and prevention more difficult with complex technologies (Grindley & Teece, 1997). Pursuing integrated licensing corresponds with higher risks of being countersued as the licensee is more likely to own patents that the licensor (un-) intentionally has infringed in the first place. The licensor can mitigate the risks of infringement and, thus, of countersuits through bifurcated licensing given that the technological focus and, thus, patent portfolio of the licensor and licensee have less or no overlap.

Moreover, because of complexity and fragmentation, it is more difficult for implementers to develop detailed knowledge of the patent landscape. Additional complexity emerges from patent holders who expand their patent portfolios to gain further leverage in negotiations (Kash &

Kingston, 2001). Consequently, hold-out, (unintended) infringement, and ex-post licensing becomes more likely.

In addition, based on anchoring theory (Tversky & Kahneman, 1974), bifurcated licensing is more attractive with complex than discrete technologies. With complex technologies, the value of the patented (intermediate) products increases more strongly along the value chain ceteris paribus because complex technology-based value chains comprise more levels and modular products (Baldwin & Clark, 2000). Thus, licensors can set even higher anchors the further downstream they are.

Hypothesis 2: Complex technologies are associated with bifurcated licensing.

Due to the nature of enabling technologies (Teece, 2018) and the fact that SEP holders often cannot own all complementary assets required to commercialize the innovation on the product market in-house (Gambardella et al., 2021; Teece, 2018), licensing is the “default value-capture mechanism” (Teece, 2018, p. 1367) for SEPs. Besides incentivizing hold-up and lock-in of implementers, this encourages standard contributors to build a portfolio of SEPs (Layne-Farrar & Lerner, 2011), thereby adding complexity to an increasingly fragmented patent ownership landscape (Causevic et al., 2022; European Commission, n.d.; Galetovic & Gupta, 2020; IPlytics, 2020; IPlytics, 2022). In addition, the non-competition-based selection of a dominant design during standardization (Kash & Kingston, 2001) negatively affects the level of competition between and variety among standards (Bekkers, et al., 2014; Shapiro, 2001). Considering the significant investments required for standard development, downstream firms cannot simply invent around a standard. As a result, downstream firms have limited substitutive options for a standard.

Aspects such as value chain disintegration (Bekkers et al., 2014) contributed to the establishment of the industry practice of device-level licensing of ICT SEPs (Geradin, 2020; SEPs Expert Group, 2021). Anchoring theory (Tversky & Kahneman, 1974) further helps to explain the preference for device-level licensing in a disintegrated industry. A higher anchor makes a royalty appear relatively smaller and, thus, more reasonable (Gautier & Petit, 2019; Teece & Sherry, 2016). Downstream licensing allows for setting higher anchors. Since special rules apply to the licensing of SEPs for antitrust reasons, conformance with established industry practices matters from a compliance as well as a transaction cost perspective. Licensing on another value chain level than the one industry practices demand likely results in higher transaction costs.

In the case of open standards, technical specifications are typically available to any firm interested in implementing the standard (Simcoe, 2006). The publication of the technical specifications by the SDOs aims to facilitate the diffusion of the standard (Katz & Shapiro, 1986). For this reason, access to the knowledge required for the standard implementation is possible even without the ex-ante licensing of SEPs.

The lack of substitutes, the existence of common industry practices, and the public ex-ante availability of standard specifications allow for ex-post and, thus, bifurcated licensing.

Hypothesis 3: Open standards are associated with bifurcated licensing.

PAEs are “firms that seek to generate profits mainly or exclusively from licensing or selling their [...] patented technology to a manufacturing firm” (Reitzig et al., 2007, p. 137). As opposed to technology vendors (Fischer & Henkel, 2012), PAEs contact firms that “already infringe on the […] patent and [are] therefore under […] pressure to reach an agreement” (Reitzig et al., 2007, p. 137), e.g., by locking implementers into technologies (Mann, 2004; Merges, 2009). Also, they typically target firms with little defensive capabilities (Cohen et al., 2019). In ex-post situations, patent holders have a stronger negotiation position vis-à-vis licensees (Green & Scotchmer, 1995; Shapiro, 2010), and licensees are particularly exposed for several reasons.

First, in ex-post licensing, licensees incur switching costs (Lemley & Shapiro, 2007; Lee & Melamed, 2015). Due to the limited in-depth knowledge of downstream firms about technologies that are implemented upstream switching costs are likely higher for downstream than upstream firms. Second, to obtain an injunction, it suffices to demonstrate that a firm infringes on a single patent. This also applies to products incorporating hundreds or thousands of patents (Lemley & Shapiro, 2007). This leads to a skewed distribution of patent values and high pressure on licensees even when a dispute involves only a few patents. Third, courts do not consider the ex-ante negotiation position when they calculate the compensatory damages. This implies that a patent holder could receive significant compensation even if the patent holder was in a very weak negotiation position ex-ante (Lee & Melamed, 2015; Reitzig et al., 2007). Lastly, downstream firms are more exposed to financial risks due to psychological effects resulting from anchoring (Tversky & Kahneman, 1974). A higher anchor makes royalties or compensatory damages look more reasonable (Gautier & Petit, 2019; Teece & Sherry, 2016). Therefore:

Hypothesis 4: PAEs as licensors are associated with bifurcated licensing.

Due to higher complexity and infringement risks, cross-licensing is mainly observable in industries employing predominantly complex technologies such as electronics. They exhibit characteristics such as short product cycles or a complementary and cumulative character of innovations (Collinson et al., 2005; Grindley & Teece, 1997). Through capture models, a cross-license may exhibit elements of ex-ante licensing by including patents that are not yet developed but will be developed during a specified time (Grindley & Teece, 1997).

In a cross-license agreement, both parties offer reciprocal access to selected patents. Both parties must gain advantages from such an agreement to have an incentive to conclude it. This is particularly likely to be the case when both parties operate on the same level in the value chain and implement similar technologies. A cross-license on the same value chain level represents a form of a horizontal license. Disintegration, i.e., the separation of knowledge and its operational implementation, can serve as a tool for patent holders to increase their leverage against licensees. At the same time, disintegration renders cross-licensing unnecessary. An example of such a move is the exit of Qualcomm and Texas Instruments as manufacturers from the Code Division Multiple Access (CDMA) and DRAMS markets (Teece, 2006).

With regards to cross-licensing, scholars identified diverse motives: the assurance of design freedom, the avoidance of patents blocking future development pathways (Grindley & Teece, 1997; Bekkers et al., 2014), the access to complementary technologies (Collinson et al., 2005), the avoidance of patent infringement (Collinson et al., 2005; Grindley & Teece, 1997), or the trading of technologies (in case of discrete technologies; Grindley & Teece, 1997). Also, in competition, patent holders might use SEPs and non-SEPs as currency (Bekkers et al., 2014). Integrated licensing can more effectively cater to these motives. Therefore:

Hypothesis 5: Cross-licenses are associated (negative) with bifurcated licensing.

Transaction costs are determined by uncertainty, asset specificity, and transaction frequency (Williamson, 1975; Williamson, 1985). Thus, transaction cost theory (Coase, 1960; Williamson, 1975) predicts that patent holders license on the level in the value chain that exhibits the highest market concentration: the higher the market concentration, the fewer licensees and license agreements, and, thus, the lower the transaction costs. If the market concentration is high on the value chain level corresponding to integrated licensing, patent holders should enforce integrated instead of bifurcated licensing. Unfortunately, the data required to comprehensively assess hypothesis 6 does not exist. E.g., market data on technology- and geography-level is required for such analysis which is already difficult to grasp yet obtain. For example, the definition of the geographic scope varies across technologies. It is larger for low-weight-to-value goods such as electronic devices than for high-weight-to-value goods such as cement. Consequently, I derive but cannot test hypothesis 6.

Hypothesis 6: Concentration on value chain level for integrated licensing is associated (negative) with bifurcated licensing.

4.2.2 Other considerations and expected correlations

It is possible that other variables related to the licensed patent (e.g., patent citations), licensed technology (e.g., age of technology), licensor (prior licensing experience), and licensee (e.g., competitiveness of product market on licensee's value chain level) exhibit links to bifurcated licensing. However, I found those links neither as convincing as the proposed hypotheses nor causal. For instance, patent citations are a proxy for patent value (Harhoff et al., 2003). But as shown earlier, bifurcated licensing requires the enforcement of a patent ex-post because firms can circumvent licensing ex-ante by using substitutes or developing alternative technologies. As argued, what type of patent is in focus determines the enforceability (e.g., product vs. process patent) but not the value of it.

Moreover, scholars showed that the competitive situations on the MFTs and the product markets affect the decision whether a patent holder pursues patent licensing (Arora & Fosfuri, 2003; Fosfuri, 2006; Trigeorgis et al., 2022). One could argue that the lower a patent holder's market share on the product market is, the more appealing are higher licensing revenues resulting from bifurcated licensing and biases associated with anchoring (Tversky & Kahneman, 1974). However, I argue that such a licensing strategy is not implementable. Ultimately, the central question of the enforceability of ex-post licensing, as discussed in 4.2.1, remains. Ex-ante, downstream firms likely switch suppliers as the litigious upstream patent holder presents a financial and operational risk and seems, from a technological perspective, replaceable as indicated by its low market share on the product market. This seems particularly likely with discrete technologies. With ex-ante licensing not being enforceable, the proposed hypotheses leading to ex-post licensing, e.g., on product patents or complex technologies, remain. In conclusion, I did not incorporate the above-mentioned variables as hypotheses. However, I controlled for them whenever I could obtain the required data.

I predict that the five variables *Litigation*, *Portfolio*, *ICT*, *Non-exclusive*, and *Licensor patent pool* correlate with several of the hypothesized variables (*Figure 8*). Due to this predicted correlation with several of the hypothesized variables, I expect all five variables to correlate with bifurcated licensing as well. These links are just correlational and not of causal nature. To avoid omitted variable bias, I control for these five variables (Cunningham, 2021).

Before a patent holder can file an infringement suit, it must detect the infringement. Compared to process patents, product patents are more effective in protecting IP and detecting infringement (Lunn, 1987; Cohen et al., 2000). Compared to discrete technologies, infringement is more likely with complex technology patents (Grindley & Teece, 1997). Thus, I foresee a correlation between *Litigation* and bifurcated licensing through the two hypothesized variables *Complex technologies* and *Product* (1). Many patentable elements (Cohen et al., 2000) and cumulative technical progress (Merges & Nelson, 1990) are characteristic of complex technologies. Consequently, unlike discrete technologies, firms developing complex technologies have large patent portfolios and, hence, engage in license agreements involving more patents (Hall & Ziedonis, 2001). Thus, I predict that patent portfolio licenses, as opposed to licenses covering single patents, correlate with bifurcated licensing via *Complex technology* (2).

ICT is a subset of *Complex technology* (Cohen et al., 2000) and, thus, exhibits only a correlational link but no independent causal link to bifurcated licensing. I foresee a correlation between *ICT* and *Complex technology* (3) and, hence, between *ICT* and bifurcated licensing.

For antitrust reasons, special rules apply to the licensing of SEPs. When a patent holder declares a patent as essential and commits to licensing under (F)RAND conditions, “the owner waives the right not to license the patent at all, or license it only exclusively” (Bekkers et al., 2014, p. 53). Therefore, I expect a positive correlation between non-exclusive licenses and bifurcated licensing via *SEP* (4).

Patent pools are particularly effective in achieving their purpose, i.e., reducing transaction costs for licensors and licensees (Bekkers et al., 2014; Layne-Farrar & Lerner, 2011; SEPs Expert Group, 2021), in high transaction cost environments. This is the case when either the licensee side or the licensor side or both sides are fragmented, which often occurs with complex technologies (Kash & Kingston, 2001). SEP holders are incentivized to file more patents due to the allocation mechanism of licensing revenues among standard contributors, leading to increased fragmentation. The share of licensing revenues is fully or partially derived from the share of patents consolidated in a patent pool (Layne-Farrar & Lerner, 2011). Therefore, I predict that *Licensor patent pool* correlates with fragmented patent ownership through *Complex technology* and *SEP*. Consequently, I expect to observe a correlation with bifurcated licensing (5).

4.3 Methods

4.3.1 Data collection, cleaning, and preparation

I sourced patent license agreements from the NIPO, RoyaltySource, and internet sources. Moreover, I added additional agreements based on RoyaltySource when the RoyaltySource dataset included only an amendment. I added an additional agreement including the date of the original agreement and highlighted the original entry as amendment. This distinction is meaningful because agreements dates could differ significantly and, thus, also the nature of operations of the involved licensees and licensors. In total, I obtained a sample of 12,355 agreements (*Table 2*).

On 22 July 2022, I extracted all 51 digitally available patent license agreements at the NIPO. The closing of the agreements took place between 1987 and 2022. Given that neither licensees nor licensors need to report agreements to the NIPO, only a few license agreements were reported voluntarily at the licensee's or licensor's request (WIPO, 2018). Consequently, companies likely pursue commercial interests by voluntarily reporting license agreements, e.g., to signal (Spence, 1973; Connelly et al., 2011) the strength of the licensed technology. Thus, the 51 obtained agreements are most likely not representative of the license agreements involving Norwegian patents.

RoyaltySource provides data on IP and intangible asset license agreements (e.g., patents, trademarks, or trade secrets) and was founded in 1997. The provider feeds its database mainly through U.S. Securities and Exchange Commission (SEC) filings. RoyaltySource also uses other sources, such as newspaper articles (RoyaltySource, n.d.a). SEC filings represent a data-rich source for regulatory reasons: Publicly listed companies must report material agreements to the SEC, i.e., "contracts upon which the company's business is substantially dependent" (Nash et al., 2004, p. 9). Since scales of operations vary across companies, materiality thresholds differ between companies. If an agreement is material for either the licensor or the licensee, it needs to be reported by the respective party, and RoyaltySource can retrieve the data through the respective SEC filing. For instance, the closing of a license agreement worth $134M in annual license revenues was material for the licensor InterDigital but not material for the licensee Apple. Thus, only InterDigital reported the agreement's closing (InterDigital, 2022).

The RoyaltySource dataset contains global agreements. Given that mostly U.S. companies are listed with the SEC and SEC data presents the most important source of RoyaltySource, most agreements involve listed U.S. companies (RoyaltySource, n.d.a). Public companies are, on average, larger than private ones (Bellon et al., 2023). As a consequence, license agreements involving small- and medium-sized companies, as well as private companies, are probably underrepresented. Due to the materiality requirement, I presume that high-value license agreements are more likely to be sourced by RoyaltySource ceteris paribus. The oldest agreement contained in the dataset is from 1952. The number of agreements started to increase in the 1980s. Most agreements were from the late 1990s and 2000s.

Two reasons can explain the time-related concentration. First, accessibility improved in the mid-1990s. SEC filings have been disclosed digitally since 1995 (RoyaltySource, n.d.a) which became mandatory in 1996 (U.S. Securities and Exchange Commission, 1995). Collecting data since 1990, RoyaltySource was launched in mid-1997 (RoyaltySource, n.d.a), thus, likely resulting in a higher capture rate of license agreements. Second, changes in the population of public companies might explain the time-related concentration of licenses. The population can change through an initial public offering (IPOs) or a delisting. Relative to the 1980s or 2000s, many small companies went public in the 1990s, thereby, increasing the number of companies who exhibit low materiality thresholds and a need to report material agreements to the SEC. With the burst of the dot-com bubble, the trend reversed (Ritter, 2023). Since its peak in the U.S. in 1996, the number of publicly listed companies has declined by 50% (Davydiuk et al., 2020), thereby, reducing ceteris paribus the likelihood that license agreements are reported in particular in the 2010s.

Besides the NIPO and RoyaltySource, internet searches represented an additional source. SEC filings are an information-rich source for material agreements and activities pursued by the submitter. Thus, I often encountered additional patent license agreements while conducting research on another agreement. In addition, I included patent license agreements I found via Internet searches.

I used databases (e.g., Orbis) and publicly available information (e.g., internet sources, SEC filings) to clean and prepare the dataset. I envisaged only “arm’s-length” license agreements as insightful for my analysis. I removed intercompany or related-party agreements, amendments, duplications, agreements involving types of IP other than patents, or acquisition agreements (as opposed to licenses). Duplications could result from using different source types (e.g., press release or material contract and SEC filing) or the same source type but different documents (e.g., both licensee and licensor filed a filing with the SEC) by RoyaltySource. Additionally, I identified and excluded agreements where the licensee was a PAE. A PAE takes on the role of an intermediary who aims at out-licensing the in-licensed patent to other licensees. By default, each patent license with a PAE as licensee represents a bifurcated license.

Moreover, I distinguished between agreements that administer the transfer of rights and knowledge and agreements that administer the transfer of ownership and usage rights in two separate transactions. I excluded the latter constellation as it solely restructures the composition of the purchase price. For instance, Qualcomm, a US-based semiconductor company and SEP owner, sold chipsets to customers in one transaction and asked them to take a patent license in a separate transaction (Hollister, 2020; Hovenkamp & Simcoe, 2020). This approach is consistent with Chapter 3. In total, I removed 6,291 agreements for the above-mentioned reasons (*Table 2*).

Source	**Total agreements**	**Excluded agreements**	**Pharma/Med Tech agrmts.**	**Patent license agrmts. in scope**
Entry added manually	198	17	0	181
Norway	51	7	0	44
RoyaltySource	11,591	6,056	2,644	2,891
Entry added based on RoyaltySource	515	211	1	303
Total	**12,355**	**6,291**	**2,645**	**3,419**

Table 2: Composition of sample by source

In a cross-license agreement, one can view each involved party as licensor and licensee. It could be that the agreement represents an integrated license for one party as licensee while it represents a bifurcated license for the other party as licensee. Therefore, I ensured that two entries existed for each cross-license with each involved party, once in the role of the licensee and once in the role of the licensor.

The first analyses indicated homogeneous licensing practices with a high tendency towards integrated licensing within the pharmaceuticals and medical technology spaces, as shown by *Table 12*. Besides the fact that a complete analysis of all patent license agreements in both spaces would add limited variance to the observed variables, it requires a significant amount of time. Thus, I decided to analyze only a sample of the agreements in pharmaceuticals and medical technology. Given that the propensity to license patents diminishes with an increasing size of manufacturing firms (Motohashi, 2008), I suspected that more experienced licensees and licensors exhibit differing fundamentals and licensing strategies from less experienced ones (not necessarily with regards to the licensing mode but to type of licensees, licensed technologies, etc.). Therefore, I applied a stratified sampling approach (Jewell, 1985) leveraging industry-specific experience-based strata. The definition of the strata varied between both spaces because pharmaceutical firms in our sample were, on average, more active in licensing activities. One stratum in the pharmaceuticals space consisted of licensees and licensors who closed five or fewer licenses as well as six or more licenses, respectively. In medical technologies, the threshold was three or fewer and four or more licenses. I classified licenses as pharmaceutical or medical technology by reviewing the licensee's product and service offering and operations as well as the licensed technology. I adjusted the weights of observations from pharmaceuticals and medical technologies in the following regression analyses (*see 4.4.5*) to reflect that only a sample of the agreements from each industry was analyzed. In total, I analyzed 37.9% and 49.4% of license agreements in pharmaceuticals and medical technologies, respectively. *Tables 3 and 4* demonstrate the composition of the sample by strata.

Sampling - Pharma	% of licensees		% of licensors	
	Full dataset	Analyzed sample	Full dataset	Analyzed sample
1-5 concluded licenses	68.0%	67.6%	64.2%	64.2%
6+ concluded licenses	32.0%	32.4%	35.8%	35.8%
Total licensees/ licensors	3,520	1,332	3,625	1,371

Note: 37.9% of all license agreements in pharmaceuticals were analyzed

Table 3: Stratified sampling approach for pharmaceuticals

Sampling - MedTech	% of licensees		% of licensors	
	Full dataset	Analyzed sample	Full dataset	Analyzed sample
1-3 concluded licenses	76.9%	76.7%	76.6%	76.7%
4+ concluded licenses	23.1%	23.3%	23.4%	23.3%
Total licensees/ licensors	939	467	992	494

Note: 49.4% of all license agreements in medical technologies were analyzed

Table 4: Stratified sampling approach for medical technologies

4.3.2 Variable definition and generation

Table 5 provides an overview of all independent variables. For the analysis, I assessed the RoyaltySource dataset and accessed publicly available data obtained, e.g., from company websites, press releases, or SEC filings, and the commercial database Orbis.

Variable	Type	Description	Hypothesis
Product	Binary	Licensed patent(s) (predominantly) consist of product patent(s) describing a concrete product or features thereof (as opposed to process patents)	1
Complex technology	Binary	Licensed technology and patent(s) are (predominantly) complex (vs. discrete), i.e., have a cumulative character and consist of multiple patentable elements	2
SEP	Binary	Licensed technology and patent(s) are (predominantly) essential to a standard	3
Licensor PAE	Binary	Licensor who owns patents w/o implementing them but to use them to generate income (excl. research entities)	4
Cross-license[1]	Binary	Patent license agreement concluded between both involved parties at same time in both directions	5
ICT	Binary	Licensed technology and patent(s) are (predominantly) in information and communications technology field, a complex technology	Correlation
Litigation	Binary	License agreement is closed after litigation action (e.g., out-of-court settlment, judgement)	Correlation
Non-exclusive	Binary	Licensor retains right to license technology to 3rd parties	Correlation
Licensor patent pool	Binary	Licensor is a patent pool who bundles and offers to license patents from multiple patent owners to third parties or other pool members	Correlation
Portfolio	Binary	License comprises portfolio of patents (>5) vs. single patent(s)	Correlation
Licensor inventor	Binary	Licensor is an individual or a group of individuals inventing new technologies, licensing or selling them to generate income; not organized as an ordinary legal entity	
Licensor researching entity	Binary	Licensor solely develops and commercializes technology without involvement in production activities	
Licensee researching entity	Binary	Licensee solely develops and commercializes technology without involvement in production activities	
Exclusive	Binary	Licensor licenses rights fully exclusively to licensee	
Sublicense	Binary	Licensee of licensed property in a different agreement is licensor of this property in the focal licensing agreement	
Age	Continuous	2024 minus year of closing of agreement (if not available: year of publication of source)	
Licensee agreements	Continuous	Average number of counted agreements licensee(s) concluded as licensee within sample (3,419 agreements plus Pharma/MedTech agreements)	
Licensor agreements	Continuous	Average number of counted agreements licensor(s) concluded as licensor within sample (3,419 agreements plus Pharma/MedTech agreements)	
Licensee total agreements	Continuous	Average number of counted agreements licensee(s) concluded as licensee and licensor within sample (3,419 agreements plus Pharma/MedTech agreements)	
Licensor total agreements	Continuous	Average number of counted agreements licensor(s) concluded as licensee and licensor within sample (3,419 agreements plus Pharma/MedTech agreements)	

[1] One entry for each direction of cross-license included in dataset

Note: Interaction terms were constructed by combining selected two variables which are displayed on this list

Table 5: Overview and description of independent variables

The capabilities, operational scope, and depth of value-add of a licensee matter for the classification of a license agreement as bifurcated or integrated. For instance, I classified the license for cellular patents with a pure downstream device maker as bifurcated, whereas I classified the license for the same technology with a vertically integrated device maker as integrated. With vertically integrated I refer in this example to a licensee who is not only assembling the device but also the respective chipsets on which the cellular patents are implemented. The vertically integrated company exhibits a larger operational scope and depth of value-add.

Considering, at times, very complex multi-country holding structures, it is very difficult to disentangle the exact capabilities of a particular legal entity. Therefore, I focused on the global ultimate owner of the licensee to classify the licensing mode. The global ultimate owner is independent and owns an influential stake in the company in focus (Moody's, n.d.). Through this approach, I avoided difficulties that might arise from agreements in which, e.g., a U.S.-based subsidiary of an international company appears as the licensee. It is not necessary to disentangle the capabilities of a company on an entity level. Consequently, I did not classify a license to a presumably pure sales subsidiary as bifurcated but as integrated if the parent company translates the knowledge underlying the licensed patent into a technical artifact.

I distinguished between complex and discrete technologies. The development of a *Complex technology* (e.g., Merges & Nelson, 1990; Kusunoki et al., 1998; Rycroft & Kash, 1999; Cohen et al., 2000; Kash & Kingston, 2001) requires the input (Kash & Kingston, 2001) and collaboration of many individuals (Rycroft & Kash, 1999). Counter to a discrete technology which comprises a "discrete number of patentable elements" (Cohen et al., 2000, p. 19) and stands for itself (Merges & Nelson, 1990), a *Complex technology* comprises many patentable elements (Cohen et al., 2000). Further characteristics of complex technologies are the ability of inventors to engineer around (Kash & Kingston, 2001) and the cumulative technical progress that leads to end products consisting of many incremental inventions (Merges & Nelson, 1990). In contrast, a slight alteration of a discrete technology, e.g., a chemical composition, typically results in a different technology (Kash & Kingston, 2001).

ICT is a type of *Complex technology* (Cohen et al., 2000) that enables the "captur[ing], transmit[ting], and display[ing] [of] data and information electronically" (Colecchia et al., 2002, p. 19) according to the OECD. For classifying a license agreement as predominantly *Complex technology* or *ICT*, I used the description of the licensed property provided by RoyaltySource, which contains publicly available information on the license in focus and, in some cases, specifies the licensed patents.

In contrast to Kusonoki et al. (1998) and Cohen et al. (2000), I decided against deriving the type of technology from the industry classification of the involved parties due to the risk of encountering ambiguities and losing accuracy. For instance, the Transportation Equipment (SIC 37) industry is a complex technology industry, according to Kusonoki et al. (1998) and Cohen et al. (2000). If an automotive OEM licenses a patent for a coating, the underlying chemical formulation – a discrete technology – is mistakenly classified as complex technology. Consequently, to capture the essence of the licensed technology as opposed to attributes of the licensing parties or the industry, I assessed the licensed patents to derive the type of licensed technology. Nonetheless, I assigned each license agreement for analysis purposes to an industry based on the Standard Industrial Classification code (1-digit and 2-digit SIC code; U.S. Securities and Exchange Commission, n.d.a). For the assignment, I analyzed the licensee's and licensor's product and service offerings and operations as well as the licensed technology. I did not consider the industry as an independent variable. On the contrary, I viewed the industry as a variable that is to be explained rather than that explains since I wanted to investigate differences across industries.

To assess hypothesis 1, I distinguished between *Product* and process patents based on patent abstracts, patent claims (whenever patents were known), and descriptions of the licensed technologies. A *Product* patent describes a patented invention that is a product by itself, e.g., a machine or a compound. In contrast, a process patent refers to an invention that is a "process, art or method […] includ[ing] a new use of a known process, machine, manufacture, composition of matter, or material" (35 U.S.C., 2023, § 100).

To evaluate hypothesis 3, I classified a license as *SEP* if it contains patents that are deemed indispensable for the implementation of the standard (Bekkers et al., 2011; Bekkers et al., 2014; ETSI, 2022). Unfortunately, the description of the licensed property provided by RoyaltySource often did not specify the licensed patents (e.g., patent number). Therefore, I assessed the description of the licensed technology, references to known standards, and outcomes from internet searches on the respective license agreement. For example, I classified the patent license with the description "The court decision relates to a patent infringement case […]. The technology […] is related to 2G, 3G and EDGE patents […]." as predominantly *SEP* as it unequivocally refers to cellular standards even without specifying the licensed patents.

For *Licensor PAE*, I drew on Reitzig et al. (2007), who characterized PAEs as “firms that seek to generate profits mainly or exclusively from licensing or selling their [...] patented technology to a manufacturing firm that, at the point in time when fees are claimed, already infringes on the [focal] patent and is therefore under particular pressure to reach an agreement” (p. 137). I further differentiated between *Licensor PAE* that concentrates on generating income from licensing ex-post and *Licensor researching entity* that concentrates similarly like PAEs on generating income from licensing but typically licenses ex-ante (Fischer & Henkel, 2012) and actively pursues R&D initiatives. Accordingly, the licensee could also be a researching entity highlighted as *Licensee researching entity*.

Contrary to the broader definition of PAEs as “individuals or firms” (Reitzig et al., 2007, p. 137), I considered individuals or groups of individuals who are not incorporated as legal entities and invented the licensed technology as *Licensor inventor*. Lastly, I classified licensors as *Licensor patent pool* when at least two patent holders jointly license patents as a package to other members of the patent pool or third parties (Shapiro, 2001; WIPO, 2014).

In addition to the information provided by RoyaltySource, I incorporated any additional information (e.g., press articles, press releases) of which I became aware to identify *Cross-license*. *Cross-license* refers to a constellation in which both parties reciprocally license at least one patent to each other. Following the same approach, I classified agreements as being closed after *Litigation* whenever the filing of a suit – independent of the outcome, e.g., out-of-court settlement or an in-court judgment – preceded the agreement's closing. Similarly, I highlighted *Sublicense* agreements as such. A sublicense describes an agreement in which the licensee licenses a patent from a licensor who does not own the patent itself but has licensed the rights to the patent from another party. Moreover, I classified each agreement as a *Portfolio* (more than five patents licensed) or a single patent license (five or fewer patents licensed). Whenever no exact number for the licensed patents was available, I applied my business judgment and relied on contextual information provided as part of the licensed property description to assess the variable.

Besides, I reflected the exclusivity of a license by distinguishing between *Non-exclusive* (licensor may grant another third party the right to use the licensed patent) and *Exclusive* (only the licensee is granted the right to use the licensed patent) licenses. Most agreements are either *Non-exclusive* (31%) or *Exclusive* (52%). For the analysis, I relied on data provided by RoyaltySource and other publicly available information.

Often, instead of the global ultimate owner, a subsidiary enters a license agreement as licensor or licensee. This is also the case in the sample. To ensure consistency, I harmonized the names, e.g., by renaming the entities “3M Company” and “3M Innovative Properties Company” to “3M Company”, the name of the global ultimate owner. I did not incorporate the appearances of subsidiaries independently but the appearances of the global ultimate owner to derive the variables *Licensee agreements*, *Licensor agreements*, *Licensee total agreements*, and *Licensor total agreements*. Additionally, I obtained the *Age* of the license agreement by deducting the year of the agreement (if available) or, alternatively, the year of the publication of the agreement from the current year, 2024.

Given the size of the dataset, I decided to involve an additional rater. Admittedly, such a step does not reduce the required overall amount of time, but it decreases the length of the analysis period by increasing the rating output. I, as the main judge, acted as a coach for a new judge who later joined the research activities. In total, the training involved about 9 hours of group training sessions in June 2023 accompanied by about 33 hours of preparatory individual sessions. After introducing the principles of rating license agreements along the defined, relevant variables, the new judge individually rated license agreements during multiple training rounds. After individual preparation, ratings were discussed and aligned in group sessions. The new judge was provided with written explanations of ratings and argumentations around rating selection. After the initial training phase, an inter-rater reliability test was conducted. Within the test, the judge derived and submitted independently the individual ratings.

Various dimensions and measures of inter-rater reliability exist. For example, the percent agreement among raters or Cohen’s kappa (Cohen, 1960; Fleiss, 1971) are very popular measures. However, the former falls short of accounting for an agreement by chance among judges (Hayes & Hatch, 1999; McHugh, 2012; Stemler, 2004). This is especially relevant in a setting of imbalanced class sizes (Stemler, 2004), as is the case with this dataset, where bifurcated licensing represents a significantly smaller share of agreements than integrated licensing. A high prevalence or bias index directly affects the size of Cohen’s kappa and its interpretation (Sim & Wright, 2005). A consequence of a high prevalence in the dataset could be an inflated percent agreement (Hayes & Hatch, 1999) and a reduced kappa (Feinstein & Cicchetti, 1990; Hallgreen, 2012; Sim & Wright, 2005). As compared to Cohen’s kappa, Gwet’s AC1 shows increased stability in results and deals more effectively with prevalence issues (Gwet, 2008; Klein, 2018; Wongpakaran et al., 2013) and changes in the marginal distribution (Klein, 2018).

When I calculated the prevalence index following Sim & Wright (2005) for the two raters in the test sample, I obtained prevalence index values of 75% warning of issues resulting from high levels of prevalence. Therefore, I deemed Gwet's AC1 as the more reliable indicator of inter-rater reliability as compared to Cohen's kappa. To counter potential biases in inter-rater reliability measures, I assessed percent agreement and Gwet's AC1 (Gwet, 2008).

Because all independent variables that are hypothesized to have a causal or correlational link to the independent variable *Bifurcated* are binary and of nominal nature, I focused on assessing the consensus among judges as opposed to, e.g., consistency (Stemler, 2004) and did not weight (dis-) agreements (Fleiss & Cohen, 1973; Sim & Wright, 2005).

To ensure small confidence intervals, I created a random sample of 36 license agreements for an inter-rater reliability test, exceeding the recommended sample size of at least 30 (McHugh, 2012). I calculated the percent agreement and Gwet's AC for two cases: One case incorporates ratings for all independent variables with a hypothesized effect on the dependent variable as well as the dependent variable itself (*Bifurcated*, *Complex technology*, *SEP*, *Licensor PAE*, *Cross-license*, *ICT*, *Litigation*, *Non-exclusive*, *Licensor patent pool*, *Portfolio*), and the other case incorporates only the ratings for the dependent variable (*Bifurcated*). For the analysis, I relied on packages developed for Stata by Reichenheim (2004) and Klein (2018). *Product* was not part of the test since I introduced the variable later and analyzed it on my own.

Landis & Koch (1977) derived benchmarking scales to assess and interpret agreement coefficients such as Gwet's AC1. One can interpret the coefficients as the "proportion of agreement corrected for chance" (p. 613) with values between 0 and 1 indicating a "better than chance agreement" (Fleiss & Cohen, 1973, p. 613) and values below 0 poor agreement (Landis & Koch, 1977). Landis & Koch (1977) argued that a coefficient value of 0.40 or below represents a fair or slight agreement, while values larger than 0.4 or 0.6 represent moderate or substantial agreement, respectively. Values larger than 0.8 correspond with almost perfect agreement.

In light of the derived 95%-confidence intervals resulting in a Gwet's AC value ranging from 0.44 to 0.92 for the rating of *Bifurcated* and from 0.86 to 0.94 for the rating of all hypothesized variables, including *Bifurcated*, the judges demonstrated at least moderate agreement (*Table 6*). As expected, given the high prevalence index, coefficients for percent agreement tended to be higher than the coefficients for Gwet's AC1. The ratings for *SEP* and *Licensor patent pool* showed perfect agreement among both raters. By conducting a t-test, I could reject in all but one case (Gwet's AC1 for *Complex technology*) the null hypothesis at the 1%-level that the coefficients for percent agreement and Gwet's AC1, respectively, subceeded the threshold of 0.4. In conclusion, the inter-rater reliability assessed in the test indicated a "better than chance agreement" (Fleiss & Cohen, 1973, p. 613).

Specification	Measure	N	Coefficient	Std. err.	t	P > | t |	[95% Conf. Intervall]	
All variables	Percent agreement	360	0.92	0.01	35.42	0.00	0.89	0.95
All variables	Gwet's AC1	360	0.90	0.02	25.95	0.00	0.86	0.94
Bifurcated	Percent agreement	36	0.75	0.07	4.78	0.00	0.60	0.90
Bifurcated	Gwet's AC1	36	0.68	0.12	2.41	0.01	0.44	0.92
Complex technology	Percent agreement	36	0.69	0.08	3.78	0.00	0.54	0.85
Complex technology	Gwet's AC1	36	0.46	0.16	0.38	0.35	0.14	0.78
SEP	Percent agreement	36			Ratings do not vary			
SEP	Gwet's AC1	36			Ratings do not vary			
Licensor PAE	Percent agreement	36	0.97	0.03	20.60	0.00	0.92	1.00
Licensor PAE	Gwet's AC1	36	0.97	0.03	19.47	0.00	0.91	1.00
Cross-license	Percent agreement	36	0.97	0.03	20.60	0.00	0.92	1.00
Cross-license	Gwet's AC1	36	0.97	0.03	19.47	0.00	0.91	1.00
ICT	Percent agreement	36	0.94	0.04	14.06	0.00	0.87	1.00
ICT	Gwet's AC1	36	0.92	0.06	9.31	0.00	0.81	1.00
Litigation	Percent agreement	36	1.00	0.00	.	.	1.00	1.00
Litigation	Gwet's AC1	36	1.00	0.00	.	.	1.00	1.00
Non-exclusive	Percent agreement	36	0.94	0.04	14.06	0.00	0.87	1.00
Non-exclusive	Gwet's AC1	36	0.92	0.06	8.37	0.00	0.79	1.00
Licensor patent pool	Percent agreement	36			Ratings do not vary			
Licensor patent pool	Gwet's AC1	36			Ratings do not vary			
Portfolio	Percent agreement	36	0.89	0.05	9.20	0.00	0.78	1.00
Portfolio	Gwet's AC1	36	0.87	0.07	6.75	0.00	0.73	1.00

Note: t-test H_0: Coefficient ≤ 0.40

Table 6: Inter-rater reliability test results for percent agreement and Gwet's AC1

4.3.3 Interaction terms, multicollinearity, and model selection

As suggested by the hypothesized mechanism (*Figure 8*), I included the interaction terms *Complex technology & Portfolio*, *Complex technology & Litigation*, *Product & Litigation*, *Complex technology & Licensor patent pool*, *SEP & Licensor patent pool*, and *SEP & Non-exclusive* as controls. Given that *ICT* represents a subset of *Complex technology*, the interaction between both would correspond with *ICT*. Thus, I did not incorporate this interaction term.

Due to the sizeable number of controls and their similarity, I tested for multicollinearity by calculating the Variance Inflation Factor (VIF) for each variable. I calculated the VIF as $VIF_i = 1/(1 - r_i^2)$ and interpreted it as the percentage "of the variability in the ith independent variable

[that] is explained by the remainder of the independent variables in the model" (Craney & Surles, 2002, p. 393). Setting the threshold for the VIF at 10 which implies an r^2 of 90% resulted in the removal of the interaction terms *Complex technology & Licensor patent pool*, *SEP & Licensor patent pool*, and *SEP & Non-exclusive* from the regression analyses. Moreover, I removed the control *Licensee total agreements* from the analysis due to a high risk of multicollinearity. *Licensee total agreements* is defined like *Licensor total agreements* but with a focus on licensees as opposed to licensors. *Table 7* demonstrates the VIF for each remaining control.

Variable	Variance Inflation Factor (VIF)
Product	1.17
Complex technology	2.10
SEP	2.12
Licensor PAE	1.28
Cross-license	1.17
Litigation	7.70
Portfolio	3.07
ICT	2.12
Non-exclusive	2.33
Licensor patent pool	1.51
Licensor inventor	1.14
Licensor res. entity	1.57
Licensee res. entity	1.30
Exclusive	2.05
Sublicense	1.02
Age	1.10
Licensee agreements	1.17
Licensor agreements	8.95
Licensor total agreements	8.69
Complex tech. & Litigation	4.80
Complex tech. & Portfolio	4.12
Product & Litigation	5.54

Table 7: Variance inflation factor by variable

Chen & Tsurumi (2010) recommended to apply the Akaike Information Criterion (AIC; Akaike, 1973) as a metric to assess a model specification in case of unbalanced data. My sample comprised predominantly integrated (88%) as opposed to bifurcated licenses (12%) and, thus, can be considered as unbalanced. I compared the AIC for a logit and a probit model and found a lower AIC for the logit model. Therefore, I selected a logit model to conduct regression analyses. Nonetheless, I ran a probit model as a further robustness test (*Table 8*).

Model	AIC
Logit	2,223.77
Probit	2,234.63

Table 8: Assessment of AIC for model selection

4.4 Results from quantitative study

I follow a threefold approach to presenting the results. First, I present descriptive statistics and results in 4.4.1, to 4.4.4. Then I illustrate the results from the regression analysis in 4.4.5. Lastly, I test the robustness of my findings in 4.4.6.

4.4.1 Descriptive results – Means and correlation analysis

Table 9 provides insights into the prevalence of selected variables. 12% of licenses were bifurcated. Licenses very frequently involved product patents (68%), complex technologies (41%), and non-exclusive terms (31%), whereas patent pools (2%) and PAEs (3%) rarely appeared as licensors. *ICT* as a subset of complex technologies was less prevalent (20% vs. 41%). Licenses regularly comprise SEPs (6%), cross-licenses (11%), and litigation (10%).

	Mean	Standard deviation
Bifurcated	0.12	0.33
Product	0.68	0.47
Complex technology	0.41	0.49
SEP	0.06	0.24
Licensor PAE	0.03	0.17
Cross-license	0.11	0.31
Litigation	0.10	0.30
Portfolio	0.21	0.41
ICT	0.20	0.40
Non-exclusive	0.31	0.46
Licensor patent pool	0.02	0.13

Table 9: Mean and standard deviation for selected variables

The correlation matrix in Table 10 demonstrated only correlations significant at the 1%-level except for very few exceptions. The sample size of 3,419 observations translated into low significance thresholds of about 0.04 corresponding with a significance of 1%. The signs of the correlation coefficients with *Bifurcated* were as hypothesized. *SEP*, *ICT*, *Complex technology*, *Licensor patent pool*, and *Non-exclusive* exhibited the strongest coefficients ranging from 0.26 to 0.44. The coefficient between *Cross-license* and *Bifurcated* was as expected negative. Also, the coefficients describing the correlations between independent variables were sizeable. For instance, *ICT* and *Complex technology* with 0.60, *ICT* and *SEP* with 0.52, *Licensor patent pool* and *SEP* with 0.49, *Non-exclusive* and *ICT* with 0.40, or *ICT* and *Portfolio* with 0.39. The size of these coefficients did not surprise. For example, *ICT* represents a subset of *Complex technology* and, as such, must be correlated. Also, intuitively, both *Licensor patent pool* and *SEP* were correlated gitven that "[…] patent pools have largely emerged from standard-setting efforts" (Layne-Farrar & Lerner, 2011, p. 300). They are an effective tool for navigating through patent thickets and blocking patents. This problem is particularly prominent with SEPs (Shapiro, 2000).

	Bifurcated	Product	Complex technology	SEP	Licensor PAE	Cross-license	Litigation	Portfolio	ICT	Non-exclusive	patent pool
Bifurcated	1.00										
Product	0.18**	1.00									
Complex technology	0.34**	0.22**	1.00								
SEP	0.44**	0.18**	0.31**	1.00							
Licensor PAE	0.17**	0.04**	0.13**	0.26**	1.00						
Cross-license	-0.10**	0.06**	-0.02	0.07**	-0.05**	1.00					
Litigation	0.15**	0.09**	0.25**	0.36**	0.26**	0.14**	1.00				
Portfolio	0.21**	0.12**	0.31**	0.36**	-0.04**	0.12**	0.14**	1.00			
ICT	0.43**	0.17**	0.60**	0.52**	0.21**	0.09**	0.31**	0.39**	1.00		
Non-exclusive	0.26**	0.06**	0.34**	0.37**	0.16**	0.10**	0.38**	0.33**	0.40**	1.00	
Licensor patent pool	0.33**	0.09**	0.16**	0.49**	-0.02	-0.05**	0.11**	0.26**	0.27**	0.20**	1.00

** Significant at 1% level; * Significant at 5% level

Table 10: Correlation matrix for selected variables

4.4.2 Descriptive results – Cross-tabulation and industry analyses

I conducted a cross-tabulation analysis for each of the five hypothesized variables (*Table 11*).

		Bifurcated		Integrated			
		#	%	#	%		
Hypothesis 1	**Product patent**	384	11%	1,948	57%	115.29	Chi sq.
	Process patent	38	1%	1,049	31%	0.00	p-value
Hypothesis 2	**Complex technology**	362	11%	1,034	30%	402.65	Chi sq.
	Discrete technology	60	2%	1,963	57%	0.00	p-value
Hypothesis 3	**SEP**	145	4%	69	2%	647.93	Chi sq.
	No SEP	277	8%	2,928	86%	0.00	p-value
Hypothesis 4	**Plaintiff PAE**	43	1%	54	2%	94.41	Chi sq.
	Plaintiff not PAE	379	11%	2,943	86%	0.00	p-value
Hypothesis 5	**Cross-license**	11	0%	347	10%	31.76	Chi sq.
	No cross-license	411	12%	2,650	78%	0.00	p-value

Table 11: Cross tables for hypothesized independent variables

In all five cases, the ratio of bifurcated licenses under the condition that the focal hypothesis is 1 to bifurcated licenses under the condition that the focal hypothesis is 0 exceeds the respective ratio for integrated licenses. For instance, the ratio for bifurcated licenses is about five times larger than the ratio for integrated ones in the case of product patents. The cross tables (*Table 11*) show highly significant chi square values (1%-level). This implies that both variables, i.e., the licensing mode and the respective hypothesized variable, are independent of each other. Therefore, further analyses are worth pursuing. It is noteworthy that bifurcated licensing is of utmost relevance for enabling technologies such as standardized technologies like 4G (Bresnahan & Trajtenberg, 1995). For instance, 68% of all SEPs were licensed in bifurcated fashion.

Further analytical depth provides a cross-table by industry (one- or two-digit SIC code) and our hypothesized variables (*Table 12*) and correlational variables (*Table 13*).

				Hypothesis 1		*Hypothesis 2*		*Hypothesis 3*		*Hypothesis 4*		*Hypothesis 5*	
		# patent license agrmts.	**Pre-valence**	**Product patent**	**Process patent**	**Complex techno-logy**	**Discrete techno-logy**	**SEP**	**No SEP**	**Licensor PAE**	**Licensor not PAE**	**Cross-license**	**No cross-license**
Manufacturing	Bifurcated	284	9%	9%	1%	8%	2%	4%	5%	1%	8%	0%	9%
	Integrated	2,806		61%	30%	29%	62%	2%	89%	1%	89%	11%	80%
Electronic & Other Electrical Equip. & Components	Bifurcated	156	31%	30%	1%	31%	0%	22%	9%	3%	27%	1%	29%
	Integrated	353		56%	14%	66%	4%	13%	57%	4%	66%	18%	51%
Transportation Equipment	Bifurcated	25	20%	20%	0%	20%	0%	17%	2%	4%	16%	0%	20%
	Integrated	103		73%	8%	74%	6%	0%	80%	0%	80%	2%	79%
Measuring, Photo., Medical, & Optical Goods, & Clocks	Bifurcated	29	6%	5%	1%	4%	2%	0%	5%	0%	5%	0%	6%
	Integrated	490		66%	29%	57%	38%	0%	94%	1%	94%	6%	88%
Industrial & Com. Machinery & Computer Equip.	Bifurcated	6	4%	3%	1%	4%	0%	0%	4%	0%	4%	0%	4%
	Integrated	158		73%	24%	82%	15%	0%	96%	4%	92%	5%	91%
Chemicals and Allied Products	Bifurcated	37	2%	2%	1%	0%	2%	0%	2%	0%	2%	0%	2%
	Integrated	1,544		58%	40%	1%	97%	0%	98%	1%	97%	13%	85%
Other	Bifurcated	31	16%	15%	2%	12%	5%	1%	16%	1%	15%	0%	16%
	Integrated	158		61%	23%	19%	65%	0%	84%	2%	82%	2%	81%
Services	Bifurcated	78	42%	34%	7%	37%	4%	2%	40%	2%	40%	0%	42%
	Integrated	109		21%	37%	40%	19%	1%	58%	2%	56%	2%	56%
Business Services	Bifurcated	64	50%	42%	9%	50%	0%	2%	48%	2%	48%	0%	50%
	Integrated	63		17%	33%	48%	2%	1%	49%	3%	46%	2%	47%
Other	Bifurcated	14	23%	18%	5%	10%	13%	0%	23%	0%	23%	0%	23%
	Integrated	46		30%	47%	22%	55%	0%	77%	0%	77%	2%	75%
Transportation and public utilities	Bifurcated	31	44%	41%	3%	44%	0%	11%	32%	13%	31%	0%	44%
	Integrated	40		27%	30%	42%	14%	4%	52%	4%	52%	11%	45%
Communications	Bifurcated	11	31%	31%	0%	31%	0%	22%	8%	25%	6%	0%	31%
	Integrated	25		42%	28%	69%	0%	8%	61%	8%	61%	22%	47%
Electric, Gas and Sanitary Services	Bifurcated	20	71%	64%	7%	71%	0%	0%	71%	0%	71%	0%	71%
	Integrated	8		7%	21%	4%	25%	0%	29%	0%	29%	0%	29%
Other	Bifurcated	0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Integrated	7		29%	71%	57%	43%	0%	100%	0%	100%	0%	100%
Finance, insurance and real estate	Bifurcated	10	77%	62%	15%	77%	0%	0%	77%	46%	31%	0%	77%
	Integrated	3		0%	23%	23%	0%	0%	23%	0%	23%	0%	23%
Other	Bifurcated	19	33%	31%	2%	28%	5%	0%	33%	0%	33%	0%	33%
	Integrated	39		34%	33%	41%	26%	0%	67%	2%	66%	0%	67%
Total	Bifurcated	422	12%	11%	1%	11%	2%	4%	8%	1%	11%	0%	12%
	Integrated	2,997		57%	31%	30%	57%	2%	86%	2%	86%	10%	78%

[1]Based on one-digit and two-digit SIC code

Table 12: Cross table for the dependent variable and causal variables across industries

The large majority of license agreements (i.e., 90%) were in Manufacturing (1-digit SIC code) followed by Services as well as Transportation and Public Utilities. On the 2-digit SIC code level, 76% of the license agreements can be assigned to Chemicals and Allied Products, Electronic

& Other Electrical Equipment & Components, as well as Measuring, Photographic, Medical, & Optical Goods, & Clocks. In spite of that, I am hesitant to interpret too much into the relative distribution. As noted, US-listed firms need to report material agreements to the SEC. Several arguments suggest that licenses closed in chemicals are more often material. Licenses typically have a "boom or bust" character in the pre-commercialization stage because of the characteristics of discrete technologies, the expensive drug development process (Wouters et al., 2020; most licenses in chemicals were closed by pharmaceutical firms), and the binary drug approval process. Moreover, in chemicals, 70% of the licensors are pure researching entities. These have a narrower focus and, thus, lower materiality thresholds than vertically integrated firms that pursue researching as well as manufacturing activities.

The prevalence of bifurcated licensing varies tremendously between industries. While the prevalence is comparatively low in Manufacturing overall (9%), it is high in electronics (31%) and Transportation Equipment (20%). Descriptive statistics indicate that this observation is related to the characteristics underlying the licenses as opposed to industry-specific circumstances. In both industries, licenses cover more often product patents, complex technologies, and SEPs than in the Manufacturing industries in general. For instance, 96% and 94% of the licenses in electronics and Transportation Equipment, respectively, involve predominantly complex technologies compared to 37% in Manufacturing. The licensing of SEPs is concentrated on very few industries, i.e., electronics, Communications, and lately, with the increasing importance of cellular standards and the emergence of the Avanci patent pool, Transportation Equipment.

Other industries with a high prevalence of bifurcated licensing are Services (42%) and Transportation and Public Utilities (44%). In particular, I observe a high commonness of bifurcated licensing in Business Services (50%), Electric, Gas and Sanitary Services (71%), and Communications industries (31%). While the former comprises, among others, software providers, the latter contains infrastructure operators such as pipeline and telecommunication network operators. PAEs are very active in the Communications industry: PAEs act as licensors in 33% of all licenses. Again, product patents, complex technologies, and SEPs play an important role in the focal industries. Interestingly, 22% (19%) of licenses in Communications (electronics) are cross-licenses out of which (almost) all are of integrated nature. In other industries, cross-licensing is less prevalent. These results correspond to the findings of Anand & Khanna (2000) and Grindley & Teece (1997). Although Anand & Khanna (2000) did not differentiate into licenses in the

Communications industry, technological similarities might explain the prevalence of cross-licensing that is comparable to the electronics industry. In both Communications and electronics, a significant share of licenses contains product patents, complex technologies, and SEPs. As with Anand & Khanna (2000), all other industries exhibited lower commonalities of cross-licensing. The overall share of cross-licenses is roughly in line (10% in my study vs. 13% in Anand & Khanna, 2000).

PAEs are particularly active in complex technology industries. Conforming with a report by the Federal Trade Commission (2016), I found that PAEs target in particular industries with a high share of complex technologies. For instance, electronics, Communications, as well as Finance, insurance and real estate are frequent target industries of PAEs (Federal Trade Commission, 2016). Nonetheless, the share of licenses naming a PAE as licensor was comparatively low, especially compared to up to 40% of filed infringement suits being initiated by PAEs (Jeruss et al., 2012). One explanation could be that PAEs are often private and, thus, information is less accessible and more difficulty to be collected by data providers such as RoyaltySource. Another explanation could be a low number of patents per case (Federal Trade Commission, 2016) and, consequently, lower commercial value and lower likelihood of exceeding materiality thresholds.

When reviewing the cross-tabulation analysis for the correlational variables, I find further support. The ratios of bifurcated to integrated licenses after litigation, when a patent portfolio or ICT patents are licensed, when the license is non-exclusive, or when a patent pool acts as licensor, exceed by far the ratios of bifurcated to integrated licenses when these circumstances do not apply. This difference is particularly remarkable with ICT: 276 out of 673 licenses involving ICT are bifurcated, whereas 145 out of 2,744 licenses that do not involve ICT are bifurcated (*Table 13*).

Like Cotropia et al. (2014), computer- and communications-related industries such as electronics and Communications are litigious areas in my sample – I assigned 38% and 5% of litigations, respectively, to these industries. In total, 92 out of 346 licenses closed after litigation are bifurcated (27%). In contrast, only 330 out of 3,073 licenses closed without litigation are bifurcated (11%). This stark contrast and the higher prevalence of bifurcated licensing after litigation further emphasize the need for research on the litigation level in the value chain. I will discuss my findings in Chapter 5.

Given that complex technologies consist of many patentable elements (Cohen et al., 2000), it appears intuitive that it is common to license patent portfolios especially in industries that comprise predominantly complex technologies. For instance, 56% and 55% of Transportation Equipment and electronics license agreements, respectively, involve portfolios of patents. In contrast, 89% of Chemicals and Allied Products licenses involve single patents. This observation aligns with the hypothesized correlation between *Complex technology* and *Portfolio of patents*. This correlation is also observable in the correlation matrix (*Table 10*). Besides the correlation, *Table 13* indicates that portfolio licenses are more often bifurcated than licenses of singular patents (e.g., 26% of licenses for patent portfolios are bifurcated vs. 9% of licenses for single patents).

Due to the nature of *ICT* as a subset of *Complex technology*, both correlate (*Table 10*). Thus, a high share of license agreements comprise *ICT* whenever these also predominantly comprise complex technologies, e.g., in electronics or Business Services. In addition, there is a significantly higher share of bifurcated licenses relative to *ICT* licenses as relative to non-*ICT* licenses (41% vs. 5%). This overarching observation applies to all industries except for other services industries. The latter comprises bifurcated license agreements to operators in the Amusement and Recreation Services and Health Services industries, such as operators of amusement parks.

Non-exclusive arrangements are more common in industries licensing predominantly complex technologies such as electronics (65%), Transportation Equipment (55%), Business Services (62%), or Communications (83%) than in industries licensing predominantly discrete technologies such as Chemicals and Allied Products (15%) or other manufacturing industries (32%). My results are comparable with the findings of Anand & Khanna (2000). As hypothesized, resulting from the correlation between *Non-exclusive* and *Complex technology*, non-exclusive license agreements are more often bifurcated (25%) than agreements with other exclusivity arrangements (7%).

Only a small share of 2% of licensors can be classified as a patent pool. In our sample, pools are active in a very concentrated range of industries and pursue a very consistent approach toward the selection of licensing targets. They are active in the electronics and Transportation Equipment industries and almost exclusively pursue bifurcated licensing. As hypothesized, pools in the sample exclusively licensed complex technologies and almost exclusively SEPs.

				Correlation 1		*Correlation 2*		*Correlation 3*		*Correlation 4*		*Correlation 5*	
		# patent license agrmts.	**Pre-valence**	**Litiga-tion**	**No liti-gation**	**Port-folio of patents**	**Single patents**	**ICT**	**No ICT**	**Non-exclu-sive**	**Other**	**Licensor patent pool**	**Other**
Manufacturing	Bifurcated	284	9%	2%	7%	5%	5%	6%	3%	6%	3%	2%	7%
	Integrated	2,806		7%	84%	16%	75%	10%	81%	23%	68%	0%	91%
Electronic & Other Electrical Equip. & Components	Bifurcated	156	31%	10%	20%	21%	10%	29%	1%	27%	4%	8%	23%
	Integrated	353		15%	54%	34%	35%	53%	16%	39%	31%	1%	69%
Transportation Equipment	Bifurcated	25	20%	11%	9%	18%	2%	19%	1%	17%	2%	11%	9%
	Integrated	103		8%	73%	38%	42%	8%	73%	38%	43%	0%	80%
Measuring, Photo., Medical, & Optical Goods, & Clocks	Bifurcated	29	6%	1%	5%	1%	4%	2%	4%	2%	3%	0%	6%
	Integrated	490		10%	84%	8%	87%	4%	91%	27%	67%	0%	94%
Industrial & Com. Machinery & Computer Equip.	Bifurcated	6	4%	0%	4%	1%	3%	1%	3%	0%	4%	0%	4%
	Integrated	158		10%	86%	20%	76%	10%	86%	28%	68%	0%	96%
Chemicals and Allied Products	Bifurcated	37	2%	0%	2%	0%	2%	0%	2%	1%	2%	0%	2%
	Integrated	1,544		3%	95%	11%	87%	0%	98%	14%	84%	0%	98%
Other	Bifurcated	31	16%	2%	15%	2%	15%	4%	12%	4%	12%	0%	16%
	Integrated	158		10%	74%	17%	67%	0%	84%	28%	56%	0%	84%
Services	Bifurcated	78	42%	2%	40%	19%	23%	33%	9%	26%	16%	0%	42%
	Integrated	109		11%	48%	7%	51%	29%	29%	20%	38%	0%	58%
Business Services	Bifurcated	64	50%	3%	47%	27%	24%	47%	2%	36%	14%	0%	50%
	Integrated	63		15%	35%	6%	43%	37%	13%	26%	24%	0%	50%
Other	Bifurcated	14	23%	0%	23%	2%	22%	2%	22%	5%	18%	0%	23%
	Integrated	46		2%	75%	8%	68%	12%	65%	8%	68%	0%	77%
Transportation and public utilities	Bifurcated	31	44%	7%	37%	10%	34%	15%	28%	21%	23%	0%	44%
	Integrated	40		17%	39%	25%	31%	35%	21%	34%	23%	0%	56%
Communications	Bifurcated	11	31%	11%	19%	6%	25%	31%	0%	31%	0%	0%	31%
	Integrated	25		33%	36%	50%	19%	69%	0%	53%	17%	0%	69%
Electric, Gas and Sanitary Services	Bifurcated	20	71%	4%	68%	18%	54%	0%	71%	14%	57%	0%	71%
	Integrated	8		0%	29%	0%	29%	0%	29%	14%	14%	0%	29%
Other	Bifurcated	0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	Integrated	7		0%	100%	0%	100%	0%	100%	14%	86%	0%	100%
Finance, insurance and real estate	Bifurcated	10	77%	54%	23%	0%	77%	69%	8%	77%	0%	0%	77%
	Integrated	3		0%	23%	0%	23%	0%	23%	23%	0%	0%	23%
Other	Bifurcated	19	33%	0%	33%	2%	31%	3%	29%	3%	29%	0%	33%
	Integrated	39		9%	59%	9%	59%	3%	64%	19%	48%	0%	67%
Total	Bifurcated	422	12%	3%	10%	5%	7%	8%	4%	8%	5%	2%	11%
	Integrated	2,997		7%	80%	16%	72%	12%	76%	23%	65%	0%	88%

[1]Based on one-digit and two-digit SIC code

Table 13: Cross table for the dependent variable and correlational variables across industries

4.4.3 Descriptive results – Licensors and licensees

Despite having obtained correlational evidence for my hypotheses as well as my hypothesized correlations, several aspects require further analysis such as the selection of the licensing target by entity types other than PAEs and patent pools. *Table 14* shows in a matrix format which type of licensor targets which type of licensee. Not surprisingly, most agreements (29%) involve practicing entities as licensors and licensees. However, practicing entities as licensor represent just 37% of all agreements – Significantly less than the 52% of agreements closed by researching entities as licensor. The large number of researching entities is related to the pharmaceuticals and medical technologies industries. Excluding both industries from the analysis, leads to practicing entities being licensor in 46% and being licensee in 82% of all remaining agreements (*Table 15*). The fact that researching entities are more prone to select other researching entities as targets is probably connected to the commercialization stage of the licensed technology. Probably the licensee needs to conduct further research until the technology can be commercialized or even brought to market. Building upon my theoretical argument on transaction costs and anchoring, the almost exclusive selection of practicing entities as licensing targets by PAEs and patent pools coincides my expectations. Licensors can set a higher anchor with practicing entities due to the higher and less uncertain commercial value of their products. In contrast, patent pools are an instrument to reduce transaction costs and, as such, are more effective by focusing on one type of licensee ceteris paribus.

		Licensee				
		Practicing entity	Researching entity	Inventor	Aggregator	**Total**
Licensor	Practicing entity	29%	8%	-	-	**37%**
	Researching entity	27%	26%	0%	-	**52%**
	Inventor	3%	2%	-	-	**4%**
	Patent assertion entity	3%	0%	-	-	**3%**
	Patent pool	2%	-	-	0%	**2%**
	Unknown	1%	1%	-	-	**2%**
	Total	**64%**	**36%**	**0%**	**0%**	**100%**

Table 14: Share of license agreements by licensor and licensee type, N = 3,419

		Licensee				
		Practicing entity	Researching entity	Inventor	Aggregator	**Total**
Licensor	Practicing entity	41%	5%	-	-	**46%**
	Researching entity	25%	11%	0%	-	**36%**
	Inventor	4%	2%	-	-	**6%**
	Patent assertion entity	5%	0%	-	-	**5%**
	Patent pool	3%	-	-	0%	**4%**
	Unknown	3%	1%	-	-	**4%**
	Total	**82%**	**18%**	**0%**	**0%**	**100%**

Table 15: Share of license agreements by licensor and licensee type excluding pharmaceuticals and medical technologies, N = 1,633

Given the correlations between PAEs and patent pools as licensors and bifurcated licensing, as I noted above, it does not come as a surprise that 44% and 93% of all licenses are bifurcated. In contrast, practicing entities, researching entities, and inventors pursue bifurcated licensing less often. Researching entities select a bifurcated approach in just 5% of all licenses (*Table 16*). The figures in *Table 16* are relative to all license agreements in the sample, i.e., including licenses assigned to pharmaceuticals and medical technologies.

		Licensee				
		Practicing entity	Researching entity	Inventor	Aggregator	**Total**
Licensor	Practicing entity	19%	8%	-	-	**16%**
	Researching entity	8%	1%	-	-	**5%**
	Inventor	18%	2%	-	-	**12%**
	Patent assertion entity	49%	-	-	-	**44%**
	Patent pool	93%	-	-	100%	**93%**
	Unknown	38%	10%	-	-	**29%**
	Total	**17%**	**3%**	**0%**	**100%**	**12%**

Table 16: Share of bifurcated license agreements by licensor and licensee type, N = 422

4.4.4 **Descriptive results – Time-based trends**

The recent dispute on patent infringement of SEPs on LTE in the automotive industry illustrates how quickly licensing practices might change in an industry. Mercedes-Benz emphasized that automotive OEMs typically purchase supplies free of third-party rights. Thus, suppliers have full responsibility for licensing (*Nokia v. Daimler,* 2020). Nonetheless, Conversant, Nokia, and Sharp sued Mercedes-Benz for infringement of SEPs on LTE (Klos, 2021; Lloyd, 2020; Richter, 2020a; Richter, 2020b). Device-level licensing of SEPs became an established practice in the automotive industry as the success of the licensing programs of the patent pool Avanci showed (Avanci, 2024). Due to these rapid shifts and the large time span in my sample, I investigated time-based trends (*Table 17*). While not yet researched in a quantitative study, bifurcated licensing is not a novel approach towards patent licensing. With the first bifurcated license agreements emerging in the 1980s – Note that the first displayed period starting in 1970 is comparatively large due to the limited observations – the share of bifurcated license agreements remained relatively stable at around 10% until the early 2000s. From then on, I saw an increase in bifurcated licensing to 15% and more. Due to the limited number of license agreements from the 2020s, I am cautious in interpreting the share of 30% bifurcated licenses observed in the 2020s. Nonetheless, these findings reiterate the relevance of the research topics and raise the need to control for time-related trends in later analyses (4.4.5 and 4.4.6).

	1970-'89	**1990-'94**	**1995-'99**	**2000-'04**	**2005-'09**	**2010-'14**	**2015-'19**	**2020-today**	**Total**
Integrated license agrmts. (abs.)	103	212	607	743	625	366	246	95	2,997
Bifurcated license agrmts. (abs.)	12	24	76	73	99	56	42	40	422
Total (abs.)	**115**	**236**	**683**	**816**	**724**	**422**	**288**	**135**	**3,419**
Bifurcated license agrmts. (% of total)	**10%**	**10%**	**11%**	**9%**	**14%**	**13%**	**15%**	**30%**	**12%**

Table 17: Licensing mode over time

4.4.5 **Regression analysis**

Before running the regression analyses, I assessed the goodness of fit. Although the Hosmer-Lemeshow test is “a commonly used procedure for assessing goodness of fit in logistic regression” (p. 67) it comes with shortcomings with large sample sizes. Already, small deviations from the expected results lead to a significant test (Paul et al., 2013). To address this issue, I created two random samples of 500 unweighted observations to conduct the Hosmer-Lemeshow test with five and ten groups (Paul et al., 2013). Each p-value exceeded 0.10, thereby, indicating a good model fit. Moreover, I compared the expected and observed values for *Bifurcated* in each of the ten groups using the full sample. Overall, the differences between the expected and observed values appeared negligible, supporting further the good model fit. In addition, I evaluated the discrimination ability of the model by determining the area under the receiver-operating characteristic curve (ROC; AUC) (Pearce & Ferrier, 2000). The AUC of 0.89 indicates a good discrimination ability (Swets, 1988).

I estimated two models displayed in *Table 18*: a base model containing the variables described in 4.3.2 and an extended model containing the variables described in 4.3.2 and the interaction terms described in 4.3.3. Both models exhibited chi square tests significant at the 1% level, thus, indicating the statistical significance of the overall models. In both models, *Product*, *Complex technology*, *SEP*, *Cross-license*, *Litigation*, *ICT*, *Licensor researching entity*, and *Licensee researching entity* were significant at the 1% level, *Licensor patent pool* was significant at the 5% level. *SEP*, *ICT*, and *Licensor patent pool* exhibited an odds ratio of about or more than four. This implies that a license for *SEP*, *ICT*, or with a patent pool as licensor is about or more than four times more likely to be bifurcated than the licenses not involving *SEP*, *ICT*, or *Licensor patent pool* ceteris paribus. In comparison, the odds ratios of *Cross-license*, *Litigation*, *Licensor researching entity*, and *Licensee research entity* were smaller than 1.0. This means that licenses displaying these characteristics are less likely to be bifurcated or, conversely, more likely to be integrated. For instance, a *Cross-license* is 0.18 times as likely to be bifurcated than non-cross-licenses ceteris paribus. I did not find supporting evidence for the hypothesized variable *Licensor PAE*. Moreover, the regression results showed mild support for *Non-exclusive* and *Age* (10% significance level). More recent agreements were associated with bifurcated licensing. This finding coincided with the observations from *Table 17* where I noted a trend towards bifurcated licensing in more recently closed licenses.

		Baseline model			Extended model		
		Number of obs =		3,419	Number of obs =		3,419
		LR chi2(19) =		551.66	LR chi2(22) =		6,043.47
		Prob > chi2 =		0.00	Prob > chi2 =		0.00
		Pseudo R2 =		0.36	Pseudo R2 =		0.36
		Log likelihood =		-1,091.89	Log likelihood =		-1,082.59
Type	**DV: Bifurcated**	**Odds Ratio**	**Sig.**	**P > |z|**	**Odds Ratio**	**Sig.**	**P > |z|**
1	Product	2.94	***	0.00	2.45	***	0.00
2	Complex technology	2.04	***	0.00	2.09	***	0.00
3	SEP	3.99	***	0.00	3.74	***	0.00
4	Licensor PAE	0.87		0.65	0.90		0.73
5	Cross-license	0.18	***	0.00	0.18	***	0.00
Corre-lations	Litigation	0.51	***	0.00	0.00	***	0.00
	Portfolio	0.81		0.27	0.54		0.28
	ICT	4.09	***	0.00	4.11	***	0.00
	Non-exclusive	1.52	*	0.10	1.51		0.10
	Licensor patent pool	4.29	**	0.02	4.23	**	0.02
Controls	Licensor inventor	0.87		0.66	0.86		0.64
	Licensor res. entity	0.38	***	0.00	0.39	***	0.00
	Licensee res. entity	0.35	***	0.00	0.36	***	0.00
	Exclusive	1.10		0.72	1.09		0.72
	Sublicense	1.18		0.65	1.20		0.61
	Age	0.98	*	0.07	0.98	*	0.07
	Licensee agreements	0.97		0.19	0.96		0.19
	Licensor agreements	1.01		0.71	1.01		0.64
	Licensor total agreements	0.99		0.46	0.98		0.37
Inter-actions	Complex tech. & Litigation				0.41		0.15
	Complex tech. & Portfolio				1.60		0.43
	Product & Litigation				4.95E+06	***	0.00
	Constant	0.06	***	0.00	0.07	***	0.00

*** Significant at 1% level; ** Significant at 5% level; *** Significant at 1% level

Table 18: Regression results (logit model)

Marginal effects are well suited to support the interpretation of the results of a logistic regression. I calculated the marginal effects at the means (MEMs; *Table 19*) for all hypothesized causal and correlational variables to put effect sizes into perspective. For a binary explanatory variable, one can interpret the MEMs as the difference in the predicted likelihood of a license agreement being bifurcated for values of the focal variable of 1 versus 0. The difference is measured in percentage points while applying for all other variables their respective mean value. As *Table 19* shows, the likelihood of an average license agreement comprising product patents to be bifurcated was 3 percentage points higher than the likelihood of one comprising process patents. Analogously to *Table 18*, the coefficients for *Complex technology*, and *SEP* were positive and significant at the 1%-level, while the coefficient for *Cross-license* was negative and significant at the 1%-level. The latter implied a 3 percentage points lower likelihood of cross-licenses being bifurcated. Relative to an overall share of bifurcated license agreements of just 12%, the difference in the case of *SEP* with 7 percentage points was particularly sizeable.

Type	**DV: Bifurcated**	**dy/dx**	**Sig.**	**P > | z |**	**[95% Conf. Intervall]**	
1	Product	0.03	***	0.00	0.02	0.04
2	Complex technology	0.02	***	0.01	0.01	0.04
3	SEP	0.07	***	0.00	0.03	0.12
4	Licensor PAE	0.00		0.62	-0.02	0.01
5	Cross-license	-0.03	***	0.00	-0.04	-0.02
Corre-lations	Litigation	-0.01	***	0.00	-0.02	-0.01
	Portfolio	-0.01		0.25	-0.02	0.00
	ICT	0.07	***	0.00	0.04	0.10
	Non-exclusive	0.01		0.14	0.00	0.03
	Licensor patent pool	0.08		0.18	-0.04	0.21

Table 19: Marginal effects at the means (MEMs)

Overall, 27% of litigations resulted in bifurcated licenses. The highly significant yet contradictory results for *Litigation* and *Product & Litigation* were striking. While the former is not associated with bifurcated licensing, the latter is. An in-depth perspective on the patent types and technologies in suits illustrated the reasons for the striking finding. Independent of the technology, i.e., complex vs. discrete technology, licensors targeted its litigation activities involving process patents always against the original infringer – All resulting licenses followed the integrated model, thereby, explaining the coefficient of 0.0 for *Litigation*. In contrast, 33% of litigations involving product patents resulted in bifurcated licenses. The share was even more pronounced for complex technologies. Consequently, the coefficient for *Product & Litigation* exceeded 1.0 by far.

Patent type	**Technology**	**Absolute**		**Relative**	
		Bifurcated	Integrated	Bifurcated	Integrated
Product	Discrete technology	4	51	1%	15%
Product	Complex technology	88	137	25%	40%
Process	Discrete technology	0	23	0%	7%
Process	Complex technology	0	43	0%	12%

Table 20: Patent type and technology in litigation

A further consideration is related to the timing of licensing of SEPs. SEPs were frequently licensed both with and without litigation. However, the share of bifurcated licensing of SEPs without litigation exceeded the share of bifurcated licensing with litigation significantly. These observations contributed to the observed regression coefficients.

Timing	Essentiality	Absolute		Relative	
		Bifurcated	Integrated	Bifurcated	Integrated
W/o litigation	SEP	79	23	37%	11%
W/ litigation	SEP	66	46	31%	21%

Table 21: SEP licensing with and without litigation

4.4.6 **Robustness tests**

I conducted robustness tests to validate the results from the regression analysis (*Table 22*). Considering the heterogeneity in licensing practices across industries (*Table 12*), one could reasonably argue that the cross-industry heterogeneity caused residuals and regressors to correlate within each industry (2-digit SIC code), i.e., an industry represents a cluster. Correspondingly, one could argue that the same occurred on a licensor and licensee level. As a result of this argumentation, the obtained regression results would be biased and lack robustness. Thus, I applied (inflated) cluster-robust standard errors to increase the robustness of my result from 4.4.5 (Abadie et al., 2023). I conducted three robustness tests with cluster-robust standard errors on industry, licensor, and licensee levels.

As other scholars pointed out, it is common practice to license SEPs on an end-product level, especially patents on cellular communication standards (Bekkers et al., 2014; Geradin, 2020; SEPs Expert Group, 2021). As shown by *Table 12*, licensing of SEPs is very common in the Electronic & Other Electrical Equipment & Components (SIC code 36) industry. Since SEPs represent a highly litigated type of patent more subject to public awareness (e.g., Love & Helmers, 2023), it could be more likely for SEP license agreements to be included in the dataset. Because of the possibility that industry- and SEP-specific practices might apply and to counter any underrepresentation in the dataset, I investigated the robustness of my results by excluding license agreements involving SEPs and being assigned to the electronics industry. To account for the heterogeneity of sources for license agreements as well as distinct incentive structures of patent pools and PAEs in comparison with practicing entities (Reitzig et al., 2007; Layne-Farrar & Lerner, 2011), I tested for robustness by excluding agreements not sourced from RoyaltySource as well as excluding agreements with patent pools and PAEs as licensors.

I presumed that active licensors could pursue a different patent licensing strategy than less active licensors. This consideration is related to predictors of the propensity to license. For example, researching entities are more prone to licensing than practicing entities (Arora & Fosfuri, 2006). Consequently, I tested for robustness by excluding license agreements from licensors or licensees with 10 or more agreements in the respective role.

		Hypotheses					Correlations				
Odds ratios (except for probit model)		1	2	3	4	5	6	7	8	9	10
Robustness check	Model	Product	Complex tech.	SEP	Licensor PAE	Cross-license	Litigation	Portfolio	ICT	Non-exclusive	Licensor pat. pool
No robustness check	Baseline	2.94***	2.04***	3.99***	0.87	0.18***	0.51***	0.81	4.09***	1.52*	4.29**
	Interaction terms	2.45***	2.09***	3.74***	0.90	0.18***	0.00***	0.54	4.11***	1.51	4.23**
Cluster-robust standard errors by industry	Baseline	2.94***	2.04*	3.99***	0.87	0.18***	0.51	0.81	4.09***	1.52***	4.29***
	Interaction terms	2.45***	2.09**	3.74***	0.90	0.18***	0.00***	0.54*	4.11***	1.51***	4.23***
Cluster-robust standard errors by licensor	Baseline	2.94***	2.04***	3.99***	0.87	0.18***	0.51***	0.81	4.09***	1.52	4.29**
	Interaction terms	2.45***	2.09***	3.74***	0.90	0.18***	0.00***	0.54	4.11***	1.51	4.23**
Cluster-robust standard errors by licensee	Baseline	2.94***	2.04***	3.99***	0.87	0.18***	0.51***	0.81	4.09***	1.52	4.29*
	Interaction terms	2.45***	2.09***	3.74***	0.90	0.18***	0.00***	0.54	4.11***	1.51	4.23*
Excluding agreements involving SEPs	Baseline	2.95***	2.11***	(omitted)	1.01	0.21***	0.39***	0.72	4.16***	1.53	(omitted)
	Interaction terms	2.53***	2.21***	(omitted)	1.06	0.21***	0.00***	0.55	4.20***	1.52	(omitted)
Exclusion of electronic equipment industry	Baseline	3.04***	2.14***	9.04***	1.13	0.36*	0.30***	0.88	6.99***	1.46	(omitted)
	Interaction terms	2.58***	2.19***	8.58***	1.23	0.38	0.00***	0.56	7.10***	1.47	(omitted)
Agreements directly from RoyaltySource only	Baseline	2.48***	2.45***	5.72***	0.78	0.39*	0.50**	0.75	3.18***	1.15	(omitted)
	Interaction terms	2.07***	2.66***	5.56***	0.82	0.39*	0.00***	0.73	3.23***	1.15	(omitted)
Excl. of pools and PAEs as licensors	Baseline	2.87***	2.09***	4.76***	(omitted)	0.19***	0.41***	0.78	3.98***	1.51	(omitted)
	Interaction terms	2.49***	2.18***	4.71***	(omitted)	0.19***	0.00***	0.55	3.97***	1.50	(omitted)
Excl. of licensors/ licensees >10 agrmts.	Baseline	3.13***	2.34***	7.85***	0.97	0.25***	0.57**	0.58**	3.11***	1.66*	2.70
	Interaction terms	2.57***	2.52***	7.50***	0.94	0.25***	0.00***	0.78	3.21***	1.68*	2.78
Probit model	Baseline	0.49***	0.36***	0.82***	-0.01	-0.77***	-0.42***	-0.15	0.76***	0.19	0.94***
	Interaction terms	0.41***	0.37***	0.78***	0.02	-0.77***	-4.35***	-0.31	0.77***	0.20	0.93***
Removal of hypothesized causal variables	Baseline	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	0.62***	0.87	7.47***	1.57*	12.1***
	Interaction terms	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)	(omitted)
Removal agrmts. median licensors/-ees w/o N/As	Baseline	2.85***	2.61***	2.41**	0.79	0.23**	0.38***	1.04	4.14***	2.06**	6.62***
	Interaction terms	2.41***	2.61***	2.19**	0.82	0.22**	0.00***	0.80	4.16***	2.08**	6.41***
Removal agrmts. median licensors/-ees w/ N/As	Baseline	2.85***	2.87***	2.78***	0.75	0.25*	0.40***	1.00	3.75***	2.20***	6.68***
	Interaction terms	2.41***	3.09***	2.62**	0.83	0.23**	0.00***	0.81	3.79***	2.25***	6.9***
Removal agrmts. median licensors w/o N/As	Baseline	2.54***	2.82***	2.08*	0.71	0.30	0.38***	1.04	4.30***	2.43**	4.46**
	Interaction terms	2.05**	2.73***	1.82	0.74	0.29	0.00***	0.61	4.33***	2.47**	4.20**
Removal agrmts. median licensors w/ N/As	Baseline	3.11***	2.57***	2.23*	0.71	0.38	0.31***	0.97	3.99***	2.63***	4.43**
	Interaction terms	2.63***	2.48***	2.02	0.74	0.35	0.00***	0.56	3.98***	2.67***	4.12**
Removal agrmts. median licensees w/o N/As	Baseline	3.24***	3.57***	7.85**	0.66	0.20*	0.20***	0.81	2.72***	2.16*	(omitted)
	Interaction terms	2.99***	3.72***	7.91**	0.63	0.20*	0.00***	0.92	2.76***	2.18**	(omitted)
Removal agrmts. median licensees w/ N/As	Baseline	3.72***	3.49***	3.95*	0.52	0.16*	0.27**	0.91	3.54***	2.76***	(omitted)
	Interaction terms	3.29***	4.01***	4.46*	0.60	0.16*	0.00***	0.76	3.53***	2.93***	(omitted)

*** Significant at 1% level
** Significant at 5% level
* Significant at 10% level

Robust
Not significant in all models or omitted
Not significant in base model but in check
Not robust - Significant in base model but not in check

Table 22: Results from robustness tests

Moreover, I conducted probit regressions for both models. For the interpretation, one must consider that I displayed the odds ratios for logit regressions and the regression coefficients for probit regressions. To conclude, the aforementioned robustness tests support my findings in 4.4.5. *Product*, *Complex technology*, and *SEP* showed a positive relation with bifurcated licensing and remained significant in every robustness test. While the latter mostly applied for *Cross-license* as well, the former was not the case: *Cross-license* consistently showed a negative association with bifurcated licensing. Also, I found strong support for *Litigation* – contrary to my expectation – *ICT*, and *Licensor patent pool*.

Besides, to evaluate whether my arguments on expected correlations with my hypothesized variables *Product*, *Complex technology*, *SEP*, *Licensor PAE*, and Cross-license hold, I excluded the five variables from one regression. On the one hand, *Litigation*, *ICT*, and *Licensor patent pool* remained significant. On the other hand, *Portfolio* remained insignificant, and *Non-exclusive* was only significant at the 10% level. Contrary to my argument in 4.4.5, licenses closed in the course of *Litigation* were not associated with bifurcated but with integrated licensing. In *Table 20*, I shed more light on this contrast.

In light of RoyaltySource's data collection approach, one could expect larger license agreements to be more likely to be material and, thus, more likely to be included in the sample ceteris paribus. As a result, smaller license agreements tended to be underrepresented in the sample. Due to a lack of quantification of the size of a license agreement, I derived the inflation-adjusted median revenue in USD based on public information (e.g., Orbis or internet research) for all licensors and licensees, respectively. Because of the large share of U.S.-based firms, I adjusted revenues by the average 1990-2023 inflation rate in the U.S. of 2.7%, and I considered a below-median revenue as a proxy for smaller license agreements. To avoid biases from overrepresenting large license agreements in the sample, I tested for robustness by conducting regression analyses with firms with below-median revenues. Since both licensors and licensees could report license agreements to the SEC, I conducted regression analyses with either the licensor or the licensee, with only the licensor, and with only the licensee having below-median revenues. In some cases, I could not obtain revenue data. Thus, I either excluded those cases from the robustness tests or treated them as having a below-median revenue of 0. The logic for the latter treatment was that one is more likely to obtain data for larger firms than smaller ones.

The tests incorporating licensors and/or licensees with below-median revenues confirmed the robustness of my results: *Product*, *Complex technology*, *SEP*, and *Cross-license* were significant at least at the 10%-level. The same applies to the tests incorporating licensees with below-median revenues. When incorporating licensors with below-median revenues, the coefficients for *Cross-license* in both models and *SEP* in the models with interaction terms were not significant. Given that each regression comprised only 16 and 17 distinct SEP licensors (instead of 55 in the full dataset), respectively, one should not overinterprete the results for SEPs. They reflected the licensing level selection of only a few SEP licensors. Analogously, *Cross-license* was less likely to occur with licensors having below-median revenues than with licensors of any size. While the former sample contained 96 and 99 cross-licenses with 86 and 89 distinct licensors, respectively, the latter contained 358 cross-licenses with 247 distinct licensors.

4.5 Discussion and conclusion

This chapter aimed to shed light on the selection of the licensing target and licensing level in the value chain. I discuss my findings and present my theoretical contributions.

4.5.1 Discussion

Even though the overall share of bifurcated licenses of 12% appears to be comparatively low, the prevalence varies strongly across industries reaching up to 50% in Business Services or 31% in Electronic & Other Electrical Equipment & Components. This observation highlights the importance of strategically selecting the licensing target in the value chain and invigorates the need to introduce an additional dimension of value capture from innovation. In the context of value capture, Teece (1986) raised the question of whether to commercialize an innovation in-house or out-license it, and Gambardella et al. (2021) raised the question of to which applications to out-license an innovation. They used the term horizontal scope to describe the range of licensing applications. In addition, I derive the questions of which level in the value chain and, closely related, with which licensing mode (i.e., bifurcated vs. integrated) to out-license. Besides, an effective operationalization of an enforcement strategy matters as well (Kafouros et al., 2021). *Figure 9* illustrates the option space for patent holders.

The observed heterogeneity in the prevalence of bifurcated licensing is a direct consequence of the relevance of the licensing mode for commercializing enabling technologies. Owners of enabling technologies often cannot own all complementary assets required to commercialize the innovation on the product market in-house (Teece, 2018; Gambardelle et al., 2021). Therefore, they depend more on licensing income than owners of other types of technologies to become financially successful. Anchoring theory addresses financial considerations in licensing decisions, supports the enforcement of higher royalties (e.g., Hastie et al., 1999; Marti & Wissler, 2000; Englich & Mussweiler, 2001), and explains much of my results. In line with this argument, I find that researching entities are not a target of bifurcated licensing.

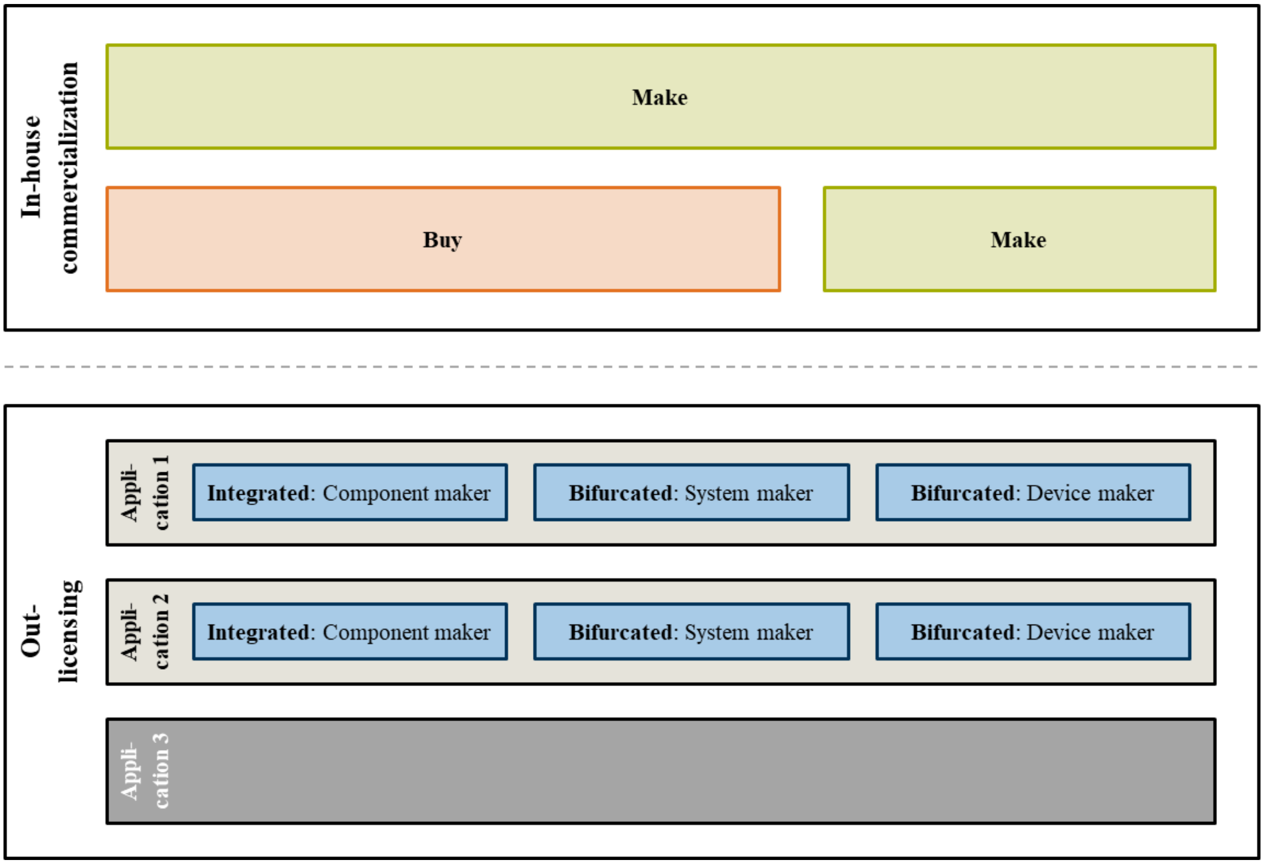


Figure 9: Illustrative option space for commercialization of innovations

Contrary to my hypothesis, PAEs are not positively associated with bifurcated licensing. A reason for the insignificant coefficient could be selection bias. Litigation PAEs – typically litigating and later settling their claims – with small patent portfolios of 10 or fewer patents complete ten times as many licenses than Portfolio PAEs with large patent portfolios comprising hundreds or thousands of patents (91% vs. 9%). In contrast, Portfolio PAEs generate four times as much revenue (80% vs. 20%). As a result, many licenses with PAEs as licensors have a negligible scope (Federal Trade Commission, 2016), likely not surpassing materiality thresholds for an SEC filing. Such comparatively small PAEs could hold different types of patents than larger PAEs and, consequently, pursue a different strategy on licensing level selection. For instance, Litigation PAEs selected more frequently retail firms – an industry often associated with bifurcated licenses – than Portfolio PAEs (Federal Trade Commission, 2016). In the sample, 85% (11 of 13) of licenses in Retail and Wholesale Trade industries were bifurcated. Intriguingly, I observed a stark contrast between licensing patterns of PAEs with and without litigation: Overall, 44% of PAE licenses were bifurcated. This contrasts with 62% of licenses with litigation and just 21% of licenses without litigation.

As shown by significant (1% level) positive correlations, it is very common to commercialize patent portfolios (correlation coefficient of 0.26) consisting of complex technologies (0.16) and, in particular, ICT (0.27) SEPs (0.49) through patent pools. A transaction cost perspective motivates this decision, as pools are a tool to reduce transaction costs compared to bilateral license agreements (Merges & Mattioli, 2017). Although this association aligns with my proposed mechanism, the mechanism argued that patent pools correlate but are not causally linked with bifurcated licensing (*Figure 8*).

Contrary to my expectations, I find a negative association (i.e., an odds ratio smaller than 1.0) between *Litigation* and bifurcated licensing. Most litigations centered around *Product* and *Complex technology* (*Table 20*). Despite the negative association, 27% of the litigation activities resulted in bifurcated licenses. This contrast indicates that tricky trade-offs in selecting the litigation target and level in the value chain need to be resolved. Due to increased leverage, litigation against customers of patent-infringing competitors is likely financially more attractive than pursuing litigation against the direct competitor but attacking customers could reflect poorly on the reliability of the patent holder as a supplier. Also, firm-related predictors affect the litigation strategy. For instance, companies with portfolios of tradeable patents tend to prefer more cooperative dispute resolutions than litigation (Lanjouw & Schankerman, 2003). Given that the sample captures only litigation activities that result in licenses and if they resulted in a license, it was frequently a bifurcated one, I deem further research on patent litigation and the strategic selection of the litigation level in the value chain as very enlightening.

When I compared the results from Chapter 3 and 4, I detected similarities of descriptive nature. Bifurcated licenses often involved SEPs and litigation. Chapter 4 showed that 34% (145/422) of bifurcated licenses comprised SEPs and 22% (92) succeeded litigation. Similarly, In Chapter 3, “ICT SEPs” emerged as most relevant mechanism with litigation-related mechanisms “Easier enforcement” and “Higher return” followed on position 3 and 4. In addition, in 13% (55)

and 10% (43) of bifurcated licenses, respectively, patent pools and PAEs were licensors. Analogously, interviewees frequently named both patent pools and PAEs in "ICT SEPs" and "Higher return" as licensors. Due to a lack of detectability in the quantitative data, I could not further quantify the occurrence of the second most frequent mechanism identified in the qualitative study, "second source", in the quantitative study. As a result, this analysis serves as a first indication of the relative frequencies despite the limited representativeness of the qualitative and quantitative samples.

4.5.2 Contribution to theory

In this chapter, I conducted the first quantitative empirical study investigating bifurcated licensing and elucidating the strategic selection of the licensing target and level in the value chain. The study quantifies the prevalence of bifurcated licensing across industries, the characteristics of the licensed technologies and patents, and the involved licensors and licensees. By identifying predictors of and proposing causal links to bifurcated licensing, I contribute theoretically to scholarly work on the profiting from innovation framework and value capture. I utilize anchoring (Tversky & Kahneman, 1974) and transaction cost theory (Coase, 1960; Williamson, 1975) to derive predictors. The varying yet in some industries high prevalence of bifurcated licensing underpins the need to incorporate the licensing level in the value chain when aiming at profiting from innovation through capturing value on the MFT. Besides the go-to-market approach (in-house commercialization or licensing; Teece, 1986) and the horizontal scope (applications in which one licenses a technology; Gambardella et al., 2021), I identify the licensing level in the value chain as an additional strategic dimension of value capture. Moreover, I show that licensors can enforce bifurcated licensing in ex-post situations. Licensors can create such ex-post situations when they license technologies with certain characteristics.

5 Quantitative study on defendant selection in patent infringement suits

5.1 Introduction and motivation

Even though Cypress, Huawei, Mercedes-Benz, Deutsche Telekom, and a U.S. coffee shop are positioned on different value chain levels, they were defendants or interveners of the defendant in infringement suits related to patents implemented in chips (Charles, 1990; Pentheroudakis & Baron, 2017; Richter, 2020). Consequently, the chip maker Cypress was the only defendant who allegedly directly infringed on a patent by having translated the patented invention into a technical artifact. All others procured a good that read on the respective patent and, thereby, indirectly infringed on it. To reflect this distinction, I differentiated between direct and indirect suits. From an economic and managerial perspective, this distinction has several important implications.

The law provides patent holders with flexibility regarding the selection of the litigation level. When infringement occurs, patent holders can sue at any value chain level, even if the infringement occurs by purchasing a good. But which level in the value chain do patent holders strategically select to litigate patent infringement? What are the predictors for the strategic selection of the litigation level?

Previous literature analyzed patent- (e.g., Lanjouw & Schankerman, 1997; Lanjouw & Schankerman, 2001; Cremers, 2004; Allison et al., 2009; Chien, 2011; Love, 2012; Marco et al., 2015), plaintiff-, defendant- (e.g., Bessen & Meurer, 2005; Chien, 2008; Marco et al., 2015), and PAE-related (e.g., Cohen et al., 2016; Cohen et al., 2019; Huang et al., 2024) predictors and implications of infringement suits (e.g., Lerner, 1995; Kesan & Ball, 2006; Bessen et al., 2011; Bessen & Meurer, 2013a, 2013b; Kiebzak et al., 2016; Mezzanotti, 2021; Onoz & Giachetti, 2023). Also, scholars examined the consequences of fee-shifting rules (e.g., Rowe Jr., 1982; Polinsky & Rubinfeld, 1998; Aoki & Hu, 1999; Helmers et al., 2013; Bernstein, 2014; Helmers et al., 2021) as well as the role of jurisdictions (e.g., Cremers et al., 2017) and litigation strategies (e.g., Rudy & Black, 2018) in litigation outcomes. Yet, scholars have not investigated the selection of the litigation level.

It might be natural to sue the original implementer in the case of infringement. Yet, suing further downstream should relatively strengthen the patent holder’s position ceteris paribus since it is less likely that the defendant understands the technology implemented further upstream (Geradin, 2020) and holds patents that allow for a countersuit (Bekkers et al., 2014).

Several contingency factors should affect the relative appeal of indirect versus direct suits for patent holders. First, anchoring theory (Tversky & Kahneman, 1974) hints that royalties appear more reasonable relative to a higher downstream product value (Teece & Sherry, 2016; Gautier & Petit, 2019). The more important royalties are relative to an injunction for the plaintiff, the stronger the link. Second, if a value chain extends over several differing IP regimes, the patent holder should prefer ceteris paribus to sue where IP protection is strong (provided a patent family member in this country). Since value chains often begin in weaker IP regimes (Miller & Temurshoev, 2017; U.S. Chamber of Commerce, 2023), overall, indirect suits should be preferred. Third, ceteris paribus, litigation should be more efficient from the patent holder's perspective with a higher market concentration of the litigation level. The last two arguments relate to transaction cost theory (Coase, 1960; Williamson, 1975). Fourth and lastly, the relative ease of detecting infringement should impact the litigation level selection.

I contributed to the managerial and economic research on infringement suits (e.g., Lerner, 1995; Lanjouw & Schankerman, 2001; Bessen & Meurer, 2013b) by establishing the concept of direct and indirect infringement suits. By employing this concept, I closed the research gap on the strategic litigation level selection. Thereby, I theoretically broadened the scholarly work on the profiting from innovation framework (Teece, 1986). By quantifying the prevalence of indirect suits across industries, I showed that the selection of the litigation level is a principal consideration for capturing value and profiting from innovation on MFTs (Arora & Gambardella, 1994; Arora et al., 2001a). By drawing on anchoring (Tversky & Kahneman, 1974) and transaction cost theory (Coase, 1960; Williamson, 1975), I identified predictors of indirect suits. As hypothesized, my regression analysis indicated that complex technologies, SEPs, product patents, and PAE are positively associated with indirect suits. I tested for robustness.

I organize the remainder of this chapter as follows: First, I derive hypotheses on predictors of indirect suits. Next, I explain the sampling process, describe the hypothesized and control variables on case- and patent-level, and discuss how I dealt with ambiguities and how I selected the applied regression models. Third, I illustrate the results from descriptive and regression analyses and test for robustness. Lastly, I summarize my findings and highlight my theoretical contribution.

5.2 Hypotheses development

In case of patent infringement or sufficient proof thereof, patent holders can freely select the litigation level in the value chain within the constraints of patent exhaustion (Kuehnen, 2019; SEPs Expert Group, 2021). I.e., patent holders may target the original infringer or a player further downstream in the value chain. Patent holders enjoy this freedom in their litigation choices independent of the type of patents, e.g., SEPs (Kuehnen, 2019; SEPs Expert Group, 2021), and the type of defendants, e.g., users (Pentheroudakis & Baron, 2017). I focused on the strategic selection of the litigation target and level, i.e., I assessed cases where patent infringement was claimed to have taken place or has already taken place. Thus, it was not necessary to understand the predictors leading to patent infringement suits in general but the preferences of patent holders regarding the litigation level.

For multiple reasons, I argue that patent holders should prefer indirect vs. direct suits. First, transaction cost theory (Coase, 1960; Williamson, 1975) predicts that plaintiffs sue wherever they incur less costs. Weak IP protection leads to patents being hardly enforceable and, thus, higher enforcement costs. Unfortunately, value chains often begin in Asia, a region consisting often of countries with weak IP protection (Miller & Temurshoev, 2017; U.S. Chamber of Commerce, 2023). Due to the nature of patents as territorial rights (WIPO, n.d.; 64 EPC, 2020, § 1), patents could only be enforced in the respective countries through direct suits at high transaction costs – if at all. This issue could be circumvented if the patent holder has patent rights in countries with stronger IP protection in which downstream activities on the value chain occur. The patent holder could file an indirect suit against a downstream firm in one of these countries with stronger IP protection.

Second, plaintiffs presumably benefit from a strong technical position, higher chances of success, and fewer legal risks associated with downstream litigation and, thereby, avoid rushed settlements at disadvantageous terms. Downstream defendants typically have little knowledge of the technology that is implemented by the original infringer further upstream (Geradin, 2020), assuring knowledge advantages and leverage for the plaintiff. While such knowledge can arguably be established over time through cumulating experiences or external acquisitions, such actions are very costly. Moreover, given that the defendant's patent portfolio likely is focused on technologies directly implemented by the defendant, it is less likely that the plaintiff infringes on one of the defendant's patents and is countersued (Bekkers et al., 2014).

Third, anchoring theory (Tversky & Kahneman, 1974) predicts that plaintiffs preferably sue downstream due to higher expected returns. This connection matters in particular for firms that focus on out-licensing as the commercialization approach within the profiting from innovation framework (Teece, 1986). The value added cumulatively by each contributing firm and, thus, the focal product value increases with each level further downstream in the value chain. Based on anchoring theory, the higher product value sets an anchor, which makes royalties appear smaller (Teece & Sherry, 2016; Gautier & Petit, 2019). Because of biases, any value closer to the anchor becomes more acceptable (Tversky & Kahneman, 1974). Even though the severity of an injunction depends on multiple factors, the higher product value downstream makes an injunction granted on a downstream value chain level more powerful ceteris paribus. For instance, a higher product value corresponds with more capital tied in inventories and, thus, higher cost of capital or obsolescence.

5.2.1 Hypotheses

I utilized the concept of value capture in the context of profiting from innovation (Teece, 1986), transaction cost theory (Coase, 1960; Williamson, 1975), and anchoring theory (Tversky & Kahneman, 1974) to derive six hypotheses on predictors of indirect infringement suits: three related to the licensed technology, one to the type of plaintiff, one to the IP regime in the country of the original infringer, and one to the market concentration of the value chain level of the original infringer. *Figure 10* illustrates the argumentative chains leading to my hypotheses.

Inventors may protect products or processes through patents – significantly affecting enforceability. Lunn (1987) argued that “the strength of the property rights provided by a patent on a new product is generally greater than that provided by a patent on a new process” (p. 744). In accordance with Lunn (1987), Cohen et al. (2000) attributed process patents a lower effectiveness in IP protection than product patents. “Given that [processes] are less public” (p. 10), it is more difficult to detect the infringement of a process patent. This difficulty is even more pronounced in indirect suits. In the case of a patent protecting a manufacturing process, the patent holder needs to prove that a downstream firm has procured a good that was manufactured by applying this process. As a result, it is, in general, easier for a patent holder to demonstrate the infringement of a product patent compared to a process patent in an indirect suit. Therefore, I posit:

Hypothesis 1: Product (vs. process) patents are associated with indirect infringement suits.

Complex technologies consist of many patentable elements (Cohen et al., 2000) and incremental technical advancements reciprocally depending on each other (Merges & Nelson, 1990). The resulting complexity and fragmentation of the patent landscapes should increase the difficulty for downstream firms, i.e., indirect infringers, relative to upstream firms, i.e., direct infringers, to understand the technology (Geradin, 2020) and, hence, to defend against litigation. Plaintiffs could take advantage of this by pursuing indirect suits.

Moreover, infringement is generally more likely and prevention more difficult with complex technologies (Grindley & Teece, 1997), resulting in a higher litigation propensity (Allison, et al., 2009). Therefore, a plaintiff filing a direct suit faces the risk of being countersued. Plaintiffs can mitigate this risk by filing indirect suits. Thus:

Hypothesis 2: Complex technologies are associated with indirect infringement suits.

Standards such as Wi-Fi or 5G are enabling technologies (Teece, 2018) and are open to the extent that the technical specifications are commonly available, at times even freely, to any firm interested in implementing the standard (Simcoe, 2006). To profit from standard contributions, firms must enter the MFT and license their SEPs. Licensing is the “default value-capture mechanism” (Teece, 2018, p. 1367) because SEP holders often cannot own all complementary assets required to commercialize the innovation on the product market in-house (Gambardella et al., 2021; Teece, 2018). Consequently, even if they file for an injunction, SEP holders rather aim to enforce a license. Obtaining an injunction in a SEP-related litigation is simply a lever to improve the SEP holders’ negotiation position. Indirect suits correspond with a litigation level further downstream, resulting in the psychological advantage of a higher product value and, thus, anchor (Tversky & Kahneman, 1974). A higher anchor makes a high royalty appear relatively smaller and, thereby, more reasonable (Gautier & Petit, 2019; Teece & Sherry, 2016). Thus:

Hypothesis 3: Open standards are associated with indirect infringement suits.

PAEs are “firms that seek to generate profits mainly or exclusively from licensing or selling their [...] patented technology to a manufacturing firm” (Reitzig et al., 2007, p. 137). Contrary to technology vendors (Fischer & Henkel, 2012), PAEs aim to build leverage by, e.g., locking implementers into technologies (Mann, 2004; Merges, 2009) and concentrating their activities on ex-post situations (Reitzig et al., 2007). Patent holders benefit from a stronger negotiation position in ex-post situations (Green & Scotchmer, 1995; Shapiro, 2010), e.g., because implementers might face high switching costs ex-post. Several additional considerations lead to the derivation of a hypothesis.

First, PAEs do not need to face counter-infringement suits, given the non-operating essence of their business model. In addition, a U.S. rule-based fee regime that limits the plaintiffs' legal expenses to one's own – independent of the case outcome – could incentivize plaintiffs to sue more often and more aggressively because of the limited downside risk and equal upside potential compared to a UK rule-based fee regime. E.g., Helmers et al. (2013) claimed that a UK rule-based fee regime deters the litigation activity of PAEs.

Second, drawing on anchoring theory (Tversky & Kahneman, 1974), royalties appear more reasonable downstream due to psychological effects (Gautier & Petit, 2019; Teece & Sherry, 2016). Third, courts do not consider the ex-ante negotiation position of the conflicting parties in calculating compensatory damages (Lee & Melamed, 2015; Reitzig et al., 2007). As a result, anchoring theory applies unconditionally to PAEs – an important consideration for the licensing income-focused PAE business model.

Fourth, PAEs aim particularly at firms with little defensive capabilities (Cohen et al., 2019). In ex-post constellations, firms are in a relatively weaker position (Green & Scotchmer, 1995; Shapiro, 2010) and face switching costs (Lemley & Shapiro, 2007; Lee & Melamed, 2015), which are likely higher downstream as firms need to deal with higher technical complexity while having less in-depth technical knowledge of single technologies implemented upstream. Thus, in comparison with upstream firms, downstream firms have weaker defensive capabilities.

Fifth, a plaintiff needs to show only that a product – even if thousands of patents are implemented in the product – infringes on a single patent to win a suit (Lemley & Shapiro, 2007). Likely, this leads to a skewed value distribution as well as higher pressure on defendants and higher relative returns for plaintiffs. Thus:

Hypothesis 4: PAEs as plaintiffs are associated with indirect infringement suits.

Transaction cost theory predicts that patent holders litigate on the value chain level that is associated with lower costs. It is preferable to enforce a patent further downstream through an indirect suit when patent holders either cannot enforce a direct suit, or its enforcement is associated with higher costs because of weak or limited IP protection.

A practical perspective illustrates these considerations. Value chains often begin in Asia (Miller & Temurshoev, 2017). At the same time, the U.S. Chamber of Commerce assessed the strength of IP regimes in Asian countries as comparatively weak (2023). For example, in their 2023 report "International IP Index", they argued regarding China that, e.g., "the Technology

Import/Export Regulations (TIER) historically included discriminatory conditions for foreign licensors" such as "indemnification of Chinese licensees against third-party infringement" or compulsory "transfer of ownership of future improvements" (p. 103). Moreover, the European Union (EU) filed a request at the World Trade Organization (WTO), responding to the difficulties of SEP holders in patent enforcement in China (U.S. Chamber of Commerce, 2023). If an inventor decides not to file for patent protection in selected Asian countries due to the lack of strength of the local IP regimes, the nature of patents as territorial rights (WIPO, n.d.; 64 EPC, 2020, § 1) does not allow patent enforcement in these territories. For the same reason, patent holders might decide not to enforce a patent upstream but further downstream in territories with stronger IP regimes and, therefore, higher enforceability. Thus, I hypothesize:

Hypothesis 5: Firms from weak IP regimes on the direct infringement suit level are associated with indirect infringement suits.

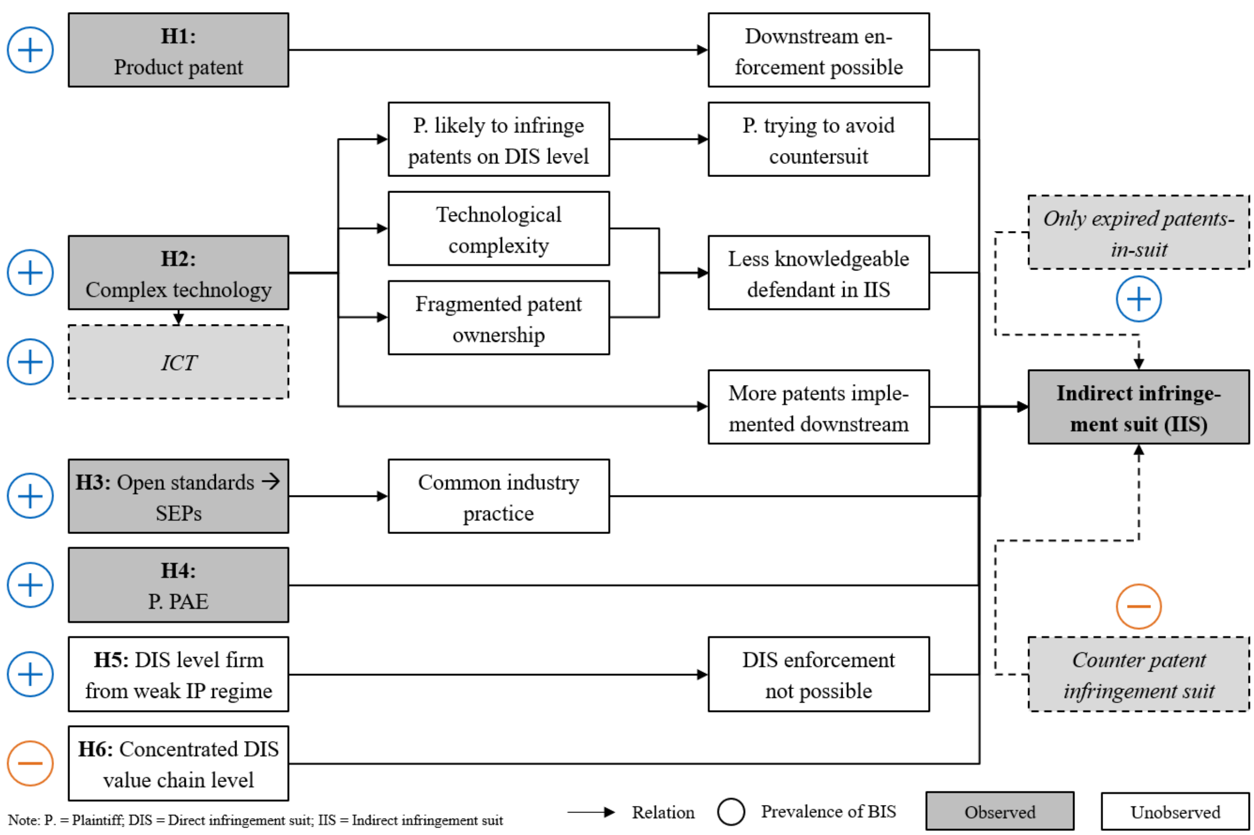


Figure 10: Argumentative chains and hypotheses – Indirect infringement suits

Transaction costs are determined by uncertainty, asset specificity, and transaction frequency (Williamson, 1975; Williamson, 1985). As a result, transaction costs are linked to the degree of market concentration. Selecting a value chain level characterized by market fragmentation as litigation level results in more plaintiff-defendant relationship pairs and a higher transaction frequency, ceteris paribus, and, consequently, an increase in industry-level transaction costs (Henkel, 2022). Transaction cost theory (Coase, 1960; Williamson, 1975) predicts that plaintiffs sue on the value chain level corresponding to higher market concentration and, thus, lower transaction costs. Thus:

Hypothesis 6: Market concentration on the value chain level corresponding with a direct infringement suit is negatively associated with indirect infringement suits.

5.2.2 Other considerations and expected correlations

Besides the six causal links to indirect suits hypothesized above, I presume to find three rather correlational links with indirect suits. *ICT* as a subset of *Complex technology* (Cohen et al., 2000) is an example of such a correlational link. As a subset, ICT does not represent an independent causal link to indirect suits. Instead, I presume a correlation between *ICT* and *Complex technology* and, thereby, between *ICT* and indirect suits.

While it is common for plaintiffs at the ITC to pursue litigation on the district court level in parallel, plaintiffs litigating on the district court level rarely pursue parallel litigation on the ITC level. I.e., only a few suits of suits filed at a district court face parallel procedures at the ITC (compare 5.4.1), whereas 89% of all ITC cases face a parallel district court case (Cotropia, 2011). Understanding the motivation of a plaintiff simplifies hypothesizing predictors of indirect suits. The motivations for filing a *Parallel ITC case* are ambiguous. Scholars attributed multiple mostly procedural advantages to pursuing cases at the ITC as opposed to district courts, such as higher speed (Hahn & Singer, 2007; Chien, 2008b; Cotropia, 2011), dealing with more experienced judges due to exclusive jurisdiction (Cotropia, 2011), greater ease of showing jurisdiction over foreign companies, or less available defenses (Hahn & Singer, 2007; Cotropia, 2011). In addition, it is said that the ITC is more patent-holder friendly (Hahn & Singer, 2007; Cotropia, 2011). All these considerations are relevant to plaintiffs in both direct and indirect suits. However, the fact that the ITC can offer only an injunction as a remedy (19 U.S.C., n.d., § 1337; Lundell et al., 2022) could imply that plaintiffs pursuing a *Parallel ITC case* primarily aim at enforcing an injunction. I argue that the most effective litigation level to stop further infringement by the original infringer and firms on subsequent levels in the value chain is the original infringer itself. This is because an injunction obtained by filing a direct suit would affect all firms that are directly and indirectly supplied by the original infringer. In contrast, a plaintiff could also seek an injunction against a customer of the original infringer to increase its leverage towards the original infringer and improve its negotiation position. Due to these ambiguous arguments, I refrain from hypothesizing a link between *Parallel ITC case* and indirect suits.

An unambiguous picture leads me to hypothesize a positive correlation between *Only expired patents-in-suit* and indirect suits. An injunction cannot be granted for an expired patent. Thus, a plaintiff selecting exclusively expired patents aims at receiving damages for past infringement as the remedy. Regarding this motivation, anchoring theory suggests the pursuit of an indirect suit to maximize damages.

Besides the positive correlation between *Only expired patents-in-suit* and indirect suits, I expect a positive correlation between *Plaintiff PAE* and *Only expired patents-in-suit* (Love, 2012). Since PAEs typically do not file patent applications by themselves but acquire patents (often from practicing entities) (Risch, 2012), it takes time until a patent finds its way into a PAE's patent portfolio. In addition, it is attractive for PAEs to pursue a strategy of locking in implementers into a patented technology (Mann, 2004; Merges, 2009), which requires time until the focal technology becomes dominant. As a result, I expect PAE patent portfolios to be older and litigated later in their patent term.

Furthermore, I presume a negative correlation between *Counter patent infringement suit* and indirect suits. A global patent conflict on LED patents illustrates this connection well. The German firm Osram sued its Korean competitor Samsung, corresponding to a direct suit, and several locations of the German electronics retailer Media Markt, corresponding to an indirect suit, for infringement of LED patents. While Media Markt could not respond with a counter-infringement suit due to a lack of relevant patents, Samsung filed a complaint with the ITC and an infringement suit at the Delaware district court (N-tv, 2011; Behlau & Klos, 2012). In general, a defendant that is the original infringer in a suit (i.e., Samsung) and is positioned on the same value chain level as the plaintiff (i.e., Osram) is more likely to counter-sue than a defendant that is downstream from the original infringer (i.e., Media Markt). Thus, I expected a negative correlation with indirect suits or, accordingly, a positive one with direct suits.

As illustrated in Chapter 2, past scholarly work evaluated which patent characteristics affected the likelihood of a patent being assigned to an infringement suit. Despite the thematic proximity of this research stream, this study takes on a different perspective. I cannot identify any theoretical argument as to why any of the patent characteristics that were found to affect the litigation propensity of a patent have an impact on the choice of the litigation level, i.e., whether to pursue a direct or indirect suit. Nonetheless, following other scholars, I control for various patent characteristics as described in 5.4.3.

In my study, I test hypotheses 1 to 4. Due to a lack of data, I cannot test hypothesis 5. To protect their competitive position, firms treat data on contracted suppliers and sourcing strategies with confidentiality. As a result, I cannot obtain data on the original infringer and the geographic scope of its activities. Also, I am unable to test hypothesis 6. First, I would need to define a geographic market for each product related to the infringement suit in focus. The definition of a geographic market alone is complex and ambiguous. While financial services such as payment processing might be offered on a country level, it is not profitable to sell goods such as cement that exhibit a low value-to-weight-ratio outside a small perimeter as logistics costs would explode. Obtaining data on market shares to calculate the degree of market concentration for each product and geographic market pair is impossible. No such data is available.

5.3 Methods

5.3.1 Data cleaning and sampling process

I used the Patent Litigation Dataset provided by the United States Patent and Trademark Office (n.d.a), which contains 81,350 unique U.S. district court cases filed between 1963 and 2016. The dataset comprises exclusively district court cases implying that it contains only first-level cases and no appeals (Galasso & Schankermann, 2015; Palmese, 2018; Lundell et al., 2022). Analyzing a dataset containing appeals would overweight cases going to appeal and, consequently, be biased due to potential differences between characteristics of infringement suits in general and appealed cases. The variable of interest is the initial selection of the litigation level which can be derived from the defendant(s) named in the first instance suit. Therefore, I included open and closed cases.

For most suits filed between 2003 and 2016, the dataset contains a classification by case type (e.g., Type 1 - Patent Infringement suit non-DJ, Type 5 - False Marking, Type 6 - Inventorship/Ownership). However, suits filed before 2003 are not exhaustively classified (Schwartz et al., 2019). To ensure the sampling of applicable suit types and recent suits, I excluded all suits filed in 2009 or earlier. In total, I excluded 45,433 suits due to the criterion above (step 1 in *Figure 11*).

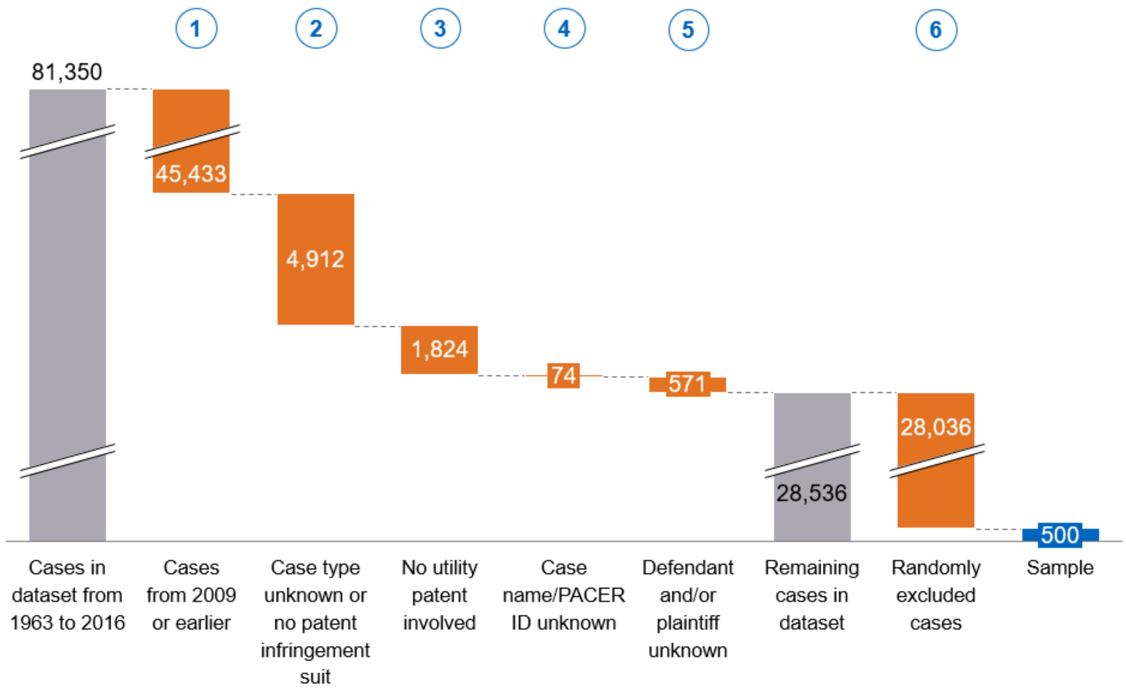


Figure 11: Data cleaning and sampling process

Building upon the case type classification (Schwartz et al., 2019), I filtered suits of type 1 („Patent Infringement suit non-DJ") which refer to suits where the "plaintiff is patent holder and sues defendant(s) for infringement of a utility, design, reissue, or plant patent" (Schwartz et al., 2019, p. 9). I excluded all other cases (e.g., disputes on inventorship of patents or on royalties) due to their lack of relevance in answering my research questions (step 2). Considering that the definition of type 1 suit explicitly includes non-utility patents and the hypothesized mechanisms (5.2) likely do not hold with non-utility patents, I excluded all suits that did not have at least one utility patent in-suit (step 3). Lastly (steps 4 and 5), I removed suits with incomplete data (e.g., missing case names, unknown defendant or plaintiff, missing PACER ID (Public Access to Court Electronics Records; Marco et al., 2017) to ensure that I can fully analyze the sample. After applying steps 1 to 5, 28,536 suits remained in the dataset. From those 28,536 suits, I randomly drew a sample of 500 suits (step 6).

For my analyses, I collected and controlled for case-level and patent-level variables. First, I illustrate the case-level variables and the collection process. As a second step, I describe the patent-level variables and how I collected them. Even though I collected the underlying data to the patent-level variables on the level of individual patents, I later calculated the variables on the aggregated case level. *Table 23* and *Table 24* provide an overview of all independent variables.

Variable	Level	Type	Description	Comment	Hypothesis
Product patent	Patent	Binary	Claims of patent protect an end product or a feature of it as opposed to a process, art or method	Equal to 1 if share of product patents among patents-in-suit exceeds 50%	1
Complex technology	Patent	Binary	Patent-in-suit is complex (vs. discrete), i.e., has cumul. character and consists of multiple patentable elements	Equal to 1 if share of product patents among patents-in-suit exceeds 50%	2
SEP	Patent	Binary	Patent-in-suit is essential to a standard	Equal to 1 if share of product patents among patents-in-suit exceeds 50%	3
Plaintiff PAE	Case	Binary	Plaintiff who owns patents to generate license income without implementing patents (excl. researching entities)	N/A	4
ICT	Patent	Binary	Patent-in-suit is in information and communications technology field, a complex technology	Equal to 1 if share of product patents among patents-in-suit exceeds 50%	Correlation
Counter patent infringement suit	Case	Binary	Defendant sued plaintiff for patent infringement at most one year before filing of the suit at hand	N/A	Correlation
Parallel ITC case	Case	Binary	Plaintiff sued defendant at US Internatational Trade Commission one year before/ after filing of suit at hand	N/A	Ambiguous
Only expired patents-in-suit	Patent	Binary	All patents assigned to suit are expired at date of filing of suit	N/A	Correlation
Average experience of plaintiff	Case	Conti-nuous	Average number of patent infringement suits plaintiffs were involved in up to 7 years prior to focal suit	N/A	
Average experience of defendant	Case	Conti-nuous	Average number of patent infringement suits defendants were involved in up to 7 years prior to focal suit	N/A	
Number of plaintiffs	Case	Conti-nuous	Number of unique plaintiffs (i.e., two subsidiaries of the same entity as plaintiffs are counted as one)	N/A	
Number of defendants	Case	Conti-nuous	Number of unique defendants (i.e., two subsidiaries of the same entity as defendants are counted as one)	N/A	
Plaintiff inventor	Case	Binary	Individual or group of individual inventors who filed (a) patent(s) and are not organized as legal entity	N/A	
Plaintiff researching entity	Case	Binary	Plaintiff develops and commercializes technology to generate royalty income without involvement in production	N/A	
Defendant researching entity	Case	Binary	Defendant develops and commercializes tech. to generate royalty income w/o involvement in prod. activities	N/A	
Year of patent in-fringement suit filing	Case	Conti-nuous	Year in which the patent infringement suit is filed (ranging from 2010 to 2016)	Incorporated as year fixed effects	
≥1 foreign plaintiff	Case	Binary	Global ultimate owner of at least one of the involved plaintiffs is headquartered outside the US	N/A	

Table 23: Overview of independent variables (1/2)

Variable	Level	Type	Description	Comment	Hypothesis
≥1 foreign defendant	Case	Binary	Global ultimate owner of at least one of the involved defendants is headquartered outside the US	N/A	
Number of utility patents-in-suit	Patent	Conti-nuous	Number of utility patents included in the respective patent infringement suit	N/A	
Number of design patents-in-suit	Patent	Conti-nuous	Number of design patents included in the respective patent infringement suit	N/A	
Number of reissue patents-in-suit	Patent	Conti-nuous	Number of reissue patents included in the respective patent infringement suit	N/A	
Continuation	Patent	Conti-nuous	Patent is a continuation, continuation-in-part, or division of a parent patent application	Continuous variable ranging from 0 to 1 on case level reflecting the share of continuations among patents-in-suit	
Reexamination	Patent	Conti-nuous	Patent was reexamined and decision announced prior to filing of suit involving the focal patent	Cont. variable ranging from 0 to 1 on case level reflecting the share of reexamined patents among patents-in-suit	
Log size of patent family	Patent	Conti-nuous	Log of average number of patents belonging to patent family according to DOCDB definition	Continuous variable on case level reflecting average patent family size of patents-in-suit	
Log backward citations	Patent	Conti-nuous	Log of number of times the focal patent cites other patents	Continuous variable on case level reflecting average number of backward citations of patents-in-suit	
Log bwd. citations added by examiner	Patent	Conti-nuous	Log of number of times an examiner of the focal patent cites other patents	Continuous variable on case level reflecting avg. number of backward citations added by examiner of patents-in-suit	
Log forward citations	Patent	Conti-nuous	Log of number of times other patents cite the focal patent	Continuous variable on case level reflecting average number of forward citations of patents-in-suit	
Log fwd. citations added by examiner	Patent	Conti-nuous	Log of number of times an examiner of other patents cites the focal patent	Continuous variable on case level reflecting avg. number of forward citations added by examiner of patents-in-suit	
Number of CPC sections	Patent	Conti-nuous	Count of distinct Cooperative Patent Classification (CPC) sections	Continuous variable on case level reflecting the average number of CPC sections of patents-in-suit	
Number of claims	Patent	Conti-nuous	Count of claims the focal patent makes	Continuous variable on case level reflecting the average number of claims of patents-in-suit	
Age of patent	Patent	Conti-nuous	Difference between date of filing of suit and the priority/ filing/ grant date of patent-in-suit (depending on patent)	Continuous variable on case level reflecting the average age of patents-in-suit	
Litigation frequency	Patent	Conti-nuous	Number of patent infringement suits in which patent was named as patent-in-suit based on Patent Litigation Dataset	Continuous variable on case level reflecting the average litigation frequency of patents-in-suit	
Patent-in-suit before	Patent	Binary	Patent was part of a patent infringement suit according to Patent Litigation Dataset	Cont. variable ranging from 0 to 1 on case level reflecting the share of patents previously in suit among patents-in-suit	

Note: Only dependent variables displayed. Thus, industry variables not displayed.

Table 24: Overview of independent variables (2/2)

5.3.2 **Definition and generation of case-level variables**

In line with the approach described in 4.3.2, I considered the capabilities, the scope of operations, and, in particular, the depth of the value-add in the defendant's operations to classify the dependent variable *Indirect patent infringement suit*. This means that an infringement suit involving the same patent against a defendant with a large depth (e.g., a vertically integrated firm) could result in a direct suit, while a suit against a defendant with little depth (e.g., operational scoped limited to one level in the value chain) could result in an indirect suit. For example, I classified a suit for infringing a cellular patent as indirect when the defendant was a pure downstream smartphone maker. In contrast, I classified a suit against a vertically integrated smartphone maker with its own chip development and manufacturing operations for infringing the same patent as direct suit. Analogously to 4.3.2, I focused on the global ultimate owner of the defendant to classify the infringement suit. This implies that even though a car manufacturer might not have an engine factory in the U.S. but in other countries, I would have classified the suit for infringing an engine-related patent filed in the U.S. as direct. A country-level analysis of a firm's capabilities is not meaningful and feasible, e.g., due to the lack of appropriate data.

I followed the same approach when dealing with cases where multiple subsidiaries of the same ultimate global owner are named as plaintiffs or defendants in a suit. I consolidated the number of involved parties and harmonized their names and their count. For instance, I counted the plaintiffs "3M Company" and "3M Innovative Properties Company" in *Number of plaintiffs* as one and used as the name the global ultimate owner's name ("3M Company"). I applied the same logic to *Number of defendants*. Before the harmonization, I removed all irrelevant parties, such as counter-defendants or counter-plaintiffs, because those types of parties were not part of the roster at the time of the filing of the suit but were added during the ongoing litigation.

To deepen the understanding of the plaintiff's selection of the litigation level, I further differentiated by introducing three defendant types in indirect suits: Manufacturers, users, and merchants. All three defendant types are not the original infringer of the patented technology. This implies that manufacturers could be positioned on any level in the value chain. With merchants, I refer to trading businesses that are not manufacturing goods but only buying and selling them. With „user" I refer to the one who is a user of a product or service incorporating the patented technology. For instance, I classified an airport that was sued for infringement of a computer tomography patent implemented in CT scanners used in security operations as a user. The classification scheme I selected benefits from its applicability across industries. Since the depth and structures of value chains are often industry-specific, I needed a sufficiently general classification framework.

Based on a review of the literature on patents, patent value, and patent litigation, I included controls for the involvement of foreign parties (e.g., Lanjouw & Schankerman, 1997; Lanjouw & Schankerman, 2001; Marco et al., 2015) on the case level. I checked the domicile of the global ultimate owner of each plaintiff and defendant. This implies that I considered subsidiaries of foreign companies, such as the U.S. subsidiary of the Japanese car maker Toyota, as foreign. If at least one plaintiff or defendant was foreign, I set the respective controls ≥ *1 foreign plaintiff* and ≥ *1 foreign defendant* to 1.

Besides differentiating defendants by their function in the value chain, I further differentiated by the nature of the business of plaintiffs and defendants. Following the elaboration in 4.3.2 on Reitzig et al. (2007) and Henkel & Fischer (2012), I differentiated between *Plaintiff PAE*, *Plaintiff researching entity*, *Plaintiff inventor*, and *Defendant researching entity*.

Building upon harmonizing the plaintiff and defendant names as described above and focusing on the global ultimate owner, I identified whether a suit represents a *Counter patent infringement suit*. For each suit, I examined the Patent Litigation Dataset (USPTO, n.d.a) whether the defendant of the suit in focus was a plaintiff in another suit against the plaintiff of the focal suit. For this examination, I focused on suits that were filed at most one year before the filing of the suit in focus. Analogously, I identified all patent infringement suits the plaintiffs and defendants were involved in up to seven years before the filing of the suit in focus to derive the *Average experience of plaintiff* and *Average experience of defendant*. Given that Schwartz et al. (2019) classified only suits filed in 2003 or later by case type, I could only apply a seven-year time window – a deviation from Somaya, who applied a ten-year time window (2004). Moreover, I identified a *Parallel ITC case* by examining the Investigations Database System of the ITC (U.S. International Trade Commission, n.d.). I considered any suit the plaintiff of the suit in focus filed with the ITC one year before or after the filing of the suit in focus against the same defendant as *Parallel ITC case*.

Analogous to 4.3.2, I assigned each suit to an industry on the level of the 1- and 2-digit SIC code (U.S. Securities and Exchange Commission, n.d.a) based on the defendants' product and service offering as well as the patents-in-suit. As in 4.3.2, I interpreted the assignment to an industry as a consequence of the selection of the litigation level and not as a determinant of the litigation level. For example, if a semiconductor company owning a patent on a chipset functionality sues a competitor, another semiconductor company, for infringement, I assign the suit to the Electronic and Other Electrical Equipment and Components industry. If the same semiconductor company sues a machinery company that manufactures laser cutting machines and integrates chipsets in its product, I assign the suit to the Industrial and Commercial Machinery and Computer Equipment industry. While the former suit targets the party that translates the patented knowledge into a technical artifact, the latter targets the party that is further downstream in the value chain. As a result, I classify the former suit as direct and the latter as indirect. If I base the industry allocation on the plaintiff's offering, I will obtain a holistic picture of the plaintiffs' industries but not of the defendants' industries where the patents are implemented and which are targeted in litigation activities.

As elaborated earlier in 5.3.1, I excluded suits that did not contain at least one utility patent. Additionally, several suits also contained design and reissue patents. Therefore, I controlled for the *Number of utility patents-in-suit*, the *Number of design patents-in-suit,* and the *Number of reissue patents-in-suit*. The USPTO can grant a reissue patent after a second application when the first application was rejected because of errors (United States Patent and Trademark Office, n.d.d). Moreover, I controlled for the *Year of patent infringement suit filing* and accounted for *Only expired patents-in-suit*. The latter refers to suits in which all presumably infringed patents have already expired when the plaintiff filed the suit. To determine the patent status, I relied on the patent term regulations of the United States Patent and Trademark Office (n.d.c).

One can argue well that incorporating value chain and market characteristics could allow for additional insights across industries – Either by interpreting them as controls or as descriptive statistics. However, market heterogeneity, industry heterogeneity, and data availability are unsolvable issues. Market-related variables need to be sufficiently specific. E.g., just looking at the automotive market size and growth rates in general fails to grasp the dynamics in certain technology fields. While combustion engines lose relevance, battery electric vehicles enjoy tremendous growth. However, the overall market is expected to grow only modestly (S&P Global, 2023). Besides, the geographic scope of a market is not generalizable across markets because of differing value-to-weight ratios of products. It is not economical to transport goods with low value-to-weight ratios for long distances (e.g., cement). In contrast, goods with high value-to-weight ratios are transported for long distances by fast but expensive modes of transport (e.g., consumer electronic devices by plane). Significant inventory holding costs, i.e., cost of capital, and value depletion reinforce these tendencies even further. In addition, value chain structures differ significantly between industries. The pharmaceuticals industry can be characterized by short value chains, whereas the automotive industry is known for complex multi-level value chains. To draw meaningful conclusions, I would need to obtain data differentiated by industry, value chain level, technology, and market geography and derive a harmonized yet differentiated framework on value chain structures. Obtaining data on that level of granularity is not operationalizable and, thus, such analyses are beyond the scope of this dissertation.

5.3.3 **Definition and generation of patent-level variables**

I used publicly available information from Google Patents to collect the patent-level variables. To assess hypothesis 1, I distinguished between product and process patents based on the patent abstracts and patent claims obtained from Google Patents. I discussed the differences between product and process patents in 4.3.2.

For hypothesis 2, I distinguished between complex and discrete technologies (e.g., Merges & Nelson, 1990; Kusunoki et al., 1998; Rycroft & Kash, 1999; Cohen et al., 2000; Kash & Kingston, 2001). Moreover, I considered *ICT* as a subset of *Complex technology* (Cohen et al., 2000). In 4.3.2, I provide further details on the characteristics of the respective technologies. I used the patent abstracts, the patent claims, and the Cooperative Patent Classification (CPC) obtained from Google Patents for classifying a patent as *Complex technology* or *ICT*.

For hypothesis 3, I examined disclosures of SDOs and conducted internet searches on news articles related to the focal patent (infringement suit) to identify a *SEP*, i.e., a patent that is indispensable for the implementation of a standard (Bekkers et al., 2011; Bekkers et al., 2014; ETSI, 2022). Even though a patent that the holder has declared as essential is not necessarily truly essential (Bekkers et al., 2020), I focused on public knowledge at the moment in time when the suit was filed. This knowledge builds the base for patent holders' selection considerations of the litigation level. Hence, I did not account for ex-post essentiality checks and decisions.

I assessed *Product patent*, *Complex technology*, *ICT*, and *SEP* on the level of individual patents. Nonetheless, the patent-level values needed to be aggregated to case-level values. Therefore, I calculated the shares of patents-in-suit which were classified as *Product patent*, *Complex technology*, *SEP*, or *ICT*. If the calculated share on the level of a suit exceeded 50%, I classified the whole suit per the respective variable.

Reviewing the literature on patents, patent value, and patent litigation led me to incorporate several patent-level control variables. I controlled for the *Size of patent family* (e.g., Putnam, 1996), the number of *Backward citations* (e.g., Carpenter et al., 1980; Lanjouw & Schankerman, 1999; Harhoff et al., 2003; Cremers, 2004), the number of *Forward citations* (e.g., Trajtenberg, 1990; Lanjouw & Schankerman, 1999; Harhoff et al., 2003; Cremers, 2004; Hall et al., 2005; Chien, 2011), the *Number of claims* (e.g., Tong & Frame, 1994; Lanjouw & Schankerman, 1999), the *Reexamination* status of a patent (e.g., Harhoff et al., 2003; Cremers, 2004; Chien, 2011), In addition, I controlled for the *Age of patent*. This follows the logic that owners renew only patents of which the underlying invention is considered valuable (Schankerman & Pakes, 1986).

I used the *Size of patent family* data from Google Patents, which applies the DOCDB simple patent family definition (Google Patents, n.d.). Counter to the broader INPADOC definition, patent family members have the same priorities and technical contents according to the DOCDB (European Patent Office, n.d.). Following, for instance, Criscuolo & Verspagen (2008) and Alcácer et al. (2009), I distinguished between the source of patent citations. This means that I differentiated between total backward and forward citations as well as backward and forward citations added by examiners only. The date of the filing of the suit served as the reference date for collecting the variables described above. This implies that I did not account for events that occurred after the filing of the suit, i.e., a reexamination decision on a patent that has taken place after the filing of the suit is not reflected in *Reexamination*.

The cumulative frequencies of *Size of patent family*, *Backward citations*, *Forward citations*, *Backward citations added by examiner*, and *Forward citations added by examiner* exhibited a skewed distribution as illustrated exemplarily by *Figure 12*. A large portion of patents showed a small number of patent family members or citations, whereas a small number of patents exhibited large outliers. To reduce the risk of biased results resulting from outliers, I calculated and controlled for the log of the respective variables.

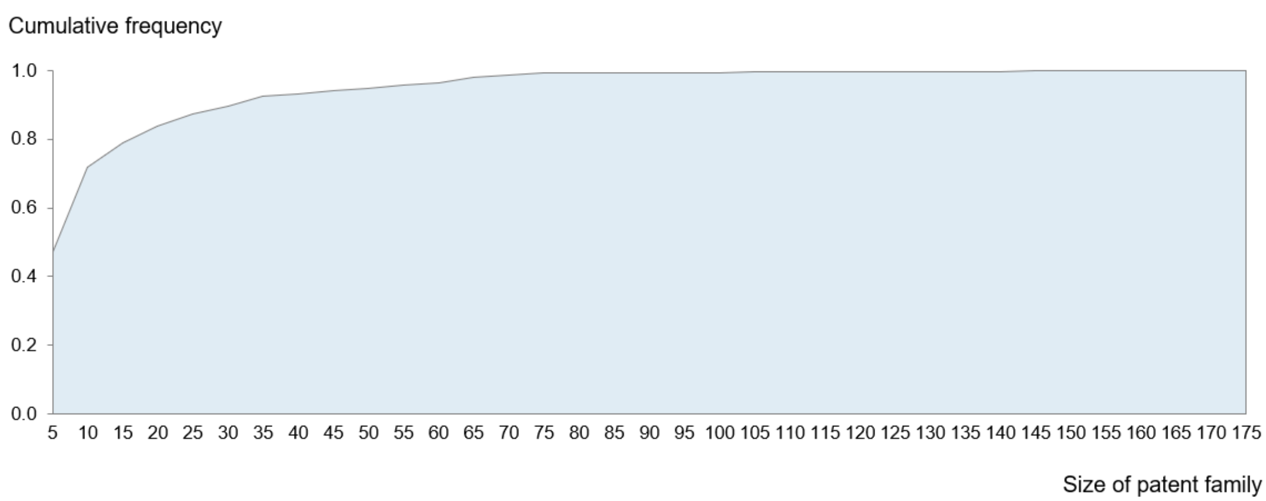


Figure 12: Cumulative frequency for size of patent family

Following, e.g., Lerner (1994), I controlled for patent scope by collecting the *Number of CPC sections*, which assesses the number of distinct Cooperative Patent Classification (CPC) sections (European Patent Office, 2013) based on Google Patents. I counted on section level (i.e., section A, B, etc.). Moreover, I controlled for *Litigation frequency*, *Patent-in-suit before* (e.g., Lanjouw & Schankerman, 1997), and *Continuation*. The first variable refers to the number of infringement suits a patent was assigned to before the filing of the focal suit based on all infringement suits included in the Patent Litigation Dataset (USPTO, n.d.a). Similarly, *Patent-in-suit before* is a binary variable indicating whether a patent assigned to the focal suit was assigned to a suit before. Lastly, I controlled for the type of application through *Continuation* (i.e., if a patent application was filed as a continuation, continuation-in-part, or divisional application; USPTO, n.d.b).

Due to the significant amount of work required to assess all patent-level variables, I received support from a research assistant for the variables *Log size of patent family*, *Log backward citations*, *Log backward citations added by examiner*, *Log forward citations*, *Log forward citations added by examiner*, *Number of CPC sections*, *Number of claims*, *Continuation*, *Reexamination*. I created a guide illustrating the step-by-step process and trained the research assistant for approximately 5 hours. The training consisted of an in-depth introduction to the data retrieval process, individual practice, and a review of variables obtained in individual practice by the research assistant and me. I discussed data discrepancies and ambiguities with the research assistant, identified root causes, and agreed on a harmonized approach.

To assess inter-rater reliability, various measures exist, e.g., the percent agreement among raters, Cohen's kappa, or Gwet's AC1 (Cohen, 1960; Fleiss, 1971; Gwet, 2008). While they apply to nominal scales (i.e., *Continuation*, *CPC class*), most patent-related variables (e.g., *Backward citations* or *Forward citations*) are continuous. Obtaining and assessing absolute agreement for continious variables with high standard deviations is not feasible (Stemler, 2004). Therefore, I applied the inter-class correlation coefficient (ICC) for all continuous variables in focus (Chaturvedi & Shweta, 2015). I calculated the ICC by applying a two-way mixed-effects model, as two raters rated all subjects along all variables (Chaturvedi & Shweta, 2015; Koo & Li, 2016). As opposed to the nominal variables, I was more concerned about the consistency of ratings than the absolute agreement. This implies that it was more critical that both raters consistently assigned a comparable number of, e.g., *Forward citations* to a patent than that both raters came to an absolute agreement (e.g., one rater consistently having few citations too many vs. both raters having complete agreement in most cases and significant divergence in a few cases in both directions) (e.g., Stemler, 2004). As opposed to a nominal variable, such as a patent (not) being a SEP, a figure of 100 or 101 for a continuous scale, such as Forward citations, is not associated with an objective meaning and, thus, absolute agreement is less important (Stemler, 2004) and the interpretation of regression coefficients less affected by disagreements among raters.

For the inter-rater reliability test, both raters independently classified a random sample of 35 patents, which exceeded the suggested minimum sample size of 30 (Koo & Li, 2016). A large sample size ensures small confidence intervals. Beyond the ICC itself, I assessed the confidence intervals and conducted an F-test (McGraw & Wong, 1996) because ranges provide additional insights into the quality of a point estimate. Koo & Li (2016) and Chaturvedi & Shweta (2015) considered ICCs above 0.75 and 0.80, respectively, as good and above 0.90 as excellent (Koo & Li, 2016). In this case, I obtained ICC coefficients of 1.0 (*Table 25*), thus, indicating an excellent inter-rater reliability. The confidence intervals and the highly significant F-test (1%-level) allowed me to reject the null hypothesis that both ICCs are 0. Obtained ICC coefficients for individual variables (e.g., *Backward citations*) were comparable, further confirming the excellent inter-rater reliability.

Also, the metrices for nominal variables (e.g., *Continuation*) were equally supportive. Applying the benchmarking scales of Landis & Koch (1977), the obtained coefficients of 0.94 or higher and the 95% confidence intervals starting from 0.87 or higher on an aggregate level for all nominal variables exceeded the threshold of 0.8 for almost perfect agreement. In addition, by conducting a t-test, I could reject the null hypotheses at the 1%-level that the coefficients for percent agreement, Cohen's kappa, and Gwet's AC1 subceeded the threshold of 0.8 indicating almost perfect agreement.

Specification	**Measure**	**N**	**Coefficient**	**Std. err.**	**t**	**P > | t |**	**[95% Conf. Intervall]**	
All nominal variables	Percent agreement	156	0.97	0.01	13.73	0.00	0.95	1.00
All nominal variables	Cohen's Kappa	156	0.94	0.03	4.27	0.00	0.87	1.00
All nominal variables	Gwet's AC1	156	0.96	0.02	7.34	0.00	0.92	1.00

Note: t-test H_0: Coefficient ≤ 0.80

Specification	**Measure**	**N**	**Coefficient**	**[95% Conf. Intervall]**		**F**	**Prob > F**
All continuous variables	Individual ICC	280	1.00	1.00	1.00	35,757.39	0.00
All continuous variables	Average ICC	280	1.00	1.00	1.00		

Table 25: Inter-rater reliability assessment

I needed to convert variables collected on the level of individual patents to a case-level measure. I conducted the conversion in case of binary patent-level variables by calculating the share of patents with a positive response (i.e., a suit involving five patents – three with a positive and two with a negative response – corresponds with an average of 0.6 on the level of the suit) and in case of continuous patent-level variables by calculating the average for all patents-in-suit (i.e., three patents with 15, 16, and 17 as respective patent age correspond with 16 as patent age on case level).

Lastly, I reviewed the hypothesized mechanisms (*Figure 10*) to detect the necessity for interaction terms. Including an interaction term between *Complex technology* and *ICT* would be equivalent to *ICT* for which I controlled anyway. Thus, there was no need to include interaction terms.

5.3.4 Treatment of ambiguities, variable selection, and model selection

Plaintiffs sued at least two defendants in 89 out of the 500 suits in our sample. While 64 out of the 89 suits involved defendants from the same level in the value chain, 25 out of the 89 suits involved defendants from different levels in the value chain. Consequently, I could not unambiguously identify the suit as direct or indirect. *Figure 13* illustrates the ambiguities.

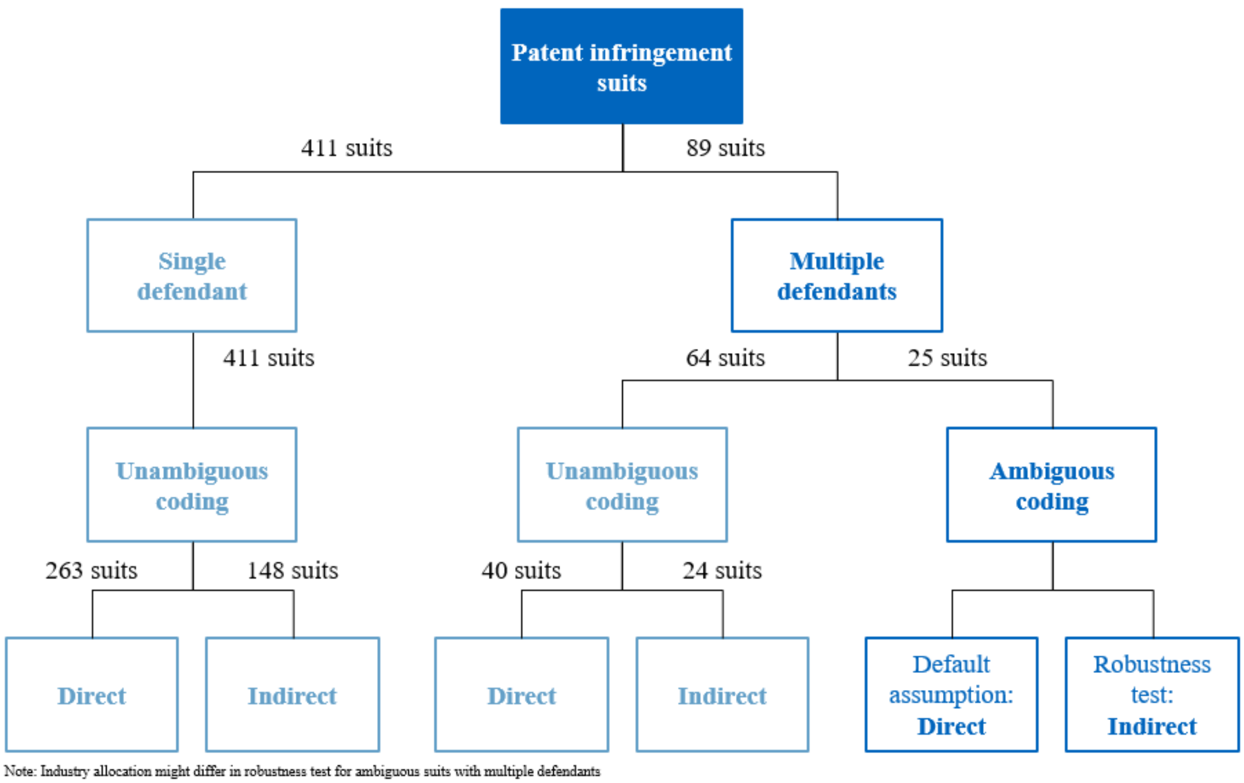


Figure 13: Treatment of ambiguous suits

To ensure the consistency and robustness of my analyses, I pursued a two-way approach. In the default case, I classified the 25 ambiguous suits as direct suits; in the other case, for robustness testing, I classified them as indirect suits. I assigned the suits to the industry accordingly. For example, if a suit names two defendants – an automotive OEM and a car retailer

– and claims infringement of an engine-related patent, I classified it as direct in the default case and assigned it to the transportation equipment industry (manufacturing as 1-level SIC code). In the case for robustness testing, I identified the case as indirect and assigned it to the automotive dealers and gasoline service stations industry (retail trade as 1-level SIC code). I tested for robustness in 5.4.7.

A cross-tabulation analysis uncovered that the independent variable *Countersuit* is a perfect predictor of indirect infringement suits. Thus, I removed the variable from regression analyses but kept it in descriptive or correlational analyses.

Due to the sizeable number of controls and their similarity, I tested for multicollinearity by calculating the Variance Inflation Factor (VIF) for each variable. I calculated the FIV as $VIF_i = 1/(1 - r_i^2)$ and interpreted it as the percentage "of the variability in the ith independent variable [that] is explained by the remainder of the independent variables in the model" (Craney & Surles, 2002, p. 393). Setting the threshold for the VIF at 10 which implies an r^2 of 90% did not show a need to remove variables from the regression analyses.

After having determined the control variables, I needed to select a model for further analyses of bivariate balanced data. I applied the Akaike Information Criterion (AIC; Akaike, 1973) and the Bayesian Information Criterion (BIC; Schwarz, 1978) to assess whether a logit or probit model fit better. Both criteria, AIC and BIC, indicated a better fit of the logit model (*Table 26*). Thus, I selected the logit model for all regression analyses. Nonetheless, I applied a probit model as a further robustness test.

Model	**AIC**	**BIC**
Logit	477.39	612.26
Probit	478.42	613.29

Table 26: Assessment of AIC and BIC for model selection

I estimated a baseline model controlling for the variables as described in 5.3.2, 5.3.3, and 5.3.4. Moreover, I estimated an extended model controlling for year-fixed effects. I imagined that time-related patterns could emerge. Therefore, I controlled for the filing date of the suit by incorporating year-fixed effects.

5.4 Results from quantitative study

I follow a threefold approach to presenting the results. First, I present descriptive statistics and results in 5.4.1 to 5.4.5, then I illustrate the results from the regression analysis in 5.4.6. Lastly, I test for the robustness of my findings in 5.4.7.

5.4.1 **Descriptive results – Forum selection**

Most plaintiffs sued for infringement of predominantly complex technology (71%) and product patents (53%). This is in line with the literature which argued that implementers are more likely to infringe on complex (vs. discrete) technologies (Grindley & Teece, 1997) as well as that patent holders can more easily detect and enforce infringement of product (vs. process) patents (Lunn, 1987; Cohen et al., 2000). A share of suits (5%) comparable to the share of licenses (8%) in 4.4.1 comprised predominantly SEPs.

The sample in this study exhibited a geographic distribution across district courts comparable to Schwartz et al. (2019). Plaintiffs have strong preferences when selecting the venue for filing an infringement suit (*Table 27*). Suits were concentrated on a few district courts, with plaintiffs having filed 63% of all suits at just five district courts, even though, in the sample, 56 distinct district courts appeared. Eastern Texas (142 suits/28%) and Delaware (90/18%) as the most popular district courts attracted by far the most suits, followed by Northern California (30/6%), New Jersey (28/6%), and Central California (26/5%). Shortly behind, Northern Illinois followed as the sixth most popular district court (21/4%).

District court	Suits [#]	Suits [%]	Indirect suits [#]	Indirect suits [%]	Indirect suits [t/o in %]	Suits by PAEs [#]	Suits by PAEs [%]	Suits by PAEs [t/o in %]
Eastern Texas	142	28.4%	67	39.0%	47.2%	119	46.9%	83.8%
Delaware	90	18.0%	29	16.9%	32.2%	50	19.7%	55.6%
Northern California	30	6.0%	12	7.0%	40.0%	12	4.7%	40.0%
New Jersey	28	5.6%	5	2.9%	17.9%	7	2.8%	25.0%
Central California	26	5.2%	8	4.7%	30.8%	9	3.5%	34.6%
Northern Illinois	21	4.2%	10	5.8%	47.6%	13	5.1%	61.9%
Southern Florida	13	2.6%	8	4.7%	61.5%	8	3.1%	61.5%
Southern New York	12	2.4%	6	3.5%	50.0%	6	2.4%	50.0%
Eastern Virginia	10	2.0%	2	1.2%	20.0%	4	1.6%	40.0%
Others	128	25.6%	25	14.5%	19.5%	26	10.2%	20.3%

Table 27: Patent infringement suits filed by district court

Forum shopping is an important consideration: Jurisdiction and venue statutes allow plaintiffs to more or less freely select their district court of choice (Moore, 2001). For instance, if "a defendant sells, offers to sell, or licenses others to sell products to residents [of a district]" (Moore, 2001, p. 563), the plaintiff may select the district's court. Fostered by competition shifting from the regional to the national level, these statutes imply that "national corporations may be sued in virtually any U.S. district court" (Moore, 2001, p. 565).

Interestingly, patent litigation activities have become more concentrated over time and, thus, geographic preferences more homogeneous. In addition, the popularity of district courts has shifted. In contrast to the findings from this study, Moore (2001) observed a concentration of just 29% of all suits on the five most popular district courts (vs. 63%). While the relative popularity of Northern and Central California, Northern Illinois, and Southern New York remained somewhat stable (9% vs. 6%, 6% vs. 5%, 6% vs. 4%, 4% vs. 2%), Eastern Texas did not appear among the leading litigation courts at all, and Delaware emerged only in sixth position with 3% (vs. 18%) of all suits (Moore, 2001).

I observed an even more pronounced geographic concentration for indirect suits and, as such, stark heterogeneity in the prevalence of indirect suits across courts. Plaintiffs filed 70% of all indirect suits in the five most popular district courts (vs. 63% of all suits in general). For instance, Eastern Texas attracted 28% of all suits but 39% of all indirect suits. This implied that 47% of all suits filed in Eastern Texas were indirect ones. In contrast, the 47 least popular district courts attracted only 26% of all suits and 15% of all indirect suits. I.e., 20% of the suits filed at these courts were indirect. As a result, the share of indirect suits filed in a district court was positively correlated ($r = 0.18$) with the total number of suits filed at the given court.

A more pronounced picture emerged in the case of suits filed by PAEs. PAEs filed almost every second of their suits in Eastern Texas, which led to PAEs being the dominant type of plaintiff at this district court: A PAE was the plaintiff in 84% of all suits in Eastern Texas. In total, PAEs filed 77% of their suits at the five most popular district courts with a strongly varying share (e.g., 25% in New Jersey). Nonetheless, I detected an even stronger correlation between the share of indirect suits and the share of PAE-initiated suits ($r = 0.53$). The overall share of PAE-initiated suits of 51% was roughly in line with the 40.4% (2011) and 58.7% (2012) observed by Feldman et al. (2013), the 40% (2011) identified by Jeruss et al. (2012), and the sizeable majority detected by Love (2012). Overall, scholars noted an increasing share of suits filed by PAEs over time (Jeruss et al., 2012; RPX Corporation, 2013; Cotropia et al., 2014). Analogously, I detected an increase in the share of suits filed by PAEs from 17% in 2010 to 61% in 2016 (*Table 28*). The share remained more or less unchanged between 2012 and 2016. Admittedly, the number of suits filed per year in the sample varied and was, in some years, small (e.g., 42 suits in 2010). This likely impacts the confidence in the observed share of suits filed by PAEs. Nonetheless, this analysis provides a first glimpse into litigation dynamics. *Table 27* provides an overview of the geographic distribution of patent infringement suits and *Table 28* on the time-related patterns underlying the suits in the sample.

5.4.2 Descriptive results – Time-based trends and cross-tabulation

The filing dates of the suits were not equally distributed over time. This is due to the disproportionate distribution over time of the suits contained in the cleaned dataset consisting of 28,536 suits (*Figure 11*). The relative distribution across years was comparable between the cleaned dataset and the random sample: 2010 exhibited the lowest share of suits (8% in both cases) followed by 2011 (11% in both cases) and 2016 (13% in both cases). Interestingly, the share of suits involving predominantly product and complex technology patents remained relatively constant over time. With the exceptions of 2011 (product) and 2010 (complex technology) the shares fluctuated around 55% and 70%, respectively. Unfortunately, I cannot draw any comparison with the cleaned dataset due to the enormous time effort required to conduct the required analyses. This applies to the other descriptive statistics displayed in *Table 28* as well.

While the increase in the share of indirect suits from 21% in 2010 to 39% in 2016 could be related to changes in the litigation strategy (e.g., defendant selection) of plaintiffs, it could also be a consequence of changes in the composition of suits. The share of suits in the electronics industry increased from 19% in 2010 to 45% in 2016, whereas the shares of suits in the chemicals industry declined from 24% in 2010 to just 2% in 2016. In addition, the share of PAE initiated suits increased from 17% in 2010 to 61% in 2016.

Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Suits (abs. | rel.)	42 | 8%	55 | 11%	75 | 15%	83 | 17%	77 | 15%	102 | 20%	66 | 13%
Product patent (abs. | rel.)	23 | 55%	22 | 40%	41 | 55%	44 | 53%	45 | 58%	55 | 54%	37 | 56%
Complex technology (abs. | rel.)	19 | 45%	37 | 67%	55 | 73%	66 | 80%	54 | 70%	71 | 70%	52 | 79%
SEP (abs. | rel.)	0 | 0%	0 | 0%	7 | 9%	7 | 8%	3 | 4%	7 | 7%	3 | 5%
PAE suits (abs. | rel.)	7 | 17%	21 | 38%	43 | 57%	44 | 53%	43 | 56%	56 | 55%	40 | 61%
Indirect (abs. | rel.)	9 | 21%	12 | 22%	26 | 35%	32 | 39%	30 | 39%	37 | 36%	26 | 39%
Electronic & Other Elect. Equip. & Components (abs. | rel.)	8 | 19%	15 | 27%	25 | 33%	28 | 34%	21 | 27%	32 | 31%	30 | 45%
Chemicals and Allied Products (abs. | rel.)	10 | 24%	10 | 18%	7 | 9%	6 | 7%	11 | 14%	9 | 9%	1 | 2%

Table 28: Patterns over time

In my sample, a suit comprised, on average, 1.1 plaintiffs and 1.6 defendants. While the average number of plaintiffs did not differ between direct and indirect suits, the average number of defendants did. Depending on the treatment of ambiguous suits, the number of defendants was either significantly (5%-level) higher in the case of direct suits (when treating ambiguous suits as direct suits) or higher in the case of indirect suits (when treating ambiguous suits as indirect suits). This is intuitive since, by definition, ambiguous suits need to specify at least two defendants. On average, plaintiffs and defendants were repeated customers involved in 23.5 and 32.7 suits, respectively. Moreover, plaintiffs claimed infringement of, on average, 2.2 utility patents per suit, which counted 74.7 backward and 101.5 forward citations at the date of the filing of the suit. In the case of all five variables, I could not observe a consistently significant difference between direct and indirect suits (*Table 29*).

		Standard classification			Alternative classification		
	Average	**Direct**	**Indirect**	**p-value**	**Direct**	**Indirect**	**p-value**
Plaintiffs per suit	1.1	1.1	1.1	0.42	1.1	1.1	0.37
Defendants per suit	1.6	1.7	1.3	0.02**	1.3	1.9	0.00***
Experience of plaintiffs (# of suits up to 7 years before focal suit)	23.5	22.8	25.0	0.63	24.4	22.2	0.60
Experience of defendants (# of suits up to 7 years before focal suit)	32.7	29.1	39.6	0.07*	29.5	37.6	0.15
Utility patents-in-suit per suit	2.2	2.2	2.2	0.80	2.2	2.2	0.91
Backward citations per patent-in-suit	74.7	72.4	79.0	0.54	73.7	76.2	0.81
Forward citations per patent-in-suit	101.5	94.8	114.2	0.17	98.7	105.7	0.61
Age of patents-in-suit	13.6	12.7	15.3	0.00***	12.6	15.0	0.00***
Litigation frequency	13.5	8.7	22.8	0.00***	9.2	20.2	0.00***
Suits involving ≥ 1 foreign plaintiff	0.2	0.2	0.1	0.01***	0.2	0.1	0.06*
Suits involving ≥ 1 foreign defendant	0.3	0.3	0.3	0.41	0.3	0.4	0.49

Table 29: Descriptive statistics for comparison of direct and indirect suits

Indirect suits comprised patents that were closer to their expiration at the date of the filing of the suit compared to direct suits. This could be related to the hypothesized association of PAEs with indirect suits. In contrast to product-producing firms, PAEs litigate patents closer to the end of their patent term (Love, 2012). This is related to their sourcing strategy for patents (i.e., rather via patent acquisitions than the filing of their own patent applications), their interest in a technological lock-in of implementers (Love, 2012), and their preference for monetary compensation over the enforcement of an injunction. Another potential reason could be that an indirect infringement suit typically implies skipping a level in the value chain and litigating further downstream. It takes more time for an invention to reach a downstream level in the value chain as opposed to an upstream level.

In addition, indirect suits contain patents that were significantly more frequently litigated before and were significantly less often assigned to suits filed by foreign plaintiffs (1%-level). The former observation could be caused by the hypothesized role of PAEs in filing indirect suits. Besides claiming infringement of more frequently litigated patents in general (litigation frequency of 23.2), PAEs selected significantly (5%-level) more litigated patents to pursue indirect suits than direct suits (28.7 vs. 17.8, p = 0.02). Also, plaintiffs could decide to follow the strategy of never changing a “winning patent”. The latter observation that foreign plaintiffs less often pursue indirect suits than direct suits could result from a lack of adequate patents or a lack of knowledge of the local competitive environment downstream. Plaintiffs require local patents for litigation due to the nature of patents as territorial rights (WIPO, n.d.a; 64 EPC, 2020, § 1).

A cross table (*Table 30*) can provide first insights into the relationship between the hypothesized variables *Product*, *Complex technology*, *SEP*, and *Plaintiff_PAE*. PAEs filed the majority of indirect suits (73%; 126/172). Plaintiffs in indirect suits claimed largely the infringement of predominantly product patents (72%; 124/172) and complex technology patents (94%; 165/172). Those observations were consistent in the case of the alternative treatment of ambiguous suits as well (PAE: 69%, 136/197; Product: 72%, 142/197; Complex technology: 94%, 185/197). Even though few suits were related to the infringement of SEPs, 93% of suits that predominantly comprised SEPs were indirect ones.

In all four cases, the ratio of indirect suits under the condition that the focal hypothesis is 1 to indirect suits under the condition that the focal hypothesis is 0 exceeds the respective ratio for direct suits. For instance, the ratio for indirect suits is about 28 times larger than for direct ones in the case of SEPs (25 to 2 vs. 147 to 326).

		Indirect		**Direct**			
		#	**%**	**#**	**%**		
Hypothesis 1	**Product patent**	124	25%	143	29%	36.82	Chi sq.
	Process patent	48	10%	185	37%	0.00	p-value
Hypothesis 2	**Complex technology**	165	33%	189	38%	80.09	Chi sq.
	Discrete technology	7	1%	139	28%	0.00	p-value
Hypothesis 3	**SEP**	25	5%	2	0%	42.83	Chi sq.
	No SEP	147	29%	326	65%	0.00	p-value
Hypothesis 4	**Plaintiff PAE**	126	25%	128	26%	52.90	Chi sq.
	Plaintiff not PAE	46	9%	200	40%	0.00	p-value

Table 30: Cross table for dependent variable and hypothesized variables – Ambiguous suits displayed as direct suits

Both cross tables (*Table 30* and *Table 31*), i.e., one cross table for each approach toward treating ambiguous suits, showed highly significant chi square values (1%-level) for all hypothesized variables, implying that both variables, i.e., the type of suit and the respective hypothesized variable, are independent of each other. Therefore, further analyses on the selection of the litigation level are worth pursuing.

		Indirect		Direct		
		#	%	#	%	
Hypothesis 1	**Product patent**	142	28%	125	25%	45.59 Chi sq.
	Process patent	55	11%	178	36%	0.00 p-value
Hypothesis 2	**Complex technology**	185	37%	169	34%	83.97 Chi sq.
	Discrete technology	12	2%	134	27%	0.00 p-value
Hypothesis 3	**SEP**	25	5%	2	0%	33.82 Chi sq.
	No SEP	172	34%	301	60%	0.00 p-value
Hypothesis 4	**Plaintiff PAE**	136	27%	118	24%	43.25 Chi sq.
	Plaintiff not PAE	61	12%	185	37%	0.00 p-value

Table 31: Cross table for dependent variable and hypothesized variables – Ambiguous suits displayed as indirect suits

5.4.3 Descriptive results – Industry analyses

Replicating the same cross-tabulation analysis on a one-digit and two-digit SIC level illustrates industry specifics and dynamics (*Table 32* and *Table 33*). Overall, 34% (39% when treating ambiguous suits as indirect ones) of all suits were indirect suits. However, the prevalence of indirect suits fluctuates across industries. While indirect suits are very common or even predominant in Transportation & Public Utilities (45%; 13/29) and Retail trade (65%; 34/52), they are less frequently observable in manufacturing (28%; 86/311) and service industries (29%; 24/82). On the two-digit SIC level, an even more heterogeneous picture emerges. For instance, indirect suits are dominant in the Transportation Equipment (57%; 12/21) and electronics industry (47%; 51/108; 58% when treating ambiguous suits as indirect ones), whereas they are less frequent in the Measuring, Photographic, Medical, & Optical Goods, & Clocks (22%; 8/37) and the Chemicals and Allied Products industries (2%; 1/53). While the exact prevalences differ between the two treatment approaches of ambiguous suits, the general observations remain unaffected.

What comes as a surprise at first sight is the high share of suits (Retail trade with 12%) targeted at retailers. In contrast, I assigned just 0.2% of all patent licenses from Chapter 4 to Retail trade. Retailers typically create value for manufacturers by placing large orders at producing firms, breaking the bulk, and offering handier unit sizes to their customers. For their customers, they typically create value by reducing transaction costs, e.g., by consolidating the offerings of many producing firms, having stores at convenient locations, and assuring the availability of goods. However, retailers typically do not produce the goods on their own and, thus, do not implement the patented by themselves. Thus, retailers need to be an attractive litigation target for other reasons, such as attractive financial returns or high leverage for plaintiffs.

Industry[1]		# patent infringe-ment suits	Preva-lence	*Hypothesis 1* Product patent	*Hypothesis 1* Process patent	*Hypothesis 2* Complex techno-logy	*Hypothesis 2* Discrete techno-logy	*Hypothesis 3* SEP	*Hypothesis 3* No SEP	*Hypothesis 4* Plaintiff PAE	*Hypothesis 4* Plaintiff not PAE
Manufacturing	Indirect	86	28%	19%	8%	27%	1%	5%	22%	22%	5%
	Direct	225		41%	32%	31%	41%	0%	72%	18%	54%
Transportation Equipment	Indirect	12	57%	48%	10%	57%	0%	0%	57%	38%	19%
	Direct	9		38%	5%	33%	10%	0%	43%	5%	38%
Electronic & Other Electrical Equip. & Components	Indirect	51	47%	31%	17%	46%	1%	15%	32%	39%	8%
	Direct	57		34%	19%	44%	8%	1%	52%	31%	22%
Measuring, Photo., Medical, & Optical Goods, & Clocks	Indirect	8	22%	14%	8%	19%	3%	3%	19%	19%	3%
	Direct	29		49%	30%	43%	35%	0%	78%	22%	57%
Industrial & Com. Machinery & Computer Equip.	Indirect	3	11%	11%	0%	11%	0%	0%	11%	11%	0%
	Direct	24		56%	33%	63%	26%	0%	89%	19%	70%
Chemicals and Allied Products	Indirect	1	2%	2%	0%	2%	0%	0%	2%	0%	2%
	Direct	52		17%	81%	0%	98%	0%	98%	2%	96%
Other	Indirect	11	17%	12%	5%	15%	2%	0%	17%	14%	3%
	Direct	54		62%	22%	12%	71%	0%	83%	12%	71%
Services	Indirect	24	29%	23%	6%	28%	1%	1%	28%	21%	9%
	Direct	58		12%	59%	65%	6%	0%	71%	46%	24%
Business Services	Indirect	18	25%	23%	3%	24%	1%	1%	24%	17%	8%
	Direct	53		13%	62%	72%	3%	0%	75%	49%	25%
Other	Indirect	6	55%	27%	27%	55%	0%	0%	55%	45%	9%
	Direct	5		9%	36%	18%	27%	0%	45%	27%	18%
Transportation and public utilities	Indirect	13	45%	38%	7%	45%	0%	10%	34%	34%	10%
	Direct	16		7%	48%	48%	7%	3%	52%	48%	7%
Communications	Indirect	7	39%	33%	6%	39%	0%	17%	22%	22%	17%
	Direct	11		11%	50%	61%	0%	6%	56%	61%	0%
Other	Indirect	6	55%	45%	9%	55%	0%	0%	55%	55%	0%
	Direct	5		0%	45%	27%	18%	0%	45%	27%	18%
Finance, insurance and real estate	Indirect	8	47%	24%	24%	47%	0%	0%	47%	41%	6%
	Direct	9		0%	53%	47%	6%	0%	53%	47%	6%
Retail trade	Indirect	34	65%	50%	15%	63%	2%	8%	58%	40%	25%
	Direct	18		6%	29%	31%	4%	0%	35%	23%	12%
Other	Indirect	7	78%	44%	33%	56%	22%	0%	78%	22%	56%
	Direct	2		11%	11%	22%	0%	0%	22%	0%	22%
Total	Indirect	172	34%	25%	10%	33%	1%	5%	29%	25%	9%
	Direct	328		29%	37%	38%	28%	0%	65%	26%	40%

[1]Based on one-digit and two-digit SIC code

Table 32: Cross table for dependent variable and hypothesized variables across industries – Ambiguous suits displayed as direct suits

Industries with a high prevalence of indirect suits tend to claim infringement of mainly product and complex technology patents and to exhibit high PAE activity (e.g., 86%/90%/43% in Transportation Equipment vs. 19%/2%/2% in Chemicals and Allied Products for *Product*/*Complex technology*/*Plaintiff PAE*). Also, established industry practices could play a role: The high share of indirect suits in electronics is likely related to the practice of device-level licensing for SEPs

(Geradin, 2020; SEPs Expert Group, 2021), with 31% of indirect suits in electronics involving SEPs (16/51).

				Hypothesis 1		*Hypothesis 2*		*Hypothesis 3*		*Hypothesis 4*	
Industry[1]		**# patent infringe-ment suits**	**Preva-lence**	**Product patent**	**Process patent**	**Complex techno-logy**	**Discrete techno-logy**	**SEP**	**No SEP**	**Plaintiff PAE**	**Plaintiff not PAE**
Manufacturing	Indirect	108	35%	25%	10%	32%	3%	5%	29%	25%	10%
	Direct	203		35%	30%	25%	40%	0%	65%	15%	50%
Transportation Equipment	Indirect	12	57%	48%	10%	57%	0%	0%	57%	38%	19%
	Direct	9		38%	5%	33%	10%	0%	43%	5%	38%
Electronic & Other Electrical Equip. & Components	Indirect	63	58%	40%	19%	56%	2%	15%	44%	45%	13%
	Direct	45		25%	17%	34%	7%	1%	41%	24%	18%
Measuring, Photo., Medical, & Optical Goods, & Clocks	Indirect	11	30%	19%	11%	24%	5%	3%	27%	22%	8%
	Direct	26		43%	27%	38%	32%	0%	70%	19%	51%
Industrial & Com. Machinery & Computer Equip.	Indirect	6	22%	19%	4%	22%	0%	0%	22%	15%	7%
	Direct	21		48%	30%	52%	26%	0%	78%	15%	63%
Chemicals and Allied Products	Indirect	1	2%	2%	0%	2%	0%	0%	2%	0%	2%
	Direct	52		17%	81%	0%	98%	0%	98%	2%	96%
Other	Indirect	15	23%	17%	6%	17%	6%	0%	23%	14%	9%
	Direct	50		57%	20%	11%	66%	0%	77%	12%	65%
Services	Indirect	27	33%	24%	9%	32%	1%	1%	32%	22%	11%
	Direct	55		11%	56%	61%	6%	0%	67%	45%	22%
Business Services	Indirect	21	30%	24%	6%	28%	1%	1%	28%	18%	11%
	Direct	50		11%	59%	68%	3%	0%	70%	48%	23%
Other	Indirect	6	55%	27%	27%	55%	0%	0%	55%	45%	9%
	Direct	5		9%	36%	18%	27%	0%	45%	27%	18%
Transportation and public utilities	Indirect	13	45%	38%	7%	45%	0%	10%	34%	34%	10%
	Direct	16		7%	48%	48%	7%	3%	52%	48%	7%
Communications	Indirect	7	39%	33%	6%	39%	0%	17%	22%	22%	17%
	Direct	11		11%	50%	61%	0%	6%	56%	61%	0%
Other	Indirect	6	55%	45%	9%	55%	0%	0%	55%	55%	0%
	Direct	5		0%	45%	27%	18%	0%	45%	27%	18%
Finance, insurance and real estate	Indirect	8	47%	24%	24%	47%	0%	0%	47%	41%	6%
	Direct	9		0%	53%	47%	6%	0%	53%	47%	6%
Retail trade	Indirect	34	65%	50%	15%	63%	2%	8%	58%	40%	25%
	Direct	18		6%	29%	31%	4%	0%	35%	23%	12%
Other	Indirect	7	78%	44%	33%	56%	22%	0%	78%	22%	56%
	Direct	2		11%	11%	22%	0%	0%	22%	0%	22%
Total	Indirect	197	39%	28%	11%	37%	2%	5%	34%	27%	12%
	Direct	303		25%	36%	34%	27%	0%	60%	24%	37%

[1]Based on one-digit and two-digit SIC code

Table 33: Cross table for dependent variable and hypothesized variables across industries – Ambiguous suits displayed as indirect suits

5.4.4 **Descriptive results – Correlation analyses**

The analysis of a correlation matrix can provide further evidence. Its interpretation needs to account for the sample size (N = 500), the resulting significance thresholds (e.g., a correlation of about 0.11 translates into a significance level of 1%), and the size of the correlation coefficients.

Mirroring the results from the cross-tabulation analysis, I detected highly significant (1%-level) correlations between all four hypothesized variables and indirect suits, thereby, further supporting my proposed hypotheses: *Complex technology* (r = 0.40), *Plaintiff PAE* (r = 0.33), *SEP* (r = 0.29), and *Product patent* (r = 0.27) (*Table 34*). These results were robust when I treated ambiguous suits as indirect suits (e.g., *Complex technology* with r = 0.41; *Table 35*). Given that *ICT* represents a subset of complex technologies the observed correlations fit my expectations: Highly significant (1%-level) correlations between *ICT* and indirect suits (r = 0.31) as well as *Complex technology* (r = 0.71). In line with findings from other scholars (e.g., Allison et al., 2012; Cotropia et al., 2014), *ICT* patents are very litigious. For instance, more than every second suit in the sample involved predominantly *ICT* patents, as the mean of 0.55 for the binary *ICT* variable shows.

My findings with regards to *Plaintiff PAE* are consistent with previous scholarly work: PAEs seem to prefer litigating ICT (Risch, 2012; Federal Trade Commission, 2016) process patents (Risch, 2012) as indicated by a significant (5%-level) negative correlation between *Plaintiff PAE* and *Product* (r = -0.10) as well as highly significant positive (1%-level) correlations between *Plaintiff PAE* as well as *Complex technology* (r = 0.51) and *ICT* (r = 0.64). Moreover, the correlation between *Plaintiff PAE* and *Only expired patents-in-suit* was positive (0.13) and highly significant (1%-level) as predicted. This correlation is in line with related findings by other scholars (e.g., Mann, 2004; Merges, 2009; Love, 2012; Risch, 2012).

As expected, due to ambiguous arguments, I failed to detect a significant correlation between *Parallel ITC case* and indirect suits (r = -0.03). Also, the overall prevalence of parallel ITC cases was low: 3% of all suits filed on the district court level were part of a parallel ITC case. While the correlation coefficients for both *Countersuit* (r = -0.07) and *Only expired patents-in-suit* (r = 0.07) showed the expected sign, both coefficients were not significant. Again, both constellations rarely occurred.

In addition, I observed highly significant (1%-level) correlations between *Age* (r = 0.26), *Litigation frequency* (r = 0.23), and *Was patent-in-suit before* (r = 0.19) and indirect suits. All three variables were highly significantly (1%-level) correlated with *Plaintiff PAE* (r = 0.39, r = 0.35, and r = 0.40). For both *Age* and *Litigation frequency*, I noted significantly higher values for indirect suits compared to direct suits in an earlier analysis.

	Mean	Indirect	Product patent	Complex tech-nology	SEP	Plaintiff PAE	ICT	Counter-suit	Only exp. patents-in-suit	Parallel ITC case
Indirect	0.34	1.00								
Product patent	0.53	0.27***	1.00							
Complex technology	0.71	0.40***	0.00	1.00						
SEP	0.05	0.29***	0.03	0.15***	1.00					
Plaintiff PAE	0.51	0.33***	-0.10**	0.51***	0.16***	1.00				
ICT	0.55	0.31***	-0.17***	0.71***	0.22***	0.64***	1.00			
Countersuit	0.01	-0.07	-0.01	-0.04	-0.02	-0.09**	-0.10**	1.00		
Only expired patents-in-suit	0.07	0.07	-0.04	0.06	0.03	0.13***	0.12***	-0.03	1.00	
Parallel ITC case	0.03	-0.03	0.02	0.09**	0.06	-0.06	0.02	-0.02	0.00	1.00

Table 34: Correlation matrix for selected variables (ambiguous suits treated as direct suits)

	Mean	Indirect	Product patent	Complex tech-nology	SEP	Plaintiff PAE	ICT	Counter-suit	Only exp. patents-in-suit	Parallel ITC case
Indirect	0.39	1.00								
Product patent	0.53	0.30***	1.00							
Complex technology	0.71	0.41***	0.00	1.00						
SEP	0.05	0.26***	0.03	0.15***	1.00					
Plaintiff PAE	0.51	0.29***	-0.10**	0.51***	0.16***	1.00				
ICT	0.55	0.29***	-0.17***	0.71***	0.22***	0.64***	1.00			
Countersuit	0.01	-0.07	-0.01	-0.04	-0.02	-0.09**	-0.10**	1.00		
Only expired patents-in-suit	0.07	0.05	-0.04	0.06	0.03	0.13***	0.12***	-0.03	1.00	
Parallel ITC case	0.03	-0.02	0.02	0.09**	0.06	-0.06	0.02	-0.02	0.00	1.00

Table 35: Correlation matrix for selected variables (ambiguous suits treated as indirect suits)

5.4.5 **Descriptive results – Technology classes and defendant selection**

The next analysis provides further insight into the types of technologies underlying the suits in the sample. I assigned the suits to Cooperative Patent Classification (CPC) (European Patent Office, 2013) based on the patent-level data provided by Google Patents. I assigned the suit to the respective section if at least one of the patents-in-suit was allocated to a section (e.g., section A) according to Google Patents. Consequently, a suit could be assigned to multiple sections, i.e., as opposed to the original 500 suits in the samples, I counted 819 assignments in this analysis (*Table 36*). Analogous to similar analyses (e.g., Cotropia et al., 2014), I observed most suits to comprise patents from CPC sections physics (G) and electronics (H). Comparable with the findings from, e.g., Cotropia et al. (2014), patents assigned to the sections human necessities (A) as well as chemistry and metallurgy (C) were frequently but, overall, less often litigated. As expected, suits comprising at least one patent from sections G or H were characterized by predominantly complex technologies at a share of 92% and 95%, respectively. On the contrary, suits comprising at least one patent from sections A or C were characterized by predominantly discrete technologies. The fact that the share of complex technologies did not reach 100% or 0%, respectively, could be explained by my definition of *Complex technology*. Any suit comprising predominantly complex technology patents, i.e., at least 50% of the patents-in-suit, was treated as *Complex technology*. This implied that a suit could not be predominantly *Complex technology* while incorporating a patent from section G or H. Per my previous analyses, the share of indirect suits was particularly high in sections with a high share of *Complex technology* suits, e.g., sections G and H. A replication of the analysis treating the 25 ambiguous suits as indirect ones led to similar results.

CPC section	Description	Suits (#)[1]	T/o complex (%)[2]	T/o indirect (%)
A	Human necessities	112	20%	11%
B	Performing operations & transporting	75	49%	24%
C	Chemistry and metallurgy	41	10%	5%
D	Textiles and paper	1	100%	0%
E	Fixed constructions	18	33%	22%
F	Mechanical engineering	28	61%	25%
G	Physics	255	92%	42%
H	Electricity	187	95%	44%
Y	New or cross-sectional technology	102	65%	32%
	Total	**819**	**69%**	**32%**

[1]Number of suits does not match with sample size: a suit in the sample could involve patent(s) from multiple CPC sections

[2]Share of suits assigned to the respective CPC section with predominantly complex technology patents-in-suit

Table 36: Share of indirect infringement suits by CPC section

In an alternative classification approach aimed at assuring robustness, I allocated a suit to a section if the majority – as opposed to at least one patent – of the patents-in-suit belonged to the respective section. In accordance with this approach, I needed to assign a suit to two sections if, for example, the suit comprised two patents which each belonged to the same two distinct sections. Consequently, the number of suits displayed in *Table 37* was lower than those from the previous counting approach. However, it still exceeded the number of 500 suits in the sample. Nonetheless, the results were comparable for both approaches, demonstrating robustness. I observed only one notable difference in section F: The share of indirect suits dropped from 25% to 16%, which could be related to an overproportionate decrease in the number of suits from 28 to 19 compared to the decrease in the overall number of suits from 819 to 739.

CPC section	Description	Suits (#)[1]	T/o complex (%)[2]	T/o indirect (%)
A	Human necessities	110	20%	11%
B	Performing operations & transporting	72	49%	24%
C	Chemistry and metallurgy	35	9%	6%
D	Textiles and paper	0	N/A	N/A
E	Fixed constructions	16	31%	19%
F	Mechanical engineering	19	42%	16%
G	Physics	233	92%	41%
H	Electricity	175	95%	45%
Y	New or cross-sectional technology	79	59%	34%
	Total	**739**	**68%**	**32%**

[1]Number of suits does not match with sample size: a suit in the sample could involve patent(s) from multiple CPC sections

[2]Share of suits assigned to the respective CPC section with predominantly complex technology patents-in-suit

Note: 4 suits without predominant assigment to CPC section

Table 37: Share of indirect infringement suits by CPC section (alternative counting approach)

Plotting the selection of the litigation level in the value chain, as well as the litigation target by plaintiff type, provides further insights into the preferences of plaintiffs (*Table 38*). As elaborated in 5.3.2, I distinguished between direct suits in general as well as indirect suits targeted at a manufacturer, a merchant, or a user. In this context, a manufacturer could be positioned on any level in the value chain, e.g., as an upstream supplier or downstream device maker, if the underlying suit is of an indirect nature. The category "Other" includes inventors and plaintiffs that could not be assigned to a type, e.g., due to lack of information. Overall, in indirect suits, plaintiffs showed a slight preference for manufacturers (16% of all suits) over users (15%). Plaintiffs rarely selected merchants (3%) as targets.

	Ambiguous suits treated as direct suits								*Ambiguous suits treated as indirect suits*							
	Direct		**Indirect**						**Direct**		**Indirect**					
Plaintiff type	**Various**		**Manufacturer**		**Merchant**		**User**		**Various**		**Manufacturer**		**Merchant**		**User**	
	(abs.)	(rel.)	(abs.)	(rel.)	(abs.)	(rel.)	(abs.)	(rel.)	(abs.)	(rel.)	(abs.)	(rel.)	(abs.)	(rel.)	(abs.)	(rel.)
Practicing entity	179	86%	11	5%	8	4%	11	5%	165	79%	14	7%	16	8%	14	7%
Patent assertion entity	128	50%	65	26%	3	1%	58	23%	118	46%	68	27%	7	3%	61	24%
Other	21	57%	6	16%	3	8%	7	19%	20	54%	6	16%	3	8%	8	22%
Total	328	66%	82	16%	14	3%	76	15%	303	61%	88	18%	26	5%	83	17%

Table 38: Litigation level in the value chain – Target selection by plaintiff type

While practicing entities predominantly selected the original implementer of the patented technology as the litigation target (86%), PAEs demonstrated a higher degree of heterogeneity in their preferences: They selected in 50% of all suits the original implementer as target. In the case of indirect suits, they selected more or less equally often a manufacturer or user. Testing for robustness by treating all ambiguous suits as indirect suits yielded similar results. For the already discussed reasons, the overall share of indirect suits and, thus, for the respective defendant types was higher when treating ambiguous suits as indirect ones.

5.4.6 **Regression analysis**

I estimated a baseline model containing the case- and patent-level variables described in 5.3.2 and 5.3.3 and an extended model in which I incorporated year-fixed effects based on the filing date of the suit. I decided to incorporate year-fixed effects because of the increasing prevalence of indirect suits over time observed in 5.4.2.

Before conducting the regression analysis, I tested the goodness of fit by running the Hosmer-Lemeshow test, "a commonly used procedure for assessing goodness of fit in logistic regression" (p. 67). I could reject the null hypothesis for the base ($p = 0.70$) and extended ($p = 0.39$) model, implying a good model fit. In addition, I tested for the discrimination ability of the model by determining the area under the ROC curve (Pearce & Ferrier, 2000). The AUC values of 0.87 (base model) and 0.88 (extended model) respectively indicated good discrimination abilities of the models (Swets, 1988).

Both the base and the extended models supported all my four hypotheses: *Product*, *Complex technology*, *SEP*, and *Plaintiff PAE* were significant at the 1%-level. In the base model, the odds ratios ranged from 2.9 (*Plaintiff PAE*) to 43.2 (*SEP*). *Product* and *Complex technology* reached odds ratios of 6.4 and 11.7, respectively. This implies, for instance, that a suit against a defendant for infringing predominantly complex technology patents is 11.7 times more likely than a suit involving predominantly discrete technology patents to be an indirect suit (*Table 39*).

In contrast to my expectations, both variables, *ICT* and *Only expired patents-in-suit*, neither had an odds ratio exceeding 1.0 nor were they significant. It appears that non-ICT complex technologies were strongly associated with indirect suits such that *ICT* as a subset of *Complex technology* was not as relevant as expected. This appeared plausible since the share of indirect suits was comparable for *ICT* (48%) and non-ICT (43%) complex technologies. With regards to *Only expired patents-in-suit*, in general, low prevalence, resulting in an imbalance, made the interpretation of results more challenging.

Besides finding supportive evidence for my four hypothesized variables, I detected significant coefficients for *Plaintiff inventor* at 5%- and 10%-level, *Number of defendants* at 5%-level, and *≥1 foreign defendant* at 10%-level in the base and extended model. The odds ratio for *Number of defendants* and *≥1 foreign defendant* was 0.8 and 0.6, respectively. This indicated a lower likelihood for a suit being indirect with an increase in the continuous variable or a positive binary variable.

		Baseline model			Extended model		
		Number of obs =		500	Number of obs =		500
		LR chi2(31) =		230.26	LR chi2(37) =		231.76
		Prob > chi2 =		0.00	Prob > chi2 =		0.00
		Pseudo R2 =		0.36	Pseudo R2 =		0.36
		Log likelihood =		-206.70	Log likelihood =		-205.95
Type	**DV: Indirect**	**Odds Ratio**	**Sig.**	**P > | z |**	**Odds Ratio**	**Sig.**	**P > | z |**
1	Product	6.39	***	0.00	6.58	***	0.00
2	Complex technology	11.66	***	0.00	11.45	***	0.00
3	SEP	43.18	***	0.00	48.16	***	0.00
4	Plaintiff PAE	2.87	***	0.01	2.81	***	0.01
Corr.	ICT	0.78		0.54	0.82		0.63
	Only expired patents-in-suit	0.76		0.61	0.72		0.55
	Parallel ITC case	0.48		0.36	0.45		0.33
Controls	Utilitypatentsinsuit	1.00		0.97	1.01		0.92
	Designpatentsinsuit	1.40		0.62	1.36		0.65
	Reissuepatentsinsuit	2.24		0.42	2.36		0.39
	Plaintiff inventor	3.39	**	0.03	3.04	*	0.06
	Plaintiff researching entity	0.47		0.68	0.43		0.65
	Defendant researching entity	11.25		0.30	13.11		0.26
	Number of plaintiffs	0.76		0.49	0.72		0.43
	Number of defendants	0.81	**	0.02	0.81	**	0.02
	Log patentfamily	0.54		0.15	0.53		0.15
	Log backward citations	1.24		0.57	1.23		0.59
	Log backward citations examinor	0.72		0.42	0.71		0.41
	Log forward citations	0.64		0.50	0.64		0.50
	Log forward citations examinor	2.11		0.29	2.17		0.29
	CPC sections	0.97		0.84	0.95		0.78
	Claims	1.00		0.55	1.00		0.56
	Continuation	1.21		0.60	1.23		0.57
	Reexamination	1.68		0.32	1.64		0.34
	Age	1.06		0.13	1.06		0.15
	Litigation frequency	1.01		0.12	1.01		0.11
	Was patent-in-suit before	1.22		0.60	1.31		0.50
	Avg. experience plaintiff	0.99		0.21	0.99		0.18
	Avg. experience defendant	1.00		0.52	1.00		0.52
	≥1 foreign plaintiff	1.72		0.26	1.79		0.23
	≥1 foreign defendant	0.58	*	0.07	0.57	*	0.07
	Year fixed effects	No			Yes		
	Constant	1.72		0.26	0.01	***	0.00

*** Significant at 1% level; ** Significant at 5% level; *** Significant at 1% level

Table 39: Regression results (logit model)

An indirect suit could target manufacturers further downstream in the value chain than the original infringer, merchants, and users alike. Due to this diversity, I shed light on the defendant selection by running a multinomial logic regression. I selected direct suits as the base in the multinomial logic model. Then, I assessed the selection of a manufacturer and indirect infringer, merchant, and user as litigation targets relative to the base. *Table 40* illustrates the model outcomes.

Number of obs =	500
LR chi2(93) =	379.460
Prob > chi2 =	0.000
Pseudo R2 =	0.396
Log likelihood =	-290.033

		Manufacturer (indirect)			**Merchant**			**User**		
Type	**Explanatory variable**	**Coefficient**	**Sig.**	**P > | z |**	**Coefficient**	**Sig.**	**P > | z |**	**Coefficient**	**Sig.**	**P > | z |**
1	Product	2.12	***	0.00	18.57		0.99	1.51	***	0.00
2	Complex technology	2.23	***	0.01	3.35	***	0.00	2.91	***	0.00
3	SEP	4.22	***	0.00	6.84	***	0.00	2.88	***	0.01
4	Plaintiff PAE	1.67	***	0.00	0.92		0.59	0.80		0.10
	ICT	0.18		0.74	-4.53	**	0.04	-0.18		0.73
Corr.	Only expired patents-in-suit	-1.36	*	0.08	-12.57		1.00	-0.03		0.96
	Parallel ITC case	-0.40		0.67	-15.61		1.00	-17.89		1.00
	Utilitypatentsinsuit	0.03		0.75	-0.67		0.30	-0.02		0.85
	Designpatentsinsuit	-22.95		1.00	0.90		0.25	-22.69		1.00
	Reissuepatentsinsuit	1.81		0.10	-11.04		1.00	-16.94		1.00
	Plaintiff inventor	1.81	**	0.03	0.43		0.74	0.87		0.23
	Plaintiff researching entity	-1.63		0.49	-14.94		1.00	-0.10		0.95
	Defendant researching entity	3.59		0.14	-9.88		1.00	-15.73		1.00
	Number of plaintiffs	-0.55		0.31	0.50		0.73	-0.19		0.72
	Number of defendants	-0.34	**	0.03	0.43		0.23	-0.18		0.16
	Log patentfamily	-0.69		0.23	-1.63		0.31	-0.39		0.48
	Log backward citations	-0.33		0.53	1.78		0.18	0.43		0.37
	Log backward citations examinor	-0.12		0.84	-0.70		0.55	-0.45		0.38
Controls	Log forward citations	-0.84		0.40	-5.26		0.18	0.27		0.72
	Log forward citations examinor	0.91		0.39	6.89		0.11	0.18		0.83
	CPC sections	0.10		0.67	0.63		0.27	-0.30		0.22
	Claims	0.00		0.99	0.01		0.53	-0.01		0.37
	Continuation	0.90	*	0.07	-1.26		0.36	-0.03		0.95
	Reexamination	1.02		0.11	3.08		0.16	0.08		0.91
	Age	0.08		0.14	-0.20	*	0.09	0.11	**	0.04
	Litigation frequency	0.00		0.56	0.07	*	0.10	0.01		0.14
	Was patent-in-suit before	0.70		0.28	-0.06		0.95	-0.30		0.55
	Avg. experience plaintiff	-0.01		0.17	-0.09		0.12	0.00		0.70
	Avg. experience defendant	0.00		0.28	0.02	*	0.10	0.00		0.38
	≥1 foreign plaintiff	1.31	**	0.04	0.94		0.45	-0.58		0.50
	≥1 foreign defendant	0.57		0.13	-20.31		0.99	-1.35	***	0.00
	Constant	-6.73	***	0.00	-23.30		0.99	-5.74	***	0.00

*** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level

Table 40: Multinomial logit model (ambiguous suits treated as direct suits)

With downstream manufacturers as the target, all four hypothesized variables remained significant on the 1%-level. With merchants as the target, *Complex technology* and *SEP* remained significant on the 1%-level, but *Product* and *Plaintiff PAE* were not significant. Results for merchants needed to be reviewed carefully and their reliability to be questioned due to the small sample size of 14 indirect suits targeted at merchants. With users as the target, *Product*, *Complex technology*, and *SEP* turned out highly significant (1%-level). Interestingly, most coefficients estimated for the four hypothesized variables exhibited a comparable size in all three models (e.g., *Complex technology* ranged from 2.2 to 3.4). Therefore, I tested for the differences between the three types of litigation targets by conducting a Wald test (*Table 41*). The Wald test indicated that the predictors of the decision to target a merchant could not be differentiated from the predictors of the decision to target a manufacturer or a user through an indirect suit or a manufacturer through a direct suit.

DV 1	DV 2	Chi2	df	Prob > chi2
Direct	Manufacturer (indirect)	81.98	31.00	0.00
Direct	Merchant	27.84	31.00	0.63
Direct	User	69.38	31.00	0.00
Manufacturer (indirect)	Merchant	23.83	31.00	0.82
Manufacturer (indirect)	User	45.14	31.00	0.05
Merchant	User	22.00	31.00	0.88

Table 41: Wald test for combining alternatives (ambiguous suits treated as direct suits)

When I treated the ambiguous suits as indirect instead of direct ones, the multinomial logit regression analysis yielded similar results (*Table 42*). In the case of a downstream manufacturer as the target, all four hypothesized variables were significant at the 1%-level. In the case of a merchant or user as the target, *Product*, *Complex technology*, and *SEP* were significant. Again, the Wald test indicated that the decision to target a merchant could not be differentiated from the decision to target a manufacturer or a user through an indirect suit or a manufacturer through a direct suit. The reliability issue resulting from the small sample size (this time 26) for merchants persisted. Moreover, the difference between selecting a downstream manufacturer and a user was only significant at the 10%-level. Therefore, I am tempted to conclude that predictors associated with the selection of the litigation level were largely consistent across the three target types for indirect suits.

Number of obs =	500
LR chi2(16) =	387.800
Prob > chi2 =	0.000
Pseudo R2 =	0.366
Log likelihood =	-336.664

		Manufacturer (indirect)			Merchant			User		
Type	**Explanatory variable**	**Coefficient**	**Sig.**	**P > | z |**	**Coefficient**	**Sig.**	**P > | z |**	**Coefficient**	**Sig.**	**P > | z |**
1	Product	2.21	***	0.00	5.84	***	0.00	1.42	***	0.00
2	Complex technology	2.40	***	0.00	2.81	***	0.00	2.75	***	0.00
3	SEP	3.84	***	0.00	6.18	***	0.00	2.48	**	0.02
4	Plaintiff PAE	1.39	***	0.01	-1.00		0.31	0.47		0.31
Corr.	ICT	0.16		0.77	-1.76	*	0.08	0.01		0.99
	Only expired patents-in-suit	-1.17		0.12	-2.36		0.73	-0.31		0.60
	Parallel ITC case	-0.67		0.45	-1.17		0.56	-16.13		1.00
Controls	Utilitypatentsinsuit	0.01		0.95	-0.06		0.72	-0.01		0.88
	Designpatentsinsuit	-16.57		1.00	0.76		0.27	-16.22		1.00
	Reissuepatentsinsuit	1.44		0.18	-13.51		0.99	-13.82		1.00
	Plaintiff inventor	1.45	*	0.06	0.43		0.68	0.52		0.46
	Plaintiff researching entity	-0.48		0.81	-14.34		0.99	0.93		0.45
	Defendant researching entity	3.10		0.19	-13.50		1.00	-14.31		1.00
	Number of plaintiffs	-0.53		0.30	-0.61		0.57	-0.28		0.59
	Number of defendants	0.11		0.31	0.67	***	0.00	0.19	**	0.04
	Log patentfamily	-0.84		0.13	-2.98	***	0.01	-0.25		0.63
	Log backward citations	-0.11		0.82	1.88	**	0.03	0.26		0.58
	Log backward citations examinor	0.14		0.80	0.25		0.77	-0.33		0.51
	Log forward citations	-1.27		0.20	-5.15	**	0.04	-0.04		0.95
	Log forward citations examinor	1.27		0.23	5.86	**	0.04	0.28		0.73
	CPC sections	0.21		0.36	0.59		0.13	-0.15		0.50
	Claims	0.00		0.95	0.00		0.90	-0.01		0.42
	Continuation	0.53		0.26	-0.36		0.66	-0.22		0.61
	Reexamination	0.69		0.30	0.76		0.61	0.12		0.85
	Age	0.07		0.20	-0.08		0.33	0.13	***	0.01
	Litigation frequency	0.01		0.43	0.02		0.50	0.01	*	0.09
	Was patent-in-suit before	0.46		0.40	0.42		0.53	-0.07		0.88
	Avg. experience plaintiff	-0.01		0.12	-0.03		0.25	-0.01		0.29
	Avg. experience defendant	0.00		0.36	0.00		0.71	-0.01		0.12
	≥1 foreign plaintiff	1.63	***	0.01	1.39		0.10	0.45		0.50
	≥1 foreign defendant	0.44		0.21	-1.09		0.13	-1.07	***	0.01
	Constant	-6.90	***	0.00	-10.82	***	0.00	-5.82	***	0.00

*** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level

Table 42: Multinomial logit model (ambiguous suits treated as indirect suits)

DV 1	DV 2	Chi2	df	Prob > chi2
Direct	Manufacturer (indirect)	85.10	31.00	0.00
Direct	Merchant	39.16	31.00	0.15
Direct	User	69.22	31.00	0.00
Manufacturer (indirect)	Merchant	38.12	31.00	0.18
Manufacturer (indirect)	User	44.05	31.00	0.06
Merchant	User	34.05	31.00	0.32

Table 43: Wald test for combining alternatives (ambiguous suits treated as indirect suits)

5.4.7 Robustness tests

Given the time-related trend in litigation target selection visible in the descriptive statistics, I further explored the timing component. I controlled for the timing by including a continuous control variable calculated as the year of the filing of the suit less 2010 instead of year-fixed effects. The coefficient of the control variable was not significant. However, the coefficients for all four hypothesized variables remained significant at the 1%-level and exhibited comparable odds ratios (*Table 45*).

In addition, I ran a logit model and treated the 25 ambiguous suits as indirect suits as opposed to direct suits (*Table 44*). All four hypothesized variables remained significant and showed comparable odds ratios. Only *Plaintiff PAE* showed a significance lower than 1%: The significance level of the coefficient amounted to 5% in the base model and 10% in the extended model. Shifting the focus to other control variables, I noted that *Plaintiff Inventor* turned out to not be significant. Furthermore, *Number of defendants* remained significant (1%-level), but the odds ratio increased from 0.8 to 1.3. This is intuitive as 25 suits involving at least two defendants, i.e., an above-average figure, were now treated as indirect suits instead of direct suits.

In contrast, *Log patent family* and *≥1 foreign plaintiff* became significant on the 5%-level. While the odds ratio of *Log patent family* was smaller than 1.0, it was larger than 1.0 in the case *≥1 foreign plaintiff*. This indicates that patents belonging to larger patent families were less likely to be assigned to indirect suits, whereas foreign plaintiffs showed a preference for downstream litigation in the U.S. One reason could be that foreign patent holders view the U.S. as a strong sales market where leverage on defendants is particularly high. In addition, *Litigation frequency* and *Avg. experience plaintiff* turned out significant on the 10%-level, implying that indirect suits tended to comprise more litigated patents and less experienced patent holders preferred indirect over direct suits. The latter could be related to several observations: First, the PAEs that appeared as plaintiffs in the sample were more experienced than practicing entities (27.8 vs. 21.5 suits).

Second, while there was no difference in the level of experience of PAEs selecting an indirect (28.3) or direct target (27.3; p-value = 0.86), indirect suits involved practicing entities as plaintiffs with, on average, less experience than direct ones (9.2 vs. 24.8; p-value = 0.05). Potentially, due to their lack of experience, less experienced plaintiffs were even more eager to avoid being attacked by countersuits and, thus, preferred indirect suits.

	Baseline model		**Extended model**	
	Number of obs =	500	Number of obs =	500
	LR chi2(16) =	226.93	LR chi2(16) =	228.33
	Prob > chi2 =	0.00	Prob > chi2 =	0.00
	Pseudo R2 =	0.34	Pseudo R2 =	0.34
	Log likelihood =	-221.79	Log likelihood =	-221.09

Type	**DV: Indirect**	**Odds Ratio**	**Sig.**	**P > | z |**	**Odds Ratio**	**Sig.**	**P > | z |**
1	Product	6.76	***	0.00	7.04	***	0.00
2	Complex technology	10.34	***	0.00	10.20	***	0.00
3	SEP	32.02	***	0.00	36.23	***	0.00
4	Plaintiff PAE	2.04	**	0.05	2.02	*	0.05
	ICT	0.91		0.82	0.96		0.93
Corr.	Only expired patents-in-suit	0.72		0.54	0.69		0.49
	Parallel ITC case	0.42		0.25	0.40		0.22
	Utilitypatentsinsuit	0.99		0.82	0.98		0.82
	Designpatentsinsuit	1.16		0.83	1.13		0.86
	Reissuepatentsinsuit	1.51		0.71	1.63		0.66
	Plaintiff inventor	2.19		0.16	1.99		0.23
	Plaintiff researching entity	1.70		0.64	1.67		0.66
	Defendant researching entity	5.89		0.42	6.54		0.38
	Number of plaintiffs	0.69		0.33	0.66		0.28
	Number of defendants	1.26	***	0.00	1.24	***	0.01
	Log patentfamily	0.45	**	0.05	0.44	**	0.05
	Log backward citations	1.33		0.44	1.34		0.42
	Log backward citations examinor	0.91		0.80	0.87		0.74
Controls	Log forward citations	0.38		0.13	0.38		0.14
	Log forward citations examinor	3.17	*	0.10	3.10		0.11
	CPC sections	1.12		0.51	1.12		0.52
	Claims	1.00		0.66	1.00		0.67
	Continuation	1.00		0.99	1.00		0.99
	Reexamination	1.40		0.50	1.37		0.54
	Age	1.06		0.11	1.06		0.11
	Litigation frequency	1.01	*	0.06	1.01	*	0.06
	Was patent-in-suit before	1.16		0.69	1.24		0.56
	Avg. experience plaintiff	0.99	*	0.08	0.99	*	0.07
	Avg. experience defendant	1.00		0.99	1.00		0.97
	≥1 foreign plaintiff	2.83	**	0.02	2.96	**	0.01
	≥1 foreign defendant	0.68		0.17	0.68		0.17
	Year fixed effects	No			Yes		
	Constant	0.01	***	0.00	0.01	***	0.00

*** Significant at 1% level; ** Significant at 5% level; *** Significant at 1% level

Table 44: Regression results (logit model; ambiguous suits treated as indirect suits)

In conclusion, both alternative approaches towards ambiguous suits resulted in contradicting significance of coefficients of control variables such as ≥*1 foreign plaintiff*. Thus, the meaning and implications of significant controls should not be overinterpreted whenever I found such contradictions.

Due to the sizeable heterogeneity between industries in the litigation level selection (*Table 32* and *Table 33*), I tested for the robustness of my results by applying cluster-robust standard errors. Cross-industry heterogeneity within each cluster could cause correlations between regressors and residuals (Abadie et al., 2023). Each (sub-) industry (1-digit and 2-digit SIC code) represented a cluster. Cluster-robust standard errors are inflated compared to the regular model specification, and thus, the derived results are more robust. All four hypothesized variables remained significant at the 1% or 5% level in both the base and extended model.

		Hypotheses				**Correlations**		
Odds ratios (except for probit model)		**1**	**2**	**3**	**4**	**5**	**6**	**7**
Robustness check	Model	Product	Complex technology	SEP	Plaintiff PAE	ICT	Only expired	Parallel ITC case
No robustness check	Baseline	6.39***	11.66***	43.18***	2.87***	0.78	0.76	0.48
	Extension	6.58***	11.45***	48.16***	2.81***	0.82	0.72	0.45
Continuous variable for year of filing of suit	Baseline	6.38***	11.65***	42.83***	2.86***	0.78	0.77	0.49
	Extension	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alternative coding of ambiguous patent infringement suits	Baseline	6.76***	10.34***	32.02***	2.04**	0.91	0.72	0.42
	Extension	7.04***	10.20***	36.23***	2.02*	0.96	0.69	0.40
Cluster-robust standard errors by industry (1-digit)	Baseline	6.39***	11.66***	43.18***	2.87**	0.78	0.76	0.48*
	Extension	6.58***	11.45***	48.16***	2.81**	0.82	0.72	0.45**
Cluster-robust standard errors by industry (2-digit)	Baseline	6.39***	11.66***	43.18***	2.87***	0.78	0.76	0.48
	Extension	6.58***	11.45***	48.16***	2.81**	0.82	0.72	0.45
Product, Complex tech., SEP, and ICT as continuous variable	Baseline	7.96***	14.00***	34.56***	2.57**	0.87	0.77	0.39
	Extension	8.13***	13.87***	38.18***	2.50**	0.92	0.74	0.38
Product/ process patent and complex/ discrete tech.	Baseline	0.12***	0.06***	0.02***	0.39**	0.82	0.79	0.45
	Extension	0.12***	0.06***	0.02***	0.40**	0.85	0.77	0.44
Probit model	Baseline	1.08***	1.35***	2.13***	0.65***	-0.16	-0.17	-0.36
	Extension	1.10***	1.34***	2.22***	0.64***	-0.13	-0.20	-0.41
Alt. coding of ambiguous suits in probit model	Baseline	1.10***	1.33***	1.99***	0.45**	-0.08	-0.20	-0.50
	Extension	1.13***	1.33***	2.06***	0.45**	-0.05	-0.24	-0.53

*** Significant at 1% level
** Significant at 5% level
* Significant at 10% level

Robust
Not significant in base model but in check
Not robust - Significant in base model but not in check
Not significant in all models or omitted

Table 45: Robustness tests

In an additional robustness test, I incorporated *Complex technology*, *SEP*, *Product*, and *ICT* in a continuous rather than binary form. The continuous form represented the number of the corresponding, e.g., product patents divided by all patents-in-suit. Thus, the variable ranged from 0 to 1. A suit comprising four patents-in-suit, of which two were classified as complex and two as discrete, resulted in a value for *Complex technology* of 0.5. In both models, the coefficients of *Product*, *Complex technology*, and *SEP* were significant at the 1% level, and the coefficients of *Plaintiff PAE* at the 5% level.

Since *Product*, *Complex technology*, *SEP*, and *Plaintiff PAE* are binary variables, I tested for significance by reversing the variables, i.e., creating new independent binary variables *Process*, *Discrete technology*, *Non-SEP*, and *Non-Plaintiff PAE*. The former three variables were highly significant at the 1%-level, the latter at the 5%-level. As expected, all odds ratios were smaller than 1.0. Lastly, I tested for the robustness of my results by deriving a probit model and treating ambiguous suits as indirect ones. All hypothesized variables exhibited coefficients exceeding 1.0, thus, indicating a positive association with indirect suits, and were significant at the 1%-level apart from *Plaintiff PAE*, which was significant at the 5%-level in the latter model specification. To conclude, the robustness tests supported my results from the regression analysis in 5.4.6.

5.5 Discussion and conclusion

This chapter aimed to investigate the selection of the litigation target and level in the value chain. I discuss my findings and, subsequently, present my theoretical contributions.

5.5.1 Discussion

In 34% of all cases, patent holders frequently and deliberately did not sue the original infringer in a direct suit but a firm further downstream in the value chain in an indirect suit. By their litigation choices, patent holders demonstrated the strategic nature and importance of selecting the litigation target and level in the value chain. The heterogeneity in litigation choices across industries, as well as the higher prevalence of 39% in the context of a less conservative treatment of ambiguous suits, further emphasized the strategic importance. Value capture is a multi-dimensional challenge for firms. Besides, the questions of in-house commercialization vs. out-licensing (Teece, 1986), the horizontal licensing scope (Gambardella et al., 2021), and the licensing mode (Henkel, 2022), firms need to find answers to the question of the litigation target and level selection. In addition, effective execution of their value capture approach matters (Kafouros et al., 2021).

As hypothesized, *Product*, *Complex technology*, *SEP*, and *Plaintiff PAE* were positively associated with indirect suits (significant at 1%-level). My results were robust. For instance, a multinomial logit regression distinguishing between the three types of defendants in indirect suits – manufacturers, merchants, and users – showed consistent results.

The results from my qualitative study in Chapter 3 support the above findings. I detected considerations of existing industry practices and levers to increase leverage and financial returns as key motivations for pursuing indirect suits. Both aspects are reflected in the highly significant coefficients for *SEP* and *Plaintiff PAE*. E.g., PAEs are known for pursuing the most attractive instead of the most obvious targets: Cohen et al. (2019) find that PAEs specifically select firms with strong cash flows.

I observed inconsistencies in the significance and/or the size of the coefficients of the control variables when I treated ambiguous suits either as direct or indirect. For instance, this was the case with *Number of defendants*, *≥ 1 foreign plaintiff*, and *≥ 1 foreign defendant*. One motivation for plaintiffs to follow an indirect suit was the perspective of more efficient and effective enforcement which could have resulted in the significant positive association of *≥ 1 foreign plaintiff* with indirect suits. Foreign plaintiffs might select the defendant and the litigation forum based on efficiency and effectiveness considerations and, thereby, skip a level in the value chain by litigating abroad in the U.S.

Any study in patent licensing and litigation comes with one shortcoming: It is impossible to fully uncover all attempts of patent holders towards the closing of a license or completing litigation. Like a dataset on patent licenses fails to uncover those attempts that do not result in a license, a dataset on infringement suits fails to uncover those attempts that do not result in a suit, respectively. Some IP-related conflicts might be settled without litigation or fizzle out. Given that Lemley et al. (2018) find that only about one-third of attempts towards patent licensing result in litigation, they utilized the picture of a patent enforcement iceberg from which only the tip is visible to describe the lack of transparency. The estimate of Lemley et al. (2018) significantly exceeded previous estimates.

Unfortunately, I am not able to reliably predict what type of patent enforcement actions did or did not end up in my sample for several reasons. This implies that I cannot generalize my findings beyond infringement suits toward patent enforcement actions in general. While it appears that larger companies are more frequently a target of patent enforcement attempts than smaller ones, the non-representative and small sample of 30 survey respondents forbids further generalization (Lemley et al., 2018).

Similarly, theoretical arguments allow opposing predictions. Two opposing arguments predict the underrepresentation of complex and discrete technologies in patent litigation, respectively. In complex and cumulative system technology industries, competing firms typically own patents that are valuable to the competitor and likely infringe on the competing firm's patents. This constellation is likely resolved via cross-licensing (Grindley & Teece, 1997) due to lower transaction costs compared with costly litigation. In comparison, the well-defined and concrete scope of discrete technologies allows for more precise and easier valuation. In light of highly uncertain litigation outcomes, owners and potential infringers of discrete technologies should have a preference for conflict resolution without litigation.

5.5.2 Contribution to theory

I introduced the differentiation into direct and indirect suits. While plaintiffs select in direct suits the original infringer as the defendant, plaintiffs target in indirect suits a party, i.e., a manufacturer, merchant, or user, further downstream in the value chain from the original infringer. Through a quantitative empirical study, I shed light on the strategic selection of the litigation target and level in the value chain and closed the research gap. I determined the prevalence of indirect suits across industries and identified predictors of indirect suits by assessing underlying technologies, patents, plaintiffs, and defendants. To develop hypotheses on the predictors of indirect suits, I relied on anchoring (Tversky & Kahneman, 1974) and transaction cost theory (Coase, 1960; Williamson, 1975). I proposed causal links to indirect suits and added on research on the profiting from innovation framework (Teece, 1986). By detecting a sizeable prevalence of indirect suits of 34% and strong heterogeneity in the prevalence across industries, I showed, first, the importance of selecting the litigation target and level in the value chain for profiting from innovation and value capture on the MFT, and second, the necessity for managers and policymakers to consider the implications of indirect suits.

6 Summary and outlook

This dissertation aimed at shedding light on the selection of the licensing and litigation level in the value chain as well as the underlying mechanisms. It consists of the first empirical mixed-methods studies on the phenomena of bifurcated licensing and indirect infringement suits. Chapter 3 aimed at qualitatively identifying mechanisms underlying bifurcated licensing and indirect infringement suits, whereas chapters 4 and 5 assessed quantitatively the involved parties in, the prevalence of, and the predictors of bifurcated licensing and indirect infringement suits across industries.

6.1 Findings and contribution

So far, the strategy literature has focused extensively on the questions of if to license patents (e.g., Gans & Stern, 2003; Motohashi, 2008; Agrawal, Cockburn & Zhang, 2015; Ruckman & McCarthy, 2017) and when to license patents (e.g., Gans, Hsu & Stern, 2008; Allain, Henry & Kyle, 2016; Hegde & Luo, 2018; Min, Lee & Kim, 2022). However, scholars have not yet investigated the role of the strategic selection of the licensing and litigation level in capturing value from innovation via the MFTs. I close this gap in the literature by building upon the concept of the licensing mode (bifurcated vs. integrated licensing; Henkel, 2022), introducing the differentiation between direct and indirect suits, and conducting the first empirical mixed-methods studies on bifurcated licensing and indirect suits. The studies show the prevalence of, the underlying mechanisms of, the predictors of, the involved parties in, and the industries relevant for bifurcated licensing and indirect suits.

In particular, I am able to measure the prevalence of bifurcated licensing (12%) and indirect suits (34%). While the overall prevalence of bifurcated licensing appears to be relatively rare, an industry-level analysis exhibits sizeable variation across industries. Industries within Services (42%) and Transportation & Public Utilities (44%) such as Business Services (50%) or Electric, Gas and Sanitary Services (71%) show high frequencies of bifurcated licensing. Similarly, I observe a high prevalence of indirect suits in Retail Trade (65%) and Transportation & Public Utilities (45%). With regards to both bifurcated licensing and indirect suits, manufacturing industries draw a heterogeneous picture. In contrast to chemicals, Transportation Equipment, and electronics build an exception and show high prevalence levels. The varying prevalence of bifurcated licensing and indirect suits across industries substantiates the strategic importance for profiting from innovation through capturing value on the MFTs. It emphasizes the need to strategically select the licensing and litigation levels.

In total, I qualitatively identify six mechanisms leading to bifurcated licensing. While the mechanism "ICT SEPs" concerns the licensing of ICT SEPs, the two mechanisms, "Higher return" and "Easier enforcement", comprise cases of patent litigation. Lastly, the three mechanisms "Second source", "Contract development/ manufacturing/ research", and "Freedom of 3rd party rights" lead to bifurcated licensing in the context of various sourcing strategies. In case of indirect suits, the interview study unveils four factors motivating plaintiffs to select a litigation level further downstream of the original infringer: "Commercial interests as supplier", "More efficient and effective enforcement", "Higher leverage and financial return", and "Established industry practice".

By employing anchoring (Tversky & Kahneman, 1974) and transaction cost theory (Williamson, 1975), I hypothesize causal links to bifurcated licensing and indirect suits. I argue that patent holders can hardly enforce bifurcated licensing ex-ante and hypothesize that specific technological characteristics of the focal patents allow patent holders to enforce bifurcated licensing Koo & Li.

Multivariate regression analyses yield complex technologies, SEPs, and product patents as predictors of both bifurcated licensing and indirect suits. However, PAEs are only significantly associated with indirect suits but not bifurcated licensing. Cross-licensing is negatively associated with bifurcated licensing. Furthermore, I distinguish between different types of defendants within indirect suits, namely manufacturers, merchants, and users, and assess the respective predictors in multinomial regression analyses. By suggesting causal links to bifurcated licensing and indirect suits, I contribute theoretically to research on profiting from innovation and value capture. The licensing and the litigation level represent a further strategic dimension for designing a value capture approach. With my dissertation, I extend the known dimensions commercialization approach, i.e., in-house commercialization vs. licensing (Teece, 1986) and horizontal scope (Gambardella et al., 2021).

Researchers expressed varying views on the impact of bifurcated licensing on MFT efficiency (e.g., Teece & Sherry, 2016; Borghetti et al., 2021; Henkel, 2022). My study proposes a more nuanced perspective, asking for a case-by-case efficiency assessment. In some constellations, bifurcated licensing appears to facilitate efficiency (e.g., "Second source"). In contrast, in others, it seems to result in higher levels of uncertainty and transaction costs for licensees (e.g., “Higher return”, “ICT SEPs”). Relative to integrated licensing, bifurcated licensing could provide the advantage of lower transaction costs due to less fragmentation on the corresponding value chain levels relative to the value chain level corresponding with integrated licensing, However, in general, I argue that bifurcated licensing up- as well as downstream in the value chain is associated with higher uncertainty, transaction costs, and, thus, less MFT efficiency.

6.2 Managerial and policy implications

My findings have implications for innovators, implementers, and policymakers. First, the prevalence of bifurcated licensing illustrates the necessity to consider the licensing level in the value chain and, thereby, the licensing mode as an important lever to capture value. Finding answers to the questions of commercialization approach (inhouse vs. out-licensing; Teece, 1986) and the horizontal scope of licensing (Gambardella et al., 2021) does not give rise to a comprehensive commercialization approach of an innovation. Selecting the licensing level in the value chain and closely related the licensing mode, i.e., bifurcated vs. integrated licensing, are of equal importance for value capture. This inference holds particularly for enabling technologies. Similarly, the prevalence of indirect suits indicates that the original infringer does not necessarily correspond with the most preferred selection as the defendant. I conclude that the selection of the defendant is also linked with the selection of the forum, given the nature of patents as territorial rights (WIPO, n.d.a; 64 EPC, 2020, § 1) and the varying strength of patent protection across countries (Levy-Carciente & Montanari, 2022). Selecting a particular level in the value chain for enforcement might not be viable due to a lack of suitable patents for such actions, e.g., because of the jurisdictional scope, the enforceability in a jurisdiction, or the scope of the patented invention. As a consequence, innovators need to first select the value-maximizing litigation level in the value chain in advance and, second, build a portfolio that allows for successful enforcement actions against the selected litigation level in the desired jurisdictions. The selection of the litigation level directly translates into requirements toward the patent portfolio in terms of, for instance, jurisdictional scope, type of patent (product vs. process), or patent scope. What the value-maximizing litigation level is, depends on various factors such as expected royalties, leverage, or the degree of experience of the defendant. There are strong arguments that enforcing a patent on the value-maximizing litigation level often corresponds with an indirect suit. In addition, indirect suits could help patent holders compensate for weaknesses in their patent portfolio by enforcing further downstream in the value chain as opposed to not being able to enforce a patent at all.

Second, given the prevalence of both bifurcated licensing and indirect suits, implementers need to preventively design a defensive strategy against any enforcement attempt. It is noteworthy that players from within and outside of traditional industry boundaries, for instance, PAEs, may pursue such enforcement attempts. Such a strategy could build upon pillars like standard selection, IP risk management, IP risk mitigation, e.g., including indemnification clauses and enforcement mechanisms in purchasing contracts with suppliers, preventive measures, e.g., broad monitoring of and opposition against filed patent applications in directly implemented as well as further upstream implemented technologies, or knowledge building, e.g., establishing internal and external legal and technical know-how. Even though patent holders might prefer to enforce patents against downstream firms, an upstream firm is equally affected by bifurcated licensing and indirect suits. An immediate consequence of both approaches is a more fundamental negotiation between all implementers in the value chain about the allocation of risks within the value chain. This negotiation also involves indirect risks, such as facing liability claims after the grant of indemnification to the downstream firm in a purchase contract.

Established industry practices matter for both the selection of the licensing level and the litigation level in the value chain. As a result, implementers need to actively get involved in establishing industry practices whenever new technologies emerge, or an existing technology gains relevance in a new industry.

Third, I argue that bifurcated licensing, as well as indirect suits in general, increase transaction costs. Both innovators and implementers must cover the resulting cost burden. This is particularly relevant for policymakers since transaction costs might hinder innovations (Heller & Eisenberg, 1998). Consequently, policymakers need to review current legislation and legislation proposals with regard to their effects on transaction costs.

6.3 Limitations and future research

As elaborated in detail in chapters 3, 4, and 5, this research comes with several limitations. Without fully repeating myself, I highlight several key considerations and illustrate pathways for future research on value capture through patent licensing and patent enforcement.

In Chapter 3, I quantified the prevalence of each mechanism that leads to bifurcated licensing and assessed the motivations for indirect infringement suits. While the sample size of 35 interviews contributed to the validity of the identified mechanisms, it is not sufficiently large and representative to allow for an interpretation of the absolute and relative frequency of each mechanism without further care.

Patents, as well as patent licenses, are a source of competitive advantage (Ireland et al., 2002). As a result, firms could impede such relevant competitive information from becoming public by closing non-disclosure agreements (NDAs). For instance, Love & Helmers (2023) observe difficulties obtaining information on patent licensing terms – even in highly litigated areas such as cellular SEPs. In general, the degree of secrecy directly impacts the representativeness of qualitative and quantitative studies on patent licensing practices. Moreover, RoyaltySource sources the intangible asset license agreements in its database mainly from SEC filings (RoyaltySource, n.d.a). Given that the SEC is a U.S. agency overseeing firms selling securities to the public in the U.S., the analyzed license agreements involve predominantly firms headquartered in the U.S. (U.S. Securities and Exchange Commission, n.d.a). Licensing behavior and the strategic use of patents differ across countries (Pitkethly, 2001; Cohen et al., 2002). Such differences could extend to the selection of the licensing target. Since, on average, public firms are larger than private firms (Hope et al., 2013) and agreements with large commercial value are more likely to be material than agreements with small commercial value ceteris paribus (Nash et al., 2004), the analyzed sample is probably overrepresenting larger firms and commercially valuable patent license agreements.

Despite analyzing a sample of patent license agreements significantly larger than the samples of other comparative studies (e.g., Anand & Khanna, 2000), my sample is likely not fully representative of the population of patent license agreements for the abovementioned reasons. However, far more essential for my results to be representative is whether the bifurcated licenses in my sample are representative. There are strong arguments why I believe my results from the study of patent licensing are robust. It is sufficient that a license is material for either the licensor or the licensee to be required to be filed with the SEC. Because small firms could have entered the sample through being involved in licenses with larger firms, the tapping of licensors and licensees probably mitigates the effect on the representativeness of my sample, at least to some extent. Also, overall, size and geographic origin might not or barely matter in selecting the licensing target. For instance, Grindley & Teece (1997) fail to identify differences in cross-licensing outcomes between large and small firms and Pitkethly (2001) detects similarities in out-licensing practices among British and Japanese firms.

More central than the question of the representativeness of my sample is the question of the representativeness of the bifurcated license agreements in my sample. By selecting a mixed-method approach combining an explorative qualitative study with a deductive quantitative study, I increased the robustness of the results. The sample of mainly headquartered in Europe but globally active firms in the qualitative study complements the U.S.-focused sample in the quantitative study. The results from the qualitative study seem to hold across geographies and industries and confirm the findings from the quantitative study. Without awareness of more representative sources of patent license agreements and considering the arguments above, I believe the results are robust across geographies and industries.

The hypothesized mechanisms in 4.2.1 suggest that licensors can pursue bifurcated licensing within ex-post constellations. In contrast to my qualitative study, unfortunately, it is impossible in the quantitative licensing study to measure more precisely ex-post vs. ex-ante licensing than solely identifying licenses resulting from litigation activities due to the lack of the required data and enormous time requirements. For instance, I would need to research the product portfolio of each licensee, the exact technical specifications of each product, and the integrated components to assess whether the licensee closed the focal license ex-post or ex-ante for agreements at times dating back to the 1970s.

To address some of the aforementioned limitations, I successfully conducted various robustness tests in *4.4.6* that, e.g., focused on small licensors and licensees as a proxy for license agreements of small commercial value, or comprised non-SEP, non-electronics industry license agreements, or inflated standard errors by applying cluster-robust standard errors.

Chapter 5 focuses on the defendant selection in infringement suits by analyzing a random sample of suits filed at U.S. district courts. Patents are territorial rights, and as such, patent holders can only enforce a patent within its applicable territory. The territory of a patent can be of national or regional character (WIPO, n.d.a; 64 EPC, 2020, § 1). Besides the differences in economic structures, the decisions of a plaintiff where to enforce a patent may depend on the fee scheme applied in the applicable jurisdiction, e.g., the U.S. vs. the UK rule (Polinsky & Rubenfeld, 2004). For example, the UK rule results in fewer cases filed but more cases going to trial (Rhode, 2004). Consequently, it helps to explain the lower prevalence of suits filed by PAEs in the UK relative to the U.S. (Helmers et al., 2013). However, central to the robustness of our results is not the question of the prevalence of infringement suits but potential structural changes to the characteristics of indirect suits compared to direct suits. I argue that while the UK rule discourages plaintiffs from filing suits with a lower probability of prevailing, it affects direct and indirect suits simultaneously. For instance, in a jurisdiction applying the UK rule, we will likely observe fewer suits filed by PAEs. Nonetheless, I see no reason why the proportion of indirect vs. direct suits filed by PAEs and why the underlying characteristics (e.g., type of technology) of the indirect suits vs. direct suits should change. Thus, I expect robust correlates and mechanisms for the hypothesized variables of product patents, complex technologies, SEPs, and PAEs as plaintiffs.

Various allays for future research exist. First, future research could further analyze the effect of bifurcated licensing and indirect suits on transaction costs because the argument that bifurcated licensing (and, accordingly, indirect suits) contribute to reductions in transaction costs (Teece & Sherry, 2016; Borghetti et al., 2021) seems not to generally hold. While a cross-industry study incorporating market fragmentation across value chain levels as a proxy for industry-level transaction costs (Henkel, 2022) is not feasible due to reasons such as data availability and lack of a common cross-industry value chain framework, future research could tackle related questions by selecting a focus industry with known prevalence of bifurcated licensing and indirect infringement suits such as the electronics or transportation equipment industries.

Second, future research on both licensing target and defendant selection could take on a comparative nature across multiple countries and, thus, jurisdictions to develop a more granular understanding of cross-countries differences. In case of indirect suits, future cross-country studies could increase the robustness of the results and shed more light on the effects on the defendant selection arising from the territorial nature of patent rights (WIPO, n.d.a; 64 EPC, 2020, § 1), the strength of an IP regime, and the legal system design on the defendant selection. Especially the trade-off between forum and defendant selection seems to be of high practical relevance. It is worth investigating whether a patent holder prefers to select a more favorable forum at the expense of a more favorable defendant and vice versa.

Third, future research could extend our understanding of price differentiation practices along the value chain. Scholars argue that bifurcated licensing allows price differentiation (SEPs Expert Group, 2021) and, thereby, ensures market efficiency (Henkel, 2022). However, bifurcated, downstream licensing may not be necessary to be able to enforce differentiated prices (Henkel, 2022). Across industries and value chain levels, future research may investigate questions around the prevalence and practices of differentiation of prices and licensing terms.

Lastly, future research could quantify the anchoring effect on granted damages and royalties by comparing indirect and direct suits.

Appendix

Appendix A – Interview guideline

Background of the interviewee(s)

1. Could you introduce yourself?

General in-licensing and out-licensing practices

2. Could you briefly describe the in-licensing approaches at your company by division and technology area? Also, please refer to the level in the value chain of the licensor and elaborate on knowledge flows underlying the license.
3. Could you briefly describe the differences – if there are any – in the in-licensing approaches between SEPs and Non-SEPs?
4. Could you briefly describe the out-licensing approaches at your company by division and technology area? Also, please refer to the level in the value chain of the licensee and elaborate on the knowledge flows underlying the license.
5. Could you briefly describe the differences – if there are any – in the out-licensing approaches between SEPs and Non-SEPs?
6. Could you briefly describe the motivations for the selection of the licensing level? Also, please differentiate by licensor/licensee perspective.

In-licensing and out-licensing in specific contexts

7. Could you briefly describe the licensing approaches (background and foreground IP) for contract research and manufacturing (if applicable)? Also, please comment on the knowledge flows underlying the license.
8. Could you briefly describe the licensing approaches for second sources? Also, please comment on the knowledge flows underlying the license.

Knowledge flows

9. Are you aware of any licensing constellation in your industry where a license is not accompanied by a product or knowledge flow (e.g., like in the smartphone industry where the OEM typically takes a license for 4G patents, while the knowledge is implemented on a chipmaker level)? If yes, please describe this constellation.

Outlook and final questions

10. Could you briefly describe any trends in patent licensing that you have observed – if there are any?

11. Is there anything you are surprised that I have not asked about?
12. Is there anything you would like to add because you find it useful for this research project?
13. Are there any other people I should interview?

Appendix B – Interview languages

All interviews were conducted in English or German and transcribed in the respective language. If the language of the interview was German, I translated the statement into English and asked the interviewee for approval of the English translation. Thus, the respective interviewee approved the direct quotes presented in the dissertation in English.

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