THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

The Battle to Define the Meaning of FRAND

The Changing Role of Intellectual Property in the Knowledge Economy

BOWMAN J. HEIDEN

Department of Technology Management and Economics

CHALMERS UNIVERSITY OF TECHNOLOGY

Gothenburg, Sweden 2017

The Battle to Define the Meaning of FRAND
The Changing Role of Intellectual Property in the Knowledge Economy
BOWMAN J. HEIDEN
ISBN 978-91-7597-640-2

Doktorsavhandlingar vid Chalmers tekniska högskola
Ny serie nr 4321
ISSN 0346-718X

Department of Technology Management and Economics
Chalmers University of Technology
SE-412 96 Gothenburg
Sweden
Telephone + 46 (0)31-772 1000

Chalmers Reproservice
Gothenburg, Sweden 2017

The Battle to Define the Meaning of FRAND
The Changing Role of Intellectual Property in the Knowledge Economy
BOWMAN J. HEIDEN
Department of Technology Management and Economics
Chalmers University of Technology

ABSTRACT
This thesis explores the battle among actors in the telecommunication value chain to define the meaning of FRAND (Fair, Reasonable, and Non-Discriminatory), which forms the basis for the IPR policy and standard-essential patent (SEP) licensing agreements in most standard-setting organizations (SSOs). As a secondary goal, this thesis seeks to improve the theoretical understanding of the changing nature of value creation from an industrial to a knowledge-based economic paradigm, particularly in relation to the changing role of patents to facilitate openness and regulate access.

An investigation of the theoretical concepts that define FRAND and SEP value as well as an empirical investigation of the industrial dynamics and the interpretation of FRAND in the US judicial system is conducted. This includes an in-depth, single case study of the landmark *Microsoft* case as well as a comparative analysis across the four initial SEP/FRAND cases in US district court. Additionally, a comparative analysis of legal and market norms is conducted through case studies and doctrinal legal analysis from the theoretical perspective of the intellectual value chain. Finally, the concepts of patent holdup and holdout are analyzed in relation to mainstream economic theory, and patent holdout is further investigated through market data as well as interviews and a survey with industry experts.

The results show that while FRAND-enabled standards have experienced historical market success, an expansion of the division of labor in the telecommunication value chain has created a profound divergence among market actors regarding the value of SEPs, often exceeding more than an order of magnitude. Concomitantly, the US courts have also produced diverse rulings in their attempt to value SEPs and set FRAND royalties with considerable implications on economic performance and efficiency. Additionally, several valuation principles are introduced regarding the determination of royalty base in patent damages that illustrate the importance of linking legal norms to the market norms of the standard in question. Furthermore, patent holdout is found to be a substantial phenomenon with specific strategies that differ in relation to actors in developed and emerging markets. Lastly, the concepts of holdup and holdout are shown to be used much differently in the current patent debate in comparison to mainstream economic theory leading to the proposal of a new, non-pejorative framework based on a spectrum of asymmetric bargaining power positions ranging from circumstantial to systematic to systemic.

Keywords: telecommunications, standards, standard essential patents, FRAND, patent holdup, patent holdout

To the two most important people in my life – my mother, who taught me I could do anything, and my wife, who reminds me what's important.

Two roads diverged in a yellow wood,
And sorry I could not travel both
And be one traveler, long I stood
And looked down one as far as I could
To where it bent in the undergrowth;

Then took the other, as just as fair,
And having perhaps the better claim,
Because it was grassy and wanted wear;
Though as for that the passing there
Had worn them really about the same,

And both that morning equally lay
In leaves no step had trodden black.
Oh, I kept the first for another day!
Yet knowing how way leads on to way,
I doubted if I should ever come back.

I shall be telling this with a sigh
Somewhere ages and ages hence:
Two roads diverged in a wood, and I—
I took the one less traveled by,
And that has made all the difference.

- Robert Frost

LIST OF PUBLICATIONS

This dissertation includes an introductory chapter and four appended papers as follows:

Paper 1
Heiden, Bowman. (2016). The viability of FRAND: How the seminal landmark Microsoft ruling could impact the value of standard essential patents and the future of telecom standards. *Telecommunications Policy*, 40(9), 870-87.

Paper 2
Heiden, Bowman. (2015). Valuing Standard Essential Patents in the Knowledge Economy: A Comparison of FRAND Royalty Methodologies in US Courts. *International Journal of Standardization Research (IJSR)*, *13*(1), 19-46.

Paper 3
Heiden, Bowman and Andreasson, Jens (2016), Reevaluating Patent Damages in the Knowledge Economy: The Intellectual Value Chain and the Royalty Base for Standard-Essential Patents, *Criterion J. on Innovation,* 1, 229.

Paper 4
Heiden, Bowman and Petit, Nicolas (2017), Patent Trespass and the Royalty Gap: Exploring the Nature and Impact of Patent Holdout. Stanford Hoover IP2 Working Paper #17010. Forthcoming in *Santa Clara High Technology Law Journal*.

Bowman Heiden is the sole author on papers 1-2 and co-author of two papers 3-4 as shown above. For Paper 3 Bowman Heiden contributed conceptually to the entire article and had main responsibility for all chapters except chapter 2. For Paper 4 Bowman Heiden co-developed the overall concept and the key theoretical themes and models, taking primary responsibility for the empirical analysis and modeling of patent trespass.

ACKNOWLEDGEMENTS

While a PhD is an individual degree, it is not an individual accomplishment. This is even truer later in life when important commitments at work and home require constant attention. Luckily, I had a great role model in my mother, who while in her late thirties went back to school to finish her undergraduate degree while working a full-time job, a part-time job on weekends, and raising me as a single mother. I've yet to meet someone with more mental toughness and compassion.

Throughout the past four years, I have received a great amount of support that made this achievement possible. First, I would like to thank Gustav Brismark at Ericsson for introducing me to the complexity of FRAND and partially funding my research while allowing me the freedom to reach my own conclusions. Second, I would like to thank my PhD committee members for their guidance. In the beginning of the process, I'm grateful for the help from Sverker Alänge, Ulf Petrusson, and Erik Bohlin, who has been my examiner and force of stability throughout the process. A great deal of credit goes to my supervisor, Mats Lundqvist, for his determination to drive this dissertation to completion – I wouldn't have made it without you. A special thanks go to Gregory Graff for his constructive criticism that improved the quality of my research and writing – it was great to have you on my committee. Third, I would like to thank my co-authors, Nicolas Petit and Jens Andreasson for their collaboration and contribution – I learned so much from you.

As stated above, my PhD was not created in a vacuum. I owe a debt of gratitude to my work colleagues at Chalmers and University of Gothenburg for supporting me over the past four years. Thank you for your support – it has been very important to me. I hope this process hasn't been too much of burden. Additionally, a special thanks go to the CIP advisory board for their wisdom and support, especially to Ruud Peters, who was always there with advice, insight, and critique when I most needed it, and to Ian Harvey, for kindly but firmly pushing me forward.

Last but not least, I need to thank my family, Åsa, Nicolas, and Julia, who have shouldered most of the burden over the past four years. It is this part of my life where I fear the cost of taking on the effort to complete my PhD has been greater than the benefit. I am grateful for your patience and hope to make it up to you all. Don't ever forget that you mean everything to me.

Leif, you're going to finally get your party! Thanks to you and Inga-Maj for all your support.

Bowman Heiden
Göteborg, 2017

TABLE OF CONTENTS

1. Introduction

1.1 Background[1]

Communication is fundamental to society, and information and communication technology (ICT), in particular, forms the backbone of the modern knowledge society (Steinmueller, 2002). Similar to healthcare and education, its value cannot simply be understood by measuring the economic output from the ICT sector – its impact affects the bottom line of all firms and the general welfare of society as a whole. Its central importance leads us to label ICT as a welfare technology, where both its current functionality and future development is critical to socio-economic growth. As a welfare technology, ICT operates at the interface of public and private spheres, between government regulation and market forces, where its borders are determined by a constant struggle among diverse stakeholders with different ideologies, objectives, and strategies (both short term and long term). Thus, ICT as both a system of knowledge as well as a means to efficiently package and distribute knowledge is both facilitating as well as impacted by the transition from an industrial to a knowledge-based economy, which in turn is challenging the institutional infrastructure of society (Antonelli, Geuna, and Steinmueller, 2000).

The telecommunications industry is currently experiencing a high-stakes battle where strong business interests are debating and defining the role of patents in the development of global, open standards. In this context, the term smartphone wars, in plural, is apropos, given that two distinct wars regarding patents are taking place. While much of the attention in the popular press has focused on the war between Apple and Samsung, which is a relatively traditional industrial battle over competing products, a potentially more important intellectual property battle concerning the future of telecommunications in the knowledge economy has been ensuing in parallel (Eichenwald, 2014). This second smartphone war is not a conventional battle over the market share of products between horizontal competitors on product markets, but a battle among vertical collaborators over the appropriation of value between upstream technology owners and downstream product implementers. As such, the current conflict in the context of telecommunication standards could be seen as part of a wider paradigm shift from an industrial to a knowledge economy characterized by the increased direct commercialization of technology through intellectual property-based business models.[2] Thus market conflicts between vertical actors, such as technology licensors and device

[1] The background section partially uses content from the four papers in this dissertation.
[2] Non-practicing entity (NPE) is an appropriate term if used descriptively, not pejoratively.
[3] See Pettersson et al. (2015), Apple, Ericsson Sue Each Other Over Phone Patent Royalties, Bloomberg Business, retrieved at http://www.bloomberg.com/news/articles/2015-01-14/apple-sues-ericsson-to reduce-

[2] Non-practicing entity (NPE) is an appropriate term if used descriptively, not pejoratively.

manufacturers, over royalties regarding global telecommunication standards[3] carry a potentially greater systemic, economic impact as it affects both the creation of global markets and the viability of a new division of innovative labor in the economy.

This vertical conflict is also potentially much broader, encompassing not only smartphones but all markets built on standards developed through consensus-based standard-setting organizations (SSOs), where ownership of patents is allowed on the technology specifications of the standard.[4] This includes many of the major SSOs in the field of telecommunications, including IEEE, ETSI, and ITU, where standard-essential patents (SEPs) are typically licensed under fair, reasonable, and non-discriminatory (FRAND) terms among members of the SSO and third parties (Bekkers and Updegrove, 2012).[5] While the traditional patent war among device makers is smoldering out, the battle over the value of SEPs is growing as the importance of standard-enabled markets in telecommunications and convergent industries grows. For example, the future development of Internet of Things (IoT) both for industrial applications (i.e. Industry 4.0) and consumer applications is predicted to greatly expand the number of connected objects as well as the number of technology standards and associated patents.[6]

The conflict described above over SEPs among vertical actors in the telecommunication industry is amplified by the fragmentation of traditionally integrated firms into a value network of diverse actors with different strategic goals regarding technology and product development.[7] Some firms view SEPs as a major source of revenue and others as a major cost of production. This heterogeneity in the value network creates a strategic conflict over SEPs that is played out not only on the market, but also through the courts, competition authorities, and the SSOs that set IPR policies that attempt to govern their use.[8] Furthermore, academic discourse has played a significant role in defining theoretical explanations for the current conflict, such as patent holdup and royalty stacking, which has been influential in the policy debate despite a lack of empirical evidence (Farrell et al., 2007; Lemley and Shapiro, 2007; Galetovic and Haber, 2017; Galetovic, Haber, and Zaretzki, 2017).[9] Adding complexity,

---

[3] See Pettersson et al. (2015), Apple, Ericsson Sue Each Other Over Phone Patent Royalties, Bloomberg Business, retrieved at http://www.bloomberg.com/news/articles/2015-01-14/apple-sues-ericsson-to reduce-royalties-on-phone-patents-1-

[4] Lemley (2002) found that 34 or the 36 SSOs studied allowed for ownership of patents in the standard and 29 of 36 allowed for licensing of these patents on reasonable and non-discriminatory terms.

[5] The inclusion of SEPs in SSOs is typically done to incentivize participation of leading technology firms in the standardization process, while the use of FRAND commitments is used to facilitate adoption and dissemination of the standard.

[6] Gartner predicts a growth from 8.4 billion interconnected devices in 2017 to over 20 billion in 2020 – see http://www.gartner.com/newsroom/id/3598917.

[7] Major market actors provide different value propositions to the telecommunication value chain, such as devices, infrastructure, chipsets, operating systems, content platforms, technology, etc. in different combinations.

[8] One could argue that national politics is also involved given the size of the telecommunication market and the impact on important national actors. See, for example, President Obama's veto of the US International Trade Commission's exclusion order of the Apple iPhone based on a SEP asserted by Samsung in 2013.

[9] Even Nobel Laureates have weighed in on the topic - see Lerner and Tirole (2014).

Bekkers and Updegrove (2012) find that there is still a large diversity among IPR policies in SSOs and that they often lack clear goals, transparency, and an unambiguous definition of FRAND.[10] This policy ambiguity, combined with an expanding multi-trillion dollar market and a growing division of labor, sets the stage for the battle to define the meaning FRAND.

1.2 Overall Purpose and Scope

The main purpose of this thesis is to better understand how competing interests seek to define the meaning of FRAND and influence the value of SEPs. This, in turn, sheds light on the role patents currently play and potentially could play in the development and commercialization of telecommunication standards from both an economic performance and efficiency perspective. In doing so, this thesis aims to provide a framework for balanced guidance to support policymakers and market actors seeking to define an agenda for the development of patent policies and IP-based business models adjusted to wealth and welfare creation in an environment of open innovation.[11] Specifically, the thesis explores the battle among actors in the telecommunication value chain to define the meaning of Fair, Reasonable, and Non-Discriminatory (FRAND), which forms the basis for the IPR policy and standard-essential patent (SEP) licensing agreements in most standard-setting organizations (SSOs). As a secondary goal, this thesis seeks to improve the theoretical understanding of the changing nature of value creation from an industrial to a knowledge-based economic paradigm by unveiling the conceptual issues, stakeholder interests, and policy impact of patents on economic performance and efficiency.

The thesis focuses on the new role of patents as a key battleground issue at the interface of economic efficiency and business strategy in the telecommunication sector, where open innovation through standardization is critical to socio-economic growth. This requires the investigation of several inter-related institutional phenomena, including open standards and standard setting organizations (SSOs), collective rights agreements, and the concept of standard-essential patents (SEPs), which jointly operate to regulate competition and collaboration, stimulate innovation and reduce potential economic hold-up/out situations. Figure 1.1 below illustrates the relationship between the institutional phenomena under study in relation to their evaluation in terms of economic output (i.e. economic performance and efficiency). In particular, the phenomena of SEPs and FRAND (fair, reasonable and non-discriminatory) agreements will be investigated in the context of mobile telecommunication standards in the knowledge economy from an inter-disciplinary perspective, specifically economics, law, and innovation/technology management.

[10] It should be noted that the ambiguity of FRAND is not a necessarily a contractual problem that is simply remedied through clearer specification. For a discussion on the usefulness of incomplete contracts see (Wright, 2013)

[11] Open innovation was coined by Henry Chesbrough (2003) and has grown to have numerous meanings in different business settings. For this dissertation, open innovation will refer to collaborative efforts among market actors to develop and commercialize knowledge through both formal and informal processes. The concept of openness will be explored in relation to intellectual property with a particular emphasis on collaborative technology platforms, such as standards.

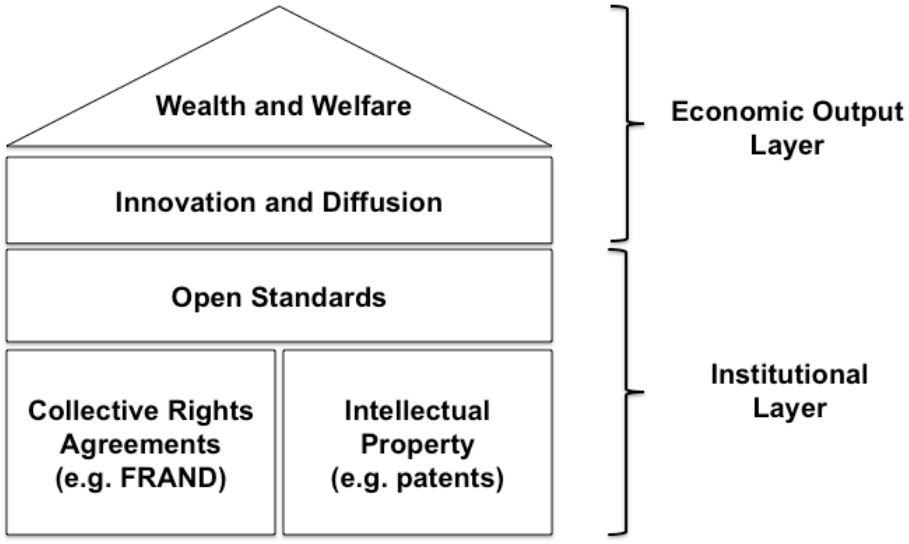

Figure 1.1 Diagram of the relationship among the key phenomena under study

1.3 Delimitations

The concept of FRAND has a long history with regards to standard-setting and antitrust remedies The first formal SSO FRAND policy was initiated by the American Standards Association in 1959, three years after the antitrust consent decrees against AT&T and Western Electric (Contreras, 2015). In the field of telecommunications, early battles over IPR issues in ETSI began around the GSM standard in the early 1990s and resulted in the adoption of FRAND IPR policies (Iversen, 1999; Bekkers et al., 2002). With this background, below is a description of the key delimitations of the investigation into FRAND for this thesis:

- This thesis focuses on the current battle over FRAND from 2007 to 2017 in the era of established, global telecommunication markets enabled by global standards and the growth of smart mobile devices, in particular, smartphones and the emergence of Internet of Things.[12]
- Open, consensus-based telecommunication standards, as opposed to de facto standards, are discussed in general, but 802.11x, H.26x, and 3G/4G/5G cellular standards are addressed in particular.
- Most of the investigations in the thesis have taken place in the context of the US market and legal system, though information from global markets, courts, SSOs, and competition authorities have been employed as sources of data.

[12] This period has experienced major shifts in the telecommunication industry. In mobile phones, for example, large new actors such as Apple and Google have entered the market and incumbents such as Nokia, Motorola, and Blackberry have exited. On the mobile chip market, ARM and Qualcomm created a dominant market share while Intel has struggled to make the transition to mobile.

- The thesis has focused on telecommunication market actors from an SEP perspective in relation to their role in developing standards and implementing standard-enabled products.
- The focus has been on patent holdup/holdout theory and the associated propositions that have become the key areas of contention over the meaning of FRAND. In particular, the concepts of royalty stacking/gap, royalty base, and patent trespass have been investigated in detail.
- While several legitimizing arenas (e.g. courts, competition authorities, SSOs, and the ITC) have been reviewed at some level, the four initial FRAND cases held in US district courts were investigated in detail.

1.4 Disposition of Study

The main theoretical and empirical investigations that build the foundation for this thesis can be described in the following two phases:

1. During 2013-14, a review of the scientific literature was conducted and compared empirically to four case studies representing the initial court decisions on SEP/FRAND royalties in the US district court system. This included the landmark case, *Microsoft v. Motorola*, and three subsequent cases, *Ericsson v. D-link Systems et al.*, *In re Innovatio IP Ventures*, and *CSIRO v. Cisco Systems*. This resulted in two published journal articles (Paper 1: Heiden, 2016; Paper 2: Heiden, 2015) that deconstructed the SEP/FRAND valuation methodologies of the courts and related them to received theory on economic efficiency and new propositions regarding knowledge-based industry dynamics. This created a base for the understanding of the complex issues, interests, and impacts of SEPs and FRAND in the telecommunication context. Furthermore, the key commercial areas of contention were identified and connected to the key concepts used by the stakeholders to define the meaning of FRAND. Lastly, several new theoretical propositions were postulated towards an improved understanding of the value/role of patents in open standards in the knowledge economy.

2. During 2015-16, the focus shifted to a deeper theoretical and empirical investigation of several key conceptual issues that have a great impact on the battle to define the meaning of FRAND. This resulted in a published journal article regarding the determination of the royalty base and the impact on patent damages from a knowledge economy perspective (Paper 3: Heiden & Andreasson, 2016) and a forthcoming article focused on the nature and evidence of patent trespass and the royalty gap as countervailing concepts to patent holdup and royalty stacking (Paper 4: Heiden & Petit, 2017).

In 2016, the main empirical findings and theoretical insights from the four papers were synthesized into five introductory chapters of this thesis. In chapter 2, the frame of reference is discussed providing the necessary theoretical background regarding the institutional nature of patents and how their norms are socially constructed, the changing norms of value creation in the knowledge economy, the, the role of SEPs and FRAND in telecommunication standards, and finally the development of the concept of patent holdup/holdout and its role in defining the conceptualization of the meaning of FRAND.[13] In chapter 3, methodology and research methods are explained including the epistemological perspective of the author, the research strategy, design, and empirical methods as well as research quality criteria. Chapter 4 provides a summary of the four papers and a description of their interconnection. Finally, chapter 5 concludes with a discussion of the contribution of thesis and then presents several elements towards a social constructionist model of FRAND and SEP value and suggestions for further research.

[13] Excerpts developed in Papers 1-4 will be re-framed together with new sections and bridging text to create a holistic, comprehensive frame of reference for the dissertation.

2. Frame of Reference

The main purpose of this thesis is to better understand how competing interests seek to define the meaning of FRAND and influence the value of SEPs. This chapter presents the frame of reference for the thesis by exploring the changing economic, institutional, and industrial norms that define the context in which the current stakeholders find themselves debating the meaning of FRAND and the subsequent value of SEPs.

This chapter does not seek to be exhaustive, but rather provide an introduction to the main, theoretical building blocks that form the foundation for the thesis, which is further elaborated on in the appended papers. Specifically, this includes (1) an epistemological perspective on patents, (2) a introduction to an intellectual value chain perspective on competitive advantage, (3) an overview of the context of FRAND in the telecommunication value chain, (4) a short review of the key competing economic theories being used to define FRAND over the past two decades, and (5) and initial conceptualization of the meaning of FRAND. The use of multiple moments is intentional, so as to be able to address the complex context of FRAND and fulfill the purpose of the thesis. This includes the linking of multiple theoretical fields, such as management, economics, and law on different theoretical levels, including metatheory (grand theory), formal/mid-range theory, and substantive theory.[14] This approach facilitates a holistic investigation by reducing bounded rationality and supporting a more reflexive evaluation and development of theoretical propositions.

The initial focus on a social constructionist perspective is done to facilitate deconstruction and the unveiling of the communicative game, so as to avoid a narrow positivistic approach, which is always tempting the social scientist to define an objective truth in a subjective reality. Furthermore, the use of the concept of "paradigm shift" is also done to support the exploration of a potential discontinuity between theory and reality as paradigmatic change creates the opportunity to move from normative closure (state of accepted reality) to a new set of norms (Kuhn, 1970). This illustrates the tension between market interests based on the clash of old and new norms in changing industries with large financial stakes. This, in turn, creates a tension as competing theories, especially substantive theories, from different paradigms are used to define the reality of institutions that impact both economic performance and efficiency. Below is an introduction to the following sections of this chapter.

Section 2.1 starts with a metatheoretical discussion of the institutional foundation of patents as social constructions from an epistemological (not simply ontological) perspective, providing a framework from which to deconstruct the communicative game that defines patents as institutional facts based on a communicative game on different legitimizing arenas. Section 2.2 continues with a mid-range theoretical discussion on the changing nature of value creation from an industrial to a knowledge economy in the context of a paradigmatic shift in market norms and structure. This primary focus is on the changing economic foundation of

[14] See Glaser and Strauss (1967) for a more detailed description of substantive, formal, and grand theories.

value creation through the development of adjacent value chains, business models, and a new division of innovative labor based on an increasingly dynamic role for patents. Section 2.3 builds on the broader knowledge-based business challenges addressed in the previous section by providing an introduction to the historical development and the current role of SEPs and FRAND in open standards in the telecommunication industry. This reinforces the importance of the changing role of patents and modes of value creation within the specific telecommunication context. Section 2.4 provides a brief overview of the development of core, substantive theoretical concepts such as patent holdup/holdout and royalty stacking that frame the current battle to define the meaning of FRAND.[15] Finally, section 2.5 provides an initial mapping and description of the conceptualization of the meaning of FRAND. This chapter ends with a concluding section presenting the overall research problem.

2.1 The Social Construction of Patents (and Patent Value)

One key institution in a society whose wealth and welfare is built on knowledge is the patent system. The perceived role and importance of patents in the development and commercialization of technology has varied over time and across industries during the history of the patent system with a concomitant effect on the perception of patent value. In recent history, with a starting point in the US in the 1960-70s, patents were seen as an anti-competitive extension of monopoly power by a number of dominant firms, which led to a campaign of compulsory licensing on the part of the Department of Justice (DoJ) and Federal Trade Commission (FTC) (Scherer and Ross, 1990). By the 1980s a pro-patent era began with the establishment of the Court of Appeals for the Federal Circuit (CAFC),[16] The reversal of philosophy at the FTC from a static to a dynamic efficiency perspective, the effects of lobbying by large corporations, and the shift in ideological view that patents were central to the competitiveness of the nation (Granstrand, 1999). These changes all led to the development of patents as a valuable corporate asset though still largely within a traditional industrial paradigm focused on the protection of manufactured goods.

In the 21st century, fueled by increased R&D and a growing awareness of the value of intellectual property, the number of patent applications and litigation rose exponentially,[17] creating what some have described as patent thickets in the software, telecommunications, semiconductor, biotechnology and other complex, multi-technology business areas that some believe threatens the development of both economic efficiency and innovation (Shapiro,

[15] An extensive theoretical critique is provided in paper 4.
[16] Henry and Turner (2006) conclude that "the CAFC's changes have clearly enhanced the value of patents and have increased the incentives of patentees to sue for infringement". Merges (1988) acknowledges the role of the CAFC as a key reform that strengthened the patent system but questioned the extent to which economic success per se should guide the CAFC's determination of patentability.
[17] The number of patent applications in the US has risen six-fold between 1983 and 2012 (www.uspto.gov/web/offices/ac/ido/oeip/taf/us_stat.htm).

2001).[18] While lacking rigorous empirical economic evidence, the specter of patent thickets and trolls combined with several high-profile legal actions[19] led to calls for legislative and judicial reform throughout the 2000s culminating in the signing of the America Invents Act of 2012 and several landmark judicial rulings. In particular, the US Supreme Court has been rather active in the 21st century reviewing cases of patent law and (re)defining issues related to injunctive relief,[20] patentable material,[21] obviousness of patent claims,[22] research exemption,[23] and patent exhaustion.[24]

In aggregate the recent legislative changes and judicial rulings in combination with the rather strong anti-patent rhetoric from the popular press potentially signal the beginning of a new patent era, epitomizing the struggle with the transition to a knowledge-based economy, where the main economic inputs, and increasingly outputs, are intellectual instead of physical.[25] Thus the new patent era is one in which the critical role of intellectual property to incentivize and govern open innovation, on one hand, is offset by the less productive rent-seeking behavior that accompanies the emergence of a new asset class on the other hand.[26] Attempts to eliminate the negative behavior without harming the positive have been made more difficult by the fact that competing interests have purposely muddied the distinction between the two behaviors (i.e. when actors are seeking legitimate returns on their investments in innovation and when they are simply gaming the system).[27]

The historical shifts regarding the fluctuating importance of patents discussed above illustrate the obvious but important ontological distinction that patents and their associated value are social constructions that are shaped and reshaped by legal, economic, and political forces over time. The concept of the patent is nothing more than a reflection of the value that is infused in

---

[18] While patents are considered a means to stimulate dynamic efficiency, Levin et al. (1987) postulates that "the semiconductor industry of the 1950s and 1960s provides an excellent example of rapid progress in accumulative technology that might have been impossible under a regime that strongly protected intellectual property", which raises the question as to whether there is an easy choice between strong or weak IP regimes in regards to innovation outside of a given technology development context.

[19] See NTP, Inc. v. Research in Motion, Ltd., 418 F. 3d 1282 - Court of Appeals, Federal Circuit (2005), where the threat of injunctive relief of Blackberry service resulted in a settlement of over 650MUSD. See US FTC Rambus Consent Order (2007) regarding misrepresentations or omissions from SSOs.

[20] See eBay Inc v. MercExchange, L.L.C., 547 U.S. 388 (2006)

[21] See Bilski v. Kappos, No. 08-964 (2010), Mayo Collaborative Services v. Prometheus Laboratories, Inc., No. 10-1150 (2012), and Association for Molecular Pathology v. Myriad Genetics, Inc. (2013)

[22] See KSR Int'l Co. v. Teleflex, Inc., 550 U.S. 398 (2007)

[23] Merck KGaA v. Integra Lifesciences I, Ltd., 545 U.S. 193 (2005)

[24] Quanta Computer, Inc. v. LG Electronics, Inc., 553 U.S. 617 (2008)

[25] The evolution of the patent system and its use by market actors are different in Europe and Asia than in the US for various reasons including the fragmented IP system in the EU and the relatively young but fast growing system in China. However, the issues surrounding the use of IP for open innovation in a knowledge economy context is changing most rapidly in the US, even more than the EU. For example, based on two recent US Supreme Court decisions (*eBay* and *Myriad Genetics*), the US courts are much less likely to grant injunctions on patent infringement and uphold gene patents than German courts, which is a much more dramatic change for the US than for Germany.

[26] The recent wave of monetization of patents through licensing and litigation has created the view of patents as a new asset class in the eyes of the financial community.

[27] Legitimacy is a normative concept that strikes at the heart of the current discourse on the role of patents. Right and wrong are based on a battle of ideology and interests where eventually one side wins the right to set the rules.

it by the societal institutions and actors that define it. Thus it is not possible to separate the concept of a patent from patent value, which is why patents are not sought in regimes with weak enforcement. Without an enforceable claim of economic value, patents basically cease to exist.[28] Recent events suggest a new patent era is evolving to challenge the norms of the pro-patent era that began in the 1980s. Below is are two theoretical models to describe the reification process of intellectual constructs that are useful for understanding how social processes (e.g. judicial disputes) during a reification stage can affect the norms and value of patents.[29]

2.1.1 Patent Value as a Hierarchy of Norms

Patents are social constructions, which means that their existence cannot be separated from the communicative actions of the actors that define them (Searle, 1997; Berger & Luckmann, 1966). The social construction of patents can be modeled as a hierarchy of norms on two levels representing tools and blocks (see figure 2.1 below).[30] Tools are rules and norms that reify institutional constructs (i.e. blocks).[31]Thus tools are used to build blocks, which represent reified institutional constructs and justified consequential norms within different contexts (Petrusson, 2004).[32] For example, patent law can be seen as a tool that is used to define the rules and norms regarding patentability (i.e. tools), which can then be applied to the development of specific patents (i.e. blocks) with the consequential norm that the patent can be further used as property in commercial transactions among other norms of use. If patent law is unclear (e.g. its meaning is ambiguous in certain contexts) or lacks sufficient enforceability (e.g. the court system is ineffective or inconsistent) then it will operate as a weak tool, which in turn, will produce weak blocks, whose legitimacy will be uncertain, as will the norms of its subsequent use.[33] The level of reification of institutional tools determines the reification of the blocks that are produced, which impacts uncertainty as well as both private and social value.

[28] The same can be said for all economic-oriented social constructions.
[29] Berger and Luckmann (1966) describe reification as "the apprehension of human phenomena as if they were things, that is, in non-human or possibly supra-human terms." It is through the process of reification that social constructions are experienced as phenomena that exist independent and separate from social action. This, however, doesn't mean that social phenomena are actually objective in the ontological sense – only that they have reached a state of normative closure within the given societal paradigm.
[30] See Petrusson (2004) for a discussion on intellectual tools and blocks as core to a norm-constructionist understanding of entrepreneurship in the knowledge-based economy.
[31] Berger and Luckmann (1966) state "the basic 'recipe' for the reification of institutions, is to bestow on them an ontological status independent of human activity and signification".
[32] Latour (1996) uses the concept of quasi-objects and networks instead of blocks and context.
[33] For example in 2013 the US Supreme Court in the Myriad Genetics case ruled that naturally occurring genes are not patentable subject material. By altering patentability as a tool they invalidated all the related gene patents (i.e. blocks) thus weakening the businesses that the patents underpinned.

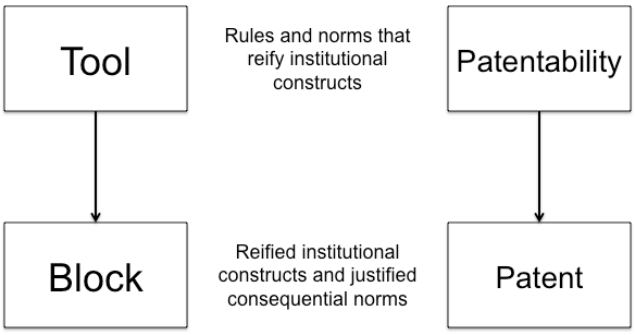

Figure 2.1 Patents as a hierarchy of norms (adapted from Petrusson, 2004)

For example, when market actors ask courts to solve disputes, they concomitantly ask courts to define the rules and norms of the game. Thus when a court is asked to value a patent (i.e. a block), it will also define the rules and norms (i.e. the tools) that will define the value of all existing and future blocks. From a market perspective, this is a very risky business, especially when the tools are considered normatively open for discussion. Under these conditions, one case can easily set a precedent that impacts the entire market, which of course is why lobbying efforts are often intensified during periods of judicial and legislative ambiguity. Therefore, patents are a classic example of institutional facts, where the norms are constantly evolving. This means that while patents may be experienced positivistically, they are actually continuously being (re)interpreted through the lens of different public and private interests.[34]

2.1.2 Patent Value as a Normative Claiming Game on Multiple Arenas

The reification of institutional tools and blocks is a process of communication and acceptance, which can be described as a period of normative openness ending in normative closure, though never completely closed.[35] During the period of openness, stakeholders make claims that are eventually either accepted (possibly in modified form) or rejected by the other stakeholders. However, communicative claims require institutional legitimacy (i.e. reified platforms where institutional tools are defined and accepted). Communicative claims can thus be seen as a game that takes place among different actors across different arenas. These different actors vie to have their claims of social reality accepted on these key arenas through various means of persuasion.

Petrusson (2004) describes patents as a communicative game on three arenas, including the administrative, judicial, and business arenas as shown in figure 2.2 below.

[34] Positivism is a scientific approach connected with the investigation of an objective reality such as in natural science. In social science, reality is not ontologically objective but can be experienced as such through reification.

[35] Teubner (2006) explains, "It is social practices in the world of business, economy and politics that create their own self-descriptions, which in turn inform and guide the underlying social practices".

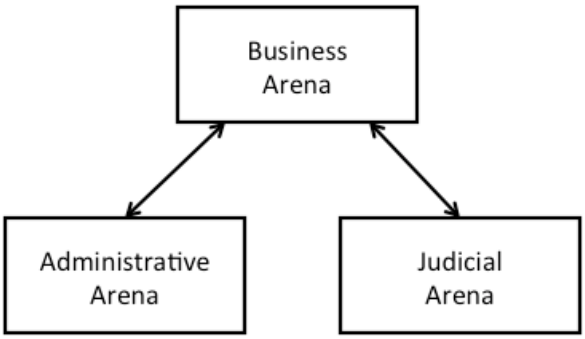

Figure 2.2 Three arenas model (Petrusson, 2004)

The focus of the model is on the Business Arena, where firms use patents to engage in licensing or to build competitive market positions to sell products and services. Value creation on the business arena is supported by actions both on the Administrative Arena, where business actors negotiate the scope and validity of their patent claims with national patent offices and the Judicial Arena, where patents are ultimately validated when disputes arise. While the different arenas have their own logic, they are also part of an interrelated system of design, development, and validation that together defines the norms that determine the commercial value of patents. Using this model it is easy to see how different actors can play a communicative game on different arenas to try to enact their claims as a means to affect not only the validity of specific commercial building blocks but also the validity of the tools that are used to build them.

2.2 The Changing Norms of Value Creation – From an Industrial to a Knowledge-Based Economic Paradigm[36]

Economic development, particularly in developed countries, is said to be in the midst of a paradigmatic shift towards what has been ambiguously termed as post-industrial (Bell, 1976), service-based, information-based, network-based (Castells, 2009), creativity-based (Florida, 2002), knowledge-based, and even post-capitalist (Drucker, 1990).[37] Certainly, there is nothing new about the observation that knowledge plays a critical role in economic development. Economic institutions themselves are social constructions of knowledge. Products are physical manifestations of knowledge. Capabilities are specialized bundles of knowledge and so on. As a core contextual issue in this thesis relates to the heterogeneity of business models and the use of patents deployed by the market actors in the telecommunication value chain, this section seeks to provide a theoretical framework for understanding several key differences between industrial and knowledge-based business. In particular, this includes (1) the difference between a static to a dynamic use of intellectual property and (2) the relationship between a material versus the intellectual value chain. This

[36] Portions of Section 2.1 are borrowed from Paper 3 in the dissertation.
[37] Drucker uses post-capitalist and knowledge-based society interchangeably. A comparative discussion is needed but beyond the scope of this thesis. For now, all these concepts will be treated as synonymous.

sets the foundation for the understanding of the role that the changing norms of value creation play in the battle to define the meaning of FRAND.

2.2.1 Knowledge-Based Business – From Static to Dynamic Use of Intellectual Property

As mentioned above there is nothing new about the observation that knowledge plays a critical role in economic development.[38] Since business cannot exist without knowledge, the existence of knowledge itself cannot be the defining characteristic of the knowledge economy in relation to an industrial economy, which was obviously also based on knowledge.

"Fundamental to a knowledge-based theory of the firm is the assumption that the critical input in production and primary source of value is knowledge. Indeed, if we were to resurrect a single-factor theory of value in the tradition of the classical economists' labor theory of value or the French Physiocrats land-based theory of value, then the only defensible approach would be a knowledge-based theory of value, on the grounds that all human productivity is knowledge dependent, and machines are simply embodiments of knowledge." (Grant, 1996, p.112)

Thus central to defining the knowledge-based business is the need to understand how firms use knowledge in different ways to create value and achieve competitive advantage (Petrusson, 2004). Two important perspectives are related to the nature of firm resources, and how the value of these resources is appropriated through IP-based transactions.

From a resource-based perspective, competitive advantage is typically defined in terms of the firm's organizational control over key tangible and intangible resources (Penrose, 1959; Wernerfelt, 1984; Barney, 1991). Over the past 40 years, there has been a significant shift in the proportion of tangible resources in relation to the market value of firms on the S&P 500 – from 83% in 1975 to 16% in 2015.[39] This is a strong indication that intangible resources are now responsible for the majority of value creation across a broad range of US firms, supporting the premise that knowledge has replaced the traditional factors of production as the primary source of value.[40] This, in turn, puts a greater emphasis on the management of knowledge to better understand the exact contribution the firm's intangible resources in relation to its value propositions. As the value of knowledge becomes increasingly recognized and objectified, the control of knowledge moves from an administrative to a key strategic

[38] The term knowledge economy is not perfect in this regard but is used to contrast the strong reification of the physical product as the center of economic activity in the industrial economic paradigm.
[39] See http://www.oceantomo.com/2015/03/04/2015-intangible-asset-market-value-study/.
[40] However, it is difficult to understand exactly what is meant by intangible resources as the measurement is only a calculated residual. In other words, tangible assets are calculated from the balance sheet of the firms, and the market value is determined by the stock exchange, but the value of intangible assets is only obtained by subtracting these two values (i.e. there is no accounting or direct market valuation of the intangible assets of firms). Similar to the calculation of Solow's residual in the 1950s, the revelation that the S&P 500 is mostly intangible capital intensive only defines the extent of our ignorance. See Solow (1957).

process of the firm. In fact, one way to differentiate the industrial and knowledge economy is to say we are moving from the control of the means of production to the control of knowledge as the core driver of competitive advantage.

From a transactional perspective, one defining aspect of the growth of knowledge-based business is that objectified knowledge (e.g. patented technology) is growing as an activity of market exchange. Thus the transformation from an industrial to a knowledge economy can also be characterized by a fundamental shift in the role of intellectual property from a static to a dynamic approach where intellectual property is used not only used to block others (i.e. static) but also as objects in commercial transactions (i.e. dynamic) (Merges, 1996). This impacts how knowledge is created, controlled, and commercialized, opening up for new knowledge-based business models and facilitating the development of a division of innovative labor (Merges, 1999). As the value of knowledge is contextual in nature, the means by which it is utilized through different business models and market norms will ultimately define its actual value-in-use (Petrusson and Heiden, 2009). Thus the value of knowledge is business model specific, where license-based models are increasingly used as a means of capturing this value in the knowledge economy. Below is an attempt to define knowledge-based business that incorporates both a resource and a transactional approach (i.e. input and output) independent of the dominant industrial logic.

Knowledge-based business can be defined as commercial activity where *proprietary knowledge* is its main resource input and/or output characterized by the following:

Value addition of knowledge

The key value drivers are mainly determined by the knowledge component (i.e. objectified intellectual assets such as technology, brands, content, designs, know-how, etc.) of the value proposition. When knowledge itself is the value proposition such as in an IP license, then this distinction is obvious. However, this is not as intuitive when the value proposition is delivered as a physical or virtual product.[41] Branded products are a good example where the value addition of the brand is worth far more than the cost of production of the product itself. Another example would be the delivery of software on a DVD or a cure for a disease in the form of a pill. In these cases, the material value proposition is of much lesser value than the knowledge-based value proposition. The physical object is simply the carrier of the real knowledge-based value proposition (Vargo and Lusch, 2004).[42]

Control of knowledge

[41] A virtual product in this context is considered a value proposition that is delivered completely as a digital product or service (e.g. a software application, search engine, etc.).

[42] Vargo & Lusch argue that the distinction between products and services is a social construction based on a historical focus on operand resources such as land and physical goods as opposed to the underlying operant resources. They contend that all economic activity is service-based – a fact that has been hidden by the indirect exchange of the market for physical goods – and call for a change in the dominant marketing logic from a focus on goods to service provision as the core to economic exchange. Here service is defined as a value proposition to customers instead of an economic activity where knowledge is the key operant resource.

Maintaining control over the key intellectual assets of the value proposition is critical to creating competitive advantage. Knowledge, once created, is neither a rival nor a scarce resource. The control of knowledge through various mechanisms including intellectual property rights is essential to the claiming of knowledge in property transactions as well as allowing for freedom to operate in knowledge-intensive industries.

Business model specific

Knowledge-based business (KBB) is business model specific, not sector specific (though some sectors use mainly KBB models, for example, IT, creative industries, etc.) Knowledge is important in all economic paradigms, but what differentiates knowledge-based business is the increasing role played by knowledge as discreet commercial objects in market transactions.

The next section will elaborate on the transformation from an industrial to a knowledge-based business paradigm in relation to changes in the structure of the firm and industry value centered on an increased dynamic use of intellectual property.

2.2.2 The Material vs. Intellectual Value Chain

The industrial economy is typified by a relatively few, well-known commercial means from which to create and extract value through the production, distribution, sales, and repair of physical goods (Porter, 1985). Figure 2.3 below depicts the classic material value chain (MVC) where firms can occupy multiple stages in the chain (i.e. vertical integration) or occupy the same stage in multiple value chains (i.e. horizontal integration). However, if proprietary knowledge is the key to competitive advantage in the knowledge economy, the traditional focus on the MVC will need to be supplemented with what could be termed as an intellectual value chain (IVC).

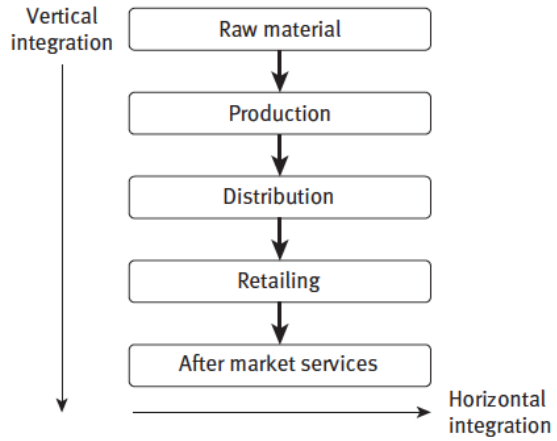

Figure 2.3 Generic Industry Value Chain (adapted from Porter, 1985)

In figure 2.4, the intellectual value creation process makes explicit the source of value as the knowledge of human resources captured as intellectual assets and property, which can then be commercialized through different business models that in turn impacts the norms and

structure of the market. This includes the use of traditional physical products as the carrier of value in which case the traditional material value chain shapes the market. In addition, though, knowledge can be delivered through virtual products (e.g. information technology solutions such as software), as knowledge transfer through license agreement (e.g. patent/technology license), as a professional service (e.g. consulting), or a combination of all these mechanisms. These different means of knowledge exploitation involve the creation of completely different market norms and business models. For example, the packaging of music in an iTunes or Spotify solution creates quite different firm and market norms than the historical model of retailing music through CDs or records (i.e. physical products). In both business models, proprietary knowledge is the key underlying asset. The change from a physical product to a virtual product/service serves to unveil the true value creation object and expose the industrial paradigm as simply one mode of commercial distribution among others.

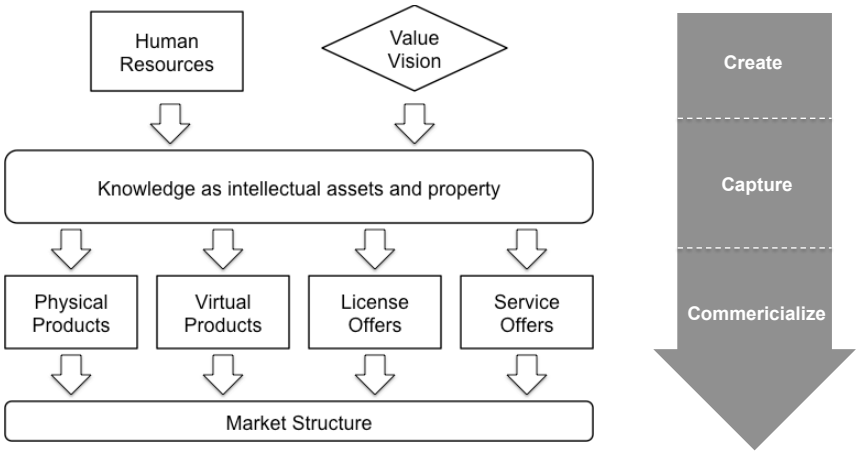

Figure 2.4 Intellectual Value Creation Process
(Adapted from Petrusson, 2004; Petrusson and Heiden, 2008)

The intellectual value creation process clarifies the creation and capture of valuable knowledge as the core resources (i.e. intellectual assets and property) of knowledge-based business in alignment with the resource-based view of the firm. It also focuses on the dynamic movement of knowledge from the minds of individuals to its explicit objectification and packaging as property through various commercial delivery mechanisms. Knowledge thus moves from being an abstract concept to objectified assets and property to be managed and transacted. The key activity of the firm, in turn, becomes the maximization of the value of knowledge through the development of innovations, markets, and ventures through the function of knowledge management as an integration of human resource management and intellectual asset/property management, differing greatly from the focus on the production and distribution of physical resources in the MVC (Petrusson, 2004).

The transition from an MVC to IVC perspective can be exemplified using Porter's generic firm value chain shown below in figure 2.5. In this industrial model, the primary activities of the firm are related to the movement, development, and servicing of the physical product.

Technology development is considered a support activity, not a profit center activity of its own. However, once knowledge is put as the focal point for value creation and extraction, technology development could be seen as the primary activity of the firm whereby the MVC becomes only one of several commercial options available to the firm as shown in figure 2.2 above. This, in turn, creates opportunities for both outsourcing of MVC activities and specialization in technology development and innovation facilitating the development of a division of innovative labor.[43]

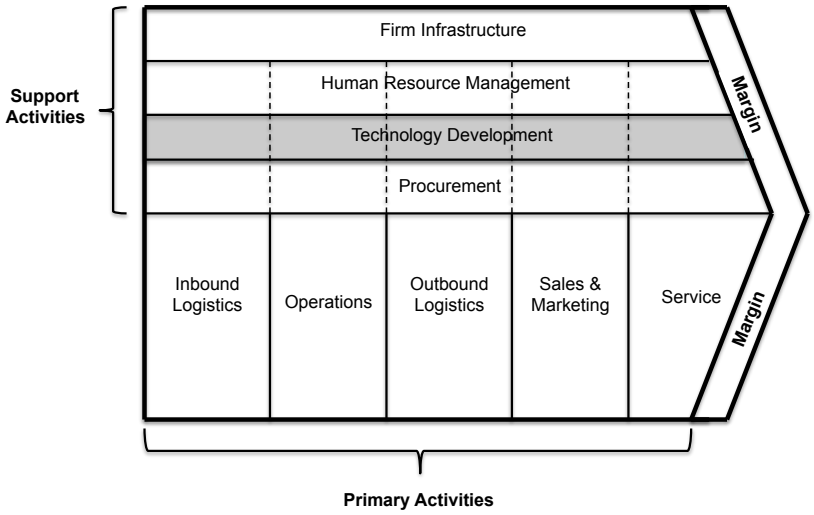

Figure 2.5 Generic Firm Value Chain – (Porter, 1985)
Author's emphasis on technology development

For this thesis the focus will be on the key operational differences between competition on a product market (i.e. a MVC) versus a technology market (i.e. an IVC), where the former is primarily concerned with the production and sale of physical products and the latter with the packaging of knowledge as intellectual property and commercialization through license-based transactions (Grindley and Teece, 1999; Arora et al., 2001). While the material value chain (MVC) can be seen as a component of a more holistic intellectual value creation process as depicted in figure 2.6, this thesis will define the two value chains as separate but complementary as a means to better illustrate the different commercial logics and strategies deployed by market actors. This is particularly relevant considering the changing role of IP licensing from being simply an alternative to in-house production to a primary means of generating revenue and facilitating access in standards-enabled markets with multi-technology products, where IP ownership is often distributed among many actors (Petrusson, 2004).

[43] The lack of marginal cost of knowledge combined with the market power created through its control (e.g. through a patent) allows for knowledge to operate separately from its embodiment in physical products and capture value through its own value chain (i.e. the IVC).

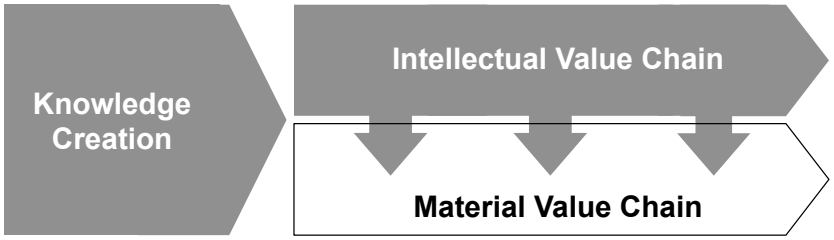

Figure 2.6 Commercialization of knowledge on both a material and intellectual value chain

Figure 2.6 above depicts how knowledge can be commercialized through both a material and intellectual value chain as products, license offers, or both. In particular, this model highlights the specific path for the transaction of intellectual property in the IVC versus the transaction of physical property, with or without the associated intellectual property, in the MVC. As technology/patent licensing is often directed at producers of physical products, it is important to understand the intersection of the two value chains (i.e. the position in the material value chain where licensing takes place) as this is particularly relevant in the determination of how value is shared across market actors in the different value chains.

2.3 SEPs, FRAND, and Open Standards in a Changing Telecommunication Value Chain[44]

2.3.1 The Value of Standards

The modern economy runs on standards (Blind, 2004; Blind and Jungmittag, 2008). In particular, the information and communication technology (ICT) sector that defines the information age is completely dependent on interoperability standards (West, 2005). One study identified 251 interoperability standards and estimated many more relevant standards in a laptop computer (Biddle, 2010). Another ubiquitous product, Microsoft's Windows 7 (a de facto standard itself) is conservatively estimated as employing at least 60 industry standards, though it is important to note that standards vary greatly in their complexity and strategic commercial use by market actors.[45] Standards, in general, are basically codified knowledge in the form of technical specifications that define systems and interfaces between systems. IEEE defines standards as follows:

Standards are published documents that establish specifications and procedures designed to maximize the reliability of the materials, products, methods, and/or services people use every day. Standards address a range of issues, including but not limited to various protocols to help

[44] Portions of Section 2.3 are borrowed from Papers 2 and 3 in the dissertation.
[45] See Microsoft's submission to the FTC Patent Standards Workshop (2011).

maximize product functionality and compatibility, facilitate interoperability and support consumer safety and public health.[46]

ETSI cites similar benefits to standardization, such as interoperability, safety, and reliability, but also emphasizes business benefits, including increased market access and innovation as well as improved consumer choice.[47]

In general, standards are viewed as pro-competitive.[48] From an economic perspective, standards are public goods in that their use is fundamentally non-rival, which means that once developed they can be diffused at low cost and used by many actors simultaneously. This explains why standards facilitate knowledge spillover and diffusion, which is widely considered to increase economic efficiency and growth through both supply-side and demand-side economies of scale.[49] However, the development of standards experience the same general difficulties characteristic of knowledge (and information) production in that they are often expensive to create but inexpensive to distribute and therefore pose challenges with the appropriation of value, which is cited as a typical reason for underinvestment in R&D.[50] Thus, while standards can facilitate the creation of efficient markets for downstream implementers of products and services, it doesn't solve the appropriation and uncertainty challenges for upstream innovators that perform the R&D that defines the technical specifications of the standard. This issue will be addressed in the next section.

2.3.2 The Tension Between Patents and Open Standards – FRAND as a Solution

Open, consensus-based standards, have played an important role in the growth of the telecommunication sector.[51] Open standardization processes can involve hundreds of actors and require access to thousands of patents that are essential to the implementation of a standard.[52] The IEEE defines standard essential patents as follows:

An *Essential Patent Claim* "shall mean any Patent Claim the practice of which was necessary to implement either a mandatory or optional portion of a normative clause of the IEEE Standard when, at the time of the IEEE Standard's approval, there was no commercially and technically feasible non-infringing alternative implementation method for such mandatory or

---

[46] Retrieved from https://standards.ieee.org/develop/overview.html.
[47] See http://www.etsi.org/standards/why-we-need-standards.
[48] See David and Steinmueller (1994) for an overview of the pro- and anti-competitive aspects of technical compatibility standards.
[49] Demand-side economies of scale are also known as network externalities, which is a well-established benefit of interoperability. See Katz and Shapiro (1985) for a discussion on the different types of network externalities.
[50] See Arrow (1962) for a discussion on the problems of markets to efficiently allocate resources for invention due to the indivisibilities, inappropriability, and uncertainty associated with information (knowledge)
[51] See Kretchmer (2006) for a typology of ten requirements that enable open standards.
[52] For example, the MPEG-LA patent pool for the ITU H.264/AVC standard consists of approximately 30 licensors, over 2400 essential patents, and over 1200 licensees. See http://www.mpegla.com/main/programs/AVC/Pages/Intro.aspx.

optional portion of the normative clause. An Essential Patent Claim does not include any Patent Claim that was essential only for Enabling Technology or any claim other than that set forth above even if contained in the same patent as the Essential Patent Claim". [53]

The complex standardization processes are typically governed formally or by voluntary participation by specific standard-setting organizations (SSOs)[54] run by industry consortiums, professional associations, and national or international NGOs.[55] SSOs are solely focused on developing the best technical specifications and formally forbid issues concerning patents and licensing to take place within standard deliberations.[56] However, as the creation of standards generate network effects that can lead to lock-in effects on the market, holders of patents essential to the execution of the standard could possess a much higher degree of market power than would normally be attributed to actors in a competitive market (Katz and Shapiro, 1985; Farrell and Klemperer, 2003). An example of the early use of standard-essential patents (SEPs) and the subsequent policy developments will be discussed below.

One key development in the creation of IPR policies in telecommunication standards can be traced back to the change in the role of patents that occurred during the development of the GSM (Global System for Mobile Communications, originally Groupe SpécialMobile) standard for mobile telephony. Using a relative advantage from a small portfolio of standard-essential patents (SEPs) Motorola altered the structure of the nascent GSM market in the late 1980s and early 1990s by forcing implementing firms to enter into licensing agreements in order to produce GSM standard-compliant equipment (Bekkers et al., 2002). The recognition of the potential power of SEPs generated a movement within European Telecommunications Standards Institute (ETSI), as well as other SSOs, to develop IPR policies to govern the role of patents in the development and commercialization of standards (Iversen, 1999). These efforts resulted in the widespread use of what is known as a FRAND agreement, where patent holders contractually agree to license their SEPs under Fair, Reasonable, And Non-Discriminatory (FRAND) terms to members of the SSO and third parties (Lemley, 2002; Bekkers and Updegrove, 2012).[57] Thus, FRAND has facilitated the transition from a static (i.e. blocking) to a dynamic (i.e. licensing) use of patents in the telecommunications value chain as discussed in section 2.1.[58] In essence, FRAND provides a market-based governance structure to balance the complex interests of diverse actors in the value chain so as to both incentivize technology contributions and facilitate market diffusion of the standard. FRAND can, therefore, be seen as a mechanism to manage two competing theories of market failures – public goods dilemma and holdup, which will be discussed further in section 2.4.

---

[53] See IEEE-SA Standards Board Bylaws (2016), p.15 at https://standards.ieee.org/develop/policies/bylaws/sb_bylaws.pdf.
[54] Examples include Bluetooth (industry consortium), IEEE (professional association), ANSI (American NGO), and ITU-T (International NGO).
[55] Standards can also be developed and governed by individual firms (e.g. Microsoft Windows) and competing standards can emerge leading to standards wars – see Shapiro and Varian (1999).
[56] See, for example, the ITU/ISO/IEC Common Patent Policy.
[57] See Contreras (2015) for a brief history of FRAND though primarily from an anti-trust perspective.
[58] For example, Motorola in GSM was easily able to block access to their SEPs, while FRAND by definition requires access.

The IPR policies of SSOs typically encourage, as opposed to requiring, members to disclose patent and patent applications that are or may become essential to the standard in a timely manner. Once disclosed the patent holder is then asked to sign an agreement defining their intention to license their SEPs under FRAND terms (or royalty fee).[59] If a declared owner of an SEP does not agree to license their patents under FRAND terms, it is usually required that a different non-infringing technical option is chosen for the standard.[60] This agreement is the key to the fundamental quid pro quo social contract that rewards inventive efforts and unlocks the pro-competitive, value-creating potential of standardization. The specifics of a FRAND license are left for negotiation between market actors. In fact, SSOs have typically steered clear of specifying what constitutes a FRAND license.[61] FRAND-enabled standards, such as 802.11, 4G/LTE, H.264, etc. have experienced great adoption and market success.

2.4 Patent Holdup, Holdout, and Economic Efficiency

2.4.1 The Rise of Patent Holdup Theory – Does it Apply to Standards?

Farrell et al. (2007) define holdup as follows:

”In very broad terms, opportunism or hold-up arises when a gap between economic commitments and subsequent commercial negotiations enables one party to capture part of the fruits of another’s investment, broadly construed. Hold-up can arise, in particular, when one party makes investments specific to a relationship before all the terms and conditions of the relationship are agreed. Hold-up generally leads to economic inefficiency that contracting parties, and courts interpreting contracts, often try to avoid.”

The concepts of opportunism and holdup have their origin in the study of transaction cost economics associated with contracting versus vertical integration (Coase, 1937, Williamson, 1975; Teece, 1976). Klein, Crawford, and Alchian (1978) describe opportunism (and holdup) as a case of appropriable quasi-rents to contracted specific assets, where opportunism can take place in either direction (i.e. the buyer or the seller). The concept of opportunism not only raises transactional issues of rent-shifting of producer surplus among market actors, but also systemic issues of economic inefficiency that raise antitrust concerns.

[59] Patent holders can also issue a Blanket Letter of Assurance ”that applies to all Essential Patent Claims for which a Submitter may currently or in the future have the ability to license.” (source: IEEE-SA Standards Board By-laws)
[60] See ITU/ISO/IEC Joint Patent Policy
[61] The exception is the recent controversial changes by the IEEE to an IPR policy that more clearly define FRAND terms has been met by resistance from key telecommunication firms with strong SEP portfolios.

The development of biotechnology, telecommunications, and computing in the 1990s gave rise to discussions on the tragedy of the anti-commons[62] and patent thickets,[63] questioning whether patents were, in fact, deterring instead of facilitating innovation (Heller, 1998; Heller and Eisenberg, 1998; Shapiro, 2001). In the 21st century, increased patenting in general and litigation by patent-assertion entities (PAEs) against firms with multi-technology products led to the refined development of a new concept, patent holdup theory (Shapiro, 2001; Lemley and Shapiro, 2007; Farrell et al., 2007; Shapiro, 2010). Proponents of patent holdup theory claim that patent owners are able to command royalties greater than the value of the contribution of their patents for the following interrelated reasons (Lemley and Shapiro, 2007):

1. Holders of minor/weak patents can claim a portion of the value of the entire product by threatening *injunctive relief* through the lost product sales on the market.[64]
2. Patent claims by multiple actors create a *royalty stacking* problem where each patent holder is able to negotiate a greater share than what would have been possible if the patents were held by one actor.[65]
3. Courts consistently grant *excessive damage awards* that surpass the reasonable royalty rate because they are not able to correctly *apportion* the value of the patented invention related to the value of the product for products consisting of many patented inventions (i.e. multi-component products).[66]

Lemley and Shapiro (2007) also extend their patent holdup theory beyond its primary focus on PAEs to the context of standards and SEPs. They argue that each of the problems of patent

---

[62] The tragedy of the anti-commons is a concept used to describe the circumstance whereby overlapping property rights among market actors effectively block the action of all actors thus severely reducing innovation and/or market formation (Heller, 1998; Heller and Eisenberg, 1998). This is in contrast to the classical discussion on the tragedy of the commons whereby common-pool resources are theorized to be depleted through collective action (Hardin, 1968). One explanation for a lack of "tragedy" in relation to systems characterized by a theoretical anti-commons problem, could be attributed to the ability of actors to self-regulate their behavior as was observed in relation to common-pool resources (Ostrom, 1990).

[63] Shapiro (2001) describes patent thickets as "a dense web of overlapping intellectual property rights that a company must hack its way through in order to actually commercialize new technology."

[64] Injunctive relief in the context of patents refers to the right of patent owners to receive a court order blocking the sale of infringing products. The dispute between NTP and RIM is often cited as an anecdotal case of patent holdup through the threat of injunctive relief, whereby RIM agreed to pay 612.5 MUSD to avoid be enjoined, while the actual patent damages levied by the court only amounted to 33MUSD (raised to 55MUSD by the judge based on willfulness). However, while this case may demonstrate the effect of patent holdup, it has been questioned whether RIM was the victim given the entire history of the case – for example, see Blaxill and Eckardt (2009).

[65] Royalty stacking in the context of patents refers to the aggregate royalty paid by product implementers to all patent owners from whom a license is required. This is a version of Cournot complements problem of multiple monopoly input owners (Cournot, 1897). For example, Bekkers and West (2009) estimate that the UMTS telecommunication standard (aka 3G) includes 1227 distinct essential patents (i.e. patent families) by 72 organizations with an aggregate royalty rate of approximately 20% of the price of a mobile phone.

[66] Apportionment of patent damages has been historically difficult to implement in practice for the US court system – see Benson (2005). A number of recent Federal Circuit decisions have taken up this contentious issue in regards to multi-technology products, including *Lucent Technologies v. Gateway*, 580 F.3d 1301 (Fed. Cir. 2009), *Ericsson, Inc. v. D-Link Sys., Inc.*, 773 F.3d 1201, 1226 (Fed. Cir. 2014), and *CSIRO v. Cisco Systems, Inc.*, 809 F.3d 1295, 1302 (Fed. Cir. 2015).

holdup hypothesized above is theoretically exacerbated in the case of standardization as implementers of the standard are locked-in to a set of technical specifications and must license the required essential patents (i.e. there is little opportunity to invent around or switch to another solution).[67]

Currently there is no conclusive empirical evidence of systemic patent holdup in any industry where standard-essential patents are offered for license under FRAND terms (Layne-Farrar, 2014; Galetovic, Haber and Levine, 2015; Galetovic, Haber and Zaretzki (2016); Galetovic and Gupta, 2016; Mallinson, 2016; Sidak, 2016)[68,69]. For example, the H.264 and 802.11 standards in question in the studied cases in Lemley and Shapiro (2007) have been extremely successful on the market, even though both standards contain thousands of SEPs and as many as 90 SEP holders. One explanation for this is that patent holdup is not based on ex post opportunism, but based on an ex ante FRAND agreement acknowledged and accepted by downstream companies before irreversible investments are made (Sidak, 2013).

While transactional patent holdup and holdout can take place at any time amongst parties to a FRAND commitment due to the incomplete nature of the contract, the market success of ICT standards suggests that both upstream and downstream actors are incentivized to negotiate in good faith for their own mutual benefit (Layne-Farrar and Wong-Ervin, 2015). This is possibly another explanation for the lack of empirical evidence of market failure in FRAND-enabled standards. However, despite the prolific use of FRAND policies by the majority of SSOs (Lemley, 2002; Bekkers and Updegrove, 2012) and the reduction in access to injunctive relief by patent owners (*eBay v. MercExchange*), there has persisted a growing concern regarding a lack of market consensus on the meaning of FRAND and that SEPs produce a systemic level of opportunism or holdup by SEP holders in the market that warrants policy remedies.[70]

---

[67] The FTC in its complaint against Google defined patent holdup in the context of standardization to be "the increase in the value of the patent based on the switching costs after it becomes a SEP is known as its 'hold-up' value."

[68] See also Reply Submission on the Public Interest of Federal Trade Commissioners Maureen K. Ohlhausen and Joshua D. Wright**,** In the Matter of – Certain 3G Mobile Handsets and Components Thereof, International Trade Commission (Inv. No. 337-TA-613, 2015), Section 2 entitled , "Empirical Evidence Suggest no Systemic Problem With Holdup." See Wright and Ginsburg (2014) for a discussion on contractual opportunism and antitrust implications. See Balkenborg, Kaplan, and Miller (2012) differentiating holdup situations that merely redistribute income (i.e. transactional) from those that block investment and create inefficiencies (i.e. systemic). The concepts of ex post vs. ex ante opportunism is another way to view the difference between transactional and systemic holdup, where the latter has a much greater impact on investment and market formation.

[69] For example, neither the 2014 EC report on Patents and Standards or the 2013 National Academy of Science report on Patent Challenges for Standard-Setting in the Global Economy – Lessons from Information and Communication Technology does not mention empirical evidence of systemic problem related to patent hold-up beyond an increase FRAND-related court cases. However, the NAS report specifically states the committee found "no empirical evidence showing that royalty stacking currently suppresses the adoption or use of standard-compliant products."

[70] For example see Comment of Cisco Systems Inc. (for Cisco, HP, IBM, and RIM), Federal Trade Commission Request for Comments and Announcement of Workshop on Standard-Setting Issues (Patent Standards Workshop, Project No.P-11-1204). See Prepared Statement for the Record of Intel Corporation for the Senate Committee on the Judiciary Subcommittee on Antitrust, Competition Policy and Consumer

Numerous remedies have been put forward as potential solutions to the theoretical problem of patent holdup. Lemley (2007) advanced ten suggestions, including limiting injunction relief in multi-technology products, ex ante disclosure and negotiation of FRAND royalties within SSOs and the concomitant loosening of anti-trust regulations that would entail, and patent reform focused on redefining reasonable royalty rates in damage calculations. More recently additional solutions have been put forward such as non-assertion after a specified time (Rysman and Simcoe, 2011), a pseudo patent pool approach (Contreras, 2013), "baseball-style" arbitration (Lemley and Shapiro, 2013), a "contingent ex ante" valuation framework (Siebrasse and Cotter, 2015),a return to a traditional incremental value model applicable to both SEPs and non-SEPs alike (Contreras and Gilbert, 2015), and a "structured price commitments" approach (Lerner and Tirole, 2015). While all of these solutions have a theoretical possibility to reduce patent holdup and increase static economic efficiency, they also have a theoretical possibility reduce dynamic efficiency potentially resulting in an overall reduction in aggregate social welfare.

Concomitantly, numerous scholars have questioned both the transactional and efficiency impact of patent holdup and royalty stacking, challenging its existence and operationalization by the scholars, courts, and regulatory actors (e.g. Galetovic and Haber, 2017; Layne-Farrar and Wong-Ervin, 2015; Sidak, 2013; Gupta, 2013; Dorsey and McGuire, 2012; Epstein, Kieff, and Spulber, 2012; Denicolo et al., 2008; Elhauge, 2008; Sidak, 2009, and Geradin and Rato, 2007; Golden (2007) among others).[71] In particular, the cooperative, repeated game nature of standard-setting is cited as a specific check on the effectiveness of opportunistic behavior in the long-run as well as a deterrent among invested actors in the short-run.[72] The open question in the debate over patent holdup theory is not whether patent holdup is theoretically possible, but whether it is practically relevant in the case of open standards operating under FRAND IPR policies and reduced access to injunctive relief. An extensive critique of patent holdup theory is provided in paper 4.

2.4.2 Patent Holdout Theory – The Forgotten Side of the Coin

FRAND-enabled technology standards are built on voluntary technical contributions that once finalized are made openly available. Thus technology standardization is a process of technology transfer where FRAND licenses are typically negotiated after products have already been put on the market. This process creates the potential for opportunism by both

---

Rights on Standard Essential Patent Disputes and Antitrust Law (2013). See US Federal Trade Commission Google Consent Degree (2013).

[71] See also Reply Submission on the Public Interest of Federal Trade Commissioners Maureen K. Ohlhausen and Joshua D. Wright, In the Matter of – Certain 3G Mobile Handsets and Components Thereof, International Trade Commission (Inv. No. 337-TA-613, 2015), Section 2 entitled, "Empirical Evidence Suggest no Systemic Problem With Holdup."

[72] A repeated game means that the activity will take place again in the future whereby the actors involved are able to take into account the behavior in the previous instance. Compare with Ostrom (1990) on the dangers of classifying collective-action problems as prisoner dilemma games.

parties, where SEP holders could leverage their power position through higher than reasonable royalty rates (i.e. patent holdup) and implementing firms can evade and delay payment of royalties while marketing products that include technology developed and owned by others. This latter concept has been termed reverse patent holdup or patent holdout (Chien, 2014; Geradin, 2010).

If one sees patent holdup and holdout as a continuum, the key, determining factor is the accessibility of injunctive relief to patent owners. This is often discussed in the context of property vs. liability rules, where the lack of injunctive relief can effectively reduce a patent owner's rights to one of mere compensation for infringement (Calabresi and Melamed, 1972). In this regard, the use of FRAND agreements in open standards can be seen as a way for market actors to contract into liability rules without altering the fundamental property rules for patents (Merges, 1996). Recently, however, the property rules for SEPs have been weakened through the US Supreme Court ruling in *eBay* that effectively eliminates injunctions in cases involving multi-technology products and the Federal Trade Commission Google decree that places prohibitions on SEP holders to see injunctive relief on antitrust grounds.[73] While regulations to reduce access in injunctive relief can lower the possibility of patent holdup, it can also increase the possibility of patent holdout. Thus, in the current regulatory environment, patent holdout theory becomes increasingly important to investigate.[74]

To date, patent holdout theory has received much less attention by scholars, courts, regulators, and policymakers (Geradin, 2010).[75] This is unusual given the weakening ability of patent owners in general and SEP owners, in particular, to obtain injunctive relief over the past decade (Chien, 2014).[76] To further confuse the situation, there exists a theoretical problem with the use of the term "holdout" as it has an existing theoretical connotation in mainstream economics related to the situation where coordination between economic agents does not occur because one agent withholds consent (Epstein, 1993; Libecap, 1993; Miceli, 2011). We are thus confronted with the dilemma that neither patent holdup nor patent holdout is consistent with the historical use of "holdup" and "holdout" in mainstream economic theory but instead used as pseudo-scientific labels in the rhetorical battle to define the meaning of FRAND.[77]

Semantics aside, implementing firms, which have already received the standard specifications, can simply choose not to accept an offer from an SEP licensor in the absence

[73] See eBay Inc. v. MercExchange, L.L.C., 547 U.S. 388 (2006), and In the matter of Google, Inc., a corporation, File No. 102 3136, (2011).
[74] The CJEU ruling in *Huawei v. ZTE* sought to balance the interests of SEP owners and implementers by defining the conditions under which a SEP owner can seek injunctive relief against an "unwilling" licensee.
[75] A recent exception in the European context is the EU Court of Justice opinion in *Huawei v. ZTE* where the court held that an injunction was possible in relation to an "unwilling licensee".
[76] eBay Inc v. MercExchange, L.L.C., 547 U.S. 388 (2006) significantly weakened the ability of patent owners to obtain injunctive relief particularly with regard to multi-component products. Additionally, the ability of SEP holders to petition for injunctive relief was restricted through the US Federal Trade Commission Google Consent Degree in 2013.
[77] A thorough treatment of this semantic, theoretical issue is provided in Paper 4.

of the threat of injunctive relief. Thus while injunctive relief can theoretically facilitate patent holdup, lack of injunctive relief could facilitate patent holdout, which could lead to a systematic delay and non-payment of FRAND royalties to SEP holders. The increase in recent SEP litigation with appeals rising to the CAFC is indicative of the difficulty to achieve agreement on FRAND terms through bilateral market negotiations.[78]

Recent evidence of aggregate royalties in standards-enabled products (i.e. the royalty stack) raises questions about whether SEP holders are actually under-compensated for their technology contributions (Galetovic, Haber and Levine, 2015; Galetovic, Haber and Zaretzki (2016); Galetovic and Gupta, 2016; Mallinson, 2016; Sidak, 2016). While patent holdup has been addressed by global competition authorities (i.e. DOJ/FTC, DG Comp), it is less obvious whether patent holdout (i.e. freeriding, trespass, or abuse of non-patent position) is considered an antitrust issue, which raises questions regarding policy remedies if it should be shown that patent holdout has a systemic impact on economic efficiency, in particular, dynamic efficiency. An extensive review and development of patent holdout theory are provided in paper 4.

2.5 Conceptualization of the Meaning of FRAND

FRAND is an example of a purposefully incomplete contract negotiated by sophisticated actors to provide a framework for private ordering in the public interest (Wright, 2013).[79] While incomplete contracts may be considered efficient and desirable, the intrinsic ambiguous nature of reasonable and non-discriminatory makes FRAND susceptible to (re)interpretation and regulatory capture as changes in their meaning can have a large financial impact. Figure 2.7 below maps the key constitutive concepts of FRAND that have been the focus of contention among stakeholders in the telecommunication value chain.[80]

[78] For example see *Ericsson v. D-Link*, 773 F.3d 1201, 1227 (Fed. Cir. 2014*)* and *CSIRO v. Cisco Systems, Inc.*, 809 F.3d 1295, 1302 (Fed. Cir. 2015).
[79] From a transaction cost perspective, contracts can be argued to be necessarily incomplete because of the costs of identifying all possible contingencies.
[80] Other FRAND issues exist such as 3rd party rights and transference of FRAND commitments through a greater consensus and less contention exists in these areas.

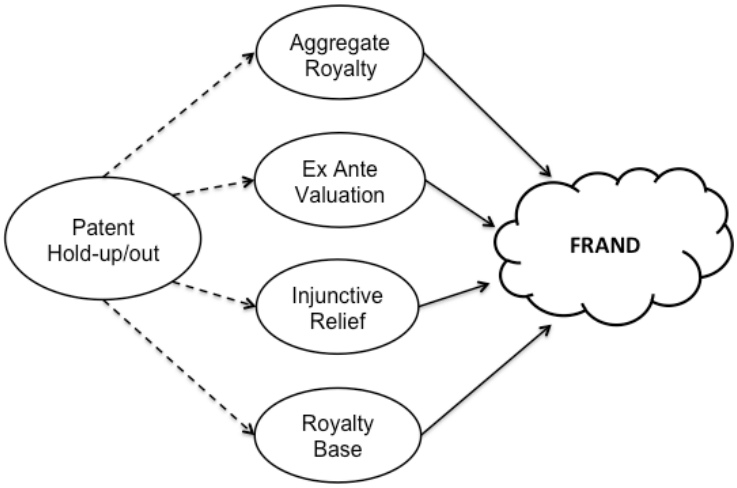

Figure 2.7 Key constituent concepts defining the meaning of FRAND

Multiple efforts to define these key concepts on the tool level through legal, economic and business argumentation have been put forward due to the possibility to enact a systemic effect. Below is a short description of each concept:[81]

Patent Hold-up/out

Patent hold-up/out is the core concept at the epicenter of the FRAND debate as introduced in section 2.4. It arises from the interaction of the exclusivity of patents and the lock-in of standards in combination with the heterogeneity of business models discussed in section 2.2. The term "holdup" has a specific negative connotation in transaction cost economics based on the exploitation of opportunism.[82] Its contemporary meaning of holdup/out in the context of patents is typically understood as the opportunity of one party to expropriate value from another party through the following:

- SEP holders charging excessive FRAND royalties to implementing firms (i.e. supra-FRAND rates) that capture the non-SEP related investments
- Implementing firms delaying or refusing to pay FRAND royalties to SEP holders (i.e. sub-FRAND rates) that capture SEP-related R&D investments

The impact of patent hold-up/out can be deemed as having both distributional and welfare effects where the former is related to rent-shifting and the latter with economic efficiency and the need for potential policy remedies.

Aggregate Royalty

The issue of aggregate royalty is not an issue of the sheer number of SEPs but of the distributed ownership of SEPs among numerous owners. Patent hold-up/out is deemed to occur through the following:

[81] Papers 1-4 provide a greater theoretical elaboration on these different concepts.
[82] Galetovic and Haber (2016) have questioned the theoretical link between patent holdup and the concept of holdup in transaction cost economics.

- Royalty stack – when multiple SEP holders charge supra-FRAND rates to implementing firms
- Royalty gap – when SEP holders receive sub-FRAND rates from multiple implementing firms

The royalty stack/gap is a systematic issue as the result of a widespread over/underpayment of FRAND royalties by implementing firms deploying standard-enabled products and services. Preliminary empirical evidence shows the lack of evidence for a systematic royalty-stacking problem in relation to mobile telecommunication standards (Galetovic, Haber and Levine, 2015; Galetovic, Haber and Zaretzki (2016); Galetovic and Gupta, 2016; Mallinson, 2016; Sidak, 2016).

Ex Ante Valuation

The concept of ex ante valuation is related to the time period in which courts should base their determination of patent damages in the context of FRAND royalties (Teece and Sherry, 2016; Lee and Melamed, 2015; Sidak, 2013).[83] The tradition use of Georgia-Pacific factor 15 sets the timing at the point before the infringement took place. However, the following competing two FRAND-based valuation timeframes have been posited:

- SSO timeframe – this theory states that the value of SEPs needs to be discounted in relation to their marginal benefit over the comparable technologies under consideration by the SSOs (Swanson and Baumol, 2005).
- R&D timeframe – this theory states that the SSO timeframe is not ex ante enough and should be placed at the time of the R&D decision of the contributing firm (Sidak, 2013).

Despite the fact that Teece and Sherry (2003) describe that the practical, counterfactual determination of what the standard would look like if another technology had been adopted is difficult to determine ex post, the SSO timeframe model as been applied to two US court decisions on FRAND royalties.[84]

Injunctive Relief

Injunctive relief in the context of FRAND is associated with the blocking of import and sale of infringed products and services. As patent hold-up/out requires the compulsion to accept supra/sub-FRAND rates (i.e. an act cannot be opportunistic if there is no compulsion to accept the act), the exclusivity provided by injunctive relief is a core legal tool in the debate through the following theories:

---

[83] Teece and Sherry (2016) state the recent inclusion of ex ante valuation of SEPs in the new IEEE IPR policy "essentially amounts to the proposition that *all* of the gains from standardization should flow to implementers and/or consumers, and none (except via the volume effect) to patent holders whose technology is incorporated into the standard"

[84] See *Microsoft Corp. v. Motorola, Inc.*, No. 10-cv-1823 (W.D. Wash.) and In re Innovatio IP Ventures LLC, No. 11-cv-09308 (N.D. Illinois).

- Patent Holdup – by threatening the removal of the entire product or service from the market, injunctive relief provides the SEP holder an asymmetric bargaining position that can potentially produce a systematic impact on implementing firms and a systemic impact on social welfare (primarily static efficiency).
- Patent Holdout – by removing the threat of injunctive relief, implementing firms have no incentive to make FRAND payments, providing SEP implementers an asymmetric bargaining position that can potentially produce a systematic impact on SEP holders and a systemic impact on social welfare (primarily dynamic efficiency).

The potential impact of injunctive relief in regard to patent holdup theory has been seen as an issue of importance for competition authorities while the potential impact of patent holdout has not been seen as an antitrust issue even though it can affect competition and economic efficiency.[85]

Royalty Base

A FRAND royalty is determined by the combination of the royalty rate and the royalty base applied to the infringing product (or service). Competing theories of the location of the royalty base in the value chain are as follows:

- Component level – proponents claim that smallest-saleable patent-practicing unit (SSPPU) should be used as the royalty base for FRAND determinations.
- Product level – proponents claim that the product price paid by the consumer represents the proper royalty base for FRAND determinations

The difference between calculating FRAND royalties using the component versus the product level is between 1-2 orders of magnitude depending on the product and standard, which has created very different results, based on divergent economic theories of SEP damages (Petit, 2016; Putnam, 2016; Sherry and Teece, 2016; Contreras, 2015)

Table 2.1 below shows the main areas of contention in relation to a patent holdup versus holdout logic and their comparative, underlying theoretical arguments.

	Patent Holdup	**Patent Holdout**
Aggregate Royalty	Multiple, independent claims produces a royalty stack	Multiple, under/non-payment produces a royalty gap
Ex Ante Valuation	SSO timeframe allows for comparison of competing technology contributions	R&D timeframe allows for comparison of competing technology investments
Injunctive Relief	Availability of injunction facilitates capture of supra-	Unavailability of injunction facilitates delay leading to sub-

[85] See for example the US FTC Google Consent Order (2013) and the US DOJ IEEE Business Review Letter (2015).

	FRAND royalties	FRAND royalties
Royalty Base	Product level royalty base leads to over compensation of SEPs compared to SSPPU	Component level royalty base leads to under compensation of SEPs compared to market value

Table 2.1 FRAND conceptual areas of contention

2.6 The Research Problem

The overarching research problem addressed in this thesis is the need for an improved theoretical understanding of the changing nature of value creation from an industrial to a knowledge-based economic paradigm. This could also be described as the need for an improved knowledge-based theory of value at the level of the firm and the market – both the technology and product market. In the chosen context of this thesis, this translates more specifically to the challenge of understanding how patents should be governed in the development and commercialization of telecommunication standards to maximize social welfare. This involves the complex dynamics of patent and competition law issues from a public policy perspective with the patent and competitive strategy issues from the corporate strategy perspective, where the latter seeks to maximize economic performance and the former, economic efficiency – both static and dynamic efficiency.[86] Furthermore, the type of standardization process under study is based on an emerging form of standard-setting organization (SSO), built on open, consensus among collaborators and competitors, operating as an open innovation platform in-between the traditional hierarchy of the firm and the arms-length transaction of the market. Finally, the actors participating in the SSO are not homogenous in their participation and commercial interests, which generates competition on both a technology market to control the standard in addition to the more tradition product market that employs the standard. This interaction of management, economics, law, and technology in both theory and practice makes for a problematic terrain for policy-makers, judges, regulators, and business leaders to navigate.

Based on the above research problem and societal challenge, this thesis seeks to answer the following main research question and sub-questions:

How do competing interests seek to define the meaning of FRAND and influence the value of standard-essential patents (SEPs)?

[86] Static efficiency refers to the maximization of social welfare through the Pareto efficient allocation of finite resources at a given time, while dynamic efficiency focuses on the generation of greater social welfare through expanding societal resources (i.e. to shift the production possibilities frontier to the right through, for example, innovation and entrepreneurship). See de Soto (2006) for a thorough discussion of the differences between static and dynamic efficiency.

- What are the current areas of contention regarding FRAND and the value of SEPs and how does this relate to the interests of actors on the telecommunication value chain?
- What are the key theoretical concepts currently used to define the meaning of FRAND and how do they impact the value of SEPs?
- How is the meaning of FRAND shaped by actors through key legitimizing arenas, such as the US court system?

Specific research problems and questions have been postulated and addressed in each for the four appended papers.

3. Methodology

The main purpose of this thesis is to better understand how competing interests seek to define the meaning of FRAND and influence the value of SEPs. In particular, the focus is on the role of standard-essential patents and FRAND agreements within the open development and commercialization of telecommunication standards and their impact on economic performance and efficiency. This in turn raises the societal challenge of how patents should be governed in the development and commercialization of telecommunication standards to maximize social welfare To address this purpose requires an interdisciplinary, mixed method approach that is further discussed in the sections below.

3.1 Rationale of Research Strategy and Design

As the epistemological and ontological orientation of the researcher has a major impact on the choice of methodology, it is important to define this from the beginning (Cunliffe, 2010). This thesis takes the perspective that social reality is a dialectical phenomenon that is both normatively closed and cognitively open (Luhmann, 1992; Petrusson, 2004), allowing for social phenomena to be described statically as reified institutions and norms and dynamically as constructs designed and re-designed by subjective social action (Searle, 1995). Ontologically, this is fundamentally a social constructionist view, but one that allows for social phenomena to be investigated on two levels – (1) on the surface as an unconscious, reified construction (i.e. approaching objectivism) and (2) beneath the surface as a conscious struggle for power and control among various actors.[87] It is through the process of reification that social constructions are experienced as phenomena that exist independently and separate from social action (Berger and Luckmann, 1967). This, however, doesn't mean that social phenomena are actually objective in the ontological sense – only that they have reached a state of normative closure within the given societal paradigm.[88] Therefore it is the role of the social scientist to understand the reification process and not to only describe phenomena but to deconstruct the interests and communicative actions that define the reality of phenomena as institutional facts.[89]

The phenomena of intellectual property and standards are two institutional mechanisms designed to generate wealth and welfare in society. Both mechanisms were developed within an industrial logic and are now facing new challenges (both regulatory and market) when applied within business settings that are becoming increasingly knowledge-based. The case of telecommunications offers a unique look into how the institutions of intellectual property and

[87] This perspective is similar to the argument for intersubjectivity by Cunliffe (2010) in her proposed revision of the typology from Morgan and Smircich (1980). However, Petrusson (2004) proposes that social phenomena need to be understood through a dynamic alternation between normative closure (objectivity) and cognitive openness (subjectivity) instead of suggesting an additional third static state (intersubjectivity).
[88] Searle (1995) uses the term "institutional facts," in contrast to "brute facts," as they require human institutions for their existence.
[89] This is comparable to what Aastrup and Halldorsson (2008) describe as "causal depth".

standards are evolving social constructions caught in the shift of economic paradigms at the interface of strong political and business interests. To investigate these phenomena in transformation it is critical to not only describe the surface level where self-interests are marketed as facts but to delve below the surface and deconstruct the conflicting interests of business and society so as to allow for a transparent, evidence-based dialogue to drive the reconstruction of these important social structures.

To investigate this transformation process using a dialectic epistemological view requires a research strategy with a mixed method approach – relying on theoretical frameworks from different disciplines and strong empirical evidence derived through primarily qualitative methods but also supported when possible by quantitative data when it serves an explanatory purpose. For example, SEPs can by investigated objectively by counting the number of declared SEPs and SEP holders in a particular standard, while the meaning of FRAND and its impact on SEP value requires a qualitative investigation of the political and economic influence of the stakeholders within the commercial and regulatory eco-system. In other words, the meaning of FRAND can be understood as both normatively closed, reified phenomena as well as a cognitively open subjective communicative actions of the relevant stakeholders. The normative space between these two epistemic perspectives in turns allows for the critical investigation of how different subjective concepts and arguments are communicated and accepted in different arenas and the subsequent analysis of the potential impact on firms and society of these beliefs. Thus, a dialectic epistemological approach creates the opportunity to study the reification process of FRAND and SEP value, which is necessary to address the research problem and achieve the research purpose of the thesis.

The research design consists of a hierarchical study in two phases. The first phase primarily deploys an exploratory, multiple case study design to develop a broad understanding of the key concepts and areas of contention that are being used by competing stakeholders to define the meaning of FRAND and SEP value. The second phase deploys a more comparative/cross-sectional design to specifically compare and contrast key FRAND concepts across different economic paradigms and business models as well as a deeper comparative review of economic theory and case law. This required both deductive and inductive methods, systematically combining empirical insights with different theoretical foundations in an abductive, integrative and evolutionary process (Alvesson and Sköldberg, 1994; Dubois and Gadde, 2002). Without the use of qualitative methods, it would be impossible to penetrate the surface to deconstruct the complexity and unveil the underlying interests that are at work defining social reality in the world of global telecommunication standards.

3.2 Qualitative Research Design Framework

The research design provides a logical framework to govern the research process. If one does not exist explicitly then it will exist implicitly (Yin, 2009). Qualitative research requires an interactive framework that allows for the different components to be assessed in relation to

one another (Maxwell, 2012). Below figure 3.1 displays Maxwell's interactive model of research design that shows the key components and their interaction.

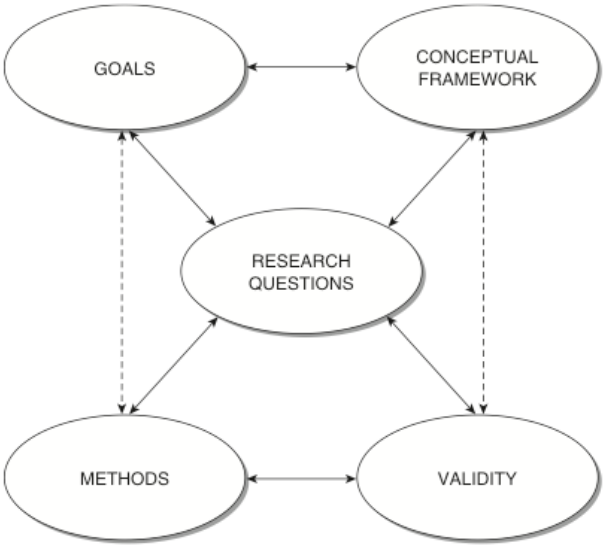

Figure 3.1 Research design framework (Maxwell, 2012)

At the center of the model are the research questions that are informed by the research goals and received literature and enacted by the methods and criteria for validity. The model governs the research logic by making explicit links among the key design components that need to be defined and substantiated. Thus, not only is the content of each component important, but also the coherence among the components as represented by the arrows in the model.

Below in figure 3.2 is a representation of the research design framework for this thesis using Maxwell's model.

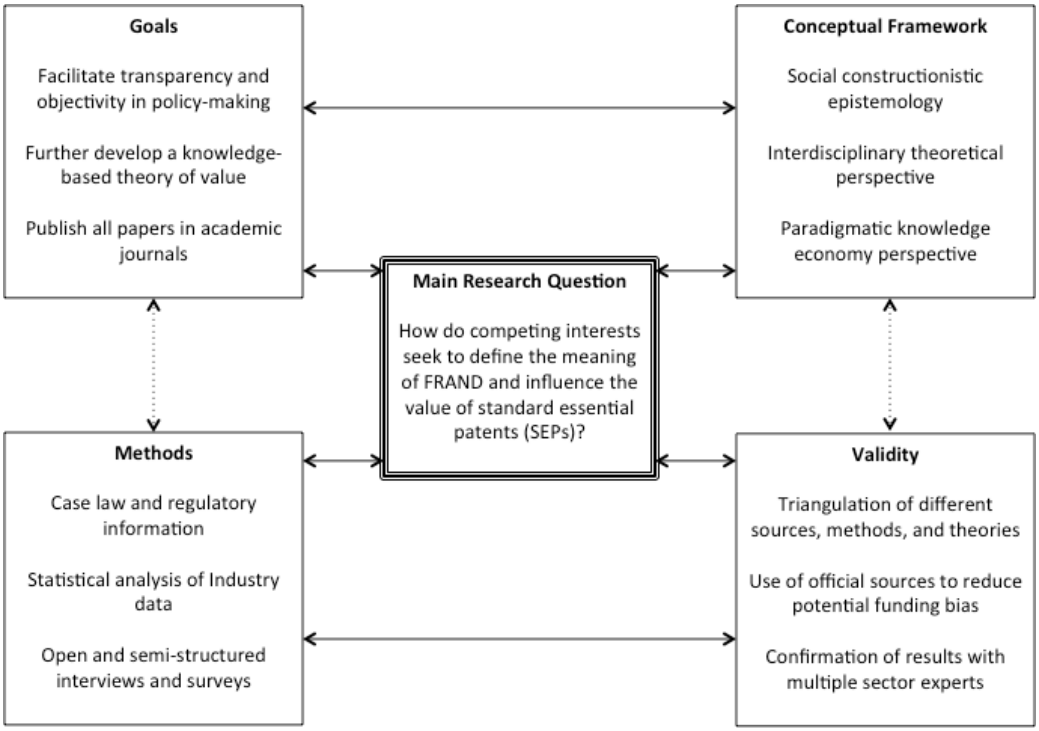

Figure 3.2 Thesis research design framework

From a case study perspective, Yin (2009) cites five components that are important to all research designs. Due to the extensive use of case studies in the thesis, a description of each component in relation to Maxwell's model is provided below:

Study Questions

This component is the same as "research questions" in Maxwell's model. Methodological fit in relation to case studies is associated with the use of "how" and "why" based research or study questions. Though the main research question above is crafted broadly, many of the related sub-questions in the papers are formulated to investigate and deconstruct specific areas of interest. Below are relevant sub-questions from each of the four papers:

- How did the actors and the court in the landmark *Microsoft* case define FRAND in its relation to SEP value? (Paper 1)
- How did the different business model logics impact the choice of SEP valuation theories presented by the key stakeholders and accepted by the court in the four initial FRAND court cases in the US? (Paper 2)
- How do Qualcomm and ARM leverage their intellectual property in the technology and product market? (Paper 3)
- How have SEP holders experienced patent holdout in their SEP licensing activities? (Paper 4)

Study Propositions

This component is similar to the "conceptual framework" in Maxwell's model though it is more analogous with the stating of hypotheses in deductive methodologies. Yin (2009) states that propositions are needed to guide the study and that even exploratory studies should state their purpose so that there can be criteria to judge the success. A general proposition is that intellectual property plays a fundamental role in regulating openness in collaborative innovation processes. In particular, patents are essential (excuse the pun) to the development and commercialization of many telecommunication standards in the knowledge economy, especially due to the increased fragmentation of the value chain. Below are several initial key propositions from the papers in the thesis related to patent holdup theory discussed in section 2.4.1:

- US courts are capable of complex apportionment in FRAND/SEP cases that do not systemically result in excessive patent damage awards (Paper 1,2)
- Stakeholder communication of general theories on patent holdup and royalty stacking is more powerful than empirical evidence in many arenas (Paper 2)
- The royalty base for licensing in telecommunication standards is different depending on the standard and the historical market norms (Paper 3)
- The weakening of injunctive relief can create a systematic patent holdout problem (Paper 4)

The challenge with initial study propositions in exploratory, interpretive research is to avoid having the proposition taint the epistemic lens of the investigation.

Unit of Analysis

This component relates to the overall scope of the study and is not specifically articulated in Maxwell's model. Yin (2009) suggests that defining the unit of analysis will help the researcher "distinguish data about the subject of your case study (the phenomenon) from data external to the case (the context)". The primary unit of analysis in this thesis is the social artifact, FRAND and the related concept of SEP value, in relation to two main groups, the firm and society, and several supporting groups (i.e. arenas), such as SSOs, competition authorities, courts, etc.

Below is an example of the multiple case study conducted in paper 2, including the primary units of analysis as shown in figure 3.3 below.

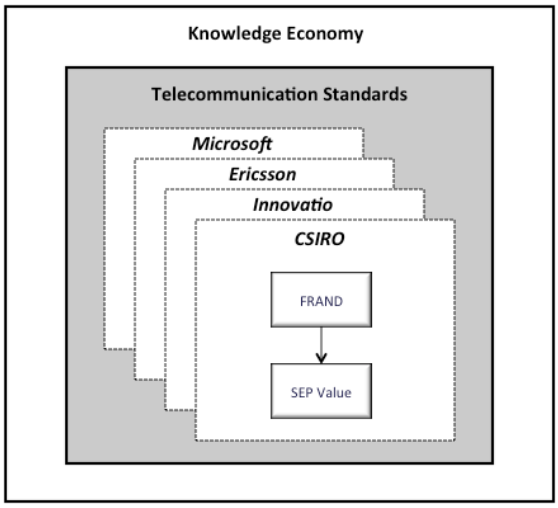

Figure 3.3 Multiple case studies with embedded units

Logic Linking the Data to the Propositions

This component is focused on defining the analytic techniques that will be used to analyze the data in relation to the purpose or propositions of the study and is similar to the "method" component in Maxwell's model. The following primary sources of data were used in this thesis:

- Case law and regulatory information
- Statistical analysis of industry data
- Open and semi-structured interviews and surveys

Criteria for Interpreting the Findings

This component is focused on the quality of the research results from an epistemological perspective and is similar to the "validity" component in Maxwell's model. This research study will enlist several strategies including the investigation of rival explanations, "peer debriefing", "member checks" as well as triangulation through the use of multiple data sources and methods. This issue will be discussed in further depth in the section below on research quality.

3.3 Research Design Options – strengths and weaknesses

Flick (2009) outlines five basic qualitative research designs – snapshots, case studies, retrospective studies, longitudinal studies, and comparative studies. The snapshot and comparative design have been consolidated together with the design named "cross-sectional" studies.[90] Below is a description of the strengths and weakness of each design including a specific discussion of case studies as the primary design of this research project.

[90] Bryman and Bell (2011) consider the comparative design as "essentially two or more cross-sectional studies carried out at more or less the same point in time."

Comparative/Cross-sectional studies

In comparative or cross-sectional studies the focus of the research is the detection of patterns across multiple cases (i.e. different contexts) and variables at a given point in time (Bryman and Bell, 2011). Through the study of variation, this research design allows for a deep understanding of specific phenomena (i.e. relationships between variables) in the current state of affairs (Flick, 2009). The main weakness is that the temporal dimension is fixed, which doesn't allow for a process or development perspective. This limits the ability to draw causal relationships and reduces the internal validity of the results (Bryman and Bell, 2011). Comparative design elements can be found throughout the four papers of the thesis but are most relevant to Paper 4 that relies heavily on semi-structured interviews and a survey. However, the extent of the analysis is more exploratory than explanatory due to the small sample size, allowing for initial testing of propositions.

Retrospective studies

In retrospective studies**,** the focus is on the analysis of historical events and processes (Flick, 2009). A key strength is the ability to investigate an activity that has already occurred and thus can provide temporal information on process development. The main weakness is the reliance on the memories and potential revisionist interpretation of the persons historically involved.[91] Data is typically collected using narrative methods and analyzed with narrative and hermeneutic approaches with the focus on developing theories (Flick, 2009). In this thesis, the historical development of mobile telephony standards was investigated to understand the changing context of the market/regulatory environment in which FRAND has evolved.

Longitudinal studies

Longitudinal studies are comparative studies focused on the collection of data over several time intervals in real time[92], which can be seen as a number of cross-sectional studies of a phenomenon taken over time (Åhlström and Karlsson, 2009). Flick (2009) states that longitudinal studies are seldom used in qualitative research, which is echoed by Pettigrew (1997) who stated: "for many the social sciences are still an exercise in comparative statics." Given the importance in managerial processes and organizational change, it is unusual that more studies are not conducted from a dynamic perspective, however, the time commitment required to conduct longitudinal studies can be extensive. Beyond the chronicling of beginning and end states, longitudinal studies can investigate the path taken between these states, which are often discontinuous and open-ended, exposing the relationship between context and action (Pettigrew, 1997). As the battle over FRAND has been quite intense, numerous events have played out in real time over the past four years of this thesis. In

[91] For a description of the revisionist dilemma in retrospective studies involving popular management literature, see Rosenzweig (2007).

[92] This is different than only investigating the temporal dimension in retroactive studies. Pettigrew (1997) describes processual analysis as capturing time through a combination of retrospective and real-time analysis.

particular, the court cases investigated in Paper 2 and their subsequent appeals represent a longitudinal investigation of the communicative game to define FRAND in the judicial arena.

Case studies

Case studies are a popular form of business research that allows for an in-depth study of complex phenomena within single settings or contexts where the boundaries between the phenomena and the context are not clearly evident. (Eisenhardt and Graebner, 2007; Yin, 2009). Case studies typically use a mixture of data collection methods, including both quantitative and qualitative, and can be deployed to provide a description, test theory, and generate theory (Eisenhardt, 1989). Yin (2009) emphasizes that case study designs should be chosen based on their methodological fit as determined by the type of research questions (typically how and why questions), the requirement for control of behavioral events (not necessary as in experimental designs), and the focus on contemporary events.[93] Though seen as answering important questions beyond the scope of other research designs, case studies have traditionally been criticized for several weaknesses. Yin (2009) describes four major prejudices including (1) the lack of rigor in operationalizing case studies and consequential concerns over validity, (2) the lack of a basis for scientific generalization, (3) the extended length of time to conduct and massive documents that result, and (4) the lack of ability to demonstrate causal relationship in comparison to experimental research designs. Some of these weaknesses can be overcome through the use of a multiple case study design, which can be useful to generate a more robust understanding of phenomena across similar contexts (literal replications) or contrasting contexts (theoretical replications), in particular, when using cases to deductively test propositions (Yin, 2009).

The use of case studies was a good methodological fit given the primary qualitative, exploratory approach of the thesis. Paper 1 deployed an in-depth single case study of the landmark US court decision while Paper 2 conducted a multiple, comparative case study method across the four first FRAND court decisions in the US to address the heterogeneity SEP value models in relation to business models of the stakeholders. Paper 3 also conducted a multiple, comparative case study of two leading firms in the telecommunication value chain to exemplify the new division of innovative labor and the tension between market and legal norms in the transition from an industrial to knowledge-based business models. All case studies were delineated with respect to the specific area of inquiry in each paper, thus allowing for a rigorous investigation within the relevant scope. The case studies utilized is this thesis facilitate the dialectic approach, allowing for the deconstruction of the key areas of contention and an evaluation of their epistemic foundation and level of reification in relation to private and public interests.

3.4 Data Collection and Analysis

[93] Yin (2009) defines case studies as contemporary and thus differentiated from retrospective studies. My belief is that this distinction is not as important as the need to investigate complex phenomena in a bounded, dependent context, whether historical or current.

For a case study research design to succeed at deconstructing social constructs and understanding the reification process at work, it must rely on multiple sources of data and an iterative analytical approach to make sense of the contradictory understandings and interpretations inherent in institutional facts, especially those in formation or reformation. The following primary sources of data were used in this thesis:

Case law and regulatory information
One of the most valid sources of data comes from information submitted to governmental organizations, such as court testimony, regulatory investigations, governmental hearings, SEC filings, etc. These documents provide accurate financial, market and business strategy information under penalty of law. This is the primary source of data for papers 1-3. Papers 1-2 do not evaluate the opinions of the court cases from a traditional legal perspective. Instead, information is adduced from the court cases and used to analyze how economic and legal principles are applied by market actors and interpreted by the court in relation to economic and organizational implications, for example, on economic performance and efficiency. The specific sources are detailed in the appended papers.

Structured and semi-structured interviews and surveys
Interviews were used to generate insights into the communicative game on the multiple arenas as well as verify results of the studies. Multiple experts were used from organizations with different ideologies and interests to control bias. Surveys were used to validate initial propositions gathered through interviews in paper 4 when public sources of statistical data were unavailable. Interviews were used as a source of insights and feedback in papers 1-3, but never as a source of empirical findings. All information discerned from interviews that influenced the results of the thesis were validated by external sources and referenced. This allowed for the respondents' names and organizations to be kept confidential to increase the access to information without negatively influencing the objectivity of the results. Paper 4 uses interviews to identify theoretical propositions that were further investigated quantitatively through a survey. The specific use of interviews and surveys is detailed in the appended papers.

Statistical analysis of industry data
When possible, industry data from trusted governmental or 3rd party sources was used to describe a particular context or validate a specific proposition. This was primarily used in paper 4. The specific use and sources of statistical data are detailed in the appended papers.

The triangulation process, where different data and methods converged in this thesis to define FRAND as an institutional fact, is shown in figure 3.4 below.[94]

[94] All four methods of triangulation defined by Patton (2002) were deployed to different degrees, including data triangulation, investigator triangulation, theory triangulation, and methodological triangulation.

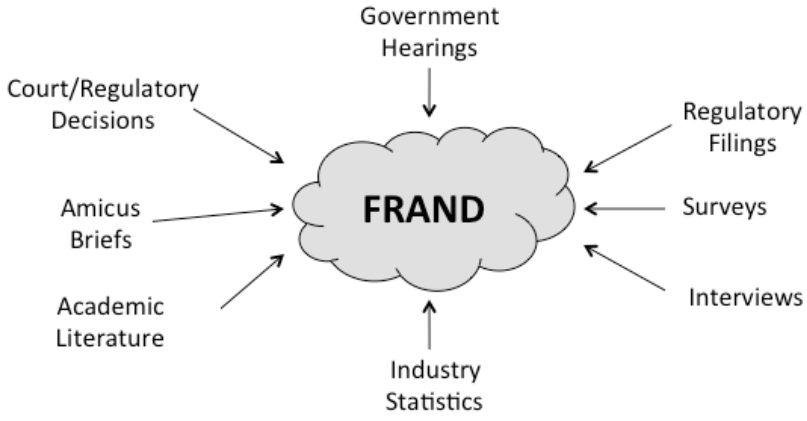

Figure 3.4 Triangulation - Convergence of multiple sources of evidence

Regarding the analysis of data, Yin (2009) proposes a predominantly deductive orientation in arguing for the analytical "testing" of predetermined theoretical propositions as opposed to Eisenhardt (1989), who focuses on theory generation through an inductive method.[95] In this thesis, an iterative approach, starting with a predominantly inductive exploratory phase to develop and ground theoretical propositions, was followed by proposition testing in the second phase. The oscillation between inductive and deductive research methods was operationalized through what can best be described as systematic combining, described as "a nonlinear, path-dependent process of combining efforts with the ultimate objective of matching theory and reality" – see figure 3.5 below (Dubois and Gadde, 2002).

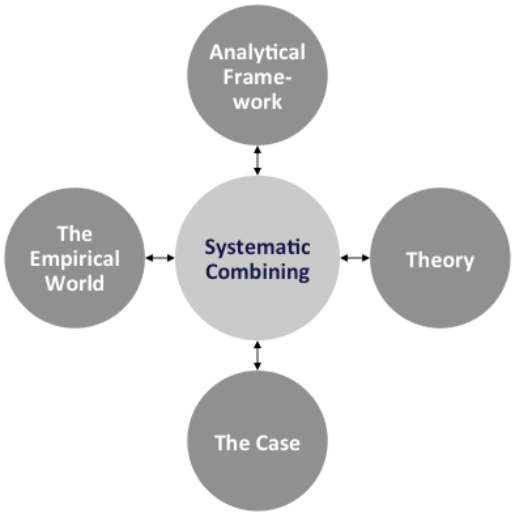

Figure 3.5 Process of systematic combing (Dubois and Gadde, 2002)

[95] Eisenhardt (1989) states "theory-building research is begun as close as possible to the ideal of no theory under consideration and no hypotheses to test." The author does, however, promote the use of research questions and the definition of initial constructs and variables.

Systematic combining facilitates multiple analytical techniques to be deployed simultaneously and iteratively in the spirit of grounded theory.[96] Thus the more deductive focused techniques espoused by Yin (2009), such as pattern matching, explanation building, time-series analysis, logic models, and cross-case synthesis, can be combined with grounded theory techniques to form an abductive logic through systematic combining. This combination allows for the critical approach necessary to deconstruct institutional facts.

3.5 Value of Research Design

In relation to the management discipline in general and the intellectual property discipline in particular, my research design has several characteristics that could be described as progressive. The first element is the dialectic approach that allows for an operationalization of a mixed epistemological orientation (i.e. an objective and subjective epistemology). This addresses the problem in the discipline where much of the management research admits that intellectual property and other institutions are socially constructed, but then proceed to study the phenomenon as "brute facts" using quantitative, positive methods. Few studies explicitly investigate the reification process with the goal to develop a new theory. The second element builds on the first by deploying a deconstructionist methodology in the collection and analysis of the data through an abductive approach as shown in figure 3.5 below. This allows for a critical approach to be applied to both received theory and empirical evidence. The third element is the interdisciplinary use of theory, in particular, the bringing together of perspectives from legal, economic, and organizational management theory. Most research in the field is focused on a law and economics perspective or a technology management perspective, but few combine these disciplines. The fourth element is the lack of case studies related to intellectual property in general and intellectual property and standards in particular.[97]

[96] Grounded theory is a constant comparative method where theories are constructed inductively through the investigation of empirical data. For Strauss and Corbin (1994) grounded theories are "inclusive of the- the multiple perspectives of the actors", which fits well with an interpretive approach to the study of institutional facts.

[97] In fact, Gibbert et al. (2008) report that only 6% of the published articles in the ten leading management journals from 1995-2000 where based on case studies.

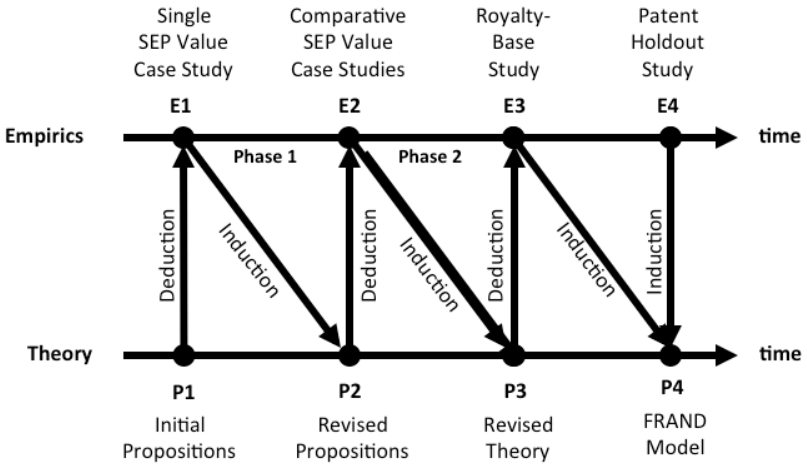

Figure 3.5 Schematic of abductive research process used in thesis

3.6 Quality Criteria

Quality in research is an epistemological issue at the heart of scientific inquiry that defines the criteria for what is considered valid knowledge. As the traditional measures of validity and reliability stem from natural science and a quantitative, positivistic epistemology, defining quality criteria for qualitative research is still under discussion and development (Bryman and Bell, 2011; Flick, 2009; Gibbert et al., 2008; Lincoln, 1995).[98] While standard validity and reliability concepts have been adapted to qualitative research (Yin, 2009), alternative criteria have also emerged for assessing qualitative research. In particular, Lincoln and Guba (1985) propose the quality concept of trustworthiness, where credibility, transferability, dependability, and confirmability are used as alternatives to validity and reliability. The main purpose of these alternative criteria is to acknowledge that more than one account of social reality is feasible (i.e. there is no one 'truth'), especially in relation to institutional facts (Bryman and Bell, 2011).

Below is a short description of the quality criteria from Lincoln and Guba (1985) applied on this thesis:

Credibility

Credibility is used as a replacement for construct validity[99] and internal validity[100] but with a more constructionist focus on the acceptability of the often multiple accounts that define institutional facts. As there is no one correct answer in qualitative research, the focus of

[98] Sutton (1997) goes as far as to provide advice when not to explicitly state qualitative processes so as enhance the opportunity for publication in a publishing paradigm still dominated by a quantitative leaning epistemology

[99] Construct validity defines how well the research measures what it is intending to measure (i.e. are the operational measures capable of measuring the constructs under investigation).

[100] Internal validity defines the strength of the match or causal relationship linking theoretical concepts and empirical observations.

credibility is to generate acceptance of the researcher's account (Bryman and Bell, 2011). The thesis deployed several methods to increase the credibility of the results as prescribed by Lincoln and Guba (1985), including multiple sources of information (see figure 3.4) and iterative peer debriefing and member checking by industry, academic, and policy experts. This took the form of multiple interviews, conversations, presentations, and readings of working papers. In addition, papers 1-3 have undergone academic review in the publishing process. The more deductive method of Paper 4 relied on semi-structured pre-interviews to complement the sparse literature as a means to develop credible operational propositions to investigate in the survey.

Transferability

Transferability is used as a replacement for external validity.[101] As qualitative research is typically focused on depth within a unique context, the positivistic definition of generalizability is untenable in its traditional perspective. The thesis uses extensive citations to reliable, public sources of information in the case studies to facilitate transferability. Many of the general insights of the thesis, though focused on telecommunication standards, would likely be applicable to other open innovation platforms operating under FRAND terms in different sectors, especially the social constructionist model. However, a major finding of the thesis is that caution should be given in relation to transferability from one context to another (e.g. in relation to court decisions and across different standards).

Dependability

Dependability is used as a replacement for reliability[102] but with a focus on the level of good practice to research procedure as opposed to replicability. As in the case of transferability above, the use of extensively cited public documents, in particular, court and regulatory information under penalty of law increases the dependability of the research. The use of confidential interviews and surveys to increases the quality of information but can be seen to lower the dependability.

Confirmability

Confirmability is used as a replacement for objectivity[103] but focused more on the good faith effort of the researcher to manage the intrusion of values on their research than on complete objectivity. The growing consensus is that it is not feasible for researchers to completely keep their values in check and therefore values will not only impact how we see things but also what we see (Bryman and Bell, 2011). Two methods to manage the risks associated with confirmability have been deployed in this thesis – auditing and self-reflection. The former method, auditing, was enacted primarily through the use of rival reviewers from industry, academia, and government organizations as described above. The latter method will be discussed in-depth below.

---

[101] External validity defines the degree to which the research findings can be generalized to other settings.
[102] Reliability defines the degree to which the operational procedures of the research can be repeated with the same results.
[103] Objectivity is based on the belief that there is a 'truth' independent of the influence of the researcher.

Self-reflection, or reflexivity, was an important process throughout the entire thesis, especially given that the research was partially funded by an industry actor in the telecommunication industry.[104] Below are several measures deployed in the thesis to manage bias from the perspective of internal and external ideology and interests:

- Research funding was managed as an unrestricted grant to the university, and the research was conducted as an academic, not consulting, project
- Information and insights provided by industry actors was verified through public, reliable sources before being included in the thesis
- An exploratory, qualitative research strategy with a deconstructionist approach was chosen to avoid the pressure to find a generalizable 'truth' and 'prove' causality
- Normativity in the papers has been purposely managed with the goal to unveil the communicative game as opposed to supporting specific positions (e.g. by providing a social constructionist model of FRAND and SEP value). However, it should be noted that the thesis is to a large extent a response to the bias of academic, industry, and policy positions based on little supporting empirical evidence. Thus if there is a normative agenda is it to level the playing field to allow for a more holistic decision-making process by policy-makers.

[104] The literature review revealed a large percentage of published papers were funded by industry actors, including the seminal 2007 article by Lemley and Shapiro.

4. Summary and Interconnection Among Papers

The main purpose of this thesis is to better understand how competing interests seek to define the meaning of FRAND and influence the value of SEPs. Specifically, the focus is to explore the battle to define the meaning of FRAND through understanding the market interests, ideological concepts, and the communicative game on the legitimizing arenas.

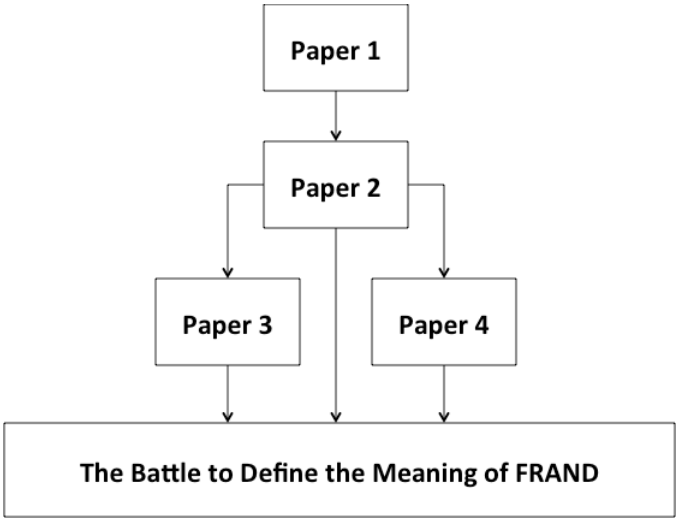

Figure 4.1 Relationship among appended papers

Figure 4.1 above describes the relationship between the appended papers. Paper 1 provides an in-depth, single case study of the landmark *Microsoft* case and is complemented by Paper 2, which shows a comparative analysis across the four initial SEP/FRAND cases in US district court. Papers 1-2 generated several key theoretical concepts defining the meaning of FRAND that were further investigated in the following papers. In Paper 3, a comparative analysis of legal and market norms is conducted through case studies and doctrinal legal analysis from the theoretical perspective of the intellectual value chain leading to better understanding of how the determination of royalty base impacts SEP value. Finally, in Paper 4, the concepts of patent holdup and holdout are analyzed in relation to mainstream economic theory, and patent holdout is further investigated through market data as well as interviews and a survey with industry experts. Together these papers address the main purpose and research questions of this thesis.

4.1 Paper 1 – The Viability of FRAND: How the Seminal *Microsoft* Ruling Could Impact the Value of Standard Essential Patents and the Future of Telecom Standards

This paper addresses the viability of FRAND policies to regulate the equilibrium between patent holdup and freeriding (or patent holdout) in the context of telecommunication standards. As market transactions are executed in the shadow of the norms of the court system, the relation between FRAND and the judicial arena is the main focus. Using the landmark *Microsoft* ruling, this paper seeks to investigate (1) what were the state of the art valuation principles deployed by the court to determine FRAND royalty rates and (2) what were the key areas of contention regarding how the valuation principles are reduced to practice and deployed as valuation methods by the court, (3) how generalizable are the decisions by the court on other standardization contexts, and (4) what are the implications of these valuation methods on industry strategy and policy. These are particularly important issues as they define the value of standard essential patents, which is one of the key battleground issues in the struggle to define the agenda for a new patent era, where the role of patents as a tool to facilitate innovation and welfare is being challenged. Below is a short summary of the findings.

Analysis of *Microsoft* Decision

The 207-page decision by Judge Robart in the *Microsoft* case highlighted the following key factors in the valuation of SEPs in a FRAND context:

1. **Five guiding principles for SEP valuation** of which four focused on static efficiency and one on dynamic efficiency.

2. **A FRAND-modified version of the Georgia-Pacific factors** adapted primarily to accommodate the principle that a FRAND royalty should be based on the economic value of the contribution of the patented invention apart from the value associated with its inclusion in the standard (i.e. the holdup value).

3. **A qualitative SEP valuation analysis**, including:
    - An ex ante evaluation of the SEP portfolio in comparison to competing technologies at the time of standardization.
    - An ex post evaluation of the SEP portfolio in relation to its use value in the standard and the impact in the end products.

4. **A quantitative SEP valuation analysis using multiple royalty bases and methods**, including:
    - Market comparable rates from both successful and unsuccessful patent pools related to the standards in the case with an implied end product royalty base.

- Market comparable rate from the computer chip industry on a component level royalty base.
- Feature Factor Method deployed in a prior valuation of the SEP portfolio by a consultancy firm with an end product royalty base.

Main Areas of Contention

Below are several areas of contention present in the *Microsoft* case that will likely define the viability of FRAND to facilitate collaboration among diverse stakeholders in standardization settings.

1. Ex Ante Evaluations Applied Ex Post

The use of comparative analysis of competing technologies prior to the setting of the standard (i.e. ex ante analysis) was deployed by the court retrospectively as a means to eliminate the holdup value of the SEP portfolio despite the fact that the court itself acknowledged that it "lacked real-world applicability" and cited its "impracticality with respects to implementation by courts." An important question is whether the comparison is made ex ante enough given the technology development decisions are made at the time of R&D investment prior to competition in standards.

2. The Royalty Base and the Battle Over the Value Chain

The court in *Microsoft* deployed multiple methods using different royalty bases to reach its decision. This implies that the logic of the apportionment argument in the valuation method takes precedence over a fast rule on the position of the royalty base. This ultimately will impact the distribution of profits in the value chain and the viability of IP-based business models.

3. Market Comparables – Transforming Apples into Oranges

The *Microsoft* court evaluated four different types of comparables to support its FRAND royalty determination – patent pool rates, previous licensing agreements employing the SEPs in suit, similar industry licensing agreements, and an expert valuation report. In addition, Motorola presented a number of prior license agreements including the specific SEPs in suit, but the court dismissed these. The varying contexts of these comparables leave open a wide range of objections and interpretations by future courts. As innovation specialists typically don't participate in patent pools, an important question is how the use of patent pool rates by courts impact the strategic behavior of innovation specialists and the rate of innovation in technology standards.

Key Implications

The *Microsoft* case offers several potential implications for reflection by industry and policymakers that impact the viability of FRAND and telecom standards, of which several key areas are described below.

1. **A potential re-imbalancing of the value of SEPs from ad hoc holdup to systemic freeriding (i.e. holdout).** The results of landmark cases have great potential to change the norms of how business is conducted. The fact that Motorola only received a small fraction of what they had originally demanded has already impacted the belief among many IP and licensing professionals that SEPs are now of much less value. Thus the normative impact of this landmark case could produce a downward pressure on all SEPs regardless of the context, which could swing the pendulum from a fear of holdup to a condition of systemic freeriding or holdout.

2. **Innovation specialists may need to reconsider the risk profile of their standardization strategies and business models.** The *Microsoft* ruling, in combination with a growing pressure on actors labeled as non-practicing entities (NPEs), will require innovation specialist firms to rethink their mode of involvement in standards and their position in the value chain to manage the risk of potentially increasing efforts to weaken the strength of SEP holders. This can impact innovation and overall economic efficiency by impacting the development of a division of innovative labor in the market.

3. **Firm strategy will continue to shift from winning the game to changing the rules of the game.** Implementation specialists, in particular, will be incentivized to delay negotiation of FRAND licenses and instead focus on weakening the concept of FRAND through judicial, legislative, policy, and regulatory means. In this regard the *Microsoft* case exemplifies the potential impact of affecting the norms of FRAND on a systemic level.

4. **Reinforcement of the fear of holdup leading to new policy proposals by SSOs, regulatory bodies, and legislatures.** While the *Microsoft* case could certainly be characterized as an anecdotal case of patent holdup, there is still no evidence of systematic patent holdup in either the H.264 or 802.11 standards, having been in use for 10 and 16 years, respectively, under FRAND-enabled IPR policies. This indicates that there is not sufficient theoretical or empirical evidence to warrant major policy changes as the systemic consequences of these changes could negatively impact economic efficiency, in particular, through an unfavorable tradeoff of static efficiency for dynamic efficiency that only redistributes instead of enhances economic surplus. Thus the Microsoft case is proof that isolated instances of patent holdup can be adjudicated by the US court system without the need of systemic policy reform that can have unintended systemic consequences.

5. **Different standards will experience different dispute profiles.** One main insight from different levels of success of the patent pools in the *Microsoft* case is that standards should not be treated as homogeneous (i.e. each standard has its own market context and norms). If this is true one might expect very little if any litigation with respect to the H.264 standard in the future. The 802.11 standard, on the other hand,

will likely experience greater litigation as WiFi is a large industry of its own with a growing number of innovation specialists and other non-practicing entities in the form of current and potential SEP holders.

6. **Motorola lost but Google may have won.** While the initial match-up between Motorola and Microsoft represented two competing philosophies on the value of SEPs, the purchase of Motorola by Google changes the dynamic. It could be argued that neither Google nor Microsoft benefit from strong SEPs and high FRAND royalties based on their current, predominate business models. This exemplifies the complexity of the market environment where different actors in the value chain use patents for completely different purposes, meaning that the same patents can vary greatly in perceived value based on the business strategy of their owners. As new entrants into the telecommunication sector develop their R&D capacity and SEP portfolios, this will lead to new rhetorical positions on the value of SEPs, thus requiring courts and policymakers to view SEPs with a systemic, long-term view based on longitudinal evidence, not short-term business interests.

4.2 Paper 2 – Valuing Standard Essential Patents in the Knowledge Economy: A Comparison of FRAND Royalty Methodologies in U.S. Courts

This paper focuses on a comparative assessment of the SEP valuation models of four recent SEP court cases in the US in 2013-14 and discusses their systemic implications for industry and policymakers (both SSO and governmental) regarding the potential impact on economic performance and economic efficiency in the context of the shift from industrial to knowledge-based business models. Specifically, this study investigates (1) the impact of evolving knowledge-based market structures and firm positioning on SEP value and (2) the operationalization of valuation principles and norms based on competing business models/value logics and competing theories of patent holdup, royalty stacking, and economic efficiency in the FRAND context. These investigations are then formulated into a set of propositions towards an improved theoretical understanding of patent value in the knowledge economy. Below is a short summary of the findings.

Comparative Analysis of SEP Court Cases in the US

The study includes the analysis of four recent US SEP court cases, including the landmark SEP ruling by the Western District of Washington (*Microsoft v. Motorola*) and three subsequent FRAND cases in the Eastern District of Texas (*Ericson v. D-Link et al. and CSIRO v. Cisco Systems*) and the Northern District of Illinois (*Innovatio IP Ventures*). Below table 1 provides comparative information across the four district court cases.

Plaintive	**Defendants**	**Trial**	**Standard**	**No. of SEPs**	**Value Base***	**FRAND Rate**
Microsoft [105]	Motorola Mobility (Google)	Bench	H.264 802.11	16 11	MPEG-LA patent pool Mixed base[a]	$0.00555 $0.03471
Ericsson	D-Link, Netgear. Belkin, Dell, HP, Acer, Toshiba, Intel	Jury	802.11	3	Previous industry licenses with 3rd parties	$0.15
Innovatio	Cisco, Motorola	Bench	802.11	19	Chipset profits	$0.0956

[105] Note that Microsoft sued for breach of contract, so Motorola/Google is the actor seeking FRAND royalties for their SEP portfolio.

	Solutions, SonicWALL, Netgear, HP					
CSIRO	Cisco Systems	Bench	802.11	1	End products	$0.83[106]

* The term value base is used to denote the source from which the FRAND royalty was calculated
[a] Based on an average of Via patent pool rates, prior non-FRAND 3rd-party component-level license agreement, and a prior consultancy valuation report
Source: Official trial documents

Table 1 Comparative overview of recent FRAND cases

In addition, the court cases have been analyzed across the following parameters:

1. Business models deployed by the litigants
2. Translation of FRAND valuation principles into legal norms
3. Application of ex ante evaluation methods
4. Determination of royalty base and FRAND valuation logics and methods

Key Findings and Implication on Economic Performance and Efficiency

Below is a discussion of four key conceptual areas supported by the evidence of the four recent cases that together form a framework for further research regarding the value of SEPs in particular, and an enhanced theory of patent value in the knowledge economy, in general.

1. Transition from a Production Logic to a Technology Logic

The four SEP holders under study exemplified the increasing use of SEPs to generate revenue (i.e. technology logic) beyond the traditional production of physical products (i.e. production logic) by both practicing and non-practicing entities. Specifically, the four cases illustrated a diverse set of contexts and business models as described in section 2.1, including a mixed use of value logics as follows:

- Practicing entities that deploy the standard in their own products but also look to monetize their superior SEP portfolio over other producing firms (e.g. Motorola and Ericsson).
- Non-practicing entities that acquire patents from other market actors (including practicing entities) with the sole purpose of patent assertion to monetize the assets (e.g. Innovatio).
- Non-practicing entities whose main function is only to perform R&D and rely completely on license-based business models to transfer their technology to the market (e.g. CSIRO)

[106] The royalty rate, for the most part, is not explicitly based on a FRAND commitment due to the historical circumstances of CSIRO relations with the 802.11 standard and the wireless industry.

Further empirical and theoretical research on the impact of the new division of innovative labor on the industrial value chain is required to better ascertain how different knowledge-based modes of firm action affect economic performance and efficiency.

2. The Context of Standards as a Determinant of SEP Value

In addition to the emergence of new roles and value logics deployed by firms discussed above, there is evidence that the contextual nature of the standard itself may have the greatest impact on the value of SEPs. Thus the profile of how a standard was developed, in particular, the primary value logic of the stakeholder firms, can be observed by the licensing and litigation history involving the standard. Widespread infringement would suggest a technology logic while extensive cross-licensing or the formation of a successful patent pool would suggest a production logic. There is a need for further research on the techno-economic typology of different standards to confirm this proposition, however, this would imply that one-size fits all business norms, valuation methods, and policy measures will likely not be economically efficient.

3. Conflicting Norms on Appropriate Royalty Base and Valuation Models

The changing landscape of IP strategies and business models was also apparent in the different value logics that underpinned the choice of valuation methods put forward by the different actors across the four cases.

While the US courts have a long history of determining reasonable royalties, it could be argued that these determinations have been primarily made within a production logic. For instance, legal norms for setting the royalty base, such as the rule implicating the smallest saleable patent-practicing unit or entire market value rule (EMVR), are designed from the perspective of an industrial value chain and may require further adaption to the new roles of IP and knowledge-based business models that often license different parts of the value chain. Therefore, it is not surprising, that in a changing paradigm from a production to a technology logic, the current legal norms are mismatched with traditional business norms, which leads to argumentation aligned to the existing legal norms instead of the current business reality. The cases show that SEP holders will likely need to show evidence of the market value of their SEPs through arms-length market transactions to prove the value through a technology logic. More research is needed to explain how the current legal norms address knowledge-based business models and its subsequent impact on economic performance and efficiency.

4. Relevance of Patent Holdup and Royalty Stacking

Given the theoretical importance of the concepts of patent holdup and royalty stacking to the determination of SEP value, the dearth of evidence put forward by the market actors in the four recent cases suggests that they are not a significant market issue in the context of the H.264 and 802.11 standards. This further implies that FRAND contracts in their incomplete, historical interpretation have been successful in regulating patent holdup and royalty stacking issues in technology transactions among market actors at least in these standards. However, one important insight stemming from the lack of evidence of systemic patent holdup and royalty stacking in the studied cases is that policy measures designed to eliminate these

problems are possibly unnecessary and could potentially alter the balance, creating patent holdout that could reduce the quality of standards and reduce overall social welfare. More research is required that models the impact of policy interventions from both a dynamic and static efficiency perspective.

4.3 Paper 3 – Re-Evaluating Patent Damages in the Knowledge Economy: The Determination of Royalty Base for Standard Essential Patents from an Intellectual Value Chain Perspective

This paper explores the applicability and implications of the current legal norms for the choice of royalty base in relation to the prevailing market norms regarding SEP transactions in the telecommunication industry. In particular, this paper investigates how US courts have deployed several procedural rules including the use of the smallest saleable patent-practicing unit (SSPPU) and the entire market value rule (EMVR) as a means to adjudicate patent damages. As these rules impact the determination of the royalty base, which can differ by orders of magnitude, the applicability of their use in different market contexts and norms requires investigation as their use by the courts could have a systemic effect on industrial dynamics and economic efficiency in specific markets, especially those reliant on open standards. Below is a short summary of the findings.

Positioning of License Agreements in the Telecommunication Value Chain

In the telecommunication industry, the market norms for the location of SEP licensing is typically at the position of the end product in the value chain as shown in figure 1 below. On the lower layer, the figure depicts a generic telecommunication material value chain consisting of component manufacturers (e.g. chipset producers), end product suppliers (e.g. brand owners and OEM/ODM), and customers (e.g. operators and/or end users). On the upper layer the figure shows how the results of R&D activities (e.g SEPs) are managed as intellectual property transactions (e.g. SEP licenses) through the intellectual value chain towards end product suppliers in the material value chain.

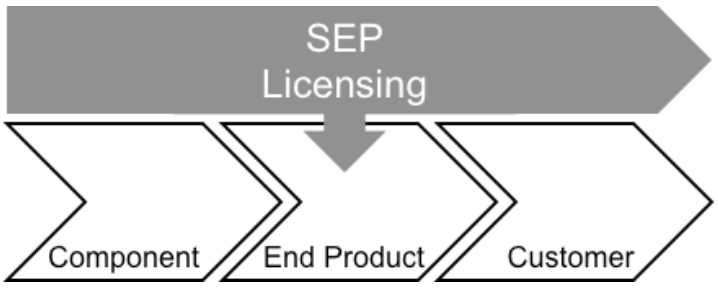

Figure 1. Position of SEP licensing in the telecommunication value chain

The choice of FRAND licensing towards end product suppliers has evolved as the predominant market norm based on the following reasons:

1. Historical norms

The history of cross-licensing among integrated firms in the telecommunication industry has created a strong norm among actors to license SEPs at the end product supplier position in the value chain. This norm has persisted even as the value chain has transformed and fragmented to include new divisions of labor. This norm can be seen in how firms make royalty declarations, in the specification of "fully compliant" product licensing in FRAND commitments, in the licensing unit of patent pools, in recent ITC rulings, and in the recent SEP court cases in the US, where the end product supplier has typically been the defendant.

2. Risk Management

For integrated firms that maintain both strong SEP portfolios and produce physical products, the position of SEP licensing is important for managing their exposure to the SEP portfolios of other integrated firms.

3. Value capture

SEP holding firms are profit maximizers, the same as all commercial firms. Given the opportunity to choose the position of the value chain in which to license SEP portfolios, a rational firm would choose a position that best reflected the value of the contribution of their technology.

Case studies

In order to better understand knowledge-based business models in the context of the telecommunication value chain, both the MVC and IVC, two short cases are examined individually first and then collectively to illustrate their interaction. The first case is Qualcomm, exemplifying a leading company originating from the telecommunication sector that operates in the both the MVC and IVC selling both components and licensing SEPs as separate but interrelated business models towards OEM/ODMs. The second case is ARM, exemplifying a leading company originating from the semiconductor/computer industry that operates exclusively in the IVC through a pure IP-based business model towards semiconductor/chip providers.[107]

While this study describes how different business models in the MVC and IVC operate and interact, it is also helpful to illustrate how different knowledge-based business models interact in the telecommunication value chain. Figure 2 below shows how the ARM and Qualcomm IP-based business models interface in the IVC, where ARM processor IP cores are licensed to Qualcomm, who integrates them together with other technology blocks to provide full system-

[107] Though ARM does not license SEPs, it does license IP and has become a major actor in the telecommunication value chain through the convergence of the mobile computing segment. It is used here to illustrate differences in IP licensing norms in relation to Qualcomm and other SEP licensing telecommunication firms. It is a particularly relevant example given that ARM's licensing practice was used as a comparable industry license in determining the FRAND royalty range and rate in the landmark *Microsoft* ruling recently upheld on appeal by the US 9th Circuit Court of Appeals.

on-a-chip (SoC) solutions for mobile devices. Qualcomm subsequently licenses its SEP portfolio to OEM/ODMs manufacturing end products.

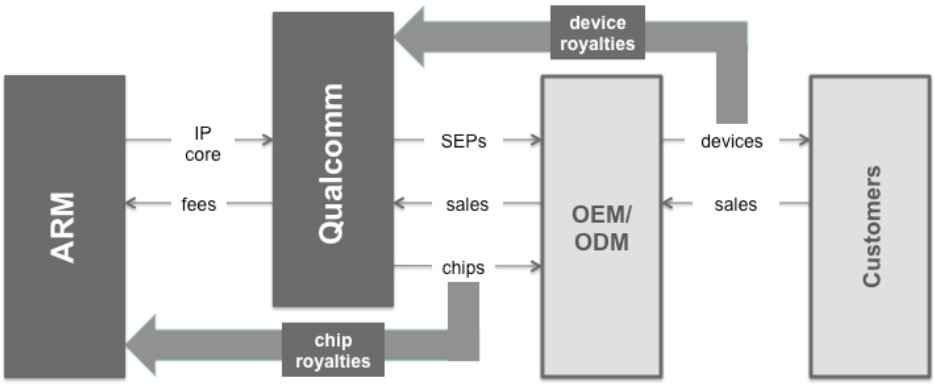

Figure 2. Interrelationship of ARM and Qualcomm IP-Based Business Models

The location of licensing in the telecommunication value chain (i.e. royalty base) of both the ARM and Qualcomm licensing models represents the influence of historical norms where ARM has its roots as a semiconductor company in the computer industry and Qualcomm has its roots as fully integrated telecommunication company. These different histories also manifest themselves in relation to the nature of the scope of their different IP portfolios. While ARM's IP relates primarily to the function and implementation of processor-based chips, Qualcomm's standard-essential IP relates to the entire telecommunication system (e.g. the 3G or WiFi communication system) with some functionality implemented on the chip level and others on the device and system level. Thus historical industry norms and the scope of the relevant technical system together with strategic business considerations based on bargaining power in the value chain have all impacted the current configuration and roles played by ARM and Qualcomm in the telecommunication value chain.

Analysis of IVC-based principles and market norms in relation to current legal norms for determination of royalty base

This section analyzes the impact of IVC principles and prevailing market norms on the interpretation of legal norms regarding apportionment and royalty base determinations in the adjudication of patent damages for standard-essential patents (SEPs). Five relevant areas of consideration have been highlighted to advise courts, regulators, SSOs, and other policy-makers when interpreting and setting norms related to SEPs, FRAND, and standard-enabled markets. In particular, these five areas are meant to generate a better understanding of how the nature of the value of knowledge and the evolution of market norms in the telecommunication value chain should normatively influence the interpretation of legal norms to provide greater equity and economic efficiency.

1. The Value of Knowledge is Not Constrained by the Material Value Chain

One key characteristic of a knowledge economy is the increased value of the knowledge component of value propositions. When we move from a MVC to IVC logic, one key challenge will be how to value different knowledge-based contributions delivered through multiple interrelated value propositions, such as knowledge embedded in physical products and knowledge packaged as license offers. In the context of patent damages, this would fall into the general category of the challenge of apportionment where the court has developed several procedural rules to help manage the complexity, such as SSPPU and EMVR. Therefore, the value of IP cannot always be defined simply by looking into the MVC. For example, the market norms in the telecommunication industry show that firms license SEPs separately from physical value propositions (e.g. chipsets) through the IVC towards end product, making the component level inappropriate as the royalty base without a necessary adjustment to account for customary business practice.

2. Royalty Lacking – Components are Not Licensed in the Telecommunication Value Chain

Building on the previous section above, the use of the SSPPU rule becomes increasingly challenging when the IP in question has not been licensed on the component level. As discussed previously, the norm in the telecommunication industry is to license SEPs at the end product position in the value chain, which effectively means that the component level is left unlicensed. This creates a downward pressure on the price of components creating what could be termed as a reverse royalty-stacking or "royalty lacking" problem if a component level royalty base is chosen in an industry that doesn't license SEPs at the component level.

3. Market Norms are to License SEPs on Fully-Compliant End Products

Based on historical norms and strategic behavior, SEP holders in the telecommunication value chain primarily license SEPs on fully compliant products sold by end product suppliers. This practice has existed now for quite some time, especially in cellular standards, though increasingly in WiFi standards, however, with less evidence of traditional licensing activity. While numerous antitrust inquiries have examined SEP licensing practice, to date no competition authority has found the practice of SEP licensing to the end product position of the value chain to be anti-competitive. However, it is possible that different industries and industry segments may have different norms as the Qualcomm and ARM cases in this paper demonstrate.

4. Standards Drive Market Demand by Definition

For consortium-based telecommunication standards, it is particularly difficult to separate the standard-setting process from the construction of the market. However, different actors view standards in different ways. For implementation firms the standard is a means to facilitate the sale of products and services, while for innovation specialists and large SEP portfolio holders, the standard is viewed as a product itself. The use of SSPPU and EMVR can be seen as a means by the court to manage the complexity of determining patent damages in multi-technology products, however, the distinction is too digital. The EMVR requirement that the

end product cannot be used as the base if the patents in suit are not proven to drive the demand for the product is not applicable for standards that drive market demand by definition.

5. Market Norms are Embedded in SEP License Agreements

The use of the Georgia-Pacific Factors (GPFs) provides an opportunity for market norms to be integrated into the determination of patent damages, in particular, GPFs 1-2. It is not a coincidence that these are the first two factors as courts have long acknowledged that the best measure of a reasonable royalty is an established royalty rate in the industry (i.e. market norms). Existing comparable licenses have market norms related to the royalty base and apportionment embedded intrinsically within the agreements. Existing licenses eliminate the need to determine these factors hypothetically as they have been determined in practice through an actual market transaction. In new areas where little case law exists, existing market agreements are valuable resources in supplying courts with important information on market norms. However, it is important that comparables are in fact comparable, so caution should be used when comparing transactions across different standardization and market contexts.

4.4 Paper 4 – Patent Trespass and the Royalty Gap: Exploring the Nature and Impact of Patent Holdout

This paper investigates the concept of "patent holdout" from a theoretical and empirical perspective, seeking to balance the predominant literature focused primarily on patent holdup. Its first ambition is to dissipate the definitional uncertainty surrounding patent holdout through a review of the meaning of holdout in mainstream economics in relation to its contemporary use of holdup and holdout in the patent context. Secondly, the paper provides a more empirical discussion of the strategies of technology implementers that practice a patent without a license and questions the use of the term, patent holdout. Lastly, the paper investigates the theoretical nature and empirical evidence of patent holdout from a transactional, systematic, and systemic perspective in relation to the concept of patent holdup. With this background, the paper attempts to identify the factors that determine the occurrence of transactional, systematic and systemic patent holdout, complementing the qualitative analysis with a quantitative measurement.

From Patent Holdout to Patent Trespass

In mainstream economics, holdout belongs to the wider category of situations of failed coordination and collective action problems amongst economic agents. Holdout is often compared, and contrasted, with the concept of externalities, which occur when B undertakes some desired action without taking into account the effects of its decisions on A. Holdout is also discussed, and distinguished, from free-riding (or freeloading). In free-riding, A provides an imperfectly excludable good, and B can enjoy its benefits without contributing to the cost of provision.

This inquiry leads to several first-order characteristics of holdout taken from mainstream economic theory:

1. The holdout firm is the property owners and holdout power is a function of the effectiveness of the property rule.
2. Holdout corresponds to a situation where strangers do not transact.
3. Holdout can be considered both from a distributional and an efficiency perspective.
4. Holdout is described as a form of self-interest.

This lead to the unexpected discovery: holdout is a term of art, which invariably defines the conduct of a property owner, not the conduct of technology implementers. Furthermore, the current discourse on patent holdup has disregarded the historical use of the term "holdout", replacing it instead with "holdup", which has a specific meaning in transaction cost economics. As a result, the paper proposes to substitute the improper concept of patent holdout with the concept of "patent trespass".

Patent Trespass Strategies

At a very general level, patent trespass occurs when a firm practices a patented technology, an SEP in the context of this paper, yet refuses to take a license. Our sample of interviews highlights several specificities of patent trespass (note that our respondents were interviewed on "holdout", but for the reasons previously explained, we document our results in terms of trespass) as follows:

1. Patent trespass is intentional and can, therefore, be distinguished from inadvertent patent infringement and the customary vetting process required to ascertain essentiality and validity in patent disputes in so far as this process is undertaken without the purpose to delay.
2. Patent trespass manifests itself through less explicit strategies with the goal of eliminating or reducing the amount of royalties paid to the SEP holder.
3. Patent trespass is not simply akin to a deferred payment due to significant transactions costs and potential loss of licensing opportunities.
4. There is some symmetry between patent holdup and trespass. A patent holdup situation necessitates that injunctive relief is available, otherwise, there is no compulsion to pay supra-FRAND rates. In contrast, patent trespass exists when injunctive relief is not available, potentially leading to the compulsion to settle on sub-FRAND rates.
5. Trespassing firms may pursue strategic goals that go beyond pure revenue sharing, creating a collective action problem.

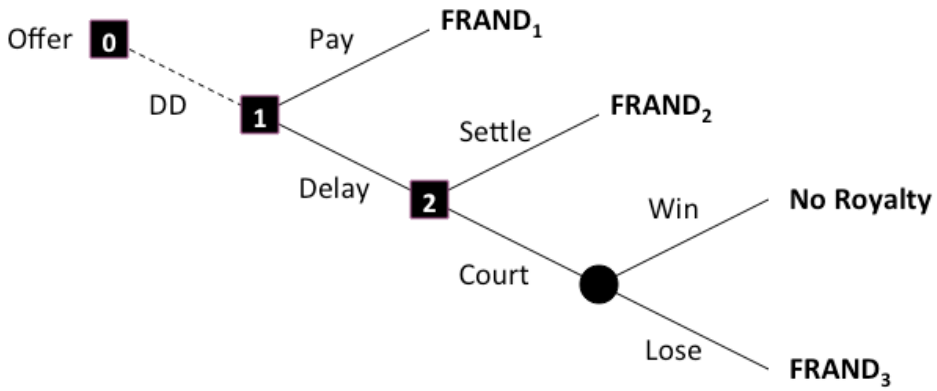

Figure 1 Patent trespass decision model

Figure 1 illustrates the decision process for delay from the perspective of the SEP implementer based on the proposed elements of patent trespass defined above. The model depicts an initial offer ($FRAND_1$) followed by the decision to accept or delay.

Several stylized examples of patent trespass strategies are reported including:

1. The trespassing firm offering negotiation terms that are not industry practice
2. Delaying tactics deployed in terms of a litigation/arbitration strategy.

3. Affirmative steps to weaken the SEP holder's position, including by starting invalidity proceedings before courts and patent offices, initiating antitrust complaints with competition agencies, and vindicating changes to patent policies before Standard Setting Organizations (SSOs).
4. Employing "*licensing in*" departments whose job it is to avoid paying anything for patent implementation, including "*licensing in litigation groups*" whose purpose is to litigate against patent holders.

Certainly, legitimate arguments can be made by SEP implementers regarding the tactics described above as many of these tactics involve issues fundamental to patent law, such as validity, infringement, jurisdiction, etc. The main question then becomes – at what point does a willing licensee, reasonably conducting due diligence and price negotiation, transition into an unwilling licensee, participating in a deliberate strategy of delay with the primary means to reduce its FRAND royalty payments?

Determinants of Transactional, Systematic, and Systemic Patent Trespass

In the patent holdup literature, systematic effects are said to occur because SEP users face a royalty stack. And systemic effects are anticipated in the reduced investment incentives of manufacturers of complementary technologies. As a mirror reflection of this, we say that trespass is *systematic* when a SEP owner faces a "*royalty gap*" – *i.e.* to refer the unlicensed segment of the market – and that systemic trespass occurs when there are adverse effects on the investment incentives of developers of enabling technologies. Table 1 below provides a symmetrical contrast between patent holdup and trespass from a transactional, systematic, and systemic perspective.

	Transactional	Systematic	Systemic
Patent holdup	Ad hoc reduction to SEP implementer surplus	Royalty stack severly reducing SEP implmenter surplus	Market failure in the product market
Patent trespass	Ad hoc reduction to SEP holder surplus	Royalty gap severly reducing SEP holder surplus	Market failure in the technology market

Table 1. Patent holdup vs. holdout

As the concepts of dominance and abuse of dominant position come from a traditional industrial economic perspective associated with "anti-trust", it might be beneficial to forego the use of industrial terms such as "holdup/out" and "patent holdup/out" for a more fundamental discussion on the competitive effects of an asymmetric bargaining position. This could be especially useful as the institutional starting point is not in a traditional vertical or horizontal relationship in the material value chain for physical products but in the technology market of standard-setting organizations (SSOs) where actors collaborate and compete in both a material and intellectual value chain. In an open innovation environment, such as an SSO,

the theoretical pro-competitive advantages must not only be compared to the theoretical anti-competitive disadvantages but must be empirically investigated to determine the actual impact on the welfare of society. In turn, any policy recommendation that alters the institutional norms of SSOs must be judged in light of the net economic impact on society. Figure 2 below provides a spectrum upon which to measure the impact of asymmetric bargaining power in the context of technology markets, in particular, standards-enabled markets developed collectively through consensus-based SSOs involving SEPs and FRAND governance. The spectrum can be used to measure the current degree of asymmetric bargaining power as well as provide a model to theoretically evaluate the impact of proposed policy changes.

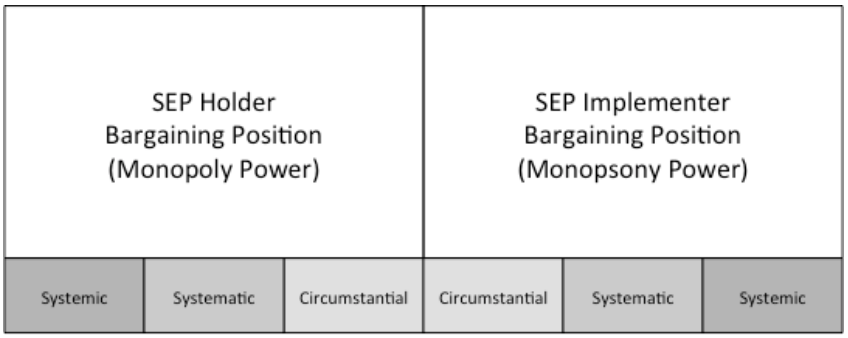

Figure 2. Asymmetric Bargaining Power Spectrum

Empirical Evidence of Patent Trespass

The preliminary empirical results show that the potential systematic impact of patent trespass manifests itself in different ways based on the heterogeneity of market actors and markets. In particular, multi-national corporations (MNCs) operating in developed markets were said to primarily deploy extensive delaying tactics with the main goal of reducing their royalty payments, while large firms in emerging markets (LFE) and small to medium-sized enterprises (SMEs), especially the "long tail" of microvenders, seek to avoid payment altogether. The latter issue is reinforced by an apparent collective action problem among competitors in combination with the growth of emerging markets. To illustrate, a patent trespass decision model is developed to explain why it is rational for SEP implementers to delay or avoid payment given the lack of access to injunctive relief and the transaction costs and uncertainty of enforcement across different jurisdictions.

While patent holdup has been addressed by global competition authorities, it is less obvious whether patent trespass is considered a competition law issue, which raises the question of whether we are focusing on the right market failure regarding policy remedies for anti-competitive behavior by SEP implementers that could have a systemic impact on economic efficiency, in particular, dynamic efficiency. This could manifest itself through collusion to change IPR policies in SSOs to reduce SEP payments or through cartelization of actors in emerging markets to avoid SEP payments. This study identifies several firm and industry level factors that would indicate an impact on economic efficiency. Preliminary evidence

substantiates these factors but doesn't produce conclusive results, which lead us to the following conclusions.

Conclusion

The main conclusion of the study is that patent trespass is a substantial theory that needs to be addressed by courts and policy-makers in their decision-making processes, in particular, as a counterpoint to the application of patent holdup theory. In fact, the study recommends the use of a new, holistic framework focused on the fundamental underlying asymmetric bargaining power between SEP holders and implementers to facilitate policy-makers in assessing the transactional, systematic, and systemic impact of current and future policies. Furthermore, due to the ubiquitous nature of consensus standards, market/legal norms and related policy changes can have a systematic and potentially systemic impact on the development of standards and standards-enabled markets. Thus, if injunctive relief can lead to super-FRAND royalty rates and royalty stacking on one hand, then the removal of injunctive relief can lead to sub-FRAND royalty rates and a royalty gap on the other hand.

As patent holdup and trespass theory predict opposite results and implications, empirical evidence is required to assess the impact of actual bargaining positions on the standards-enabled market so as to effectively advise policy. Several empirical studies have attempted to calculate the aggregate royalties in standards-enabled products (i.e. the royalty stack) (Galetovic, Haber and Zaretzki (2016); Sidak, 2016; Mallinson, 2015). This study adds to the discourse but more importantly urges academics and policy-makers to engage in further empirical studies to support better theory development and evidence-based decision-making.

5. Discussion and Future Research

The main purpose of this thesis is to better understand how competing interests seek to define the meaning of FRAND and influence the value of SEPs. This in turn sheds light on the role patents currently play and potentially could play in the development and commercialization of telecommunication standards from both an economic performance and efficiency perspective. In doing so, this thesis aims to provide a framework for balanced guidance to support policy makers and market actors seeking to define an agenda for the development of patent policies and IP-based business models adjusted to wealth and welfare creation in the knowledge economy.

The previous chapter has summarized the investigations and contributions of the appended papers that add to an enhanced understanding of the battle to define the meaning of FRAND. This chapter will further discuss the overall findings of the thesis through the development of a preliminary model that addresses the holistic issue of the political economy of FRAND by mapping the market interests, ideological concepts, and the communicative game on the legitimizing arenas. As parts of the model are incomplete and untested, this chapter will conclude with areas of future research.

5.1 Towards a Political Economy Model of FRAND and SEP Value

This thesis investigates the battle among market actors to define the meaning of FRAND through policy interventions that seek to change the rules of the game in alignment with their strategic interests. While many scholars have discussed the concept of FRAND, there has not yet been a holistic study of the political processes behind the construction of its meaning.[108] This thesis takes a first step towards building an operative model by defining the self-assertive interests, key normative concepts and claims, and legitimizing arenas where the meaning of FRAND is being actively socially constructed. The primary goal at this stage is not to be exhaustive across all actors, arenas, and geographies, but to start to unveil the normative game whereby actors seek to define reality from the perspective of their own self-interest, whether economic or ideological, so as to facilitate more objective research and more effective decision-making.

Applying the constructionist approach from section 2.1.1 to the context of SEPs, one could interpret from the research results of this thesis that the value of SEPs are ambiguous due to

[108] Political processes are construed broadly to encompass all activities outside of the private marketplace that impacts the meaning of FRAND, including legislative, judicial, and other regulatory actors as well as SSOs.

the fact that the institutional tools (i.e. rules and norms) that define reasonable royalties for SEPs in FRAND circumstances (i.e. blocks) are not reified – see figure 4.1 below.[109]

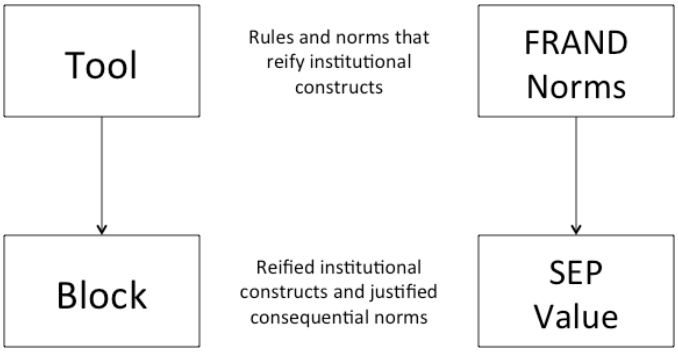

Figure 5.1 SEP value as a hierarchy of norms

This ambiguity gives rise to opportunism, which in turn leads to litigation where courts attempt to better define the institutional rules and norms that allow for business strategies and investments to be made with more certainty. In the period of ambiguity, lobbying efforts primarily by industry, through politicians and even academics, intensifies with the goal of influencing legislators, regulators, and courts to accept their view of reality. Typically normative agendas are put forward as "facts", requiring both the self-interests as well as the arguments put forward by different actors to be deconstructed and separated for analysis. This discussion explores the foundations of a social constructionist model of FRAND built on the deconstruction of the heterogeneity of interests in the telecommunication value chain (section 5.1.1) and the reification of FRAND on legitimizing arenas (section 5.1.2).

5.1.1 Heterogeneity of Interests in the Telecommunication Value Chain

Figure 5.2 below shows the creation of a new industrial dynamic within the telecommunication sector, which has resulted in greater division of labor including innovation specialists and implementation specialists together with integrated firms, who all compete in the same value chain with very different strategies and incentives (Geradin and Rato, 2007; Schmalensee, 2009). These actors interpret the patent system and anti-trust regulations towards the standardization process in very different ways in their search to maximize economic performance. In particular, the division of innovative labor, represented by Firm B in figure 5.2, illustrates the full transition from an MVC to an IVC logic discussed in section 2.2.3 and Paper 3, while many integrated firms have increasingly developed strong licensing programs in the IVC to complement their MVC offerings. When all market actors are integrated firms, cross-licensing and patent pools can often be used to facilitate freedom-to-

[109] This would seem to be true for patent damages in general as Landers (2006) states that "under the courts' elastic and somewhat uncertain standards, the potential forms of evidence that might be presented to a jury are inestimable."

operate and competition on the product market (Shapiro, 2001).[110] However, it is easy to understand why a fragmented value chain creates different perceptions of the value of SEPs as implementation specialists use standards to develop markets where they can sell their products while innovation specialists look for a return on investment for the technology in the standard itself. For implementation specialists, SEPs are viewed as an added cost to their end product, while for innovation specialists, the standard is their product and SEPs are the means to benefit from their R&D investment.[111]

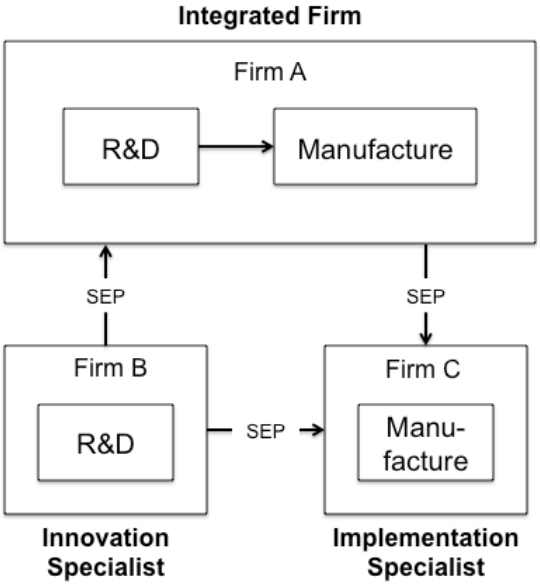

Figure 5.2 SEPs and the new division of labor in the telecommunication value chain

From a standardization perspective, firms operating in this new division of innovative labor (i.e. innovation specialists) are completely dependent on having their patented technology included in the open standards under terms that allow for them to receive a return on their R&D investment.[112] This changes the traditional pre-competitive nature of standards development focused on product market competition into a high-stakes game of poker on the technology market. In this new IVC logic, the inclusion of a firm's technology in the standard creates a competitive bargaining position against rival product firms operating downstream and a significant opportunity for royalties for upstream technology firms. Hybrid firms with both strong patent positions and product manufacturing benefit with lower costs on the

[110] Grindley and Teece (1997) describe how the historical role of patents in the electronics industry has been strongly associated with the use of cross-licensing agreements between competing manufacturers, which has been a norm in the industry since the very beginning.

[111] The fragmentation of the value chain provides a good illustration of the alienation of the value of knowledge in traditional, integrated industrial firms. A division of innovative labor forces a separate accounting of value for the knowledge contribution and the manufacturing contribution (i.e. the intellectual and the material value chain), which was previously hidden in the end product price in vertically integrated firms. The transformation from a hierarchical relationship to a market transaction forces the value of knowledge to be unveiled.

[112] Firms operating under this division of labor are often labeled as non-practicing entities (NPEs) to distinguish them from actors that produce goods and services. This distinction is tenuous given the fact that many firms traditionally viewed as practicing have outsourced most of their manufacturing and have developed extensive patent and technology licensing programs.

product side and additional income from royalties from product actors with smaller patent positions in the standard. In the context of standards, patents have taken on the role of allowing for a new division of innovative labor by providing upstream actors a claim on their R&D contributions outside of the sale of products as well as offering a means for all actors to receive a return on their investment for their innovative efforts (Merges, 1999; Hall and Ziedonis, 2001).[113] Thus SEPs, based on FRAND commitments, have facilitated the development of an intellectual value chain, where value is distributed through license transactions to the owners of the underlying technology in parallel to the material value chain for the manufacture and distribution of physical products. While patents and standards have traditionally been depicted at odds with one another, it could be said that an increased dynamic use of patents and division of innovative labor in the knowledge economy makes patents essential (excuse the pun) to the development of most standards, as many knowledge-based firms increasingly compete in the upstream technology market, not only the downstream product market.[114]

The discussion above illustrates why the distinction between the MVC and IVC is likely better than practicing entities (PE) and non-practicing entities (NPE). Based on the transformation of the telecommunication value chain, the concept of the non-practicing entity (NPE) as the only actor possessing an asymmetric patent bargaining power is not tenable. The main distinction is not whether a firm is a practicing entity or not but instead the strength of the bargaining position based on the relative positions of market actors in the intellectual value chain (e.g. based on the relative strength of their SEP portfolios and product liability). Thus, two practicing entities can experience the same SEP-based bargaining asymmetry as a non-practicing and practicing entity from an SEP perspective. Thus the IVC offers bargaining power to actors that complements and competes with bargaining power traditionally reserved to implementing firms in the MVC. However, when the property dimension of patents is reduced through the weakening of injunctive relief, bargaining power can swing back in favor of implementing firms in the MVC through patent holdout/trespass as discussed in Paper 4.

5.1.2 Reification of FRAND on Legitimizing Arenas

The reification of institutional tools and blocks is a process of communication and acceptance, which can be described as a period of normative openness ending in normative closure as discussed in section 2.1.1. During the period of openness, stakeholders make claims that are eventually either accepted (possibly in modified form) or rejected by the other stakeholders.

[113] This is particularly true for NPEs. For operating companies, the inclusion of in-house technology in the standard could also provide manufacturing advantages as the contributing company has more tacit knowledge related to their own technology. This discussion does not include non-SEPs, which represent innovative, valuable solutions outside of the implementation of the standard.

[114] It should be noted that the concepts of ”upstream” and ”downstream” as well as ”vertical” and ”horizontal” arise from a material value chain logic and are not directly transferable to an intellectual value chain, which operates under a different logic. However, these concepts can be useful when describing the intellectual value chain in relation to the material value chain in an integrated value chain/network.

However, communicative claims require structural legitimacy (i.e. reified platforms where institutional tools are defined and accepted). Communicative claims can thus be seen as a game that takes place among different actors across different arenas as described in section 2.1.2. These different actors vie to have their claims of social reality accepted on these key arenas through various means of persuasion.

Using the example of patents in the context of standards we can construct an extended model of five key arenas where FRAND as a tool and specific SEPs as building blocks are being communicatively claimed by influential stakeholders (see figure 5.3 below).[115]

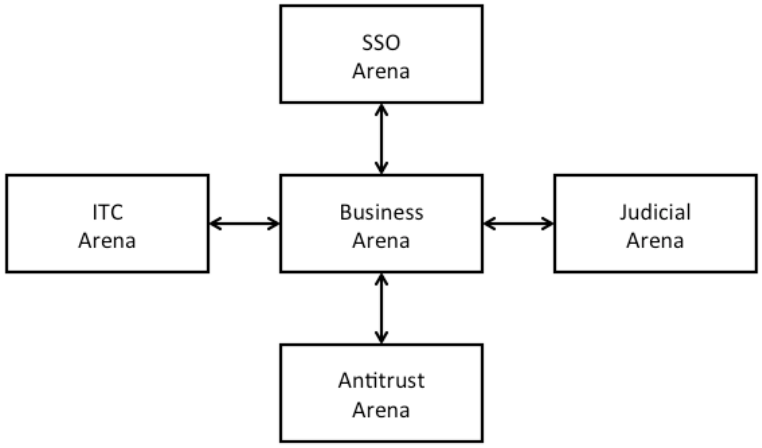

Figure 5.3 FRAND as a communicative game on five arenas

Below is a brief description of each of the arenas from a US perspective:

Business Arena

This arena consists of commercial actors and associated market and financial institutions involved in the development and implementation of technology, products, and services in standards-enabled markets. It is placed in the middle because patent value is ultimately created and extracted in this arena through the influence and constraints of the other arenas.[116] Actors on this arena typically make communicative claims in their own economic interests (i.e. either short term or long term) and attempt to influence both the norms on the business arena (e.g. through new knowledge-based business models) as well as influence the development of norms in the other four arenas that collectively impact the meaning of FRAND. This is done through direct and indirect actions that affect specific SEPs as well the general concept of FRAND (i.e. both on the block and tool level). Direct actions focused on specific technology contributions or SEPs include, for example, participation in the development of new standards through an SSO, filing patents and requesting reexaminations

[115] Note that the model is focused on the US perspective, but is also transferable to other countries (minus the ITC arena) and could be used to evaluate the global development of FRAND.
[116] Note that most litigation is resolved outside of the courts, and even when court decisions are made, business actors often negotiate a settlement in the shadow of a potential appeal.

at the USPTO or other PTOs, participation as a litigant in a court or ITC proceeding, filing an antitrust complaint, and negotiation of FRAND licenses with other market actors. Indirect actions focused on redefining FRAND include, among others, lobbying for legislative change, filing amicus briefs to influence courts and regulatory actors, proposing changes to SSO IPR policies, and supporting academic and media channels. The business arena, in turn, is directly influenced by antitrust and SSO policies, legal norms and judicial rulings, and the competitive strategy of the different market actors. Firms operating in different parts of the value chain view FRAND and the value of SEPs differently, which creates a disequilibrium of interests that incentivizes and facilitates an environment for opportunistic behavior through direct and indirect means. While this has resulted in prolonged FRAND negotiations, increased litigation, and recently, the need for FRAND royalty rates to be determined by the courts, standards-enabled markets have historically shown signs of considerable success in general.[117]

Judicial Arena

This arena consists primarily of the federal district court system that adjudicates patent cases, including the Court of Appeals for the Federal Circuit (CAFC) and the Supreme Court. Courts are influenced directly by legislation, procedural law, expert testimony, and the argumentation of the litigants and indirectly through amicus briefs submitted by concerned 3rd parties. Court decisions have direct impact on specific SEP portfolios through the determination of patent validity, infringement, essentiality, damages, and ongoing FRAND royalties as well as through injunctive relief. In addition, court rulings also have a systemic effect on the meaning of SEPs and FRAND by creating new procedural law that impacts future courts and market expectations as discussed in all the appended papers. This includes, for example, the interpretation of Georgia-Pacific Factors, ex ante valuation, royalty stacking, royalty base, injunctive relief, and patent holdup from a FRAND perspective.

ITC Arena

In addition, the judicial arena there exists in the US a quasi-judicial entity known as the International Trade Commission (ITC), which has the authority to block entry into the US of imported goods that are deemed to infringe US patents.[118] The ITC reports to Congress, POTUS, and the US Trade Representative (USTR) and is influenced by changes in legislation and the veto power of the President and USTR. Recent shifts by US district courts to a more stringent test for injunctive relief in combination with the fact that most telecommunication products are imported to the US has generated increased caseload at the ITC based on its ability and perceived willingness by patent holders to grant exclusion orders.[119] Thus SEP holders have petitioned the ITC for exclusion orders against implementing firms that infringe their SEP portfolios. For example, in 2013 an exclusion order was granted by the ITC blocking certain Apple products for import in the US-based on infringement of SEPs owned by Samsung. However, USTR through delegation from POTUS vetoed the order citing

[117] See Galetovic et al. (2015), which shows that SEP-reliant industries have the fastest quality-adjusted price declines in the US economy.

[118] See 19 U.S.C. § 1337

[119] See Chien and Lemley (2012), who describe the rush to the ITC after the *eBay* decision.

agreement with the guidelines with USDOJ-USPTO policy statement on FRAND remedies.[120] Despite the previous veto, the ITC in 2015 issued an exclusion order against Nokia (now MMO) for the infringement of an SEP owned by Interdigital, providing in its decision the information requested in the previous USTR veto letter, in particular, the justification that MMO was practicing patent holdout as an unwilling licensee. This opens the door for ITC-based exclusion orders under the circumstance of refusal to license on FRAND terms.

Antitrust Arena

The key regulatory actors in the antitrust arena in the US are the Federal Trade Commission (FTC) and the Antitrust Division of the Department of Justice (DoJ). The FTC is a quasi-judicial, independent organization charged with preventing anticompetitive business practices and protecting consumers.[121] The Antitrust Division of the Department of Justice has a similar role of promoting competition and enforcing antitrust laws. Together, these actors have direct influence in determining the antitrust implications of IP transactions through, for example, evaluating mergers and acquisitions involving large SEP portfolios[122] and providing business review letters (BRLs) regarding cross-licensing, patent pool formation, and SSO IPR policies.[123] They also conduct investigations into the alleged anticompetitive use of FRAND-enabled SEPs by individual market actors.[124]

Standard Setting Organization (SSO) Arena

This arena consists of various national and international organizations whose primary role is to define technical standards and publish the associated technical specifications. There are a great number and variety of standard setting organizations (SSOs) with the role of facilitating the collaborative development of industry standards.[125] While SSOs are generally considered to be pro-competitive, collective participation by competing firms creates an environment for opportunistic behavior with potential anti-competitive effects (Anton and Yao, 1995). Many SSOs are private, non-profit organizations governed by private members, either individual professionals as with IEEE (Institute of Electrical and Electronics Engineers) or organizations as with ETSI (European Telecommunications Standards Institute). In addition, countries can also be members as is the case with ITU (International Telecommunication Union), which is a UN agency. Given that the actors in the business arena can also be members in the SSOs, there is a potential conflict of interest in the development of objective technical standards that must be overcome. This is particularly challenging due to the asymmetric distribution of market power in SSOs with predominantly corporate members. A recent controversial change

---

[120] See https://www.uspto.gov/about/offices/ogc/Final_DOJ-PTO_Policy_Statement_on_FRAND_SEPs_1-8-13.pdf.

[121] See https://www.ftc.gov

[122] For example see DOJ investigation of Google's purchase of Motorola Mobility, and Rockstar consortium's purchase of the Nortel patent portfolio

[123] For example, the DOJ has issued BRLs for 3G, MPEG-2, and DVD patent pools and for SSO IPR policies for IEEE and VITA – see http://www.justice.gov/atr/business-reviews

[124] For example, see FTC consent orders in the cases of Unocal, Dell, Rambus, Google/MMI (https://www.ftc.gov/enforcement/cases-proceedings/1210120/motorola-mobility-llc-google-inc-matter) and Robert Bosch (https://www.ftc.gov/enforcement/cases-proceedings/1210081/bosch-robert-bosch-gmbh).

[125] Bekkers and Updegrove (2012) identified over 840 SSOs in the ICT sector alone.

in IPR policy at IEEE illustrates how SSOs can be used as an important arena to define the meaning of FRAND (Petit, 2016; Teece, 2015; Sidak, 2015).

From the brief descriptions above it is easy to see how different actors can play a communicative game on different arenas to try to enact their claims as a means to affect not only the validity of specific commercial building blocks but also the validity of the tools that are used to build them. While the different arenas have their own logic, they are also part of an interrelated system of design, development, validation, and enforcement. Additional arenas, such as legislative (i.e. Congress) and administrative (i.e. USPTO) could also be added to this communicative system defining the meaning of FRAND.

Figure 5.6 below shows an influence diagram describing how market interests can impact the meaning of FRAND through the legitimizing arenas discussed above.

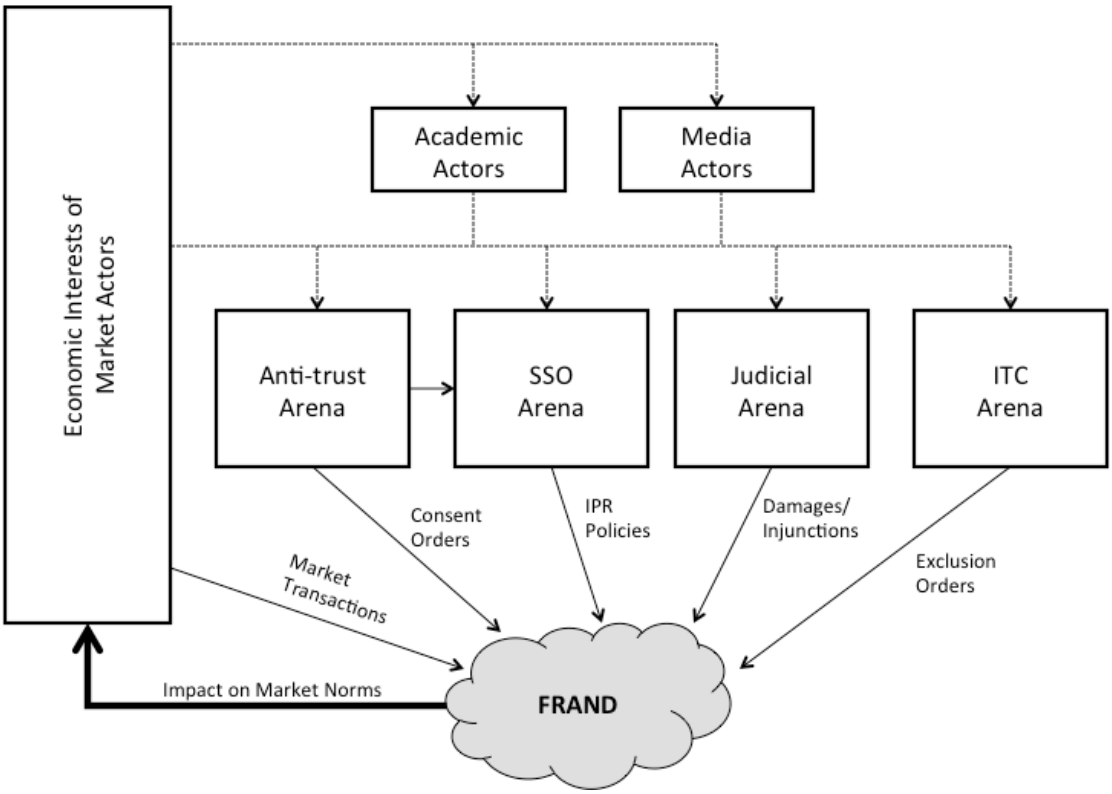

Figure 5.4 Influence diagram of legitimizing arenas defining the meaning of FRAND

5.2 Future Research

The interrelated issues of telecommunication standards, patents, and FRAND agreements could be seen to part of a greater movement that is redefining the role of intellectual property and open innovation in the knowledge economy. Below is a list of important areas for future research:

- A broader investigation of FRAND decision-making by courts, competition authorities, and SSOs worldwide
- A deeper political economy investigation of FRAND building on the social construction model presented in section 5.1.
- A deeper investigation of the role of competition law and the impact of the competition authorities in relation to technology standards involving actors with heterogeneous business models.
- Further economic modeling and empirical studies of patent holdup and holdout in relation to knowledge-based business models.
- A comparative study of different technology standards in relation to patents, performance, and interoperability.
- An international comparative study of FRAND norms in the different arenas.
- A new look at how the emerging Internet-of-Things (IoT) impacts standardization strategies and the role of SEPs and FRAND agreements.
- The continued examination of mainstream law and economic concepts towards the development of an improved knowledge-based theory of value, in particular, for open innovation platforms that use intellectual property to facilitate openness and regulate access.

6. Conclusion

The use of FRAND has a long history as an antitrust remedy and a governance structure for collaborative technology development. This thesis focuses on the recent battle to define the meaning of FRAND over the last decade from 2007-2017 set in the context of the large and globally expanding telecommunications market enabled by open, consensus-based standards. While much of the attention in the popular press has focused on the war between Apple and Samsung, this thesis has focused on the potentially more important intellectual property battle concerning the future of telecommunications standards in the knowledge economy. It has been shown in this thesis that this parallel conflict is not a conventional battle over the market share of products between horizontal competitors on product markets, but a battle among vertical collaborators over the appropriation of value between upstream technology owners and downstream product implementers. As such, the current conflict in the context of open telecommunication standards could be seen as part of a wider paradigm shift from an industrial to a knowledge economy characterized by the increased direct commercialization of technology through intellectual property-based business models. While the smartphone is one, albeit important, product, the future development of Internet of Things (IoT) both for industrial applications (i.e. Industry 4.0) and consumer applications is predicted to greatly expand the number of connected objects as well as the number of technology standards and associated patents. Given the increasing importance of standards, this thesis can be viewed as an effort towards addressing the growing contention over how patents should be governed in the development and commercialization of open technology standards to maximize social welfare. The following sections discuss the key findings and main contributions.

6.1 Key Findings

The main purpose of this thesis has been to better understand how competing interests seek to define the meaning of FRAND and influence the value of SEPs. The following questions were addressed in the context of the telecommunications industry and below are the key findings:

1. **What are the current areas of contention regarding FRAND and the value of SEPs and how does this relate to the interests of actors on the telecommunication value chain?**

The main area of contention among market actors is concerned with the determination of the distribution of rents among SEP holders and implementers in the telecommunication value chain.[126] In particular, the fragmentation of the telecommunication value chain has created

[126] There are important non-market actors in the overall telecommunication eco-system, including policy-oriented organizations, such as competition authorities focus on the welfare impacts associated with balancing the needs of innovation and consumers. Additionally, standard-setting organizations (SSOs) occupy the role of managing open innovation platforms that benefit both their members and society and influence FRAND through the setting of IPR policies.

increasing asymmetric incentives among market actors that develop and implement standards. This has created the need to value SEPs outside of the context of the traditional industrial material value chain, which in turn creates a battle to define the meaning of FRAND within the context of large, competing commercial interests. Standards with different market norms based on the type of technology and the business models of its members can view FRAND and SEP value very differently.

2. **What are the key theoretical concepts currently used to define the meaning of FRAND and how do they impact the value of SEPs?**

Patent holdup and holdout have emerged as the most important theoretical concepts used to define the meaning of FRAND. It was found that neither patent holdup nor patent holdout is aligned with the mainstream economic theories of holdup and holdout, respectively. A new framework is suggested that removes the pejorative terms and models the potential asymmetric bargaining positions between SEP holder and implementers on a continuum across a spectrum from monopoly to monopsony power.

The key sub-concepts include argumentation over aggregate royalties (i.e. royalty stack/gap), injunctive relief, ex ante valuation, and the royalty base. The literature and cases studied showed a lack of empirical evidence of systematic or systemic patent holdup but growing evidence of systemic patent holdout/trespass in the telecommunication market due to decreased inability to obtain injunctive relief and the difficulty of SEP enforcement in emerging economies. This creates a rational incentive on the part of multi-national SEP implementers to delay payment of FRAND royalties and small and large firms in emerging countries to avoid FRAND payments based on collective action problems. No significant systemic impact from patent holdout is currently observed in the mobile telecommunication market, but there are signs that should be further investigated and monitored.

3. **How is the meaning of FRAND shaped by actors through key legitimizing arenas, such as the US court system?**

Market actors shape of the meaning of FRAND and the value of SEPs through market transactions as well as through interventions on other legitimizing arenas, including SSOs, courts, competition authorities, the International Trade Commission (ITC), and through legislation. The results showed that the US court system is willing to accept a broad range of patent damages theories/models if they substantially account for the apportionment of SEP value. The legal norms of SSPPU and EMVR are applied within the context of the case, allowing for the inclusion of market norms to influence the determination of royalty base in SEP damages. Different countries currently apply different market and legal norms in defining the meaning of FRAND thus further research into other arenas and geographies is required to construct a global understanding of the meaning of FRAND and SEP value.

6.2 Main Contributions

To accomplish the purpose and investigate the main questions of this thesis, four interrelated studies were conducted and one synthesizing framework has been put forward to capture the results. In particular, the phenomena of SEPs and FRAND agreements were investigated from an inter-disciplinary perspective, specifically economics, law, and innovation/technology management. This was done to provide balanced guidance to support policymakers and market actors seeking to define an agenda for the development of patent policies and IP-based business models adjusted to wealth and welfare creation in an era of open innovation.

The overarching research problem addressed in this thesis is the need for an improved theoretical understanding of the changing nature of value creation from an industrial to a knowledge-based economic paradigm. This could also be described as the need for an improved knowledge-based theory of value at the level of the firm and the market – both the technology and product market. The following theoretical and empirical contributions of the thesis are summarized below.

6.2.1 Theoretical contributions

The theoretical activities and results of the thesis are discussed below:

- Verification of key areas of contention on FRAND and SEP value through analysis of landmark FRAND cases in relation to received theory (Paper 1/2)
- Development of new propositions of SEP value based on the business model/market logic, standardization context, royalty base and valuation models as well as verification of lack of empirical evidence of patent holdup and royalty stacking (Paper 2)
- Development of a knowledge-based theory of competitive advantage and SEP value based on vertical competition between actors on the product and technology market (i.e. the interaction between the material and intellectual value chain) in the context of the telecommunication value chain (Paper 3)
- Creation of five propositions regarding the relationship between patent damages and royalty base from an intellectual value chain perspective (Paper 3):
    - The value of knowledge is not constrained by the material value chain
    - Components are not licensed in the telecommunication value chain
    - Market norms are to license SEPs on fully-compliant end products
    - Standards drive market demand by definition in relation to EMVR
    - Market norms are embedded in SEP license agreements
- Critical revision of received theory of patent holdup and holdout leading to new theoretical concepts/propositions including patent trespass and royalty gap (Paper 4)
- Development of a new decision model of patent trespass (Paper 4)

- Development of a new model of asymmetric bargaining power in the context of SEP holders and implementers (Paper 4)
- Verification of patent trespass strategies against empirical survey of global SEP holders (Paper 4)
- Creation of three initial models describing the political economy of FRAND and SEP value to unveil the communicative game and interests influencing policy and strategy (Summary chapter)
    - SEPs and the new division of labor in the telecommunication value chain
    - FRAND as a communicative game on five arenas
    - Influence diagram of legitimizing arenas defining the meaning of FRAND

6.2.2 Empirical contributions

The key empirical investigations and results of the thesis are discussed below:

- Description of landmark FRAND case from a techno-economic perspective and key implications for firms and policymakers (Paper 1)
- Description and comparative analysis of SEP valuation models presented and accepted in four initial FRAND case before the US district court system (Paper 2)
- Doctrinal analysis of US patent law in relation to patent damages in general and SEP damages in particular (Paper 3)
- Description and comparative analysis of commercial transactions on a product and technology market regarding the norms of royalty base between the computer/semiconductor industry and the telecommunications industry (Paper 3)
- Description of patent trespass strategies based on interviews of global SEP holders (Paper 4)
- Description of the nature and impact of patent trespass based on survey of global SEP holders (Paper 4)

Further theoretical and empirical contributions can be found in the appended papers or the summaries in chapter 4.

7. References

Aastrup, Jepser and Halldorsson, Arni (2008), "Epistemological role of case studies in logistics: A critical realist perspective", *International Journal of Physical Distribution & Logistics Management*, Volume 38, Issue 10, pp. 746-763.

Alvesson, M., & Sköldberg, K. (1994). *Tolkning och reflektion: vetenskapsfilosofi och kvalitativ metod*. Studentlitteratur.

Antonelli, C., Geuna, A., & Steinmueller, W. E. (2000). Information and *International Journal of Technology Management*, *20*(1-2), 72-94.

Arora, A., Fosfuri, A., & Gambardella, A. (2001). Markets for technology and their implications for corporate strategy. *Industrial and corporate change*, *10*(2), 419-451.

Arrow, K. (1962), "Economic welfare and allocation of resources for invention", in *The rate and direction of inventive activity*, Princeton University Press. 609 – 25.

Balkenborg, D., Kaplan, T., & Miller, T. (2012). A simple economic teaching experiment on the hold-up problem. *The Journal of Economic Education*, *43*(4), 377-385.

Barney, Jay B. (1991), "Firm Resources and Sustained Competitive Advantage", Journal of Management; 17, (1).

Bekkers, R. & Updegrove, A. (2012). A study of IPR policies and practices of a representative group of Standards Setting Organizations worldwide, US National Academies of Science, Board of Science, Technology, and Economic Policy (STEP), Project on Intellectual Property Management in standard- setting processes, Washington, D.C.: National Academies of Science.

Bekkers, R., Verspagen, B. & Smits, J. (2002). Intellectual property rights and standardization: The case of GSM. In: Telecommunications Policy 26, p. 171-188.

Bekkers, R., & West, J. (2009). The limits to IPR standardization policies as evidenced by strategic patenting in UMTS. *Telecommunications Policy*, *33*(1), 80-97.

Bell, Daniel (1976), *The Coming of Post-Industrial Society: A Venture in Social Forecasting*, Basic Books; Reissue edition.
Berger, Peter and Thomas Luckmann (1967), Social Construction of Reality – A Treatise in the Sociology of Knowledge, Anchor.

Biddle, Brad, Andrew White and Sean Woods (2010), "How Many Standards in a Laptop? (And Other Empirical Questions)", Working paper, September 10, 2010, available at SSRN: http://ssrn.com/abstract=1619440.

Blaxill, M., & Eckardt, R. (2009). *The invisible edge: taking your strategy to the next level using intellectual property*. Penguin Group.

Blind, Knut (2004), *The Economics Of Standards: Theory, Evidence, Policy*, Edward Elgar.

Blind, Knut and Jungmittag, Andre (2008), "The impact of patents and standards on macroeconomic growth: a panel approach covering four countries and 12 sectors", Journal of Productivity Analysis, Volume 29, Issue 1, pp. 51-60.

Bryman, A, and Bell, E. (2011), *Business Research Methods (3rd edition),* Oxford University Press, Oxford.

Calabresi, Guido and Melamed, Douglas A. (1972), "Property Rules, Liability Rules, and Inalienability: One View of the Cathedral", *Harvard Law Review*, Vol. 85, No. 6, pp. 1089-1128.

Castells, Manuel (2009), *The Rise of the Network Society: The Information Age: Economy, Society, and Culture Volume I*, Wiley-Blackwell; 2nd Edition.

Chesbrough, Henry (2003), *Open Innovation: The New Imperative for Creating And Profiting from Technology*, Harvard Business Review Press.

Chien, C. V. (2014). Holding up and Holding out. *Mich. Telecomm. & Tech. L. Rev.*, *21*, 1.

Coase, Ronald H. (1937), "The Nature of the Firm", Economica 4 (16): 386–405.

Conner, Kathleen R. and C.K. Prahalad (1996), "A Resource-based Theory of the Firm - Knowledge Versus Opportunism, *Organizational Science,* Vol. 7, No. 5, (Sep-Oct), pp. 477-501

Contreras , Jorge L. (2013). Fixing FRAND: A Pseudo-Pool Approach to Standards-Based Patent Licensing, *79 Antitrust Law Journal 47.*

Contreras, J. L. (2015). A Brief History of FRAND: Analyzing Current Debates in Standard Setting and Antitrust Through a Historical Lens.

Contreras, J. L. (2015b). CSIRO v. Cisco: The Convergence of RAND and Non-RAND Royalties for Standards-Essential Patents.

Contreras, J. L., & Gilbert, R. J. (2015). Unified Framework for RAND and Other Reasonable Royalties. *Berkeley Tech. LJ*, *30*, 1451.

Cournot, A. (1897), *Researches Into the Mathematical Principles of the Theory of Wealth* translated by Irving Fisher. The MacMillan Company.

Cunliffe, A. L. (2010), "Crafting Qualitiative Research: Morgan and Smirchich 30 Years On", *Organizational Research Methods*, Vol. 14, pp. 1-27.

David, P. A., & Steinmueller, W. E. (1994). Economics of compatibility standards and competition in telecommunication networks. *Information Economics and Policy*, *6*(3), 217-241.

Denicolo, V., D. Geradin, A. Layne-Farrar, and J. Padilla. 2008. "Revisiting Injunctive Relief: Interpreting eBay in High-Tech Industries with Non-Practicing Patent Holders." Journal of Competition Law and Economics 4: 571-608.

Dubois, A. and Gadde, L. E. (2002), "Systematic Combining: An Abductive Approach to Case Research", *Journal of Business Research*, 55, pp. 553-560.

Dorsey, E., & McGuire, M. R. (2012). How the Google consent order alters the process and outcomes of FRAND bargaining. *Geo. Mason L. Rev.*, *20*, 979.

Drucker, Peter (1993), *Post-Capitalist Society*. New York: Harper Collins.
Eichenwald, Kurt (2014), "The Great Smartphone War", Vanity Fair, June issue

Eisenhardt, K. M. (1989), "Building Theories from Case Study Research", *Academy of Management Review*, Vol. 14, No. 4, pp. 532-550.

Eisenhardt, K. M. and Graebner, M. E. (2007), Theory Building from Cases: Opportunities and Challenges", *Academy of Management Journal*, Vol. 50, No. 1, pp. 25-32.

Epstein, R. A. (1993). Holdouts, externalities, and the single owner: One more salute to Ronald Coase. *The Journal of Law and Economics*, *36*(1, Part 2), 553-586.

Epstein, R., S. Kieff and D. Spulber, "The FTC, IP, and SSOS: Government Hold-up Replacing Private Coordination," Journal of Competition Law and Economics 8:1-46.

Elhauge, Einer (2008), "Do Patent Holdup and Royalty Stacking Lead To Systematically Excessive Royalties?" *Jnl of Competition Law & Economics* 4 (3): 535-570.

Farrell, J., Hayes, J., Shapiro, C., & Sullivan, T. (2007). "Standard setting, patents, and hold-up". Antitrust Law Journal, 74(3), 603-670.

Farrell, J., & Klemperer, P. (2007). Coordination and lock-in: Competition with switching costs and network effects. *Handbook of industrial organization*, *3*, 1967-2072.

Flick, U. (2009), *An Introduction to Qualitative Research*, 4th edition, Sage, London.

Florida, Richard (2002). *The Rise of the Creative Class: And How it's transforming work, leisure, community and everyday life*, New York: Perseus Book Group.

Galetovic, A., & Gupta, K. (2016). *Royalty Stacking and Standard Essential Patents: Theory and Evidence from the World Wireless Industry*. Hoover IP2 Working Paper 15012.

Galetovic, Alexander, and Stephen Haber. "The Fallacies of Patent-Holdup Theory." *Journal of Competition Law & Economics* 13.1 (2017): 1-44.

Galetovic, A., Haber, S., & Levine, R. (2015). An Empirical Examination of Patent Holdup. *Journal of Competition Law and Economics*, *11*(3), 549-578.

Galetovic, A., Haber, S., & Zaretzki, L. (2017). Is There an Anti-commons Tragedy in the Smartphone Industry?, Hoover IP2 Working Paper.

Geradin, D. (2010). 6 Reverse Hold-ups: The (Often Ignored) Risks Faced by Innovators in Standardized Area. *The Pros and Cons of Standard Setting*, 101.

Geradin, Damien and Layne-Farrar, Anne and Padilla, Jorge (2008), "The Complements Problem within Standard Setting: Assessing the Evidence on Royalty Stacking", *Boston University Journal of Science and Technology Law*, Vol. 14, No. 2

Geradin, Damien and Rato, Miguel (2007), "Can Standard-Setting Lead to Exploitative Abuse: A Dissonant View on Patent Hold-Up, Royalty Stacking and the Meaning of Frand", 3 Eur. Competition J. 101

Gibbert, M., Winfried, R., and Wicki, B. (2008), "What Passes as a Rigourous Case Study", *Strategic Management Journal,* 29:, pp. 1465–1474.

Glaser, Barney G & Strauss, Anselm L. (1967), *The Discovery of Grounded Theory: Strategies for Qualitative Research*, Chicago, Aldine Publishing Company.

Godfrey-Smith, Peter (2003), *Theory and Reality*, The University of Chicago Press.
Golden, John M. (2007), "Patent Trolls and Patent Remedies", 85 *Tex. L. Rev*. 2111.

Granstrand, Ove (1999), *The Economics and Management of Intellectual Property: Towards Intellectual Capitalism*, Cheltonham: Edward Elgar Publishing Limited

Grant, R.M. (1996), "Toward a Knowledge-Based Theory of the Firm," Strategic Management Journal (17), Winter Special Issue, pp. 109–122.

Grindley, P., & Teece, D. (1997). Managing Intellectual Capital: Licensing and Cross-Licensing in Semiconductors and Electronics. *California Management Review*, 39 (2), Winter, 1-34.

Gupta, K., 2013 "The Patent Policy Debate in the High-Tech World," Journal of Competition Law and Economics 9: 827-858.

Hardin, G. (1968). The tragedy of the commons. *science*, *162*(3859), 1243-1248.

Heller, M. A. (1998). The tragedy of the anticommons: property in the transition from Marx to markets. *Harvard law review*, 621-688.

Heller, M. A., & Eisenberg, R. S. (1998). Can patents deter innovation? The anticommons in biomedical research. *Science*, *280*(5364), 698-701.

Henry, Matthew D. and Turner, John L. (2006), "The Court of Appeals for the Federal Circuit's Impact on Patent Litigation", *The Journal of Legal Studies*, Vol. 35, No. 1, pp. 85-117.

Iversen, EJ (1999) *Standardization and Intellectual Property Rights: ETSI's controversial search for new IPR-procedures*. In: IEEE Conference on Standardisation and Innovation in Information Technology, 15-17 Sept 1999, Aachen, Germany.

Katz, Michael L. and Shapiro, Carl (1985), "Network Externalities, Competition, and Compatibility", *The American Economic Review,* Vol. 75, No. 3 (Jun., 1985), pp. 424-440.

Klein, B., Crawford, R. G., & Alchian, A. A. (1978). Vertical integration, appropriable rents, and the competitive contracting process. *The journal of Law and Economics*, *21*(2), 297-326.

Kretchmer, Ken (2006), "Open Standards Requirements", *The International Journal of IT Standards and Standardization Research*, Vol. 4 No. 1, January – June.

Kuhn, Thomas S. (1970), *The Structure of Scientific Revolutions,* (2nd Edition) University of Chicago Press.
Latour, B. (1996). *Aramis, or, The love of technology* (Vol. 1996). Cambridge, MA: Harvard University Press.

Layne-Farrar, Anne (2014) Patent Holdup and Royalty Stacking Theory and Evidence: Where do we Stand After 15 Years of History, *available at* http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DAF/COMP/WD%282014%29%2084&doclanguage=en.

Layne-Farrar, Anne and Wong-Ervin, Koren W. (2015). An Analysis of the Federal Circuit's Decision in Ericsson v. D-Link, *CPI Antitrust Chronicle*, March (1).

Lee, W. F., & Melamed, A. D. (2015). Breaking the Vicious Cycle of Patent Damages. *Cornell L. Rev.*, *101*, 385.

Lemley, Mark A. (2002), "Intellectual Property Rights and Standard-setting organizations," California Law Review, Vol. 90, 1889-1990

Lemley, M. A. (2007). Ten things to do about patent holdup of standards (and one not to). *BCL Rev.*, *48*, 149.

Lemley, Mark A. and Carl Shapiro (2007), "Patent Holdup and Royalty Stacking," Texas Law Review, Vol. 85, pp. 1991.

Lemley, M. A., & Shapiro, C. (2013). A simple approach to setting reasonable royalties for standard-essential patents. *Berkeley Tech. LJ*, *28*, 1135.

Lerner, J., & Tirole, J. (2014). A better route to tech standards. *Science*, *343*(6174), 972-973.

Lerner, J., & Tirole, J. (2015). Standard-essential patents. *Journal of Political Economy*, *123*(3), 547-586.

Levin, R. C., Klevorick, A. K., Nelson, R. R., Winter, S. G., Gilbert, R., & Griliches, Z. (1987). Appropriating the returns from industrial research and development. *Brookings papers on economic activity*, *1987*(3), 783-831.

Libecap, G. D. (1993). *Contracting for property rights*. Cambridge university press.

Lincoln, Y. and Guba, E. G. (1985), *Naturalistic Inquiry*, Sage Publications, Newbury Park, CA.

Lincoln, Y. S. (1995). Emerging criteria for quality in qualitative and interpretive research. *Qualitative inquiry*, *1*(3), 275-289.

Luhmann, Niklas (1992), "Operational Closure and Structural Coupling: The Differentiation of The Legal System", *Cardozo Law Review*. Vol. 13, No. 5 1992, p. 1420.

Mallinson, K., 2016, "Don't Fix What Isn't Broken: The Extraordinary Record of Innovations and Success in the Cellular Industry Under Existing Licensing Practices," George Mason Law Review 23, 967-1006.

Malthus Thomas, R. (1798) *An Essay on the Principle of Population*. Oxford World's Classics.

Maxwell, Joseph (2012), *Qualitative Research Design: An Interactive Approach*, 3rd edition, Sage, London.

Merges, Robert P. (1988), "Commercial Success and Patent Standards: Economic Perspectives on Innovation", *California Law Review*, Vol. 76, No. 4 (Jul., 1988), pp. 803-876.

Merges, Robert P. (1996), "Contracting into Liability Rules: Intellectual Property Rights and Collective Rights Organizations", *California Law Review*, Vol. 84, No. 5, pp. 1293-1393

Miceli, T. J. (2011). Free riders, holdouts, and public use: a tale of two externalities. *Public Choice*, *148*(1-2), 105-117.

Morgan, G., & Smircich, L. (1980), "The case for qualitative research", *Academy of Management Review*, 5, pp. 491-500.

Ostrom, E. (2015). *Governing the commons*. Cambridge University Press.

Patton, M.Q. (2002). *Qualitative Research and Evaluation Methods,* Sage Publications, Thousand Oaks, CA.

Penrose, Edith T. (1959), *The Theory of the Growth of the Firm*. New York: John Wiley.

Petit, N. (2016). The IEEE-SA Revised Patent Policy and Its Definition of 'Reasonable' Rates: A Transatlantic Antitrust Divide?

Petit, N. (2016). The Smallest Salable Patent-Practicing Unit ('SSPPU') Experiment, General Purpose Technologies and the Coase Theorem.

Petrusson, Ulf (2005), *Intellectual Property & Entrepreneurship: Creating Wealth in an Intellectual Value Chain*, Center for Intellectual Property, Gothenburg.

Petrusson and Heiden (2009)

Pettigrew, A. M. (1997), "What is a Processual Analysis", *Scandinavian Journal of Management*, 13, pp. 337-348.

Porter, M.E. (1985), *Competitive Advantage*, New York, NY: Free Press.

Putnam, J. D., & Williams, T. A. (2016). The Smallest Salable Patent-Practicing Unit (SSPPU): Theory and Evidence.

Rysman, M., & Simcoe, T. (2011). A NAASTy Alternative to RAND Pricing Commitments. *Telecommunications Policy, 35* (11), 1010-1017.

Romer, Paul M. (1994) "The Origins of Endogenous Growth". The Journal of Economic Perspectives 8 (1): 3.

Rosenzweig (2007), *The Halo Effect: …and eight other business delusions that deceive managers*, Free Press, New York.

Schumpeter, Joseph A. (2010) [1942]. *Capitalism, Socialism and Democracy*, London.
Searle, John (1995), *The Construction of Social Reality*, Free Press, New York.Routledge Classics.

Shapiro, Carl (2001). "Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard-Setting", in Jaffe, Adam B.; et al. *Innovation Policy and the Economy I*, Cambridge: MIT Press. pp. 119–150.

Shapiro, Carl (2010). "Injunctions, Hold-Up, and Patent Royalties", *American Law and Economics Review* 12, no. 2, 509-557.

Sidak, G., 2009, "Patent Holdup and Oligopsonistic Collusion in Standard-Setting Organizations," Journal of Competition Law & Economics 5: 123-188.

Sidak, G., 2013, "The Meaning of FRAND, Part I: Royalties," Journal of Competition Law & Economics 9: 931-1055.

Sidak, J. G. (2015). The Antitrust Division's devaluation of standard-essential patents. *Geo. LJ Online*, *104*, 48.

Sidak, G., 2016, "What Aggregate Royalty Do Manufacturers of Mobile Phones Pay to License Standard-Essential Patents?" The Criterion Journal on Innovation 1: 701-711.

Siebrasse, N., & Cotter, T. F. (2015). A New Framework for Determining Reasonable Royalties in Patent Litigation.

Solow, Robert M. (1956) "A Contribution to the Theory of Economic Growth". *Quarterly Journal of Economics* (The MIT Press) **70** (1): 65–94.
Spender, J.C. (1996), "Making Knowledge the Basis of a Dynamic Theory of the Firm," Strategic Management Journal (17), Special Issues, pp. 45–62.

Strauss, A. and Corbin J. (1994), "Grounded Theory Methodology: An Overview" in *Handbook of Qualitative Research*, Denzin N. K., and Lincoln Y. S (eds), Sage Publications.

Sutton, R. I. (1997), “The Virtues of Closet Qualitative Research”, Organization Science, 8 (1), January-February.

Teece, D.J. (1976). *Vertical integration and vertical divestiture in the U. S. oil industry: economic analysis and policy implications*. United States: Institute for Energy Studies,Stanford, CA.

Teece, D. J. (2015). *Are the IEEE Proposed Changes to IPR Policy Innovation Friendly* (No. 2). Working Paper.

Teece, D. J., & Sherry, E. F. (2016). The IEEE’s New IPR Policy: Did the IEEE Shoot Itself in the Foot and Harm Innovation?. *Manuscript dated August*, *3*, 2016.

Teece, D., Pisano, G. and Shuen, A. (1997), "Dynamic Capabilities and Strategic Management". Strategic Management Journal, Vol. 18, No. 7, pp. 509–533.

Teubner, Gunther (2006), Coincidentia oppositorum: Hyprid Networks Beyond Contract and Organization. Storrs Lectures 2003/04 Yale Law School. In: Robert Gordon and Mort Horwitz (eds.) *Festschrift in Honour of Lawrence Friedman*, Stanford University Press.

Shapiro, C., & Varian, H. R. (1999). The art of standards wars. *California management review*, *41*(2), 8-32.

Sherry, E. F., & Teece, D. (2016). On the 'Smallest Saleable Patent Practicing Unit'Doctrine: An Economic and Public Policy Analysis.

Steinmueller, W. E. (2002). Knowledge-based economies and information and communication technologies. *International Social Science Journal*, *54*(171), 141-153.

Vargo, Stephen L. and Lusch, Stephen L. (2004), *Evolving to a New Dominant Logic for Marketing*, 68 Journal of Marketing 1, 5-12.

Wernerfelt, B. (1984), "A resource-based view of the firm". Strategic Management Journal, Vol.5, pp. 171–180

West, Joel (2007), “The economic realities of open standards: Black, white and many shades of gray“, in *Standards and Public Policy*, Greenstein, Shane and Stango, Victor eds., Cambridge Press.

Warsh, David (2007), *Knowledge and the Wealth of Nations: A Story of Economic Discovery*, W. W. Norton & Company

Wernerfelt, Birger (1984), "A resource-based view of the firm". Strategic Management Journal, Vol.5, pp. 171–180

Williamson, O. E. (1975), *Markets and Hierarchies: Analysis and Antitrust Implications*, New York, NY, Free Press.

Williamson, Oliver E. (1981). "The Economics of Organization: The Transaction Cost Approach". The American Journal of Sociology 87 (3): 548–577.

Wright, J. D. (2013). SSOs, FRAND, and antitrust: lessons from the economics of incomplete Contracts. *Geo. Mason L. Rev.*, *21*, 791.

Wright, Joshua D. and Ginsburg, Douglas H. (2014). Patent Assertion Entities and Antitrust: A Competition Cure for a Litigation Disease, *79 ANTITRUST L.J. 501, 509*.

Yin, R. K. (2009), Case Study Research: Design and Methods, 4th edition, Sage, London.

Åhlstrom, P. and Karlsson, C. (2009), "Longitudinal Field Studies" in *Researching Operations Management,* ed. Karlsson, C., pp. 196-235, Routledge, New York.