Università degli Studi dell'Insubra
Scuola di Dottorato in Scienze Economiche e Statistiche
Doctoral Program in "Methods and Models for Economic Decisions"

Université de Bordeaux
École doctorale Entreprise, économie, société
Doctoral Program in Economics

Innovation, Intellectual Property Rights and Non-Practicing Entities in the European Patent Market

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Introduction

Nowadays we experience an unparalleled accessibility to powerful and sophisticated innovations. These cutting-edge technologies are the result of the information and knowledge economy we live in (Powell and Snellman, 2004), wherein intangible assets, such as intellectual property (IP), are as important as tangible ones (Elsten and Hill, 2017).

Patents are a form of intellectual property rights (IPRs) that are especially relevant to promoting innovative activities. A patent grants its owner a temporary exclusive right over inventions that are new, involve an inventive step and are susceptible of industrial application. Relying on this right, inventors can protect their ideas from imitation and gain an economic return from their investments in research and development (R&D).

However, the use of patents has undergone a significant transformation, extending far beyond the traditional purpose of rewarding innovative efforts. Particularly in the field of Information and Communication Technology (ICT), patents are increasingly used as strategic tools (Blind, 2021). Moreover, over the past three decades, the sharp increase in the number of granted patents and the unprecedented

flourishing of patent trading have paved the way for new intermediaries in the market for technology (Hagiu and Yoffie, 2013).

Non-practicing entities (NPEs)—firms that do not use their patents in a traditional manufacturing sense, but primarily engage in licensing and enforcement—have emerged as prominent actors on the patent market (Golden, 2007; Feldman and Ewing, 2012). Also referred to as Patent Assertion Entities (PAEs), sometimes pejoratively called "patent trolls," NPEs have greatly polarized the academic and policy debate. In particular, they have been accused of capitalizing on the frictions of the patent system and engaging in opportunistic patent enforcement (Larson, 2013). Furthermore, due to their non-manufacturing status, NPEs have unique advantages over operating companies. They are typically shielded from patent infringement counter-claims and have recently faced allegations of employing patent "hold-up" strategies, which some argue it imposes a significant "tax on innovation" (Chien, 2008) with potential negative effects on subsequent innovation (Lemley and Shapiro, 2007). While NPEs have been extensively analyzed in the US patent market since their emergence in the early 2000s, where they have often been targeted by patent law and judiciary actions (Mezzanotti, 2021; Lemley and Zyontz, 2021), it is only recently that researchers have started to investigate their presence in the European technology market (Fusco, 2013; Love, 2013; Leiponen and Delcamp, 2019). This thesis aims to address these research gaps by examining the NPE phenomenon in the European context.

In the first chapter, I adopt an original approach based on the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) protocol to systematically collect and review the academic literature on NPE business models. In particular, I first provide a bibliometric analysis of the extant literature on NPE business models to identify the intellectual, thematic, and collaboration structures of the extant research on the subject. Second, I delve into the content of the scientific contributions collected through the methodology adopted and I provide a systematic literature review of the scientific production on the subject of NPE business models. More specifically, I use the insights provided by the bibliometric analysis to structure the review around the four main themes that I uncovered: (i) the high heterogeneity of the NPE phenomenon, which presents various business models; (ii) the challenging assessment of the net impact of NPEs' activities on the technology markets; (iii) the complex interplay between patent quality and NPE business models; (iv) the policy concerns triggered by NPEs and the suggestions proposed to limit their undesirable effects. Finally, to report a more complete and contextualized picture of the NPE business model, I complement the systematic literature review with three case studies. Through three semi-structured interviews with European industry professionals and IP experts active in the patent licensing sector, I provide fresh qualitative data and insights on three distinct NPE licensing business models. This chapter contributes to the literature in several ways. First, it outlines an updated and layered picture of the NPE phenomenon. Second, it aims to overcome the polarized debate that surrounds NPEs by addressing an important research gap in the literature. Notably, the predominant focus on

NPEs' patent acquisition and litigation activities, which often neglects the real-world dynamics of patent licensing.

The second chapter—co-authored with Gianluca Orsatti, Valerio Sterzi and Andrea Vezzulli—empirically investigates the presence of NPEs in the European patent market through a brand-new dataset of NPE patent filings and acquisitions at the European Patent Office (EPO). Furthermore, we develop an original taxonomy, thus categorizing NPEs into three business models: "Litigation," "Portfolio" and "Technology" NPEs. The dataset building process involves multiple sources of data. First, we rely on two proprietary lists of NPE names provided by Clarivate's Darts-IP and Allied Security Trust. Second, we employ the Bureau van Dijk's Orbis Intellectual Property Database (Orbis IP) to collect information on EPO-patents owned by business entities, distinguishing between filed and acquired patents. Third, we collect patent quality characteristics from the OECD Patent Quality Database, 2021 Version (Squicciarini et al., 2013) and PATSTAT (Version October 2019). Finally, we include patent litigation data provided by Clarivate Darts-IP. Then, through the analysis of their patent portfolios and the exploration of their patent acquisition sources and the industries they operate in, we emphasize the substantial presence of NPEs in the European patent market. We find that NPEs own almost 20,000 patents filed at the EPO, and that they acquired about 9% of all transacted patents in the Electrical Engineering field in the past decade. In addition, we uncover significant heterogeneity among NPEs in terms of the characteristics of the acquired patents and their use. In particular, we report evidence that NPEs with higher propensity for litigation ("Litigation" NPEs) tend to acquire patents with a higher risk of infringement but of similar technological quality to those acquired by practicing entities. By contrast, patent aggregators ("Portfolio" NPEs) and technology companies ("Technology" NPEs) acquire patents of superior technological quality compared to operating firms. Finally, patent acquisitions by "Litigation" NPEs and "Portfolio" NPEs are associated with a reduction in follow-on innovation.

The third chapter—co-authored with Andrea Vezzulli and Valerio Sterzi—investigates NPEs' litigation strategies in Europe. Specifically, we explore the interplay between the quality characteristics of the asserted patent and the propensity of NPEs to choose specific European jurisdictions where to initiate litigation (*forum shopping*). We posit that both producing entities (PEs) and NPEs engage in forum shopping, however their incentives and motives are radically different. NPEs, which do not manufacture any products, focus on leveraging the exclusionary right provided by patents in litigation. Instead, given their manufacturing nature, PEs are interested in the technology protected by the asserted patents. For this reason, when PEs engage in forum shopping they are mainly driven by market competition. In this context, we hypothesize that NPEs may engage in strategic forum shopping by asserting lower-quality patents in injunctive-based regime, such as Germany and Italy. Conversely, NPEs may prefer to assert higher-quality patents in fee-based regimes, such as the UK and France. For lower-quality patents, in fact, the possibility of obtaining an injunction provides NPEs with a strong bargaining power in negotiations

with the infringing PEs. The threat of an injunction can generate a strong incentive for the alleged infringer to settle, thus avoiding the disruption of its production and R&D efforts. In case of injunction, the economic loss for NPEs in terms of foregone licensing fees is limited given the lower quality of the patent. On the contrary, for higher-quality patents, NPEs have more to lose as an injunction would result in the loss of potentially lucrative licensing fees. To conduct this analysis, we combine two data sources. First, we use Clarivate's Darts IP to gather data on EPO patents used in infringement cases between 2007 and 2020, focusing on Germany, Italy, the UK, and France. Second, we retrieve patent quality characteristics from the OECD Patent Quality Database (Squicciarini et al., 2013). The results suggest that the higher the quality of a patent, the higher the probability of observing an NPE initiating a lawsuit in a fee-based regime (the UK or France), as compared to PEs. Conversely, the lower the quality of a patent, the higher the probability of observing an NPE litigating in an injunctive-based jurisdiction (Germany or Italy), as compared to PEs.

Acknowledgments

My doctoral studies have been an enriching academic and personal journey that I will always cherish.

I would like to thank all people and institutions that helped to develop this work and made this experience truly unique. I want to thank the Department of Economics of the University of Insubria to have accepted me in their "Methods and Models for Economic Decisions" PhD program, and the Bordeaux School of Economics for the warm welcome and support I received during the long stay within the cotutelle program.

I would like to express my sincere gratitude to my thesis advisors Andrea Vezzulli and Valerio Sterzi for their constant help and guidance throughout my PhD. Their expertise, patience, and dedication have been crucial in shaping the direction of my research and in helping me grow as a scholar.

I am deeply thankful to Dr. Claudia Tapia Garcia for having actively supported the development of the first chapter of this work, allowing me to tap into the invaluable expertise of Ericsson's IPR Policy Research team and her extensive network of IPR experts. Her unwavering support, guidance and mentorship during my six-month internship in Munich have enriched me with an incredible wealth of experience and knowledge that goes beyond the professional sphere. Moreover, I would like to thank all the fellow IPR Policy interns with whom I shared many learning experiences and moments of laughter and hard work. With you I grew professionally and as a person.

I would like to extend my sincere appreciation to Aldo Geuna and Daniel Fernando de Souza for their generous offer of a stimulating six-month research visit at the Department of Cultures, Politics, and Society (CPS) at the University of Turin.

I want to express my heartfelt gratitude to all my colleagues and fellow graduate students met along these years. You have constantly stimulated my curiosity and offered me continuous academic and personal support. Your kindness, support and friendship has truly enriched me and helped making this experience an incredible journey. I want to extend this gratitude to all my friends, old and new, who have always showed me their continuous unwavering support.

Finally, I want to express my deepest gratitude to my parents for their unwavering encouragement, understanding, and love. Your belief in my abilities has been a constant source of motivation in this challenging but incredibly rewarding journey.

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Chapter 1

Non-Practicing Entities' Business Models: A Systematic Literature Review with Bibliometric Analysis and Case Studies

1.1 Introduction

Non-practicing entities (NPEs), also referred to as Patent Assertion Entities (PAEs) or *"patent trolls,"* are entities that do not use the patents they own in a traditional manufacturing sense. Instead, their primary focus lies in generating revenues through patent licensing (Shrestha, 2010; Abrams et al., 2019).[1] In building their patent portfolios, NPEs may engage in direct research and development (R&D) and file their own patents, or acquire intellectual property assets from other inventors in the secondary market. As a result, NPEs exhibit different configurations of patent filing and acquisition activities (Reitzig et al., 2007; Pohlmann and Opitz, 2013; Leiponen and Delcamp, 2019).

The academic and policy discourse on NPEs is generally polarized. On one hand, NPEs may serve as valuable intermediaries in the technology markets, as small inventors, universities and SMEs may not have the proper resources, or knowledge, to capitalize on their patents and therefore prefer to collaborate with licensing specialists (McDonough III, 2006; Shrestha, 2010; Papst, 2012; Cheng et al., 2017; Nikolic, 2019; Abrams et al., 2019; Chari et al., 2022). On the other hand, NPEs may also engage in assertive patent litigation (Feldman and Lemley, 2015; Kiebzak et al., 2016; Cohen et al., 2019; Appel et al., 2019;

[1] In certain instances, the term NPE has been interpreted in a broad sense to include also universities, technology transfer offices, single inventors, start-ups, and technology development companies (Chien, 2008). In this study we adopt a more restrictive definition. We exclude universities and research centers, start-ups and inventors to focus solely on companies that center their business around patent monetization.

Chen et al., 2023), which has led to allegations of frivolous patent assertions aimed at extracting rents from alleged infringers (Morton and Shapiro, 2013; FTC, 2011; Lemley and Melamed, 2013; Feng and Jaravel, 2020). What makes the NPE phenomenon and interesting research theme is the fact that they fundamentally change the economics of patent enforcement and litigation (Larson, 2013). Particularly, NPEs enjoy various asymmetrical advantages compared to operating entities in patent litigation, such as typically being immune to infringement counter-attacks (Lemley and Shapiro, 2006; Chien, 2010; Larson, 2013).

As a result of their distinct approach to patent monetization, NPEs have gained momentum and a substantial body of academic literature on this subject has been produced.[2] At the same time, NPEs have been frequently considered as a rather homogeneous phenomenon. We argue that this is not the case and we provide a systematic literature review of the scholarly contribution that focuses more specifically on NPE business models. The objective of the present review is to gain a comprehensive understanding of the academic literature that specifically investigates NPE business models, the relationship between different NPE business models with patent quality, and the impact of different types of NPEs on the market for technologies. To identify and review the scholarly contributions on NPE business models, the present study employs an original systematic literature review approach (Tranfield et al., 2003). Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol (Page et al., 2021), we develop a search query and we retrieve the relevant studies on the topic from the two largest scientific peer-reviewed articles database: Web of Science (WoS) and Scopus. Then, we provide a bibliometric analysis of this body of literature, which also serves as a road map for a more systematic literature review.

Given the availability of data on NPE patent acquisitions and litigations, academic empirical research has mainly focused on these two key dimensions. However, patent licensing—a crucial part of the NPE business—is generally not directly observable, nor easily quantifiable, because of the secrecy of such patent licensing deals. To overcome this limitation, we also adopt a qualitative research approach to gather new knowledge and information on the NPE business models and their patent management and monetization activities (Hoepfl et al., 1997; Qu and Dumay, 2011). More specifically, we conducted three semi-structured interviews with three different industry stakeholders active in the patent and technology licensing business. In this way, we complement the present systematic literature review with three case

[2]First appeared in the late 1990s within the US patent market, NPEs have progressively attracted significant attention by both researchers and policymakers (Lemley and Melamed, 2013; FTC, 2016b). In the early 2000s, a combination of policy interventions and courts decisions in the US aiming at undermining some key leverages of NPEs, prompted them to look for more favorable patent and technology market, such as Europe (Mezzanotti, 2021).

studies of European-based NPEs thus providing a more contextualized picture of NPEs and of their various patent-related activities.

This chapter proceeds as follows. Section 1.2 outlines the data sources and the methodology used to gather the relevant literature on NPE business models and presents the results of the bibliometric analysis. The important bibliometric insights thus obtained provide the road map for the systematic literature review presented in Section 1.3. More specifically, the literature review, in light of the results of the bibliometric analysis previously conducted, is organized around four main research themes: first, the analysis of the activities and complex business models displayed by NPEs (Section 1.3.1); second, the study of the interplay between NPE business models and patent quality (Section 1.3.2); third, the efforts to assess the impact of different NPE business models on technology markets (Section 1.3.3); fourth, the policy concerns related to NPE activity and the suggestions to regulate their potentially side effects (Section 1.3.4). Section 1.4 explains the qualitative research approach adopted to expand our knowledge on NPE business models and presents the new information and knowledge obtained in the form of three case studies. Finally, Section 1.5 presents the limitations of this study and future research avenues, while Section 1.6 concludes.

1.2 Bibliometric Analysis

1.2.1 Research method

To thoroughly examine the relevant research on NPE business models, we conduct a systematic literature review (Denyer and Tranfield, 2009; Tranfield et al., 2003) of the contributions developed worldwide. More specifically, we first aim to identify and systematize the heterogeneous studies on NPEs' business models. Second, our objective is to explore the connection between these different patent monetization strategies and the quality of the patents owned by NPEs. Finally, we examine the impact of the different NPEs' business models on the market for technologies (MFTs), exploring in particular the implications on technology diffusion. After having analyzed the extant scientific production on this research topic, we identify potential gaps and unexplored research avenues.

The methodology adopted by the systematic literature review recognizes the importance of transparency in the data selection and reporting process, with the objective of minimizing researchers' biases and ensure replicability. The characteristics of the research contributions identified (i.e. the articles and documents' bibliographic information, such as type of publication, authors, journal, year of publication, keywords, etc.) serve as the data for our bibliometric analysis (Kumpulainen and Seppänen, 2022).

The reporting technique adopted in the current study is guided by the standards of the Preferred

Reporting Items for Systematic Review and Meta-Analysis (PRISMA) Statement (Sarkis-Onofre et al., 2021; Page et al., 2021). PRISMA is an evidence-based reporting protocol that provides a set of procedures developed to guide systematic literature reviews and meta-analyses.[3] This technique, initially employed mainly in the medical field, has been increasingly adopted in several other scientific domains—including the social sciences—as a reference for conducting rigorous and replicable systematic literature reviews (Moher et al., 2009). A PRISMA literature selection and reporting follows a set of key steps. First, the identification of the literature, second the screening and eligibility of the identified studies, and third the final selection of the most relevant ones (Haynes and Alemna, 2022). More specifically, the PRISMA guidelines require the researcher to: (i) clearly outline the research objectives and provide a reproducible methodology; (ii) to perform a systematic search to identify studies that meet the eligibility criteria; (iii) validate the included research contributions; (iv) synthesize the characteristics, the content and the findings of the included documents (Liberati et al., 2009).

1.2.2 Data sources and search strategy

The primary databases used for the systematic search of the literature are Web of Science (WoS) and Scopus.[4] Both sources are rich abstract and citation databases of peer-reviewed literature. More specifically, WoS is Clarivate Analytics' academic citation and indexing database that provides access to journals in the domain of the arts and humanities disciplines, sciences, and social science. Similarly, Scopus is Elsevier's largest citation and abstract database with peer-reviewed academic literature covering the areas of social sciences, life sciences and health sciences.

1.2.2.1 Search query and identification

The objective of the search strategy adopted is to maximize the recall of potentially relevant studies to obtain a complete picture of the literature on NPE business models. More specifically, a first set of key-terms—i.e., "non-practicing entit*", "nonpracticing entit*", "NPEs", "patent assertion entit*", "PAEs", "patent troll*", "troll*",[5]—was searched in the titles, abstracts and in the keywords defined either by the

[3] For the complete checklist of 27 items, see: http://www.prisma-statement.org/.

[4] Scopus available at: https://www.elsevier.com/solutions/scopus; WoS at: http://www.webofknowledge.com

[5] The term "patent troll", or simply "troll", has been used to pejoratively denote NPEs. However, excluding this term would entail the risk to miss out relevant literature.

databases[6] or by the authors.[7] The initial sample of studies retrieved with this initial search included a large number of false positives.[8] To address this issue, we developed a more refined search query. These initial key-terms were combined with a second set of more characterizing key-terms—for instance, among other, "business model*", "patent quality", "patent monetization", "patent licensing", "patent litigation", "technology diffusion"[9]—to be searched in the articles' abstracts only. The rationale of this search strategy is to strike the proper balance, thus complementing the terms generally referring to NPEs (first set of key-terms), which maximize the retrieval of potentially relevant studies, with more specific terms (the second set of key-terms) to refine and narrow down the analysis, thus ensuring the inclusion of studies specifically focused on NPE business models. In fact, given the relatively vast nature of the topic of non-operating patentees—and its interdisciplinarity—searching for more characterizing key terms in the abstracts represents a necessary step in order to specifically focus on NPEs' patent monetization business models, the influence of the patent quality characteristics on these models, and the impact of NPEs' activities, especially for technology diffusion and the dynamic of technology markets.

For both databases the same research strategy and query was applied. The automated database search conducted using the combination of key-terms previously described resulted in a total of 1,329 documents. This constitutes the initial set of documents. Among these, 614 were obtained from WoS and 715 from Scopus. The use of databases such as Scopus and WoS ensures comprehensive interdisciplinary coverage in the identification phase of the scholarly contributions. In addition, both databases provide different filtering options to adjust the search output.

Due to the inclusion of acronyms in our automated search (such as, "NPE" and "PAE"), many articles in distant research areas (such as, Humanities, Chemistry, and Engineering) were captured by our queries. Therefore, to adjust the search focus towards the relevant records that fall within the objective of this review, we applied a set of inclusion criteria. Results were then delimited by research subject areas. WoS allows researchers to do so by limiting the search to the relevant *Web of Science Categories*. Therefore, we searched in the "Economics", "Law", "Business", and "Management" categories. The same operation can be performed in Scopus, which provides a similar option with its *Scopus Subject Areas*. Thus, we limited our search to the "Business, Management and Accounting", "Social Sciences", "Economics, Econometrics and Finance", "Decision Sciences" areas. To better refine the identification process, and to guarantee scientific

[6]Web of Science keywords are called "KeyWords Plus": those are words or phrases that frequently appear in the titles of an article's references, but do not appear in the title of the article itself. See: http://www.webofknowledge.com

[7]The asterisk (*) wildcard enables the searched databases to automatically retrieve the plurals of our search-terms.

[8]In Web of Science, searching for the first set of key-words led to 3,253 results, while Scopus returned 3,892 records.

[9]The full research queries, and the two complete sets of key-terms, are reported in Appendix 1.7.

integrity in our research, we excluded sources such as conference proceedings, books, notes, magazines, letters, and blog posts from our analysis. Therefore, we limited our search to scientific articles and reviews, published in English, between 2000 and 2023.[10]

Table 1.1 reports the applied inclusion and exclusion criteria. The application of the specified set of criteria resulted in the identification of 242 records, of which 138 from Scopus and 104 from WoS, extracted in April 2023.

Table 1.1: Inclusion and exclusion criteria

Criterion	**Inclusion**	**Exclusion**
Time period	2000-2023	Documents published outside this time period.
Document Type	Articles and reviews published in peer-reviewed journals	Documents outside these categories.
Research Categories/Subject Areas	Web of Science Categories: 1. "Economics" 2. "Law" 3. "Business" 4. "Management" Scopus Subject Areas: 1. "Business, Management and Accounting" 2. "Social Sciences" 3. "Economics, Econometrics and Finance" 4. "Decision Sciences"	Documents outside the specified research areas.
Studies in English Language	Documents published in English.	Documents published in other languages.

1.2.2.2 Screening and eligibility criteria

To unify the refined search results and proceed to the screening phase, the records were saved in ".bib" files (BibTeX Bibliographical Database file) and processed with *R*. This allows to convert the records into data frames of consistent format and to merge them into a single harmonized dataset of bibliographic records. In merging the two data frames, 87 identical duplicates have been removed.[11] The residual subset of 155 documents constitutes the result of our search criteria, merging process and deduplication.

At this stage, to perform a more fine-grained screening and selection, the unified dataset was exported and saved in Excel. An additional number of 4 duplicates was identified. These excluded articles presented slightly different titles and did not report the Digital Object Identifiers (DOI). For this reason the previous deduplication process was not completely effective. The subsequent selection process was then conducted following two eligibility criteria.

[10]The terms "patent troll" first emerged in the US at the end of the 1990s, for this reason we set the year 2000 as the first publishing year to be considered.

[11]A certain degree of overlap in the records obtained from both databases using the same queries is expected, since scientific contributions can be indexed in multiple bibliographic databases. The R function *mergeDbSources* merges data frames identifying common tag fields and duplicated records (Aria and Cuccurullo, 2017).

First, articles were screened in their titles and abstracts to double-check the accuracy of the search strategy and to assess their fit to the research question. After this check, 17 studies were discarded because they were erroneously captured by the research queries but are not related to our research topic. These records dealt with other topics and did not examine non-practicing entities. Such articles fell into the search parameters mainly because of the presence in the title, abstract and keywords of the acronyms searched, in particular "PAE" and the popular and generic term "troll" (and their variants), together with the presence, in the abstracts, of some other relatively general terms, such as "typology" and "model".[12]

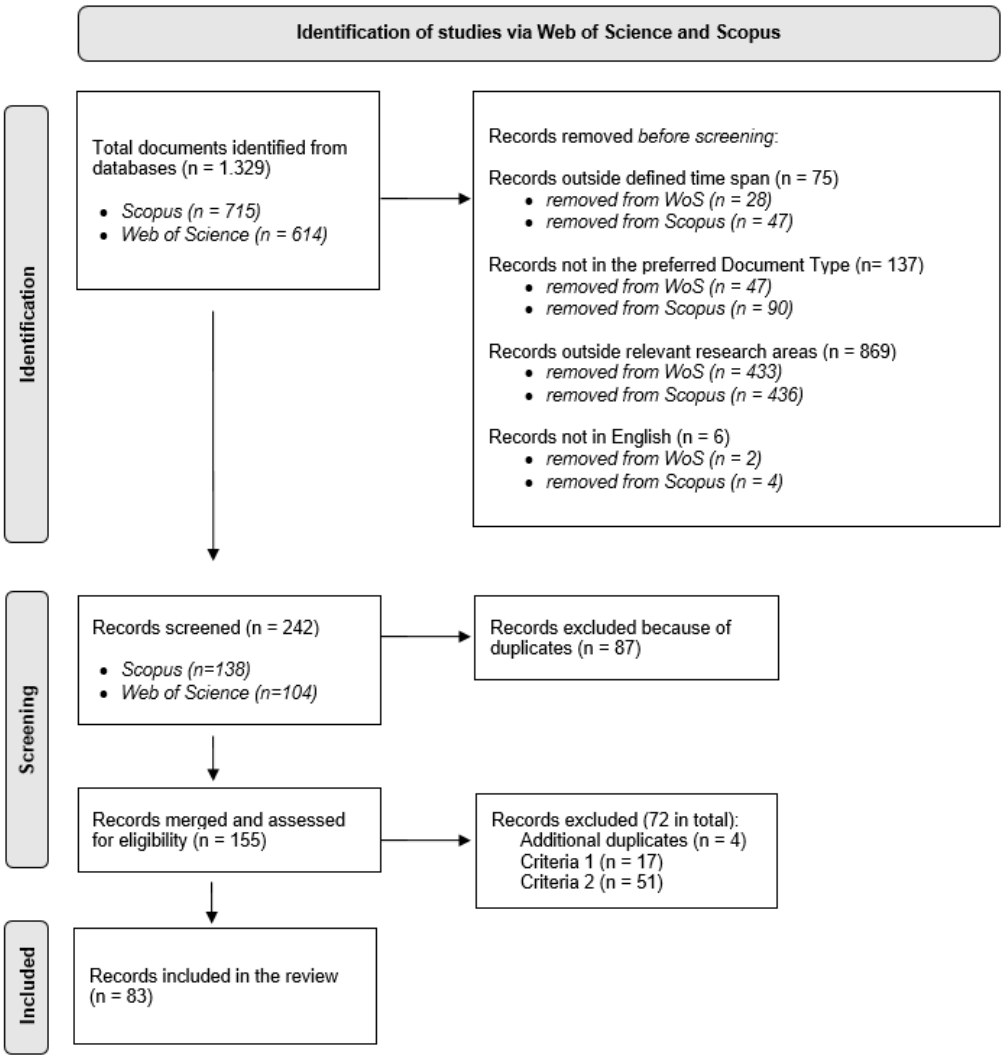
The second eligibility criteria consisted in searching and downloading the remaining articles to more accurately assess their content. At this stage, 51 additional documents have been excluded: 8 were not accessible, and the remaining 43 were discarded as they only briefly mentioned NPEs without focusing on their business models, patent quality in relation to their activities, or their impact on technology markets. Our final set of selected scientific studies consists in 83 documents, reported in Table 1.8 in Appendix 1.7 sorted by total number of citations received.[13]

Figure 1.1 provides an overview of the complete process of literature search, identification, screening and selection as recommended by the PRISMA Protocol.

[12]This represents a limitation of our preferred search queries that is discussed more in details in Section 1.5.

[13]Of the 83 selected studies, 64 have been retrieved from Web of Science and 19 from Scopus.

Figure 1.1: PRISMA flow diagram for systematic literature reviews



Notes: The figure reports the literature identification, screening, and selection phases as recommended by the PRISMA protocol.

1.2.3 Analysis of selected studies

To perform a comprehensive description and bibliometric analysis of the selected literature, we deployed the *bibliometrix* R package and the related *Biblioshiny* web-interface (Aria and Cuccurullo, 2017). First, we provide in Section 1.2.3.1 a descriptive analysis of the selected scientific production on NPEs to explore its main characteristics. We then move to the analysis of authors' keywords co-occurrences, references co-citation, historical direct citation of the most influential documents, co-authorships structure, country collaboration structure, and we provide the respective network visualizations (Batagelj and Cerinšek,

2013).[14] In particular, co-word, co-citation and collaboration analysis are common science mapping analyses that help identify the main research focuses, detect trending (or declining) topics, and retrace the thematic evolution over time of a research topic (Xia et al., 2022; Tan Luc et al., 2022).

1.2.3.1 Descriptive analysis

The descriptive summary of the sample of retrieved studies is reported in Table 1.2. The 83 selected documents have been published in 62 academic journals, in a time span of 18 years, from 2005 to 2023. On average, selected studies are six and a half years old and have been cited by 15 scientific documents each. The table also shows that identified studies consist in 72 articles and 11 reviews. Within the selected set of publications, there are a total of 139 authors affiliated with 105 institutions, including universities, schools, and research centers worldwide. Out of these, 35 are single authors and the total number of single-authored studies is 36, while in case of collaboration the research team consists on average of two authors (1.9 co-authors per document).

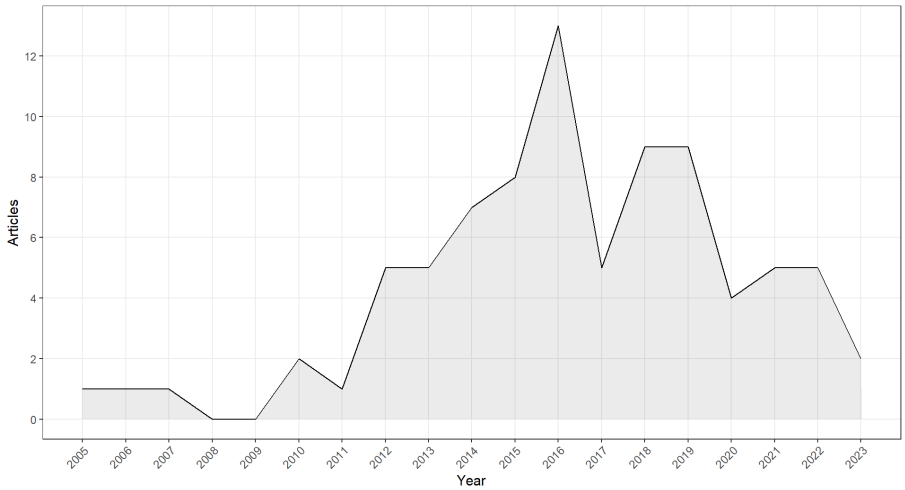
Table 1.2: Descriptive summary of the selected studies

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2005:2023
Sources (Journals)	62
Documents	83
Average Annual Growth Rate %	3.93
Document Average Age	6.63
Average citations per doc	15.22
Average citations per year per doc	1.56
References	4533
DOCUMENT TYPES	
article	72
review	11
DOCUMENT CONTENTS	
Keywords Plus (ID)	177
Author's Keywords (DE)	173
AUTHORS	
Authors	139
Author Appearances	158
Authors of single-authored docs	35
AUTHORS COLLABORATION	
Single-authored docs	36
Documents per Author	0.597
Co-Authors per Doc	1.9
International co-authorships %	4.819

[14] Network visualization is a form of science mapping (Boyack et al., 2005), which attempts to find representations of the conceptual and intellectual connections within scientific knowledge (Small, 1973).

The scientific production over time is displayed in Figure 1.2. The graph shows how research on the topic of NPE business models was limited until 2011. From 2011 onward, the number of published studies started to increase steeply—reaching a peak of 13 publications in 2016—and it remained high in both 2018 and 2019 (9 documents published each year). However, in the past three years the scientific production slightly decreased (4 articles in 2020, 5 for both 2021 and 2022).[15]

Figure 1.2: Annual scientific production



Notes: Number of published articles per publication year. Own elaboration.

The concentration of publications on NPE business models between 2012 and 2019 may be due to different concurrent events in the US.[16] First, patent litigation attributed to non-practicing patent owners increased after 2010 (White House, 2013), and it was mirrored by notable court cases.[17] Second, landmark patent reforms in the US sparked considerable policy debate on NPEs' business models and their implications (Jeruss et al., 2012).[18] Third, a greater availability of patent litigation data stimulated

[15]The recent relative decline in publications as compared to the years 2016-2019 could be due to the Covid-19 pandemics, which has greatly impacted also non-Covid-19 scientific research, with a general negative effect on productivity and academic collaborations (Raynaud et al., 2021).

[16]In these years, NPEs' activities increased first in the US (FTC, 2011; White House, 2013; FTC, 2016b), and only in a second time in Europe, mainly as a consequence of a series of legal and policy measures that decreased NPEs' leverage in the American patent market (JRC, 2016).

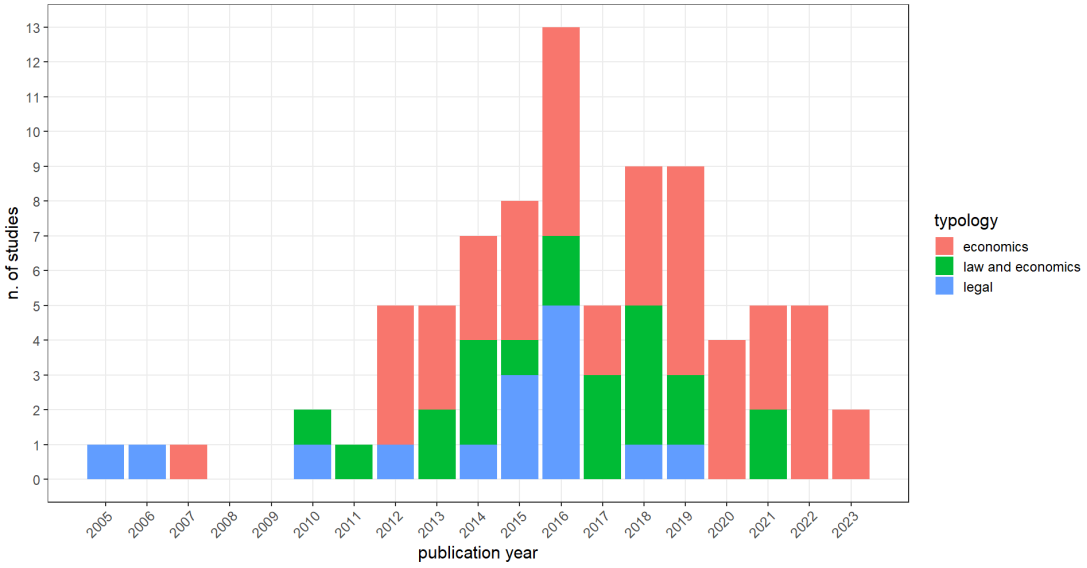
[17]Such as the 2014 *Alice* case: *Alice Corp. Pty. Ltd. v. CLS Bank Int'l - 573 U.S. 208, 134 S. Ct. 2347 (2014)*. At the same time, the effects of the 2006 *eBay* case were still being analyzed and debated, see: *Ebay Inc. v. MercExchange, L.L.C., 547 U.S. 388, 126 S. Ct. 1837 (2006)*.

[18]Such as the 2012 Leahy–Smith America Invents Act (AIA), and its subsequent 2015 amendment, which specifically targets patent trolls.

broad academic research on the topic (Miller, 2018).[19] Finally, newspapers[20] and popular media[21] widely reported about instances of patent "trolls" (Mazzeo et al., 2013).

Regarding the research domains to which the collected publications belong, Figure 1.3 displays the annual count of academic articles categorized by area of research. The majority of the scientific articles in the collection are in the field of economics (56.63%), while the remaining studies belong to the law & economics field (25.30%), or the legal research stream (18.07%). This distribution over time highlights how legal scholars have been the first to analyze NPEs and their business models, while economists engaged with the topic at a later stage and more consistently only after 2012. Nonetheless, from 2017 onward, studies in the economics or in the law & economics research fields started prevailing over purely legal contributions.

Figure 1.3: Annual scientific production by research domain



Notes: The histogram reports the annual scientific production on NPE business models (tot. n=83) by type of contribution (i.e., Economics, Law, Law & Economics) over time. Own elaboration.

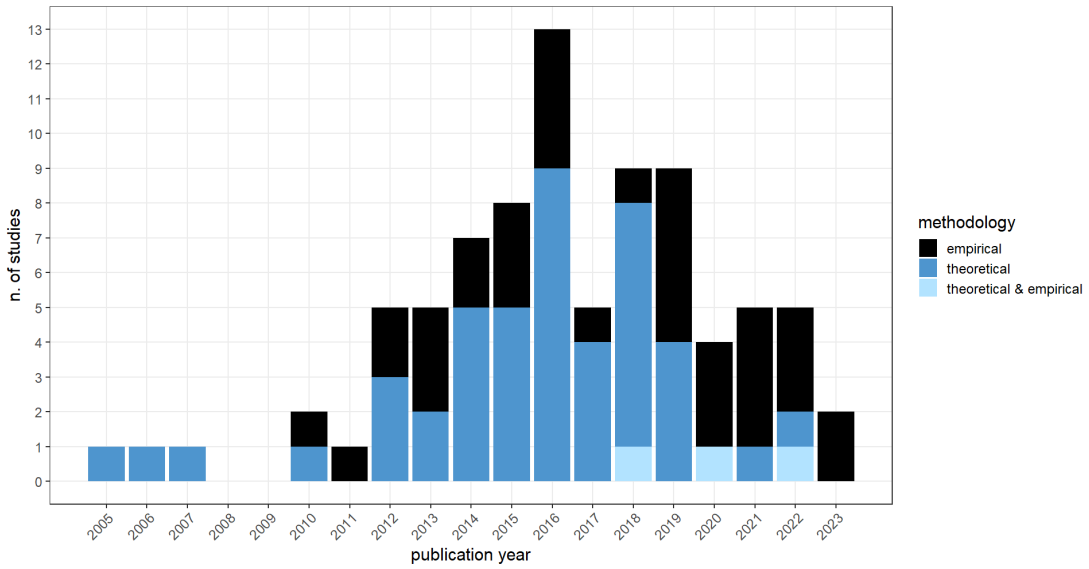
[19] See for instance the popular "The Stanford Non-Practicing Entity (NPE) Litigation Dataset" (Miller et al., 2017).

[20] See for example: "A Payday for Patents 'R' Us" by Ian Austen and Lisa Guernsey, The New York Times, May 2, 2005, https://www.nytimes.com/2005/05/02/technology/a-payday-for-patents-r-us.html; "Aggressive Patent Litigants Pose Growing Threat to Big Business" by William M. Bulkeley, The Wall Street Journal, September 14, 2005, https://www.wsj.com/articles/SB112666647063840131; "Patenting Air or Protecting Property?" by Jonathan Krim, The Washington Post, December 11, 2003, https://www.washingtonpost.com/archive/business/2003/12/11/patenting-air-or-protecting-property/a1d8769c-384c-4d29-9b72-fad42029c8a7/.

[21] A reportage on Intellectual Ventures—accused of being the largest US patent *"troll"*—by NPR journalist Laura Sydell and Planet Money co-host Alex Blumberg appeared in the episode called "When Patents Attack!" of the radio program "This American Life" aired on July 22, 2011. Available at: https://www.thisamericanlife.org/441/when-patents-attack.

In addition, we observe that, within the same research field, studies are highly heterogeneous in terms of methodologies used. In this respect, Figure 1.4 reports the annual scientific production categorized by methodological approach. The majority of the studies analyzed presents a theoretical approach, or develop a conceptual framework, to analyze NPE business models (54.22%). Nonetheless, there is a consistent number of contributions that explores the subject empirically (42.17%), while a minority develops both types of analyses (3.61%). Interestingly, from 2019 onward, there has been a noticeable increase in the publishing of empirical studies. This coincides with an increase in the presence of studies belonging to the Economics or the Law & Economics field, which generally tend to privilege data-driven and empirical analyses.

Figure 1.4: Annual scientific production by type of methodology employed



Notes: The histogram reports the annual scientific production on NPE business models (n=83) by type of methodological contribution (empirical, theoretical or both) over time. Legal articles have been categorized as theoretical/conceptual. Own elaboration.

The analysis of the core journals of our literature collection highlights the marked interdisciplinarity of the research on NPE business models. These journals, in fact, belong to either the economics or the legal research field, or at the intersection of the two disciplines. Overall, the 83 contributions analyzed are published in 62 scientific journals. Table 1.3 reports the list of the top 10 scientific journals by number of manuscripts published.

Table 1.3: Top 10 journals by number of studies published

Journals	Articles
RESEARCH POLICY	5
JOURNAL OF COMPETITION LAW & ECONOMICS	4
TECHNOLOGICAL FORECASTING & SOCIAL CHANGE	4
JOURNAL OF EMPIRICAL LEGAL STUDIES	3
ANTITRUST BULLETIN	2
COLUMBIA LAW REVIEW	2
CORNELL LAW REVIEW	2
HASTINGS LAW JOURNAL	2
INTERNATIONAL JOURNAL OF INDUSTRIAL ORGANIZATION	2
INTERNATIONAL REVIEW OF LAW & ECONOMICS	2

The most productive academic journals in the economics field are Research Policy (RP) and Technological Forecasting and Social Change (TF&SC). This highlights the empirical nature of several selected studies on NPEs (Fischer and Henkel, 2012; Lee et al., 2019; Kwon and Drev, 2020), and the aim of these research efforts to provide evidence-based analyses on NPEs' business models and their broad implications for technology markets (Kiebzak et al., 2016; Caviggioli and Ughetto, 2016; Leiponen and Delcamp, 2019; Sterzi et al., 2021; Chen et al., 2023). The Journal of Competition Law & Economics is a relevant source of interdisciplinary NPE-related research in the domain of law and economics. This journal presents contributions that have a special focus on competition and anti-trust issues in relation to NPEs (Mazzeo et al., 2013; Sterzi, 2021; Geradin, 2019; Layne-Farrar, 2017). When journals publish broader legal topics, contributions are still distinctly empirical, such as in the case of the articles published in the Journal of Empirical Legal Studies (JELS) (Cotropia et al., 2018; Kesan et al., 2019; Lemley and Zyontz, 2021) or in the Antitrust Bulletin (Harris, 2014; Abramson, 2014). The latter one, in particular, publishes a diversified range of research output from antitrust authorities that generally focus on global antitrust law, competition policy, and industrial economics. This highlights how research on NPEs has greatly focused on antitrust issues (Geradin et al., 2012; Mazzeo et al., 2013; Gagnon, 2013; Geradin, 2019; Lemley and Zyontz, 2021; Dayani, 2023), and how recent research on specific NPE business models (such as in the case of "hybrid PAEs") has devoted considerable attention to relevant subjects in the competition law field (Harris, 2014; Cotropia et al., 2018). On the purely legal side, the Columbia Law Review, the Cornell Law Review and the Hastings Law Journal are the respective law schools flagship journals. The articles published in these journals represent a reference in the legal research on NPEs in the United States (Chien, 2010; Lemley and Melamed, 2013; Bessen and Meurer, 2014; Rose, 2015; Young, 2016). Again, at the crossroads of law and economics, the International Review of Law and Economics provides a forum for interdisciplinary research (Haus and Juranek, 2018; Brander and Spencer, 2021). Finally, the International Journal of Industrial Organization publishes both theoretical and empirical studies in the industrial organization domain (Turner, 2018; Bar and Kalinowski, 2019).

Among the 83 articles selected, the 10 most cited manuscripts (core articles) by number of total

citations (TC) received are reported in Table 1.4.[22]

Table 1.4: Top 10 most cited articles by number of total citations received

Paper	Journal	TC	TCperYear	NTC
Reitzig, Henkel, and Heath (2007)	RESEARCH POLICY	119	7.00	1.000
Mann (2005)	TEXAS LAW REVIEW	113	5.95	1.000
Fischer and Henkel (2012)	RESEARCH POLICY	87	7.25	2.979
Lemley and Melamed (2013)	COLUMBIA LAW REVIEW	85	7.73	3.102
Bessen and Meurer (2014)	CORNELL LAW REVIEW	85	8.50	3.132
Allison, Lemley, and Walker (2011)	GEORGETOWN LAW JOURNAL	84	6.46	1.000
Chien (2010)	HASTINGS LAW JOURNAL	67	4.79	1.072
Shrestha (2010)	COLUMBIA LAW REVIEW	58	4.14	0.928
Schwartz and Kesan (2014)	CORNELL LAW REVIEW	53	5.30	1.953
Cohen, Gurun, and Kominers (2019)	MANAGEMENT SCIENCE	38	7.60	3.677

Notes: Top 10-most cited documents in the collection of 83 articles selected. Along with the total citations received by each document (TC), to avoid the risk of time-dependence of citations, the yearly average number of times each manuscript has been cited (TCperYear) is reported. In addition, to account for differences in citation practices across disciplines and provide a more meaningful comparison of citation impact, Normalized Total Citations (NTC) are also reported. The NTC index is calculated by *bibliometrix* by dividing the total number of citations of an article by the average number of citations of all documents published in the same year (Aria and Cuccurullo, 2017).

The most cited articles of the collection, receiving more than 100 TC each, are the ones by Reitzig et al. (2007) and Mann (2005). The high number of citations received by these two contributions depends first on their age (these contributions are among the oldest in the sample of selected studies),[23] but it also depends on other factors. For example, Reitzig et al. (2007) represents a seminal contribution which directly addresses the phenomenon of NPEs in a broad perspective that encompasses economic, legal, and managerial aspects. Instead, in the case of Mann (2005), the high number of citations may be due to its specific, and also hotly debated, main research topic addressed. In fact, the author analyzes patenting in the software industry and discusses the issues of patent quality and NPEs' activities in relation to software patents. The other highly cited publications target more specifically, and more exclusively, the topic of NPE business models and their implications for technology and patent markets (Fischer and Henkel, 2012; Bessen and Meurer, 2014; Allison et al., 2011; Chien, 2010; Shrestha, 2010; Schwartz and Kesan, 2014).

Considering the set of selected studies, 18 articles have not received any citations (yet). This may be due to their recent publication, and in fact almost half of these contributions (6 in total) have been published from 2022 onward. This is the case of Chen et al. (2023), Dayani (2023), Ma et al. (2022), Ganglmair et al. (2022), Chari et al. (2022), and Bergin (2022). Alternatively, the absence of citation may be the consequence of the contributions' specialization in niche areas. This is particularly marked in the legal field. For instance, Layne-Farrar (2017) summarizes the key findings, and methodological

[22]The full list of selected studies, ordered by the number of total citations received, is provided in Appendix 1.7.2.

[23]In general, the top 10 articles average publication year is 2011.

limitations, of the FTC report on PAEs business models (FTC, 2016b), while Sung (2015) provides an analytical study of permanent injunctions in US Federal Courts patent litigations after the 2006 Supreme Court *eBay* decision. Several un-cited studies address the interplay between NPEs and competition law (Gagnon, 2013; Abramson, 2014; Gabison, 2015). Some contributions focus on emerging patent markets, as in the case of Yanbei (2016), who analyzes NPEs' regulation proposals in China. Other un-cited articles deal with special cases of patent litigations brought by NPEs, as in the case of Jenweeranon (2017) who studies the Japanese and Taiwanese IT industries, or Ryu et al. (2016) and Chávez and Lara (2020) who analyze patent litigation over connectivity technology in the automotive industry.

Upon a closer look at the leading authors in the specific literature analyzed, the overwhelming majority of them (90%) have only authored one article related to NPEs business models. This observation suggests the possibility that contributions on this specific research theme are sporadic in nature, indicating that researchers may engage in intermittent explorations of the topic. Table 1.5 reports the top 10-most influential first authors in this collection according to their h-index,[24]

Table 1.5: Top 10 first authors by h-index

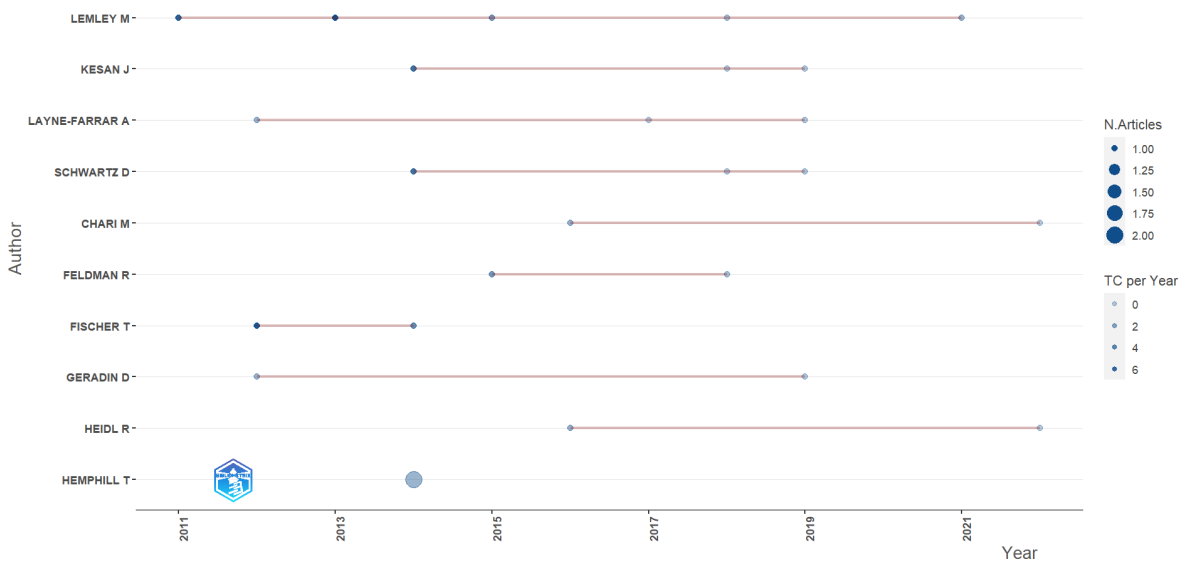
N.	Author	H index	TC	N.Pub	First PY
1	LEMLEY M.	4	202	5	2011
2	FELDMAN R.	2	29	2	2015
3	FISCHER T.	2	123	2	2012
4	HEMPHILL T.	2	13	2	2014
5	CHARI M.	1	11	2	2016
6	GERADIN D.	1	16	2	2012
7	HEIDL R.	1	11	2	2016
8	KESAN J.	1	55	3	2014
9	LAYNE-FARRAR A.	1	16	3	2012
10	SCHWARTZ D.	1	55	3	2014

Notes: The leading authors are sorted by their h-indexes. The table also reports the total citations received (TC), the number of authored publications included in the set of selected articles (N.Pub), and the year of fist publication (First PY).

Figure 1.5 displays the production over time of the core authors (in terms of number of publications and total citations per year) of the literature collection analyzed.

[24]The h-index is an author-level metric that measures both the productivity (number of publications published) and the frequency of citation (citation impact). In other words, h-index = the number of publications with a citation number greater than or equal to h.

Figure 1.5: Top 10 most productive authors over time



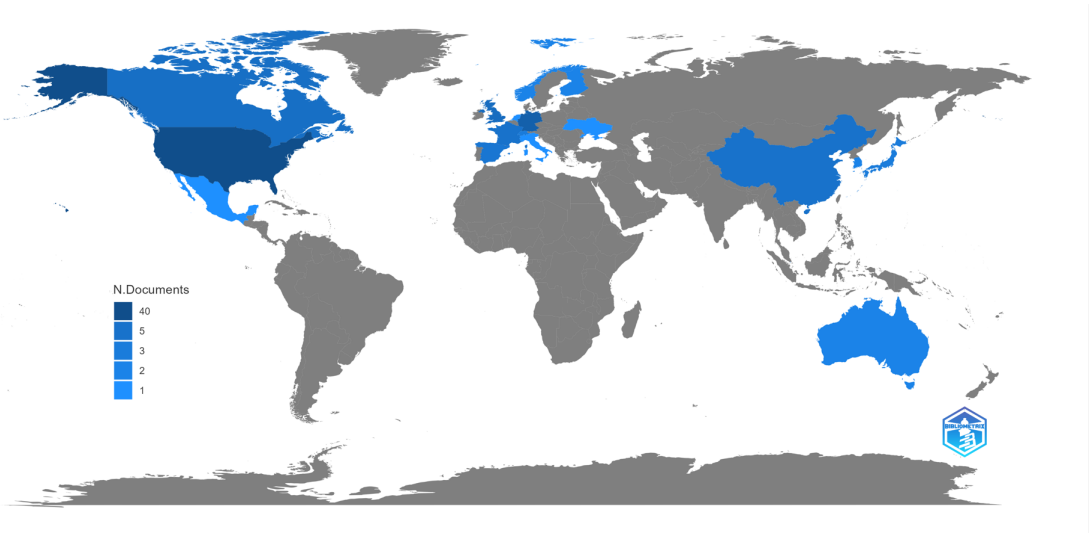
Notes: The 10 most relevant authors are sorted by number of publications over time. Author's timeline is represented by the lines, the size of each dot is proportional to the number of published documents. The darker the color of a dot, the higher the number of citations received in that give year. The graph was generated with the shiny app web-interface *Biblioshiny*, available within the R *bibliometrix* package (`https://www.bibliometrix.org/home/index.php/layout/biblioshiny`). Own elaboration.

The core authors are also the most productive ones in our collection. In fact, the top 10 most influential authors (according to their h-index) have each produced at least 2 articles that are included in our selected scientific production on NPE business models. They also co-author together in many instances. The most productive author in the collection is Mark A. Lemley, who is the author of 5 articles on the NPE topic over a long period of time (2011-2021). Lemley often co-authored with Robin Feldman, another highly productive author in the collection (Lemley and Melamed, 2013; Allison et al., 2011; Feldman and Lemley, 2015; Lemley and Feldman, 2018; Lemley and Zyontz, 2021). Jay Kesan, Anne Layne-Farrar and David Schwartz are other prolific authors with 3 articles each, and they have also collaborated in several instances (Cotropia et al., 2018; Schwartz and Kesan, 2014; Kesan et al., 2019). Other highly productive and impactful authors are Timo Fischer (Fischer and Henkel, 2012; Fischer and Ringler, 2014), and Damien Geradin (Geradin et al., 2012; Geradin, 2019). Mukund Chari and Ralph Heidl are co-authors and their two contributions are in the organizational and managerial research field (Steensma et al., 2016; Chari et al., 2022). Tomas Hemphill is the only author that has not collaborated with any other scholars on the NPE research topic (Hemphill, 2014a,b).

The analysis of the geographical distribution of publications may suggest relevant insights on which markets for technology—or, when it comes to patent litigation, jurisdictions and legal systems—are most appealing to NPEs. Figure 1.6 displays the country scientific production, which quantifies the frequency

of appearances of the authors in the selected studies based on their country affiliations.[25] Specifically, the scientific production on NPE business models is mainly concentrated in North America and Europe. Considering the Asian region, China, Japan and South Korea are the most productive countries.

Figure 1.6: Country scientific production



Notes: Map visualization of the scholarly contributions per country of affiliation of the authors included in the selected literature collection. The different shades of blue correspond to different productivity rates: dark blue = high productivity, gray = no articles. The map was generated with the shiny app web-interface *Biblioshiny*, available within the R *bibliometrix* package (https://www.bibliometrix.org/home/index.php/layout/biblioshiny).

Among the 19 countries identified, the US is the leading country with 40 publications about NPEs, their business models and the analysis of the implications of their activities. Germany follows with 14 studies, the United Kingdom with 7, Canada with 6, China and France with 5 studies each. There are no scientific contributions coming from Latin America, Africa, India, Russia and the Middle East. The network representations of authorships and country collaborations are reported and analyzed in details in Section 1.2.3.4.

[25]The country scientific production measures the authors' appearances by country of affiliation (Aria and Cuccurullo, 2017). Consequently, each time an article includes authors from different countries, or an author with multiple affiliations, the appearance counter for each country's affiliation increases by 1. For example, if an article has authors from the US, France, and Spain, each of these three countries' appearance count will be increased by 1. Therefore, each article is attributed to the countries of all its co-authors, resulting in multiple counts equal to the number of authors. For this reason, the total of the country scientific production may exceed the total number of articles in the presence of co-authored studies (Aria and Cuccurullo, 2017).

1.2.3.2 Keywords co-word analysis

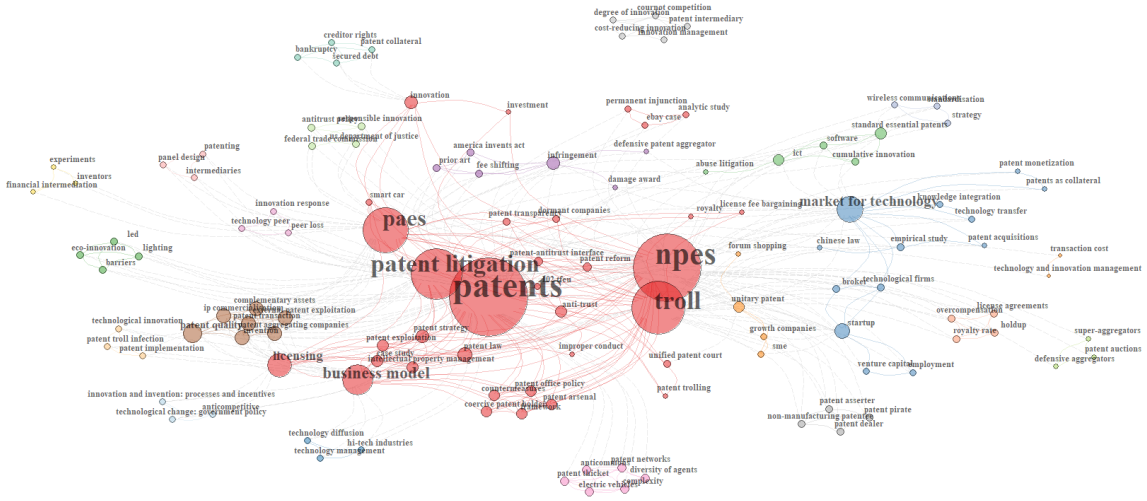
Co-word analysis is a bibliometric technique that helps explore the conceptual (thematic) structure of a bibliographic collection—meaning, what literature talks about in terms of main research themes (Callon et al., 1983; He, 1999; Lee and Su, 2010).[26] To conduct this type of analysis (and to get guidance for the full-text content analysis of the 83 selected articles, presented in Section 1.3) we privileged authors' keywords over databases' keywords. In fact, authors directly apply the keywords that they believe can effectively summarize the concepts addressed in their research. Moreover, authors' keywords can better reflect the original content of a document, thus providing important insights into the thematic structure of the selected literature (Aria and Cuccurullo, 2017).

The present co-word analysis is based on co-occurrences analysis techniques, which are used to measure the frequency of pairs of authors' keywords occurrences (i.e., keywords appearing together) in the same literature collection (Batagelj and Cerinšek, 2013; Liu et al., 2015). Each node represents a keyword, and both the node and the label size represent the co-occurrence frequency. The co-occurrence relationship is represented by the edge connecting two nodes. Different colors indicate clusters of keywords that suggest conceptual families and research focuses (Xia et al., 2022).[27] Clusters represent the most active, or important, areas of research within the field of NPE-related research. The network of keywords co-occurrences is presented in Figure 1.7.

[26]The conceptual structure of a body of literature can be though as of the set of associations, connections, and thematic relationships between keywords, which correspond to different concepts (Callon et al., 1983; Liu et al., 2015).

[27]Synonyms and keywords addressing the same topic have been aggregated. For instance, the keywords "standard essential patent", "SEPs", "essential patents", and "essential iprs" are mapped as "standard essential patents". The full list of synonyms is reported in Appendix 1.7.3.

Figure 1.7: Authors' keywords co-occurrences network



Notes: Network mapping of co-occurrences of authors' keywords (200 nodes are displayed after merging synonyms, 1 minimum edge, walktrap clustering algorithm, association normalization). Both circle and label size indicate keyword co-occurrences counts and colors indicate clusters. The R package *bibliometrix* was used to generate the network. Own elaboration: the analysis was performed based on the 47 studies that report authors' keywords.

The network is made of one major central cluster (in red), surrounded by a series of smaller and more peripheral ones. In the central cluster there are, not surprisingly, the main key-terms used for the database search: "NPEs", "PAEs", "troll".[28] However, many keywords that do not belong to the key-terms search-list emerge. For instance, "patent litigation" (Turner, 2018; Lee et al., 2019; Bian, 2021; Brander and Spencer, 2021; Chen et al., 2023), "anti-trust" (Hemphill, 2014b; Harris, 2014; Agrawal et al., 2016; Leiponen and Delcamp, 2019), "improper conduct" (Meng, 2016), "patent reform" (Abramson, 2014), "patent law" (Larson, 2013; Meng, 2016), "102 tfeu" (Gagnon, 2013), "patent transparency" and "dormant companies" (Sterzi et al., 2021) also belong to the central cluster. This seems to suggest the tight connection, between the NPE phenomenon and the legal research stream, specifically focused on the one side on patent law, and on the other side on anti-trust and competition law. Grouped close together there are additional themes related to NPEs' activities, such as "business models" (Leiponen and Delcamp, 2019; Fischer and Henkel, 2012) and "licensing" (Harris, 2014; Krech et al., 2015; Larson, 2013) (two of the searched key-terms) but also new keywords, such as "patent exploitation" (Larson, 2013; Krech et al., 2015), "patent strategy" and "intellectual property management" (Lee et al., 2019; Steensma et al., 2016). These keywords reflect the interest that NPEs generate in the empirical economics and management

[28]The key-terms used in the database search are also the ones with the largest frequencies and they also have a central position in the network. For the complete list of key-terms identified and searched, see Appendix 1.7.1.

research field. Other central concepts are the ones of the "countermeasures" and "patent office policy" (Smith, 2015; Steensma et al., 2016), which refer to the debate surrounding some NPEs' monetization practices and the proposals to counterbalance trolls' activities. A second cluster (in brown) deals with "patent quality" (a searched key-term) and the concepts of patent "value", "ip commercialization" and "external patent exploitation" (Krech et al., 2015). The other central cluster (in blue), centered around the theme of the "market for technology" (one of the items in the search-list), "technology transfer" (Cheng et al., 2017), and "patent acquisitions" (Fischer and Henkel, 2012), shows a variety of additional connected themes. For example, the analysis of the impact of NPEs' activities on start-ups and innovative firms is fairly developed, as suggested by the frequently occurring keywords "start-up" (Appel et al., 2019; Rantasaari, 2018), "technological firms" (Pénin, 2012), "patents as collateral" (Fischer and Ringler, 2014; Ma et al., 2022), "venture capital" and "employment" (Appel et al., 2019). The other central and relevant cluster (in purple) is the one focused on patent "infringement" (Reitzig et al., 2007; Bar and Kalinowski, 2019; Chen et al., 2023) and "patent litigation" (Gossart et al., 2020; Haus and Juranek, 2018; Ryu et al., 2016), whose related themes are "damage award" (Reitzig et al., 2007), "defensive patent aggregator" (Kwon and Motohashi, 2014), "fee shifting", "prior art", and "america invents act" (Bar and Kalinowski, 2019).

The analysis of the clusters situated at the periphery of the network—and mainly consisting of keywords that do not correspond to any of the searched items—reveals interesting aspects of the collection's conceptual structure. First, a rather distant and separate type of NPE business model seems to emerge, which is the one of the "super aggregator" and "defensive patent aggregator" (Caviggioli and Ughetto, 2016; Kwon and Drev, 2020), connected to the "patent auctions" theme (Caviggioli and Ughetto, 2016). A highly researched and discussed theme is the one of NPEs' assertion of standard essential patents (SEPs). By means of the co-word analysis, this theme emerges clearly from the keywords "standard essential patents" (Kang and Motohashi, 2015; Contreras and Picht, 2018), "standardization", "ICT", "wireless communications" and "cumulative innovation" (Jenweeranon, 2017; Comino et al., 2019; Lee et al., 2019), and it is visible in the top-right part of the network visualization of Figure 1.7. Interesting clusters (in orange and gray) are the ones analyzing the concepts of "holdup", "royalty rate", "overcompensation" and "license agreements" (Lu, 2012), and the negative effects that some types of NPEs' activities seem to generate (Yang, 2012). Finally, the themes of the "unitary patent", "forum shopping", "growth companies", and "SME" (Gabison, 2015; Rantasaari, 2018; Volik et al., 2019; Cohen et al., 2019), appear to be highly connected with the central cluster. This is because the studies reporting these keywords have focused on NPEs' litigation activities and their implications in Europe in light of the introduction of the Unified Patent Court (UPC). The only cluster on its own, meaning that there are no keywords co-occurrences with the main central clusters identified, is the one consisting of the concepts of "patent intermediary", "cost-reducing innovation", or "cournot competition" (Agrawal et al., 2016).

Overall, the co-word analysis suggests that around the core clusters analyzing NPEs, the interplay with patent quality and the implications for the MFTs, there is a high number of heterogeneous, smaller, and highly specialized clusters (i.e., themes or concepts). This may be the result of the high interdisciplinarity of the NPE-related research literature identified. However, this heterogeneity may also signal that research on NPE-related themes is a rather niche topic. At the same time, the peripheral and narrow clusters may also represent emerging and under-developed research directions.

1.2.3.3 Co-citation analysis

We perform co-citation analysis (Small, 1973) and historical citation analysis (Garfield, 2004) to complement the conceptual analysis performed through the co-word analysis of Section 1.2.3.2. Because total citation counts can only assess the contributions of key authors without identifying more detailed interconnections (Liu et al., 2015), we perform references co-citation analysis to analyze the intellectual base of the scientific research output selected.[29] Co-citation analysis identifies articles that are frequently cited together by other articles,[30] with the underlying assumption that if two papers are cited together then they are highly related and thus the stronger is the intellectual similarity between them (White and Griffith, 1981; Braam et al., 1991; Xia et al., 2022). Therefore, co-cited documents represent the knowledge base of a given research domain and co-citation mapping can help identify clusters of documents that are intellectually similar (Small, 1973; Shafique, 2013; Mas-Tur et al., 2021).

1.2.3.3.1 References co-citation

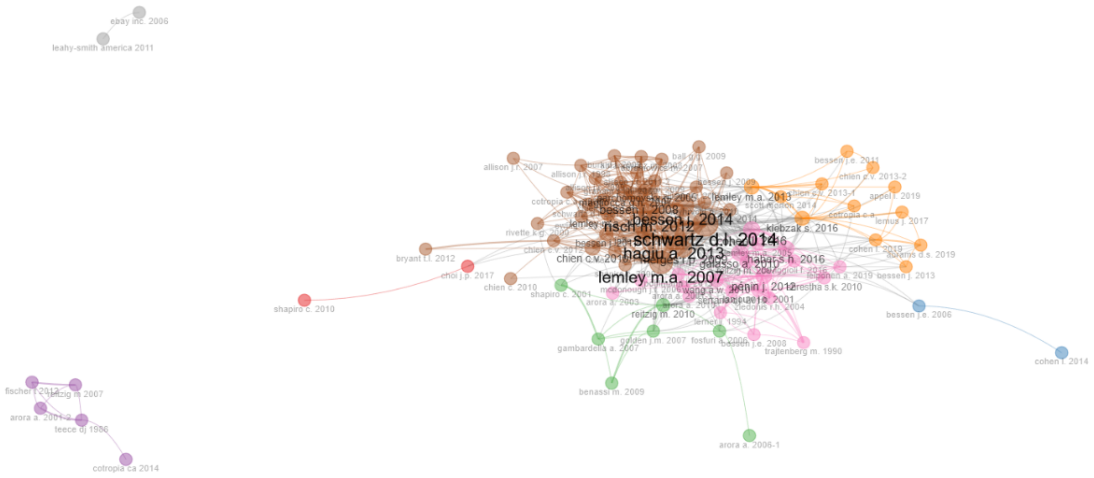
Figure 1.8 reports the co-citation network representation of the 100 most cited references within the analyzed scientific production on NPEs' business models and their effects on the MFTs.[31] Nodes represent cited references and edges represent co-citation relationships involving two references. The larger the reference's name and the greater the weight of the node (and the size of the corresponding label), which is determined by the total number of edges connected to that node. Nodes sharing the same color belong to the same cluster, suggesting that they are intellectually similar.

[29] The references co-citation analysis is a type of intellectual structure analysis. The intellectual structure can be thought as the set of relationships and influences between scientific documents, or, in other words, how the work of an author influences a given scientific community (Aria and Cuccurullo, 2017).

[30] Co-citation occurs when two distinct documents are both cited by the same third document (Mas-Tur et al., 2021).

[31] A total number of 4,533 references were cited by the 83 selected studies. For computational reasons a complete co-citation network mapping could not be performed, therefore the focus is limited to the 100 most cited references.

Figure 1.8: Co-citation network of highly cited references



Notes: Network mapping of co-citation of references (100 nodes are displayed, 2 minimum edges, walktrap clustering algorithm, association normalization). Each node represents a reference, and links represent the co-citation relationships. Colors represent clusters such that references are split into 8 clusters according to their intellectual similarity. The network was generated using the shiny app web-interface *Biblioshiny*, available within the R *bibliometrix* package (https://www.bibliometrix.org/home/index.php/layout/biblioshiny). Own elaboration.

The co-citation mapping presents 8 clusters of different sizes. Focusing on the 4 most central clusters, the most populated one is the brown cluster. Co-cited references belonging to this cluster mainly focus on PAEs' patent litigation activities (Lemley and Shapiro, 2007; Hagiu and Yoffie, 2013; Bessen and Meurer, 2014; Risch, 2012; Schwartz and Kesan, 2014). Several contributions try to assess the quality of litigated patents, and in particular their validity (Jaffe and Lerner, 2004; Allison and Mann, 2007; Allison et al., 2009). Alternatively, they analyze the risk of patent holdup posed by NPEs (Lemley and Shapiro, 2007), putting forward policy suggestions and remedies to harmful patent trolls (Golden, 2007; Chien, 2012). The second most numerous cluster is the pink one, which is also close and strictly intertwined with the previous one (the brown cluster). This cluster presents a greater variety of topics analyzed: co-cited contributions tend to focus on NPEs from an economic and managerial standpoint, rather than a legal one, and their analyses are generally empirical. Some of the co-cited references closely analyze the activities of NPEs and their broad implications for the technology markets in which they operate (Pénin, 2012; Cohen et al., 2016; Haber and Werfel, 2016). Other contributions are the pillars of the research on MFTs, patent transfers, and patent thickets (Arora et al., 2001; Ziedonis, 2004; Arora and Gambardella, 2010; Galasso and Schankerman, 2010; Serrano, 2010). Finally, there are landmark studies on patent quality, which are still today a reference for researchers focusing on the subject (Trajtenberg, 1990; Lerner, 1994). The other central cluster is the yellow one, which is also intellectually similar to the previous ones. In fact, co-cited contributions tend to analyze in depth NPEs' business models (Lemley and Melamed, 2013; Cotropia et al., 2014; Abrams et al., 2019), focusing also on the emerging "hybrid PAE" model (Lemus

and Temnyalov, 2017), and their effects on entrepreneurial activity and start-ups (Kiebzak et al., 2016; Appel et al., 2019). Finally, the green cluster is mainly focused on patent licensing (Shapiro, 2000; Arora and Ceccagnoli, 2006; Fosfuri, 2006; Gambardella et al., 2007) and patent brokerage and intermediation (Benassi and Di Minin, 2009).

There are three rather small clusters (in red and in blue in the figure) consisting of only two articles each that are close to the central clusters. Shapiro (2010) and Choi and Gerlach (2017) have been assigned to the red cluster, while Bessen and Meurer (2006) and Cohen et al. (2014) are part of the blue one. The red cluster focuses on the themes of hold-up, royalty negotiations and strategic patent portfolio theories. The themes analyzed in blue cluster are the ones of the economics of patent litigation and the (negative) impact of patent trolls. While these two clusters are close to the central ones, the third small cluster (the gray one) is located in the far part of the network. It consists of two documents that are not academic contributions: the 2006 Supreme Court *eBay* decision,[32] and the 2012 Leahy-Smith America Invents Act.[33] Moving to the other most peripheral cluster (the violet cluster), this one consists of five landmark and highly cited publications analyzing the functioning of the MFTs (Reitzig et al., 2007; Teece, 1986; Arora et al., 2001; Fischer and Henkel, 2012; Cotropia et al., 2014) and the effects NPEs' activities on the functioning of such markets.

Based on the network configuration obtained from the co-citation of references, it seems that our collection of literature has a central intellectual reference base, represented by the four central clusters (in Figure 1.8, the brown, pink, yellow and green clusters). These clusters are likely to represent the main themes, or topics, that are addressed in the literature. The interconnectedness between these clusters suggests some degree of overlap and interrelation between these themes. The presence of small and isolated clusters (in Figure 1.8, the gray and violet clusters), as well as very small clusters near the central ones (the red and the blue clusters), may indicate that there are some peripheral, or niche, areas that are only weakly connected to the main themes. These areas may be less explored or less significant in the literature.

1.2.3.3.2 Historical direct citation

The analysis of the historical pattern of direct citation among the most relevant publications (in terms of local total citations received)[34] can help detect shifts in perspectives and paradigms within a research topic (Xia et al., 2022). The articles that have been central for defining the research on NPEs' business models

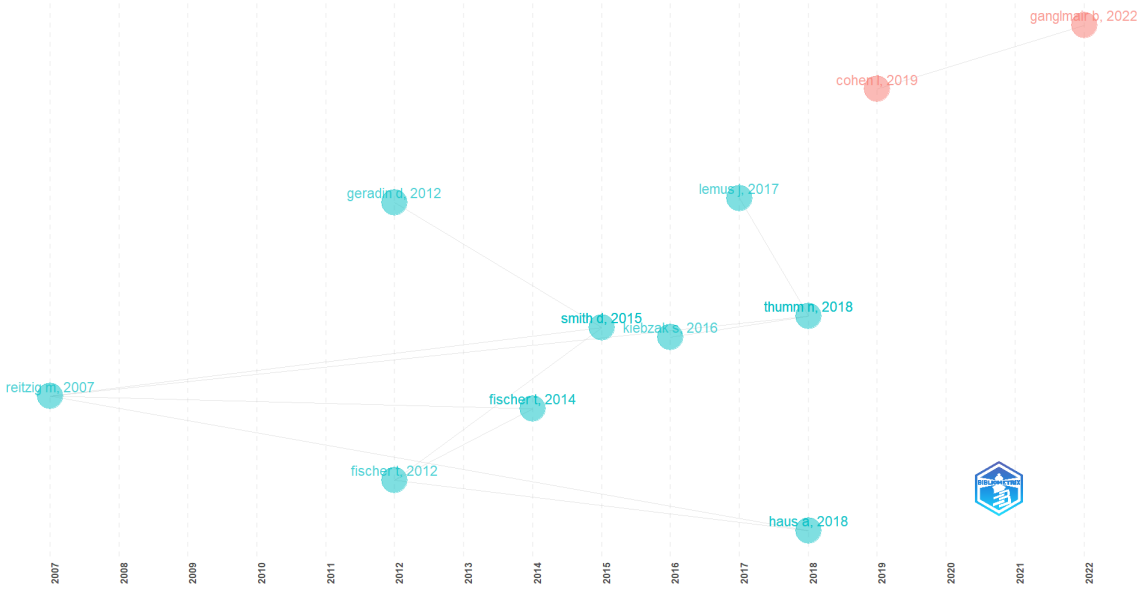
[32] *Ebay Inc. v. Mercexchange, L. L. C., 547 U.S. 388, 126 S. Ct. 1837 (2006)*

[33] *125 Stat. 284 — Leahy-Smith America Invents Act, Public Law 112-29.*

[34] Local citations measure how many times an author included in the collection of the selected studies have been cited by other authors also in the collection (Aria and Cuccurullo, 2017).

and implications for technology markets are reported in the historiograph, which is the chronological direct citation network representation developed by Garfield (2004), in Figure 1.9. In the historiograph, nodes are the relevant documents included in the selected literature, edges represent direct citations between two publications while the horizontal axis represents the publication year. Colors identify different clusters, or historical research paths (Aria and Cuccurullo, 2017).

Figure 1.9: Historical citation network of the most influential articles in the collection



Notes: Historiograph of the most influential articles within the selected collection. The R package *bibliometrix* was used to generate the network. Own elaboration.

Table 1.6 reports the influential publications according to the historical citation analysis and their respective global (GCS) and local citations (LCS) received.

Table 1.6: Most influential articles in the collection by number of local citations (LCS)

Article	Journal	LCS	GCS	cluster
Reitzig, Henkel, and Heath (2007)	RESEARCH POLICY	4	119	1
Fischer and Henkel (2012)	RESEARCH POLICY	3	87	1
Cohen, Gurun, and Kominers (2019)	MANAGEMENT SCIENCE	1	38	2
Kiebzak, Rafert, and Tucker (2016)	RESEARCH POLICY	1	31	1
Geradin, Layne-Farrar, and Padilla (2012)	INDUSTRIAL & CORPORATE CHANGE	1	15	1
Lemus and Temnyalov (2017)	RAND JOURNAL OF ECONOMICS	1	6	1
Fischer and Ringler (2014)	JOURNAL OF BUSINESS VENTURING	0	36	1
Smith (2015)	TIM REVIEW	0	5	1
Thumm (2018)	TECH. ANALYSIS & STRATEG. MANAG.	0	5	1
Haus and Juranek (2018)	INTERNAT. REVIEW OF LAW & ECONOMICS	0	4	1
Ganglmair, Helmers, and Love (2022)	JOURNAL OF LAW ECONOMICS & ORGANIZ.	0	0	2

Notes: Most influential articles emerging from the historical direct citation analysis. Publication year (Year), local citations received (LCS), total (global) citations received (GCS), and relative cluster are reported. Cluster 1 corresponds to the blue one, cluster 2 corresponds to the pink one. Own elaboration.

The chronological map of the most relevant citations in the bibliographic collection reveals the presence

of two main clusters, with no interconnections between each other in terms of citation behavior. The first cluster (in blue), which is also the most numerous, includes 9 documents published between 2007 and 2018. The earliest contribution in this research path is the seminal paper of Reitzig et al. (2007). This foundational publication is also one of the most cited articles of the literature collection: it received 119 (total or global) citations, and it has been cited by 4 other influential articles among the set of selected articles. More specifically, Fischer and Ringler (2014) analyze the characteristics of patents used as a collateral to secure venture capital—trying to distinguish the prevailing effect driving collateralization (i.e., "technology-related characteristics" effect vs "patent exclusion right" effect). On the other hand, Smith (2015) synthesize the business models of the so called "coercive patent holder", Haus and Juranek (2018) test the hypothesis for which NPEs act as superior patent asserters, while Thumm (2018) provides an overview of PAEs' litigation activities in the European technology market. Other influential works are the ones of Fischer and Henkel (2012), Geradin et al. (2012), Kiebzak et al. (2016). Although they do not cite the original seminal contribution for the research on NPEs (Reitzig et al., 2007), they are highly cited in terms of total citations received, and relatively highly cited locally. Specifically, Fischer and Henkel (2012) analyze the quality of NPE-acquired patents, arguing that patents acquired by NPEs are on average of higher quality (compared to those acquired by other types of market actors). On the same line, Geradin et al. (2012) conclude that NPEs can generate an increase is competition and innovation, as well as greater consumer welfare. Finally, Kiebzak et al. (2016) suggests that patent litigation frequency may initially stimulate venture capital investments, at least until a certain threshold after which the effect turns to be negative. Contrarily, the work of Lemus and Temnyalov (2017), an apparently isolated publication, stands out due to its relatively high citation count. This can be attributed to its pioneering investigation into the business model of the "patent privateer." The second cluster (highlighted in pink) includes two recently published papers: Cohen et al. (2019), which provides empirical insights into NPEs' opportunistic behavior, and Ganglmair et al. (2022), which examines contemporary market-based solutions aimed at mitigating "patent trolling," such as private defensive litigation insurance products.

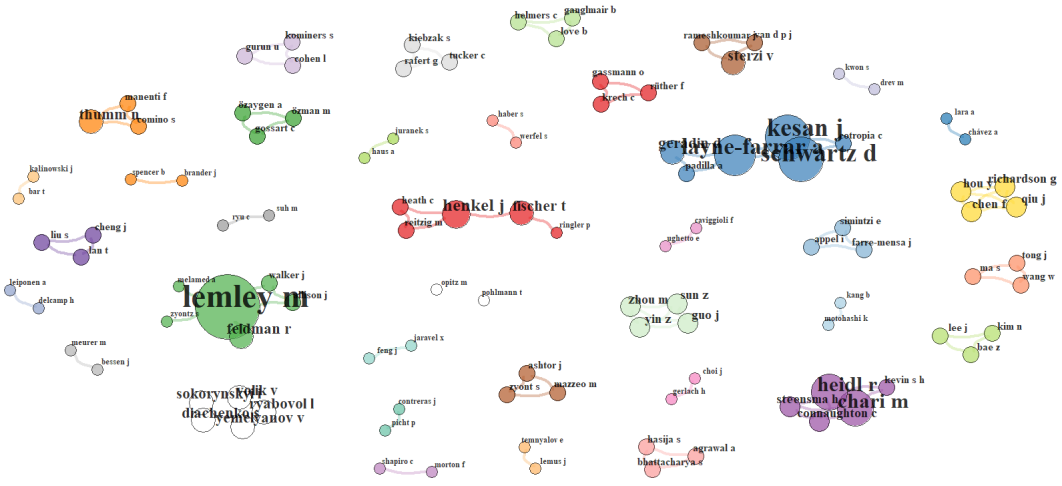
The historical direct citation analysis, mapped in Figure 1.9 and summarized in Table 1.6, indicates that the bulk of the core publications appeared between 2012 and 2018 and that these scientific articles have only weakly cited each other. This citation pattern suggests that these central publications have exerted only a limited influence on each other, with the possible exception of the seminal paper of Reitzig et al. (2007). Overall, there seems to be that research on NPEs business models is relatively fragmented, yet it still exhibits a strong level of specialization and in-depth analysis of specific research questions, sometimes in niche research areas.

1.2.3.4 Collaboration analysis

The co-citation analysis and the historical analysis of direct citations have highlighted the presence of a number of overarching background themes, with varying degrees of overlap between each other, and also a weak direct citation patterns among the 83 selected publication. This may signal a fragmented state of research on the phenomenon of NPEs. This fragmentation might stem from the inherently interdisciplinary nature of the research topic under investigation. Alternatively, it could signal the presence of distinct, highly specialized research streams and groups with limited scientific contamination.

Collaboration analysis is particularly useful to analyze the social structure of research, and to complement the results obtained from the study of both the conceptual structure (Section 1.2.3.2) and the intellectual structure of the literature (Section 1.2.3.3). In this respect, mapping the collaboration network (where nodes are authors, or countries, and edges are co-authorships (Glanzel and Schubert, 2004)) can help shed light on the degree of collaboration between researchers and their respective institutions. Authorship mapping provides rich and valuable information regarding the characteristics of the authors, and their collaboration patterns, or the relationships among countries involved in the research (Koseoglu, 2016; Haynes and Alemna, 2022). Figure 1.10 shows the co-authorship network, where each node corresponds to one researcher.

Figure 1.10: Co-authorship network



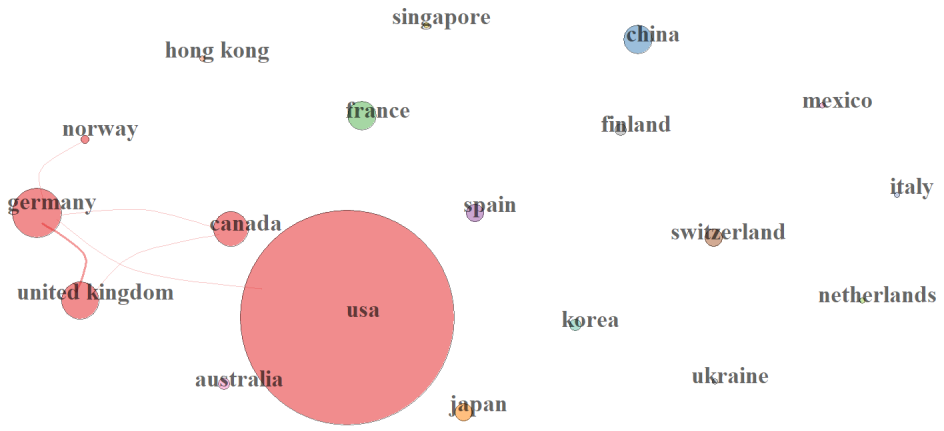
Notes: The network illustrates the structure of co-authorships between collaborating authors, single authors are therefore excluded (108 nodes, 1 minimum edge, walktrap clustering algorithm, association normalization). The network was generated with the R *bibliometrix* package. Own elaboration.

Two nodes are linked if the corresponding authors collaborated at least in one paper with another author of the collection. Node size is proportional to scientific production. The authorship network suggests the presence of various different research groups, that appear rather isolated and dispersed (the

descriptive analysis of the most influential and productive authors in Section 1.2.3.1 already revealed this aspect). The largest research collaboration clusters, both in terms of number of researchers and scientific production, are the one of Schwartz D., Kesan J., and Layne-Farrar A. (in blue in the figure), and the one in which Lemley M. is the central author in terms of number of publications (in green in the figure). Another relatively big and central cluster is the one composed of Henkel J., Fischer T. and co-authors (in red in the figure).

Figure 1.11 shows the countries involved in research on NPEs and their respective collaboration relationships. Each node corresponds to one of the 19 countries in our sample, node size is proportional to the number of papers authored by at least one researcher affiliated in an institution of that country.

Figure 1.11: Country collaboration network



Notes: Network mapping of the structure of collaborations between countries (19 nodes, 1 minimum edge, walktrap clustering algorithm, association normalization). The network was generated with the R *bibliometrix* package. Own elaboration.

The figure clearly highlights the prominent role played by the US in researching the topic in terms of number of papers published by researchers belonging to US organizations (as already highlighted in Section 1.2.3.1). However, in terms of cooperation with foreign researchers, Germany scores higher and it has the highest number of collaborations: 2 collaborations with the UK, 1 with the US, 1 with Norway and 1 with Canada.

Overall, both authors and countries' collaboration analysis indicate a low collaboration frequency and the prevalence of isolated research efforts. This may suggest a fragmented and highly specialized scientific production. Both collaboration networks indicate that research on NPEs is mainly centered in North America—with the US taking the lion's share of scientific production on NPEs—and in few European countries—namely, Germany, the UK, France, Spain and Switzerland. This in turn could mirror the fact that NPEs historically originated in the US patent market and subsequently have become more active

in the European MFTs (Reitzig et al., 2007; Lemley and Melamed, 2013), thus spurring research on the topic. Nonetheless, both collaboration analyses reveal that Asian researchers are increasingly focusing on NPEs (Jenweeranon, 2017). This ultimately may suggest that Asian markets for technologies are rapidly becoming attractive venues for NPEs' activities, in particular in China (Meng, 2016; Bian, 2021; Yin et al., 2022).

1.3 Literature Review

The bibliometric analysis carried out in Section 1.2 provides notable insights into the literature on NPE business models. This analysis, in fact, reveals several noteworthy characteristics of the 83 studies identified and offers a valuable framework to further delve into the content of the retrieved articles. First, the articles collected through our search strategy are highly interdisciplinary. In fact, NPE business models have been examined from a variety of research perspectives in both the legal and the economics field, as well as at the intersection of these two disciplines.

From a chronological point of view, legal scholars engaged first in the exploration of NPE business models (Mann, 2005; Landers, 2006; Chien, 2010)[35], while, in the past recent years, scholars in the economics field started exploring the topic more intensively (Fischer and Henkel, 2012; Pénin, 2012; Lu, 2012; Pohlmann and Opitz, 2013; Hemphill, 2014a,b; Smith, 2015; Sterzi, 2021). Second, even within the same research area, contributions are heterogeneous, and different research focuses and methodologies co-exist. In the economics domain, although several articles develop a theoretical approach (Geradin et al., 2012; Haber and Werfel, 2016; Agrawal et al., 2016; Lemus and Temnyalov, 2017; Turner, 2018; Bar and Kalinowski, 2019; Bergin, 2022), a significant number of the studies identified, particularly the most recent ones, adopt an empirical approach in the analysis of the NPE phenomenon (Fischer and Henkel, 2012; Kang and Motohashi, 2015; Krech et al., 2015; Haus and Juranek, 2018; Feng and Jaravel, 2020; Sterzi et al., 2021; Sterzi, 2021; Sterzi et al., 2021; Bian, 2021; Ma et al., 2022; Chari et al., 2022; Chen et al., 2023). Third, the research themes identified are strictly interrelated and often addressed simultaneously within the same contribution.[36] These characteristics suggests the need to systematize a literature that also appears relatively fragmented, both in terms of authors' contributions and engagement over time, as well as in terms of collaborations patterns. In this respect, only a few authors engaged with the topic of

[35] With the notable exception of Reitzig et al. (2007).

[36] For instance, NPEs' different patent monetization business models, implications for technology markets, patent quality features of NPE owned patents, patent litigation activities and antitrust, hold-up and standardization concerns, NPEs and start-ups activities, etc. For a detailed discussion of all the research themes explored in the identified literature collection, see section 1.2.3.2.

NPE business models more than once.[37] In addition, the contributions identified tend to be extremely specialized, dealing with narrow and specific research questions.

Although the literature retrieved for the bibliometric analysis is comprehensive, the methodology used to identify and analyze the literature on NPE business models has some limitations. As a result, certain relevant studies analyzing the subject have not been captured by our search strategy. This is due to various reasons. First, only academic articles and reviews have been included in the database search, consequently other types of research contributions are not present in the bibliometric analysis. This is the case of government reports, such as the two reports of the US Federal Trade Commission (FTC, 2011, 2016b) or the US Government Accountability Office (GAO) report (GAO, 2013),[38] policy reports, such as the Joint Research Centre of the European Commission's study on PAEs (JRC, 2016), book chapters (Love et al., 2016), and studies other than academic ones, as in the case of consultancy reports (PWC, 2012). Second, despite the vast coverage of both Scopus and Web of Science, articles that are not indexed in such bibliographic databases are necessarily not included in the previous analysis (McDonough III, 2006; Benassi and Di Minin, 2009; Papst, 2012; Ewing, 2012; Fusco, 2013; Tucker, 2014; Sipe, 2015; Cohen et al., 2016; Abrams et al., 2019; Nikolic, 2019; Mezzanotti, 2021; Klapper and Siemering, 2023; Orsatti and Sterzi, 2023). Third, given their specific construction and the criteria adopted, our search queries may have missed relevant papers (Morton and Shapiro, 2013; Hagiu and Yoffie, 2013; Cotropia et al., 2014; Feldman and Lemley, 2018).[39]

Thus, through the in-depth content analysis of the retrieved articles, first we organize a systematic literature review of NPE business models according to the central themes that emerged from the bibliometric analysis conducted in Section 1.2. The bibliometric analysis provides a useful road-map to overcome the limitations arising from the heterogeneity of the contributions and the challenges posed by the interdisciplinarity of the retrieved literature. The four main research themes that emerge consist in: (i) the analysis of the activities of NPEs, and the classification of these entities into identifiable business models; (ii) the analysis of the interplay between NPEs and patent quality; (iii) the assessment of the

[37] See also Fig. 1.5 reporting the top 10-most productive authors. Besides the top 10-most productive ones, the other non-sporadic authors are Sterzi V., Thumm N., Henkel J.

[38] The GAO released its report on NPEs in August 2013, and it consists of a thorough analysis of the NPE phenomenon in the US. However, Cotropia et al. (2014) have highlighted some critical flaws in the analysis provided by such report. First, the GAO analyzed data from patent lawsuits initiated between 2007 and 2011, therefore before the adoption of the America Invents Act in late 2011. Second, the Office never disclosed the underlying data analyzed and used to classify entities in "PAEs" or "NPEs". For this reason, other researchers have been prevented from replicating and testing the results. For instance, it is still unclear which entities were classified as "PAEs" or "NPEs", the amount of revenue associated with these entities, and other information necessary to evaluate the claims contained in the report (Cotropia et al., 2014).

[39] For a detailed explanation of the specific limitations of the search strategy and the queries developed, see Section 1.5.

impact of NPEs' activities on technology markets and the implications for the innovation ecosystem; (iv) a discussion of the policy concerns related to NPEs and the regulation of the potentially negative effects of NPEs' activities (mainly through patent policy, antitrust policy and marketplace solutions). Second, given the limitations discussed above, we integrate the content analysis of the 83 selected studies with the relevant articles and documents that have escaped our methodology, therefore providing a complete systematic literature review on NPE business models.

1.3.1 NPE business models

The economic separation of patent rights from their underlying technologies (Mazzeo et al., 2013) enables NPEs to generate revenues from the *right to exclude* granted by patents (Fischer and Henkel, 2012). Specifically, the exclusive right to exclude others from manufacturing, using and commercializing the patented technology enables NPEs to enforce their patents against alleged infringing companies (Weatherall and Webster, 2014). Consequently, operating companies may be sued by NPEs for several reasons and the typologies of prospective licensees may range, from companies clearly infringing a patented technology to manufacturers that will require access to the technology at some point in the future (Larson, 2013). Other times, however, companies may only allegedly infringe on a patented technology, thus prompting opportunistic legal action, especially from assertive NPE business models (such as, Patent Assertion Entities) (Cohen et al., 2019).

Therefore, NPEs may pursue different monetization activities. Generally, NPEs negotiate licensing agreements with prospective licensees and then collect royalty payments from such agreements (Allison et al., 2009). Typically, the NPE identifies and establishes a contact with the prospective licensee with the aim to start licensing negotiations, which, if successful, will generate royalty fees to the NPE (Larson, 2013). Then, if the negotiation process breaks down or reaches a deadlock, the NPE may initiate a patent infringement action. In this way, NPEs can obtain court ordered damages from successful infringement litigations, or reach a settlement with the infringer (Larson, 2013). Alternatively, NPEs may enforce patent rights on behalf of third parties (Shrestha, 2010; Yang, 2012; Haus and Juranek, 2018; Thumm, 2018), or may decide to enter into agreements with other companies and direct their litigation efforts towards the client's rivals (Golden, 2012; Harris, 2014; Kesan et al., 2019). Another option for NPEs consists in the opportunity to sell IP assets on the secondary market for patents (Fischer and Henkel, 2012; Reitzig et al., 2007; Pénin, 2012; Sterzi et al., 2022).

The literature analyzed highlights how NPEs operate along a broad spectrum of business models and engage in various activities. Additionally, several contributions aim to provide NPE taxonomies (Fischer and Henkel, 2012; Papst, 2012; Ewing, 2012; Lemley and Melamed, 2013; Larson, 2013; Pohlmann and Opitz, 2013; Hemphill, 2014a; Cotropia et al., 2014; FTC, 2016b; JRC, 2016; Krech et al., 2015; Caviggioli

and Ughetto, 2016; Ryu et al., 2016; Thumm, 2018; Leiponen and Delcamp, 2019; Bian, 2021). The present study conducts a review and a classification of the NPEs' taxonomies encountered in the retrieved studies and, more broadly, in the relevant literature on NPEs. In fact, despite the different labels and categories developed—and the viewpoints from which NPEs have been studied—common underlying NPE business models and characteristics have been identified. However, as indicated by both the bibliometric analysis of Section 1.2 and the case studies that will be presented in Section 1.4, the NPE business models illustrated in what follows should not be considered as rigidly separated from each other as, on the contrary, they tend to coexist and sometimes overlap.

1.3.1.1 Patent intermediaries

In the past decades, a secondary market has been developing from a number of innovative actors owning patent assets that are unlikely to be used to manufacture end-products, and that are costly to maintain (FTC, 2011). This is the case of failed big companies or innovative startups that originally invented the patented technology to further manufacture products or deliver services (Cotropia et al., 2018). In Europe, a considerable share of patents acquired by NPEs originate from former large operating companies active in the ICT industry, in particular handset manufacturers that failed in the market in the mid-2000s (Sterzi et al., 2022). Furthermore, the current complexity of some technology sectors, together with the increasing volume of patents, has posed significant challenges in monitoring of technological advancements (Reitzig et al., 2007).

In this context NPEs may enter into play as valuable intermediaries by making a complex secondary market for inventions more efficient. In fact, NPEs are specialized in various forms of patent intermediation and represent a valuable part of the demand side of the market for patents (Papst, 2012). Also referred to as "patent dealers" (McDonough III, 2006) or "patent brokers" (Pénin, 2012), NPEs enhance the liquidity of patents and reduce the frictions in the patent market, which ultimately boost competition (McDonough III, 2006; Shrestha, 2010; Pénin, 2012; Caviggioli and Ughetto, 2016). In fact, inventors directly licensing their patented inventions to other firms directly face several transaction costs (Pénin, 2012). These costs typically derive from the activities related to the searching for potential licensees, the negotiation of licensing agreements, and the enforcement of patents against potential infringers (Chari et al., 2022). However, in many instances, inventors are not efficient in performing such commercialization activities since the scale needed to perform innovation does not always match the scale needed to perform patent licensing and enforcement (Steensma et al., 2016). Additionally, smaller inventors with limited scale and resources (such as individuals, small firms and research institutions) may completely lack the capacity to commercialize their inventions (Chari et al., 2022). NPEs can also provide other patent and technology-related services to patentees. For instance, NPEs can perform patent landscape analyses and

technology screenings to patent-owners lacking the necessary means to map their technologies (Larson, 2013). Therefore, NPEs act as powerful catalysts for patent commercialization and create a bridge between technology demand and supply (Thumm, 2018; Comino et al., 2019). As such, NPEs create a value added in the patent market by providing patent enforcement and monetization services to their clients (Papst, 2012; Larson, 2013).

The intermediation role played by NPEs also allows producing companies to vertically specialize along the technology supply chain (Teece, 1986), such that owners of IP assets can focus on the technology development process (Haus and Juranek, 2018). For all these reasons, although they generally do not engage in technology development, NPEs play a desirable intermediary role by connecting independent inventors and technology implementers. In this sense, NPEs have been found to behave as "market void fillers" (Yang, 2012), allowing in particular financially constrained inventors and R&D companies to efficiently monetize their patents and sustain their R&D activities. By doing so, NPEs greatly enhance the bargaining power of small innovative actors in their interactions with more dominant and established companies (Shrestha, 2010; Yang, 2012; Thumm, 2018). Furthermore, NPEs foster efficient technology markets by exerting downward pressure on market prices and expanding consumer choice, thus increasing profits for the incumbent firms (Agrawal et al., 2016). This positive dynamic promotes innovation and fosters increased market competition (Geradin et al., 2012). From this perspective, Yang (2012) caution against the misleading use of the term "patent troll," which has been at times used in a derogatory sense to describe all NPE business models.[40] In addition, at the patent market level, NPEs also act as filters, sifting between higher and lower quality patents (Shrestha, 2010) to gather patents that would otherwise be difficult to identify and properly allocate (Lu, 2012).

Interestingly, we find that several studies have empirically identified instances of a positive intermediation activities played by NPEs (Kang and Motohashi, 2015; Cheng et al., 2017; Abrams et al., 2019; Chari et al., 2022; Sterzi et al., 2022). For instance, Chari et al. (2022) find that, as NPEs' patent procurement and enforcement activities increase in some technology classes, "focused inventors" (i.e., small firms, universities, and laboratories that typically lack commercializing capabilities) start producing more inventions in these classes, as compared to larger inventors (Chari et al., 2022). Similarly, Cheng et al. (2017) investigate the influence of NPEs' intermediation activities on patenting and technology transfer. Accounting for different degrees of NPE involvement in R&D, the authors find that NPEs with prominent R&D activities are particularly skilled in integrating knowledge from the innovation, which generate valuable patents and

[40] More specifically, Yang (2012) argues that several patent-owner has the potential to engage in monetization activities, similar to a "troll", at least relative to certain underused patents (Yang, 2012). This is due to the fact that companies are unlikely to have the resources to actively practice all the patents they own (Chien, 2010).

ultimately facilitates technology transfer (Cheng et al., 2017). In this respect, R&D capabilities equip NPEs with the expertise and skills to facilitate efficient technology transfer through patent transactions (Cheng et al., 2017).[41] Analyzing the two opposing narratives that depict NPEs as either the "middleman" or the "stick-up artist," Abrams et al. (2019) find that NPEs acquire patents that are more likely to be asserted and enforced against other firms to conclude licensing agreements. While at first sight this may resemble a typical patent troll behavior, Abrams et al. (2019) point out that it actually signals that NPEs are effective in creating value by defending the patents of small firms lacking the means to defend their intellectual property (Abrams et al., 2019). This protection incentivizes small firms to innovate more while it discourages large firms who might intentionally infringe on small firms' patents (Abrams et al., 2019). Additionally, NPEs can resort to their full broker network and are able to allocate patents to the users that actually need them, thus overcoming the informational asymmetries of a complex patent market (Abrams et al., 2019). Furthermore, NPEs are also found to actively, and positively, engage in the process of technology standardization. In comparing operating companies and NPEs' technology strategies relatively to standard-essential patents in the wireless communication sector, Kang and Motohashi (2015) find that the two types of actors adopt indeed different patenting and technology strategies. In particular, in the standardization process, while operating firms accumulate their technological capabilities in specific technology fields, NPEs cover broader technology fields (Kang and Motohashi, 2015). Although both types of actors contribute to the advancement and adoption of the technology, manufacturers are found to focus more on subsequent innovations based on the standards, whereas NPEs contribute more to upgrading the technology of the standard itself (Kang and Motohashi, 2015). Therefore, operating companies and NPEs actually carry out complementary functions in the standardization process (Kang and Motohashi, 2015).

1.3.1.2 Patent asserters

As observed in the thematic analysis of Section 1.2.3.2, the reviewed literature extensively examines patent litigation cases involving a specific category of NPEs, known as Patent Assertion Entities (PAEs), or pejoratively "patent trolls." Generally, PAEs consist of independent licensing companies that frequently adopt an assertive approach to patent enforcement (Leiponen and Delcamp, 2019; Nikolic, 2019; Benassi and Martin-Sanchez, 2022). Typically, PAEs refrain from directly participating in technology development and, as a consequence, they do not file the patents they own (Chien, 2010). Consequently, they assume the role of proactive acquirers within the secondary market for patents, as this activity enables them to create their patent portfolios (Sterzi et al., 2022). Several authors have pointed out that PAE' patent

[41] Additionally, compared to NPEs without any R&D involvement, R&D-performing NPEs generally monetize their patents without resorting to excessive litigation (Cheng et al., 2017).

acquisition activities might represent a threat towards efficient technology markets (Fischer and Henkel, 2012; Morton and Shapiro, 2013; Hagiu and Yoffie, 2013; Hemphill, 2014a; Orsatti and Sterzi, 2023). In fact, PAEs' patent purchases are accused of increasing the overall fragmentation of the intellectual property space (Comino et al., 2019), while patent transfers to PAEs may also signal looming opportunistic patent litigation (Sterzi et al., 2021).

However, the PAE business model expands far beyond patent transactions to include active patent assertion. This gives rise to various forms of economies of scale (Bessen and Meurer, 2014; Leiponen and Delcamp, 2019), typically arising from PAEs' serial litigation of the same patents (Chien, 2012), the simultaneous enforcement against multiple infringers (Larson, 2013), or from large settlements before final court decisions (Mazzeo et al., 2013). A common tactic employed by PAEs involves initiating a patent infringement lawsuit when the targeted company has already incorporated the allegedly infringed technology into the end-market product (Pohlmann and Opitz, 2013), and irreversible investments have been made by the alleged infringer (Fischer and Henkel, 2012). This culminates in a state of lock-in, which PAEs may exploit to obtain royalties that are higher than what would have been agreed upon in an equitable bargaining situation (Lemley and Melamed, 2013; Caviggioli and Ughetto, 2016; Boscheck, 2016). In this respect, Lemley and Shapiro (2007) points out that the possibility of obtaining an injunction greatly improves the negotiation position of the PAE against the operating company, in particular in the case of complex products, which are prone to "royalty stacking,"[42] where the divide between the PAE's bargaining power and its opponent is even more exacerbated (Fischer and Henkel, 2012). In this scenario, the impossibility for the operating company to invent-around makes *ex post* patent licensing more attractive to PAEs than *ex ante* licensing (Reitzig et al., 2007).[43] Additionally, owing to their status as non-practicing entities, PAEs are immune to any counter-litigations for infringement, while they are also uninterested in cross-licensing (Mann, 2005; Reitzig et al., 2007). These characteristics of the PAE business model impose relevant costs and uncertainty to downstream operating firms (Yang, 2012; Bessen and Meurer, 2014; Pohlmann and Opitz, 2013; Lee et al., 2019; Appel et al., 2019; Dayani, 2023; Lemley

[42] Royalty stacking refers to the cumulative effect of multiple royalties or licensing fees that a company might need to pay when utilizing a combination of technologies or components from different patent holders (Lemley and Shapiro, 2006). As more technologies are integrated into a product, each with its associated royalty, the total licensing costs can "stack up," and potentially becoming a significant financial burden. This phenomenon is particularly relevant in industries where products incorporate numerous patented technologies, such as telecommunications, where devices may utilize multiple standards and patents (Geradin et al., 2007).

[43] More specifically, "ex ante" licensing refers to licensing agreements negotiated and agreed before any potential infringement occurs. These agreements typically derive from the decision of a company to seek permission to use a particular technology and involves the payment of royalties for the use of the patented technologies in its products or services (Comino et al., 2011). On the other hand, "ex post" licensing involves negotiating and establishing licensing agreements after a potential infringement has been identified or alleged. This type of licensing often arises when the patent-owner asserts that a company is using its proprietary technology without authorization (Lemley and Feldman, 2016).

and Zyontz, 2021).

Accordingly, PAEs have been accused of opportunistic behaviors (Feldman and Lemley, 2015), which potentially hinder, rather than facilitate, technology transfer and follow-on innovation (Feldman and Lemley, 2015). In this vein, Lemley and Melamed (2013) distinguishes between two types of opportunistic PAEs. The first is characterized as "lottery-ticket trolls," where PAEs engage in risky litigations to secure substantial settlements against established market incumbents. The second type, known as "bottom-feeder trolls," adopts a strategy of seeking quick settlements below the cost of litigation from numerous small companies (Lemley and Melamed, 2013). In addition, Cohen et al. (2019) characterize the PAE business model as that of an opportunistic "blackmailer," focusing on extracting fees rather than supporting the uptake of innovations through licensing. In fact, the authors highlight how PAEs tend to target relatively weaker firms, such as those already involved in lawsuits and with limited or no dedicated legal teams (Cohen et al., 2019).

Thus, numerous theoretical studies have portrayed the PAE business model under a negative light. Additionally, there is also considerable empirical studies generally suggesting a negative effect of the patent asserter business model on downstream firms and, more broadly, on subsequent innovation and technology transfer (Bessen and Meurer, 2014; Tucker, 2014; Feldman and Lemley, 2015; Kiebzak et al., 2016; Feldman and Lemley, 2018; Appel et al., 2019; Cohen et al., 2019; Chen et al., 2023; Dayani, 2023; Orsatti and Sterzi, 2023). For instance, with the aim to explore the relation between patent license demands from PAEs and subsequent innovation or technology transfer, Feldman and Lemley survey in two similar studies the companies targeted by PAEs' patent licensing demands. Overall, the authors find that only a minority of PAEs' licensees directly lead to new inventions (Feldman and Lemley, 2015, 2018). In particular, most demands grant the freedom to operate to licensees that were already using a specific technology (Feldman and Lemley, 2015). Furthermore, it was observed that PAEs' requests for licensing seldom resulted in knowledge and staff sharing, joint venture formation, or the development of novel products (Feldman and Lemley, 2018). Several authors find desperate negative effects of PAEs' assertions on operating companies' welfare and incentives to innovative. For example, Kiebzak et al. (2016) explores the effect of increased PAE enforcement on the entrepreneurial economy and suggest that high levels of PAE litigation have a statistically negative relation with venture capital (VC) investments, which is an essential financial mean for innovative companies (Kiebzak et al., 2016). In the same vein, Appel et al. (2019) indicates that frivolous patent infringement claims made by PAEs negatively affect startups' ability to grow and create jobs, innovate, and raise capital. Similarly, Cohen et al. (2019) show that NPE litigation has a negative impact on the future innovative activity of targeted firms in general. Furthermore, Dayani (2023) reports also a negative effect of PAE patent infringement claims on the acquisitions of small firms, while Chen et al. (2023) suggests a negative impact of PAE litigation on the market value and innovation strategies. This result holds not only of the defendants, but also for their technology peers

(Chen et al., 2023). Focusing on the special case of medical imaging software technology, Tucker (2014) finds that litigation by a PAE negatively affected the sales of such technology. Moreover, the effect on PAE assertion goes beyond that and directly determines to a lack of incremental product innovation during the period of litigation (Tucker, 2014). Additionally, PAEs are also responsible for increasing the costs of companies operating further down in the technology value chain. More specifically, Bessen and Meurer (2014) empirically estimated the costs of PAE litigations on operating companies downstream by combining survey data, information on publicly listed PAEs, and developing a stock market event study (Bessen and Meurer, 2014). According to their estimates, they report that the total direct costs of PAEs' litigations to defendants is approximately $29 billion in the year 2011. This figure does not include the indirect costs sustained by defendants, such as diversion of investments, delays in market launches, and loss of market share (Bessen and Meurer, 2014). Additionally, in their event-study research, Bessen and Meurer (2014) suggest that the annual aggregate cost to defendants from NPE lawsuits may reach $80 billion. Based on these figures, the authors argue that PAEs might well impose a "tax on innovation," which ultimately decreases defendants' incentives to innovation (Bessen and Meurer, 2014). More broadly, Orsatti and Sterzi (2023) explore the indirect impact of PAE patent acquisitions on the R&D strategies of the firms operating around the technologies targeted by the PAE. The authors empirically estimate a significant post-transfer drop in forward citations received by patents acquired by PAEs, which suggests a decrease in its subsequent use and indicates an average negative impact of PAEs on follow-on innovation around targeted technologies (Orsatti and Sterzi, 2023).

However, the negative narrative that often surrounds PAEs might simplify the dynamics of a diversified and complex patent ecosystem (Risch, 2015), where PAEs may, instead, play a valuable enforcement role (Mann, 2005; Schwartz and Kesan, 2014). In fact, patent litigation initiated by PAEs can be viewed as a way of streamlining patent licensing, especially in the presence of information asymmetries and illiquidity in the patent market (Thumm, 2018). Therefore, PAEs provide a practical solution to unlicensed patents by creating R&D incentives (Lemus and Temnyalov, 2017), especially for economically constrained innovative actors (Pohlmann and Opitz, 2013) and small and medium-sized enterprises (SMEs) (Rantasaari, 2018), which could see PAEs as an additional patent enforcement channel (Lu, 2012; Larson, 2013). According to this view, PAEs can assist individual patent owners who may lack the necessary financial resources and legal expertise to effectively engage with established and well-resourced manufacturers (Haber and Werfel, 2016). In this respect, Haus and Juranek (2018) empirically investigate the specialization hypothesis according to which PAEs are nothing more than enforcement specialists, and that their superior expertise in patent litigation is not in contrast with, but rather complements, their role as patent intermediaries. More specifically, the authors search for indirect evidence in support of their specialization hypothesis by investigating the duration pattern of PAE-initiated lawsuits (Haus and Juranek, 2018). Their findings support their hypothesis, thus confirming that PAEs cases resolve quicker, with the only exception of

litigation brought against large companies (Haus and Juranek, 2018). In this way, due to their specialization towards patent enforcement, PAEs can contribute in making technology more broadly available. This has the positive effect of undermining anti-competitive structures based on more restrictive forms of licensing (Pénin, 2012; Boscheck, 2016). Hence, a portion of the literature assigns to PAEs' assertions an important function. This is particularly true for some inventors of highly valuable technology, who either lack the skills—and scale—to assert their patents against downstream infringers, or may face difficulties in identifying potential technology transfer partners (Morton and Shapiro, 2013), such as SMEs, universities, and research institutions (JRC, 2016; Chari et al., 2022). For these smaller actors, PAEs can also represent an effective tool to offset patent "hold-out" (JRC, 2016).[44]

Finally, some part of the literature reports more mixed evidence on the effects of PAEs' hotly debated enforcement practices, and it seems overall more agnostic towards the net effect of the PAE business model. In fact, several authors have empirically investigated litigation data, exploring potential difference between PAEs and operating companies in terms of litigation outcomes and amount of awarded granted. Despite the aggressive connotation that seems to characterize PAEs at first glance, part of the literature seems to suggest that PAEs' litigation outcomes, and award granted, do not significantly differ from those of producing entities (Allison et al., 2009; Lu, 2012; Mazzeo et al., 2013; Pohlmann and Opitz, 2013; Fischer and Ringler, 2014; Love et al., 2016; Ryu et al., 2016; Risch, 2015; Cotropia et al., 2018). These results therefore greatly downsize the overcompensation hypothesis (Lu, 2012), whereby the PAE business model is based on the assertion of marginal patents that, via injunction threats or nuisance settlements, enable them to extract unreasonable rents from sued companies (Boscheck, 2016).

1.3.1.3 Patent privateers

Some studies collected and analyzed in Section 1.2 delve into a special category of the NPE business model known as the "patent privateering" business model (Lemley and Melamed, 2013; Harris, 2014; Boscheck, 2016; Lemus and Temnyalov, 2017; Kesan et al., 2019; Leiponen and Delcamp, 2019; Geradin, 2019). However, a more accurate analysis of the literature reveals that in the past few years several theoretical studies have devoted considerable attention to this peculiar NPE business model (Golden, 2012; Ewing, 2012; Morton and Shapiro, 2013; Lemus and Temnyalov, 2014; Sipe, 2015; Contreras et al., 2017; Rubinfeld, 2018; Klapper and Siemering, 2023).

[44] Broadly speaking, patent hold-out denotes the unwillingness of technology implementers and operating companies to pay the due royalties by deploying delaying tactics (Heiden and Petit, 2017; Love and Helmers, 2023).

Patent privateers, or more neutrally "licensing companies affiliated with product companies" (Leiponen and Delcamp, 2019), can be considered a special category of PAEs, and for this reason they are often called "Hybrid PAEs" to differentiate them from the classical "Pure PAEs" (Ewing, 2012; Golden, 2012; Geradin, 2019). More specifically, patent privateers are licensing specialists affiliated with a downstream operating firm (Kesan et al., 2019). In fact, a patent-owner may decide to transfer part of its patent portfolio to the privateer that will subsequently assert against a competitor of the original owner of the transferred patents (Golden, 2012).

Typically, the affiliation between an operating company and a privateer is established through contractual agreements of different types (Boscheck, 2016). For instance, a privateering arrangement could involve an agreement to distribute the revenues generated from patent enforcement with a company operating further down the value chain (Morton and Shapiro, 2013). Alternatively, a privateer can form a joint venture with the downstream firm. In this way, the joint venture acquires the patents and the downstream firm maintains a license not only for its own use but also potentially for other entities it supports, such as its strategic partners (Morton and Shapiro, 2013). Subsequently, the joint venture asserts the patents against competitors of the downstream firm (Morton and Shapiro, 2013). Other times, patent privateers can also take the form of shell companies or dormant companies affiliated to operating firms (Landers, 2006; Sterzi et al., 2021).

The existence of contractual ties between privateers and the original owner of the transferred intellectual property rights raises concerns regarding the potential for exclusionary practices (Geradin, 2019), especially when it involves the transfer and assertion of standard essential patents (SEPs) (Morton and Shapiro, 2013; Boscheck, 2016; Contreras et al., 2017). In fact, manufacturer may outsource patent enforcement to privateers to increase the costs for the downstream rivals, while they minimizes their reputational damages deriving from a direct exposure to patent litigation (Golden, 2012; Lemley and Melamed, 2013; Sipe, 2015). Thus, all the strategies deployed by the "Pure PAE" business model can also be applied by the "Hybrid PAE" model (Morton and Shapiro, 2013). However, there are some additional effects of the privateering business model. First, the privateer will charge higher royalties for the patents it enforces, and it will also raise the costs of the downstream firm's rivals (Morton and Shapiro, 2013). In addition, operating companies may employ privateers to shape the rate of technology adoption between a novel technology and a more mature one, they may delegate the licensing of a broader array of patents to change some aspect of the legal framework, or they may generally build influence within an industry and block new market entrants (Ewing, 2012). Furthermore, the privateering business model may also be exploited by investors to grow their existing investments against rivals in a specific technological sector (Ewing, 2012). This strategy may be used, for instance, to influence the value of publicly traded companies stock prices, to ease short selling, to influence a company's value during investment processes, or to recover R&D costs (Ewing, 2012). Therefore, the patent privateering business model has the potential to change the overall

enforcement system, primarily by enabling operating companies to evade licensing obligations and raise the overall costs and frequency of patent assertions in a particular industry or for specific technologies (Rubinfeld, 2018; Klapper and Siemering, 2023).

However, as in the case of "Pure PAEs," a positive interpretation of Hybrid PAEs is also possible. Such narrative suggests that the privateering business model assumes risks, for which it obtains compensation, while, at the same time, it injects liquidity in the patent market through litigation expenses and upfront patent royalties (Kesan et al., 2019). Thus, privateers emerge as profit-oriented companies that, leveraging on their extensive knowledge of the evolving patent landscape and legal framework, tend to engage in patent acquisition and enforcement very carefully (Kesan et al., 2019). From this viewpoint, the patents acquired by Hybrid PAEs are presumably valuable and robust, and it follows that privateering enforcement actions would not be frivolous and filed merely to impose costs on a downstream firms (Kesan et al., 2019).

Among the studies reviewed, Kesan et al. (2019) are the first to empirically investigate these two opposed narratives on patent privateers. The authors find no empirical evidence that privateers systematically enforce frivolous or lower-quality patents as compared to other litigants, and that the patents they acquire are generally of high quality (Kesan et al., 2019).

1.3.1.4 Patent aggregators

As suggested by the thematic analysis provided in Section 1.2.3.2, the studies identified through our search strategy report an additional form of NPE business model, which consists in the so-called "patent aggregator" (Chien, 2010; Lemley and Melamed, 2013; Krech et al., 2015; Caviggioli and Ughetto, 2016; Young, 2016; Thumm, 2018; Cotropia et al., 2018; Kwon and Drev, 2020; Leiponen and Delcamp, 2019). Although the term is used in a variety of ways in the broader literature on patent aggregating companies (Benassi and Di Minin, 2009; Papst, 2012; Hagiu and Yoffie, 2013; Orr, 2013; Cosandier et al., 2014), generally these types of NPEs massively acquire patents, however they do not perform direct R&D activities (Benassi and Di Minin, 2009; Krech et al., 2015).

Generally, the business model adopted by patent aggregators revolves around the strategic acquisitions of complementary patent assets from the patent market to create portfolios consisting of the IP rights capable of posing a threat to their subscriber (Caviggioli and Ughetto, 2016). In this way, the aggregator's subscribers gain access to specific technologies and are protected against external patent enforcements (Kwon and Drev, 2020). Moreover, if necessary, patent aggregators may also actively engage in patent litigation (Papst, 2012; Lemley and Melamed, 2013).

Given the heterogeneity displayed by aggregators, a deeper analysis of these types of NPEs seems necessary to detangle their various IP strategies. In fact, the objective of an aggregator may be twofold: either gain freedom to operate (i.e., the aggregator adopts a defensive strategy), or monetize patents within

a portfolio (i.e., the aggregator adopts an offensive strategy) (Thumm, 2018). Specifically, the second approach makes "Offensive Patent Aggregators" (OPAs) similar to other types of NPEs and patent-related business models, such as PAEs, patent funds, patent pools and patent brokers (Papst, 2012; Thumm, 2018). On the other hand, the defensive approach adopted by "Defensive Patent Aggregators" (DPAs) (Papst, 2012; Cosandier et al., 2014; Krech et al., 2015; Comino et al., 2019), also called "defensive patent trusts" (Chien, 2010), consists in acquiring patents so that they will not be asserted—in particular by PAEs and other enforcement specialists—against the licensees of the DPS. Thus, as the business model of DPAs is to take away from the market large numbers of potentially enforceable patents (Hagiu and Yoffie, 2013), these types of entities are often in competition with more aggressive PAEs (Kwon and Drev, 2020). However, contrary to aggressive PAEs engaging in nuisance litigations, when DPAs litigate they generally seek earlier and larger settlements (Cotropia et al., 2018). Generally, patent aggregators seek compensation on their licensing agreements from the members of the consortium on an annual or a fixed fee (Chien, 2010; Pénin, 2012; Lemley and Melamed, 2013).[45]

Furthermore, going beyond the distinction between defensive and offensive aggregators, Caviggioli and Ughetto (2016) and Hagiu and Yoffie (2013) identify the "super-aggregator" business model. Because of its aggressive patent enforcement activities, this category is the closest to the PAE business model, however it is brought to a much larger scale (Hagiu and Yoffie, 2013). These aggregators, in fact, generate revenues from large technology companies, or from institutional investors, and offer them a return for their investment. The capital raised is subsequently used by super-aggregators to finance patent purchases campaigns with the goal of patent monetization through sales or licensing (Caviggioli and Ughetto, 2016).

However, although defensive aggregators are aligned with the subscribers' aim of reducing the litigation threat posed by PAEs, this alignment doesn't inherently lead to an enhancement in the overall efficiency of the patent market (Hagiu and Yoffie, 2013; Comino et al., 2019). In fact, at least to some extent, aggregators may foster collusion between larger operating companies, thus potentially harming smaller inventors (Hagiu and Yoffie, 2013). The patent aggregator business model, by definition, revolves around the acquisition of relevant patent assets at the lowest possible cost to safeguard the aggregator's members , rather than maximizing the value of the patents they acquire (Cosandier et al., 2014; Comino et al., 2019). Consequently, patent aggregators may unintentionally exacerbate the imbalances in bargaining power and information asymmetries between smaller patent-owners and large operating firms (Hagiu and Yoffie, 2013).

[45] Additionally, through a series of semi-structured interviews with patent aggregating companies, Krech et al. (2015) identify four typologies of patent aggregators based on the value they provide to the original patent holders: the *guarders*, the *shielders*, the *funders* and the *earners*.

1.3.1.5 Technology developers and R&D companies

Finally, NPEs can actively pursue research and technology development activities, thus assuming the role of technology providers specialized in upstream R&D activities (Hemphill, 2014a).[46] In this category one can find companies that invested in the development of technologies, mainly with the intention of licensing rather than commercializing any products or services (Cotropia et al., 2018). From a value chain perspective, vertical specialization enables technology providers to gain advantage in product innovation, and to reap the benefits of process innovation investments made by their manufacturing partners (Shin et al., 2017). This is common for complex technologies, which may also present long technology value chains, such as for instance in the semiconductor industry where firms focused on technology development are referred to as "fabless firms" (Langlois, 2003). Therefore, R&D specialists may decide to outsource manufacturing activities (Arora et al., 2001; Gambardella et al., 2007), or seek to license their patents on the market for technologies to technology-implementing companies, which operate further down in the value chain (Pénin, 2012; Larson, 2013; Bian, 2021). Some relevant contributions emphasize the engagement of these NPEs in direct R&D activities, referring to them as "R&D-performing NPEs" (Cheng et al., 2017), "technology development firms" (Leiponen and Delcamp, 2019), or "technological firms" (Pénin, 2012). Fischer and Henkel (2012) describe this typology of NPEs as "pure research firms" seeking to license their technologies, specifying that technology licensing by pure research firms generally occurs *"ex ante,"* thus before patent infringement occurred (Fischer and Henkel, 2012). These NPEs are also found to possess strong technology transfer capabilities (Cheng et al., 2017). In fact, potential technology-users may find greatly beneficial to conclude deals with the "R&D-performing NPE," which generally license not just the patents but also the key knowledge and know-how associated with the developed technology (Cheng et al., 2017).

The technical expertise of this type of NPEs enable them to strategically direct their licensing and litigation efforts (Pohlmann and Opitz, 2013), thereby mitigating the risk of engaging in inefficient litigation (Leiponen and Delcamp, 2019). Thus, given their patent portfolios, non-practicing technology providers may be well positioned to resort to strategic patent enforcement (Chien, 2010; Leiponen and Delcamp, 2019).

[46] In its broad definition, the term NPEs includes a very broad range of actors. From this perspective, start-ups, single inventors, universities and technology transfer offices can all be considered as NPEs. For instance, universities often patent the inventions that are developed in their laboratories with the aim of transferring and monetizing the technology, thereby functioning as non-practicing patent holders (Chien, 2010).

1.3.2 Patent quality and NPEs

Although a complete discussion of patent quality is outside the scope of this literature review, this theme frequently emerges in relation to NPEs' activities and business models.[47]

Defining and assessing patent quality constitutes one of the most challenging, and long investigated, research topics in the field of economics of innovation and intellectual property studies. In fact, patent quality is inherently a multidimensional concept (Higham et al., 2021), as it involves a certain degree of subjectivity due to the involvement of various stakeholders throughout all the stages of the patent life-cycle, from the patenting process to its subsequent use and commercialization (Van Pottelsberghe de la Potterie, 2011; Guerrini, 2013; Khanna, 2019). The patent system, in fact, is the result of complex interactions between its actors, who bring forward their specific expertise and interests, so that the concept of patent quality is shaped by these interactions (Khanna, 2019). Therefore, the perception of a patent applicant, a patent examiner, a patent attorney, a patent-owner and a patent-user may be very different (De Rassenfosse et al., 2021). Despite this inherent complexity, there exists a substantial body of research aiming to identify effective measures and indicators that can actually capture the multifaceted nature of patent quality (Lanjouw et al., 1998; Harhoff et al., 2003; Lanjouw and Schankerman, 2004; Mann and Underweiser, 2012; Trappey et al., 2012; Squicciarini et al., 2013; Higham et al., 2021; De Rassenfosse et al., 2021).

Overall, two main interconnected aspects concur to define the quality of a patent: technical content and legal robustness (Scellato et al., 2011; Khanna, 2019). The technical content of a patent refers to the technical merit of the technology protected by the patent claims and its level of inventiveness. A patent with high technical quality is one that is likely to protect a technological breakthrough, or a significant technical advancement in its field of technology (Arrow, 1962). On the contrary, a patent with lower technical quality may describe a more incremental improvement of an existing technology, or it may be narrower in scope (Khanna, 2019). On the one hand, the literature has acknowledged various indicators to capture the technological quality of a patent.[48] For instance, patent citations have often been deployed to capture the radicalness of an innovation (Griliches, 1990; Trajtenberg, 1990; Jaffe and Trajtenberg,

[47] In this article, patent quality is kept distinct from *patent value*, although the two concepts are sometimes grouped together and considered in a single dimension (Burke and Reitzig, 2007). In fact, patent value more specifically deals with the commercial value and the market opportunities of having an intellectual property right (Kabore and Park, 2019).

[48] Squicciarini et al. (2013), for instance, developed a series of indicators to evaluate patent quality and build novel indexes, for example: patent citations (forward and backward), number and content of patent claims, patent scope, citations to non-patent literature, family size, grant lag, generality index, originality index, etc. According to Trajtenberg (1990), patents with a greater number of technology classes cited in their prior art are more original, as they integrate in a novel way technological elements from diverse fields (Guerzoni et al., 2014)). Conversely, according to Serrano (2010), patents that score higher in generality are more likely to be traded.

2002; Harhoff et al., 2003; Hall et al., 2005). The size of the patent family and a broad geographical protection generally signal high technical quality (Putnam, 1996; Harhoff et al., 2003; Martinez, 2010; Dechezleprêtre et al., 2017). Patent claims are often analyzed, in terms of quantity, content and clarity, to assess patent scope, and therefore the technology's breath (Lerner, 1994; Marco et al., 2019). On the other hand, a patent is generally considered to be legally robust if it has a high probability of being upheld in court (Mann and Underweiser, 2012). Thus, from this standpoint, patent quality refers to the ability of a granted patent to reach (or exceed) the statutory requirements of patentability, namely novelty, non-obviousness, and industrial applicability (Wagner, 2009).[49] Failure to satisfy these criteria renders an invention ineligible for patenting in the first place, or it exposes the resulting patent to the risk of being invalidated in court (Merges, 1999). Other factors that may affect the legal robustness of a patent include the clarity and specificity of its claims, or the presence of prior art that may be used to challenge the patent in validity and opposition proceedings (Harhoff and Reitzig, 2004; Scellato et al., 2011).

In this context, part of the literature on NPE business models sees in poor, or declining, patent quality the reason behind the emergence and proliferation of NPEs. According to this perspective, NPEs initiate opportunistic litigations leveraging on low quality patents that should not have been granted in the first place, while other studies, instead, debunk this perspective. Moreover, several authors aim to empirically investigate the quality characteristics of NPEs' patents compared to those owned, and/or litigated, by operating companies (Shrestha, 2010; Allison et al., 2011; Lu, 2012; Fischer and Henkel, 2012; Mazzeo et al., 2013; FTC, 2016b; Caviggioli and Ughetto, 2016; Cheng et al., 2017; Kesan et al., 2019; Chávez and Lara, 2020; Gossart et al., 2020; Sterzi et al., 2021; Bian, 2021; Sterzi et al., 2022; Ma et al., 2022).

Therefore, some scholars argue that the intensification of patent litigation initiated by NPEs, especially from the 2000s onward, was inflated by the granting of patents of dubious quality (Mann, 2005; Chien, 2010; Allison et al., 2011; Thumm, 2018; Comino et al., 2019). According to Mann (2005), the intense NPE litigation activity traditionally taking place in the US is due to the significant number of patents granted for software innovations.[50] In fact, the high degree of abstraction of software translates into broader and unclear patent claims, which ultimately result in fuzzy patent boundaries (Comino et al., 2019). This, together with the broad interpretation of software patent claims by US courts in the past years, increases the risk of litigation because of accidental infringement (Thumm, 2018).[51] In this respect, Allison et al.

[49] Statutory requirements for issuing patents are generally similar across jurisdictions but not identical (Khanna, 2019), and differences may occur for instance in patentable subject matter, utility, and appropriate disclosure (Scellato et al., 2011).

[50] In its 2016 report the US Federal Trade Commission found that approximately 75% of the patents asserted by highly litigious PAEs include software-related claims (FTC, 2016b). Furthermore, when considering patent aggregators (defined in the FTC report as "Portfolio PAEs"), the number of software patents is around 80% (FTC, 2016b).

[51] Mann (2005) also discusses patent quality in biotechnology, a relatively young industry where a large portion of prior

(2011) find that both litigated software patents and patents owned by NPEs turn out to be weaker—from a legal standpoint—compared to other litigated patents. Analyzing the litigation frequency, in fact, NPEs and software patent holders consistently experience unfavorable rulings, even when repeatedly litigating their patents (Allison et al., 2011; Mazzeo et al., 2013). In addition, several empirical studies indicate that NPEs acquire weak and lower-quality patents to initiate patent litigations (Allison et al., 2010, 2011; Cohen et al., 2016, 2019; Mazzeo et al., 2013; Feng and Jaravel, 2020). In this respect, Chien (2010) also suggests that NPEs are to blame for having generated a patent "arms race." That is, by fostering a market for patents that are never actually used, NPEs contributed in decreasing the overall quality of the issued patents (Chien, 2010). Along these lines, both Allison et al. (2011) and Pohlmann and Opitz (2013) emphasize that initiating patent enforcement against multiple infringers—a typical NPE strategy (Chien, 2012; Larson, 2013)—may signal simultaneous invention and, consequently, raise questions about the patent's level of obviousness. Recently, Feng and Jaravel (2020) has suggested that PAEs predominantly acquire patents granted by the so-called "lenient examiners." These patent examiners, in fact, are those that are responsible for issuing patents of lower quality, which have higher probabilities of being both invalidated and litigated more frequently (Feng and Jaravel, 2020).

However, opposite empirical findings demonstrate that patents acquired and litigated by NPEs are generally of high quality—if not of higher quality—as compared to operating companies, in terms of both technical content (proxied by various indicators of technological quality) and legal robustness (in terms of survival to invalidity and opposition) (Fischer and Henkel, 2012; Larson, 2013; Risch, 2015; Kesan et al., 2019; Leiponen and Delcamp, 2019; Gossart et al., 2020; Bian, 2021; Ma et al., 2022; Sterzi et al., 2020). For instance, Risch (2015) finds that software patents—in particular those acquired by NPEs—tend on average to survive more often in invalidity proceedings compared to hardware-related ones. Similarly, both Fischer and Henkel (2012) and Lu (2012) conclude that NPE-acquired patents are of significantly higher quality compared to those acquired by operating companies. Furthermore, Ma et al. (2022) find that the most valuable patents sold by firms filing for bankruptcy are more frequently acquired by NPEs. In terms of legal robustness, recent empirical evidence offered by Bian (2021) suggests that NPE-owned patents survived validity challenges more often than operating company patents.

As already outlined, at least partially, in Section 1.3.1, several scholars investigate the propensity of different NPE business models towards the acquisition and assertion of patent rights of different quality (Pohlmann and Opitz, 2013; Caviggioli and Ughetto, 2016; Leiponen and Delcamp, 2019; Sterzi et al., 2021). Thus, part of the literature moves away from a uniform perspective on NPEs and explores the

art is not in the form of patents, but in the form of non-patent information.

preferences of various NPE business models towards different patent quality features. For example, Pohlmann and Opitz (2013) find that NPEs that do not actively perform R&D and resort more frequently to assertive litigation, own legally weaker patents that are likely to be invalidated in court. Caviggioli and Ughetto (2016) point out how defensive patent aggregators tend to buy younger and higher quality patents. This acquisition pattern provide long-lasting protection to the aggregator's subscribers, and it is consistent with a "catch and release" approach, whereby purchased patents are resold in the open market to other entities (Caviggioli and Ughetto, 2016). As compared to operating companies and other forms of NPEs, aggregators acquire patents that, on average, receive more forward citations, are narrower in scope, display a higher technical merit, have a longer residual life and list fewer inventors in the patent application (Caviggioli and Ughetto, 2016). Sterzi et al. (2021), investigating the characteristics of patents owned by NPEs registered as dormant companies in the UK, reveal that NPEs' portfolios, although of average technological quality, are more likely to be infringed and litigated. By providing a novel taxonomy of NPE business models, Leiponen and Delcamp (2019) highlight that generally all types of NPEs tend to acquire broader patents in terms of number of claims, as compared with operating firms. However, the authors find substantial heterogeneity persists both between NPEs and operating companies and among the different types of NPE business models suggested (Leiponen and Delcamp, 2019). In fact, compared to product-companies, "independent licensing companies" and "technology development companies" are found to acquire highly cited patents. Patent aggregators, instead, purchase patents that received fewer citations, while "entities affiliated with product firms" (i.e., patent privateers) are not statistically different from operating firms (Leiponen and Delcamp, 2019).

In this respect, in Chapter 2 of the present thesis, we explore the patent acquisition strategies employed by NPEs in Europe and examines in detail the characteristics of the patents acquired by different NPE business models (Sterzi et al., 2022). Contrary to the Fischer and Henkel (2012) and Leiponen and Delcamp (2019), who rely on limited samples of patents acquired by large and known NPEs, our data allow for a wider and more systematic identification and analysis of the activity of NPEs. In fact, we included subsidiaries and small entities that often escape the media's attention. We empirical shows that, on many levels, NPEs differ significantly from operating companies with respect to the characteristics of the patents they acquire. In addition, we investigate possible heterogeneity due to diverse NPE business models. In this way, we contribute to the literature in two ways. Firstly, we build upon Leiponen and Delcamp (2019) and we develop a taxonomy of NPEs based on two dimensions: the propensity of the NPE to acquire (rather than to file) patents, and the NPE patent litigation intensity. Depending on the relative position in the distribution, NPEs are assigned to one of the following three categories: "Technology NPE" (if the NPE portfolio consists in large part of filed patents, rather than acquired patents), "Litigation NPE" (if the NPE portfolio consists in large part of acquired patents that are used relatively often in litigation activities), and "Portfolio NPE" (if the NPE portfolio consists in large part of acquired patents that are

used relatively rarely in litigation activities). Secondly, we additionally investigate the quality features of the acquired patents and how these patents are used. More specifically, we find that "Litigation NPEs" acquire patents at high risk of infringement, but of similar technological quality if compared with patents acquired by practicing companies. This is not the case of other types of NPEs that, instead, acquire highly-cited patents. Additionally, our empirical results indicate a heterogeneous correlation of patent acquisition strategies with follow-on innovation across NPE business models. In this respect, we observe that, after the transfer, the number of citations drops significantly only for patents acquired by "Litigation NPEs." This suggests that both the use of these technologies and the overall level of subsequent innovation reduce when more aggressive NPEs enter the market for technology through patent acquisitions.

Finally, our review of the literature help us identify an interesting contribution at the crossroads of the economic and legal research. That is, Brander and Spencer (2021) contribute to the literature on NPEs by proposing a theoretical model to investigate the strategic relationship between NPEs' enforcement strategies in different legal regimes (i.e., fee-based vs injunction-based) and the patent quality features of the asserted patents. The authors theoretically suggest that NPEs litigate taking into account both dimensions, that is, patent quality on the one side, and the type of jurisdiction on the other (Brander and Spencer, 2021). Based on their contribution, in Chapter 3 of the thesis, we empirically contribute to the analysis of the relatively overlooked NPE enforcement activities in Europe (Sterzi et al., 2022). Thus, we link together, in an original way, the quality characteristics of NPEs' litigated patents and the choice of the most favorable jurisdictions where to initiate a patent infringement lawsuit (i.e., forum shopping). More precisely, we hypothesize that NPEs present different patent enforcement incentives compared to operating companies. Specifically, NPEs bring litigation in different European legal regimes—i.e., in either injunctive-based or fee-based regimes-—depending on the quality characteristics of the asserted patents. Our findings suggest that NPEs, contrary to product-companies, strategically adapt their forum shopping activity and assert higher-quality patents in injunctive-based jurisdictions (such as Germany and Italy), and lower-quality patents in fee-based jurisdictions (such as France and the UK).

1.3.3 Effects of NPEs on technology markets

To what extent do NPEs patent monetization activities stimulate technology diffusion? As previously outlined from the analysis of the empirical contributions that explore the different NPE business models (Section 1.3.1) and the review of the studies that investigate more closely patent quality in relation to NPEs' acquisitions and litigations (Section 1.3.2), the literature is equally polarized regarding the broader impact of NPEs on technology markets. This is largely due to the difficult empirical assessment of the net effect of NPEs' activities (Abrams et al., 2019), which leads to mixed findings within the reviewed contributions.

Numerous negative side effects related to some NPE business models on product-manufacturing companies operating further down in the technology value chain are empirically documented in the literature. First, contrary to the idea for which NPEs constitute valuable intermediaries, there is evidence that only a relatively small share of the costs imposed by NPEs to targeted firms is eventually passed to the original patent-owner (Morton and Shapiro, 2013). In the words of Morton and Shapiro (2013): "the transfer of funds from allegedly infringing downstream firms to patentees is done using a very *leaky bucket*." In addition, Feldman and Lemley (2015) cast doubts on the possibility that licensing demands by NPEs consist in actual technology transfer. The authors suggest, on the contrary, that licensees are more likely to purchase the freedom to keep using the technology that has already been implemented (Feldman and Lemley, 2015). Additionally, there is evidence of NPEs frequently discussed opportunistic behaviors. Not only NPEs use weak patents to engage in strategic litigations (Lu, 2012; Feng and Jaravel, 2020), but they are also find to frequently provide incomplete information regarding patent ownership, thus concealing on purpose the boundaries of patent rights (Sterzi, 2021; Sterzi et al., 2021). In this regard, NPEs often make use of subsidiaries to confound both their competitors and their litigation targets about their acquisition strategies (Sterzi et al., 2021; Sterzi, 2021), which ultimately increase licensing costs (Feldman and Ewing, 2012; Morton and Shapiro, 2013).

Second, there is evidence supporting the common allegation that NPEs impose a "tax on innovation" (Morton and Shapiro, 2013; Asay, 2017; Lemley and Feldman, 2018). Specifically, Morton and Shapiro (2013) argue that NPEs can potentially hinder two types of competition dynamics. First, NPEs may request royalties beyond the actual value of the technology being licensed and, as a consequence, these excessive royalty demands may push downstream operating firm to raise their prices, ultimately harming consumers (Morton and Shapiro, 2013). Second, as NPEs reduce the downstream firm's profits by taking a share of them, innovation may be substantially discouraged if operating innovative firms are not adequately compensated for their past R&D investments (Morton and Shapiro, 2013). Additionally, if downstream manufacturers fear potential holdup coming from NPEs they may decide to adapt their investment strategies, thus offering products that diverge from those that would emerge in a truly competitive market (Morton and Shapiro, 2013). For instance, if an NPE has developed a portfolio targeting a specific industry, new industry players may be deterred from selling their products, or they may need to adapt such products to avoid being "taxed" by NPEs (Morton and Shapiro, 2013).

Several contributions highlight how that such "tax" can take various forms. In fact, shedding light on the economic impact of patent litigation initiated by NPEs, Bessen and Meurer (2013) examine stock market events and estimate that defendants incurred losses of approximately half a trillion dollars over the two decades leading up to 2010. In a subsequent study, Bessen and Meurer (2014) valued the direct costs of NPE activity to amount to $29 billion in 2011. In addition, operating companies receiving licensing demands or that are sued for patent infringement by NPEs are found to experience a sensible reduction in

financing (Kiebzak et al., 2016; Thumm, 2018), which also undermines job creation (Appel et al., 2019). In this respect, start-ups and smaller companies are particularly exposed to NPEs. Based on survey data, Chien and Lemley (2013); Chien (2013) followed 300 venture capitalists and their supported start-ups and found that litigation initiated by NPEs dramatically affected both the development of new business lines and employment. Moreover, Dayani (2023) finds that NPEs' litigations negatively affect the market for firm acquisitions. Specifically, patent-infringement claims by NPEs increase the cost of innovation for small firms, forcing them to exit the market prematurely via discounted acquisitions (Dayani, 2023). Scholars have also empirically documented a decline in product commercialization after a litigation initiated by an NPE. Within the medical imaging industry, Tucker (2014) found that NPE-initiated litigation not only reduced the defendant's follow-on innovation activity, but also led to a reduction in product sales.

Finally, patent acquisition and litigation by NPEs determines both a decline in R&D and a decrease in the overall quality of patenting (Mezzanotti, 2021). In fact, operating companies that came into contact with NPEs tend to decrease their share of filed patents and increase the share of licensed patents (Yin et al., 2022). In particular, Cohen et al. (2019) not only find a decline in patenting after an NPE lawsuit, but also weaker citation patterns compared to firms whose cases are dismissed. More specifically, over 25% reduction in the targeted firms' R&D investment is due to lawsuit brought by an NPE (Cohen et al., 2016, 2019). Based on patent transfer and citation data in Europe, Orsatti and Sterzi (2023) found that the number of subsequent citations to patents acquired by NPEs decreases significantly, likely because the product-manufacturing companies reduce R&D and patent applications in the affected technology areas to avoid potential future litigation. In addition, the whole system of downstream operating companies seems to be affected by NPE enforcement practices. In fact, Chen et al. (2023) reports that the technological peers of a company sued by an NPE are likely to be negatively impacted as well. In fact, the increased chances of litigation posed by NPEs push the technological peers to intensify their R&D activities with the objective of developing alternative technologies. However, these increased R&D efforts are found to ultimately lead to an overall decline in the quality of the resulting patents (Chen et al., 2023).

On the other hand, there are opposite findings suggesting that NPEs act as beneficial intermediaries on the market for technologies. First, several studies empirically demonstrate that NPEs' acquisition and litigation activities do not systematically differ from those of their operating counterparts. In fact, Shrestha (2010) find that NPEs litigate patents of similar quality as compared to manufacturing litigants, debunking the idea they engage in opportunistic litigation. Concerning the litigation outcomes, Ashtor et al. (2013) examined over 1,750 patent cases litigated that reached a final verdict, and found little difference in the outcomes between NPEs and product-manufacturing companies. Similarly, (Cotropia et al., 2014) analyzed information about the parties involved in the patent infringement cases filed between 2010 and 2012 and concludes that the alleged dangers posed by NPE litigation are overestimated. As far as the costs associated to NPE disputes are concerned—and the alleged direct "tax on innovation" that their

enforcement practices allegedly impose—Schwartz and Kesan (2014) analyze additional data on litigation costs and settlements following an NPE lawsuit. The authors re-visit the estimates of the costs of the NPE-initiated lawsuits provided by Bessen and Meurer (2014), suggesting that such figures likely represent an overestimation of the costs sustained by targeted manufacturers. In addition, NPEs have also been frequently accused of being overcompensated in court. Analyzing cases in which damages are awarded to patent-owners, Mazzeo et al. (2013) find no significant differences in the distribution of the awards granted to NPEs as compared to those granted to operating entities.[52] Similarly, Lu (2012) analyzes licensing royalty rates and empirically demonstrates that NPEs licensing demands are not systematically inflated.

Second, several studies indicate that NPEs provide support to smaller patentees while they also help stimulate innovation. For instance, Haber and Werfel (2016) provide empirical evidence that NPEs provide insurance services, liquidity and protection against free-riding of the intellectual property of smaller and constrained innovative firms (Abrams et al., 2019). That is, NPEs enhanced bargaining power and expertise in licensing negotiation support independent inventors' innovative efforts (McDonough III, 2006; Haber and Werfel, 2016). Therefore, NPEs—particularly those who directly invest in R&D and technology development (Cheng et al., 2017)—are able to evaluate and monetize under-exploited patents Krech et al. (2015), which ultimately promotes further investments in innovation (Geradin et al., 2012). Furthermore, Chari et al. (2022), using a proprietary dataset of NPE lawsuits, find that as NPE intermediation for a given class of technologies increases, larger numbers of focused inventors—such as, small firms, universities, and laboratories—, which typically lack commercialization capabilities, start producing inventions in that technology class. Further, the authors find that, compared to their larger counterparts, these focused inventors respond to an increase in NPE intermediation by producing more inventions (Chari et al., 2022).

Interestingly, also firms "targeted" by NPEs ultimately benefit from such exposure. Lee et al. (2019) demonstrates that companies defending against NPE litigations broaden their information sources, apply for patent protection in wider technology areas, are more likely to co-patent with other entities, and engage more in patent acquisitions. Studying the Chinese patent market, the results obtained by Yin et al. (2022) suggests that the presence of NPE stimulates Chinese companies to increase R&D investment and the overall quality of the granted patents.

Finally, NPE enforcement practices have also been accused of potentially hindering both the development and the adoption of key technologies, such as the standardized ones (Comino et al., 2019). In this special context, Kang and Motohashi (2015) empirically compare operating firms and NPEs' strategies

[52] However, the value of awarded damages varies among types of NPEs, meaning among universities, individuals, and Patent Assertion Entities. In particular, universities and individuals are found to generally receive lower damage awards compared with PAEs (Mazzeo et al., 2013).

towards standard-essential patents (SEPs) and technology development. The authors find evidence that manufacturing firms accumulate their technological capability in specific technology fields, while NPEs cover broader technology sectors, thus often leading the standardization process (Kang and Motohashi, 2015). Therefore, both operating companies and NPEs contribute to the standardization process by adopting different but complementary strategies. Specifically, while manufacturers focus on subsequent innovations based on the standards, NPEs contribute more to upgrading the technology of the standard itself (Kang and Motohashi, 2015).

Triggered by the conflicting empirical evidence that emerges from the review of the empirical contributions aiming to assess the effects of NPEs on technology markets, in Chapter 2 of the present thesis we aim to go beyond this polarized debate on NPEs—generally seen as a unique phenomenon—and investigate the effects of different NPE business models on follow-on innovation (Sterzi et al., 2022). More specifically, we empirically find how different NPE business models are associated with different impacts on downstream innovation. Specifically, the use of the patents acquired by "Litigation NPEs" reduces after the acquisition, compared to acquisitions by practicing entities. This is not the case for other types of NPE business models, particularly for "Portfolio NPEs" and "Technology NPEs," which both act as valuable intermediaries in the European patent market.

1.3.4 Policy concerns and suggestions to regulate NPEs

The content analysis of the 83 identified studies on NPE business models and the broad literature review carried out uncover a significant polarization of the policy discourse surrounding NPEs. It is not entirely surprising that NPEs represent unique and controversial actors in the market for technologies (Comino et al., 2019). In fact, what makes NPEs a potential policy concern is the existence of an asymmetrical relationship between them and the targeted operating companies (Lemley and Melamed, 2013; Coase, 2013; Larson, 2013).

Arguably, the most significant strategic advantage for NPEs is their being immune to any counter-claims of patent infringement because of their non-manufacturing status (Larson, 2013; Chen et al., 2023). Contrary to competitors, in fact, NPEs cannot be counter-sued nor are interested in securing patent cross-licensing agreements with the defending company (Hagiu and Yoffie, 2013). This advantage places NPEs in a favorable position to exploit patent "hold-up" strategies (Lu, 2012).

In the context of an NPE-initiated enforcement, patent hold-up refers to the theoretical situation whereby the operating company that has already incurred considerable sunk costs to manufacture and commercialize its patent-implementing products would face the choice of either accept excessive licensing

royalty demands, or lose its sunk investments (Lemley and Shapiro, 2006).[53] Patent hold-up, therefore, potentially allows patent-owners the opportunity to charge supra-competitive licensing royalties potentially exceeding the true economic value of the patented technology (Lemley and Shapiro, 2006). Thus, patent hold-up can greatly increase the bargaining power of the patent-owner in licensing negotiations and potentially prompt downstream implementers to withdraw their products from the market (Larson, 2013). Furthermore, in order to commercialize a product, a manufacturer may need to take licenses for all the patents that affect its final product. Given that such royalties are "stacked" one upon another, this scenario is commonly referred to as "royalty stacking" (Lemley and Shapiro, 2006). The licensee might, consequently, end up with an unprofitable product as the cost of acquiring all the necessary licenses for commercialization could become prohibitively high (Larson, 2013). In addition, the simple hold-up threat leveraged by NPEs in litigation can force the alleged infringers to settle, even when the infringed patent claims are not fully disclosed, are not valid, or are not really infringed (Harris, 2014). In many instances, in fact, the cost of litigating can substantially exceed the NPE's settlement demands (Harris, 2014).

Therefore, NPEs may potentially enforce their patent rights against manufacturers that already use, at least allegedly, the patented technology (Lemley and Zyontz, 2021), which result in what is referred to as "ex post" patent licensing (Lemley and Melamed, 2013).[54] In addition, in a patent hold-up scenario, companies implementing the patented technology become committed to using it exclusively (i.e., technology "locked-in"), which implies that they can no longer explore alternative designs that may have been accessible during "ex ante" licensing negotiations (Larson, 2013). This is attributed to the fact that switching to an alternative technology, or finding a way to circumvent the infringing feature, becomes prohibitively costly (Larson, 2013). In this context, the fact that NPEs' activities may facilitate "ex post" patent transactions has raised policy concerns about the overall role of NPEs in promoting innovation and economic growth (Feldman and Lemley, 2015; FTC, 2016b).

Moreover, the possibility of obtaining injunction orders in court further exacerbates the hold-up problem and potentially increases the amount demanded to settle the dispute (Shapiro, 2010). In fact, injunctions represent highly valuable legal remedies for NPEs as they can be leveraged to effectively halt the activities of the alleged infringing company (Contreras and Husovec, 2021). This situation gives NPEs

[53] However, to date, empirical evidence supporting the patent hold-up theory is scarce. See, for instance: Geradin et al. (2008), Barnett (2014), Gupta and Snyder (2014). Additionally, in the US it is extremely difficult for patent-owners to be granted an automatic injunction since the *eBay* decision of 2006, which introduced a four-factor test before the granting of such remedy: *eBay v MercExchange, LLC, 547 US 388, 391 (2006)*.

[54] What separates "ex ante" from "ex post" is the possibility that the defending company has already invested heavily to design, manufacture, market, and sell the product incorporating the allegedly infringed technology (Lemley and Shapiro, 2006). Conversely, in "ex ante" patent transactions the technology and the related patent rights are licensed to a manufacturer before the product is developed and marketed (Mezzanotti, 2021).

significant leverage in litigation and increase their bargaining power in licensing negotiations (Chien, 2012). In fact, the mere threat of an injunction can prompt the infringing firm to settle or to speed up the ex post licensing process of the allegedly infringed patented technology to avoid the potential disruption caused by a court-ordered cease of activities (Lemley and Feldman, 2016). Moreover, NPEs can strategically file the lawsuit in a timely manner to put under maximum pressure the alleged infringing firm (Chen et al., 2023). In fact, the threat of injunction is particularly relevant when the alleged infringer has already undergone considerable investments in technology implementation and commercialization (Cotter, 2019).

NPEs can also strategically bring their lawsuits in specific jurisdictions, for instance before courts known for favoring patentees (Helmers and Love, 2022) or jurisdictions that traditionally favor granting injunctions in presence of patent infringement (Tochtermann, 2019). This practice is generally known as "forum shopping" (Moore, 2001; Elmer and Lewis, 2010). Such litigation practice can lead to inconsistent decisions (Simsek, 2017) and potentially generate an unfair advantage for patent-owner (Shapiro, 2010). In this respect, the specific rules of a certain legal environment can impact NPE business models. In fact, the rules for damage awards and injunctions can alter the NPE forum shopping practices (Fischer and Henkel, 2012). In this context, in Chapter 3, we empirically investigate NPEs' patent litigation strategies in Europe, where different legal regimes favoring either injunctions or damages exist. More precisely, we link the quality characteristics of NPEs' asserted patents with the choice of the most favorable jurisdictions where to initiate a patent infringement lawsuit (i.e., forum shopping). Our hypothesis is that NPEs have different patent enforcement incentives compared to manufacturers. In this respect, we posit that NPEs bring litigation in different European legal regimes—i.e., in injunctive-based or fee-based regimes—depending on the quality of the asserted patents.

The consequences of NPEs litigations can be particularly severe when standard-essential patents (SEPs) are involved (Kang and Motohashi, 2015; Comino et al., 2019). On the one side, the development of standardized technologies through within the framework of Standard Setting Organizations (SSOs) is regarded as having considerable advantages. Such *de jure* standardization process, in fact, provides interested market players with the opportunity to collectively develop the best technological solutions (Drexl, 2011). On the other side, when it comes to standardized technologies, NPEs may also worsen ex post licensing situations as the absence of alternative technologies is a concrete possibility given that the technology has already been standardized (Larson, 2013). Moreover, the complex standardization process may result in potential distortions of competition, and in particular in "patent ambush" (Hagiu and Yoffie, 2013; Randakeviciute, 2017). Patent ambush can be broadly described as a particular type of patent hold-up in the context of standardization (Lim, 2015). More specifically, patent ambush occurs when companies participating in standardization withhold information about the essentiality of their patents, and subsequently assert infringement claims against the implementers of the recently released standard (Pohlmann and Opitz, 2013). The goal of patent ambush is to seek licensing fees or leveraging the threat

of injunctive relief on SEPs protecting widely implemented standardized technologies (Comino et al., 2019). For example, in the early 2000s, several memory chip companies accused Rambus of ambushing the industry with litigation just after a new industry standard for microchips had been set (Wallace, 2009; Pohlmann and Opitz, 2013).[55] With respect to standard-development, the patent privateering business model prompts particular concerns as patent privateers are expected to further exacerbate patent ambush, eventually increasing the costs for downstream standard implementers (Geradin, 2019). Furthermore, there are concerns that hybrid PAEs asserting SEPs subject to fair, reasonable and non-discriminatory (FRAND) licensing terms and conditions may not honor these commitments (Harris, 2014).

According to several scholars (Morton and Shapiro, 2013; Lemley and Melamed, 2013; Feldman and Lemley, 2015), the above mentioned policy issues associated with NPEs are worsened by the fragmentation of complementary patent assets between too many patent-owners (Morton and Shapiro, 2013), such as in the case of patents that protect technologies implemented together in the same product (Contreras and Picht, 2018). In this respect, NPEs have also been found to engage in opportunistic behaviors aiming at concealing key information regarding patent transactions and ownership (Smith, 2015; Sterzi et al., 2021; Sterzi, 2021).

However, in more recent years, a new policy concern has been emerging in the context of SEPs licensing, gaining increasing attention among both scholars and practitioners (Heiden and Petit, 2017). This time concerns are directed towards the behavior of technology implementers engaging in the so-called patent "hold-out" (Layne-Farrar, 2016), which consists in opportunistically delaying patent licenses with the goal of avoiding, or minimizing, royalty payments (Love and Helmers, 2023). Patent hold-out, which has been described as the opposite situation to patent hold-up (Angwenyi, 2017), has gained vast attention in recent years and not only from policymakers and media outlets,[56] but also from academic scholars that devoted several theoretical contributions to discuss the policy implications of such opportunist behavior arising from the licensees' side (Layne-Farrar, 2016; Heiden and Petit, 2017; Llobet and Padilla, 2023). At the same time, there is consistent anecdotal evidence from case law documenting that some implementers are intentionally using various delaying tactics to avoid taking a license (Epstein and Noroozi, 2017; Heiden and Petit, 2017; Gupta et al., 2019; Heiden and Rappaport, 2023; Barnett and Kappos, 2022). As a result, SEPs licensing coverage has been falling steadily over the past few years and this has warned

[55] See: *Rambus, Inc. v. Infineon Techs. AG, 318 F.3d 1081 (Fed. Cir. 2003)*. In *Rambus, Inc. v. Infineon Techs. AG*, Rambus filed patent applications intending to sue implementers once the standard became widely adopted. The Court of Appeals for the Federal Circuit held that the Standard Setting Organization (SSO) rules did not expressly impose a duty on Rambus to disclose its patents, and instead faulted the SSO for failing to draft a policy to address attempts by Rambus to "mine a disclosed specification for broader undisclosed claims" (Lim, 2015).

[56] See JRC (2016). See also: IAM, 24 January 2020, "The focus in Europe moves from patent hold-up to hold-out": https://www.iam-media.com/article/hold-out-in-europe-recent-evidence-and-its-impact.

about the long-run negative effects of hold-out on the sustainability of technology standardization (Heiden and Petit, 2017). Interestingly, in this scenario, NPEs—and in particular PAEs specialized in patent enforcement—may represent key partners for other technology developing companies to tackle the patent hold-out strategies adopted by implementers (Nikolic, 2019). For instance, the JRC (2016) study has precisely confirmed that difficulties in patent monetization may lead R&D-focused companies to transfer their patents to PAEs to enhance their monetization chances (Nikolic, 2019).

To the best of our knowledge, the vast majority of the literature analyzed has largely focused its policy concerns on the potential negative impact of NPE patent assertions on the alleged patent infringers. Instead, only a very limited number of contributions that delve specifically into NPE business models has also discussed the policy implications of patent hold-out coming from implementers (JRC, 2016; Nikolic, 2019). In Section 1.4, we will present three instances of NPE business model and we will outline how the challenge to overcome hold-out behaviors constantly emerges in all of the interviews collected.

In what follows we present the policy solutions discussed in the literature to limit the potential negative harms deriving from NPEs' activities. A consistent number of studies that we have reviewed suggest various solutions to mitigate the potential undesirable effects of NPEs activities. We identify four main axis of policy intervention—(1) patent office policy, (2) patent law policy, (3) competition policy and (4) marketplace and managerial solution—and we present the proposals put forward accordingly.

1.3.4.1 Patent office policy

The idea that patent quality and intensity of NPEs activity are strictly related clearly emerges from the many proposals aimed at increasing the overall quality of the grated patents in several jurisdictions. More specifically, NPEs exploit frictions in the patent system that then affect litigation more broadly, such as the way patent rights are crafted (Feng and Jaravel, 2020). Numerous articles consider patent and trademark offices (PTOs) standards unsatisfactory (Chien, 2010; Allison et al., 2011; Smith, 2015; Feng and Jaravel, 2020). In this respect, different scholars advocate for patent policies focused on promoting invention quality, rather than limiting litigation (Lemley and Melamed, 2013; Leiponen and Delcamp, 2019; Sterzi et al., 2021; Feng and Jaravel, 2020). Suggested solutions foresee a limitation of broad patent claims with the purpose of increasing clarity of granted patents' boundaries, along with enhanced patent clearance and discovery (Pohlmann and Opitz, 2013; Reilly, 2015; Turner, 2018; Comino et al., 2019). Other contributions advocate for greater transparency in both the corporate and patent markets, suggesting increasing patent offices authority in monitoring patent ownership changes (Landers, 2006; Sterzi et al., 2021; Sterzi, 2021).

1.3.4.2 Patent law policy

In the domain of patent and administrative law, several suggestions are presented with the aim to tighten patent validity requirements, and generally to curb the leverages of NPE litigation.

The high costs of patent enforcement, in particular in the US legal system, has been associated with NPE misbehavior (Mann, 2005; Lemley and Melamed, 2013; Schwartz and Kesan, 2014). In order to tackle frivolous litigations, proposed interventions include a case-by-case analysis to evaluate the relative importance of the infringement, alternative payment schemes such as capped fees per phase of the case, and an overall reduction of legal costs for accused infringers (Schwartz and Kesan, 2014). To reduce NPEs leverage and the profitability of their business model, the broad adoption of loser-pays-all provisions is advised (Pénin, 2012). A prominent proposal advocates for a limitation of permanent injunctions awarded to NPEs in infringement cases (Mann, 2005). This proposal found actual implementation in the 2006 *eBay* Supreme Court decision (Sung, 2015).[57] In assessing the effects of *eBay*, Sung (2015) find that the decision had the effect of discriminating NPEs not directly investing in R&D. On the topic of restricting the scope of patent-eligible subject matter, Lemley and Zyontz (2021) empirically assess the effects of the 2014 *Alice Corp. v. CLS* US Supreme Court decision on district and federal court decision outcomes.[58] As a result of *Alice*, individual inventors and inventor-started companies were found to be more likely to lose their patents as compared to aggressive NPEs (Lemley and Zyontz, 2021). Administrative mechanisms to challenge the validity of already granted patents are discussed. According to Schwartz and Kesan (2014), both the Inter Partes Review (IPR) and Post Grant Review (PGR) proceedings introduced by the America Invents Act provide effective validity challenges.[59] Additional mechanisms, such as the provision of a "small-claims court" for patents below a threshold value and Alternative Dispute Resolution (ADR), are advised (Schwartz and Kesan, 2014). Given that Inter Partes Reviews tend to terminate when parties settle, to wipe out low quality patents Bar and Kalinowski (2019) suggest the IPR proceedings to be extended until a decision on validity is made, regardless the presence of settlement agreements.

However, the literature recognizes the challenge for policy makers to design a balanced patent systems able to curb troll-like behaviors while preserving the interests of technological firms and brokers, which

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

[58] *Alice Corp. v. CLS Bank International, 573 U.S. 208 (2014).* In *Alice*, the Court confirmed that to determine the patentability of a claim, a two-step test should be followed. The test consists of the following questions: (1) is the claim "directed to" an abstract idea, law of nature, or other excluded subject matter? and (2) if so, does the claim include an inventive step beyond merely the claimed abstract idea or natural phenomenon? (Lemley and Zyontz, 2021)

[59] Following the Leahy-Smith American Invents Act (AIA), three proceedings for challenging the validity of issued patent claims have been introduced: Inter Partes Review (IPR), Post-Grant Review (PGR) and Covered business method review (CBM) (Martinelli et al., 2022).

play a vital role in a knowledge-based economy (Mann, 2005; Pénin, 2012; Schwartz and Kesan, 2014; Asay, 2017; Lemley and Zyontz, 2021).

1.3.4.3 Competition policy

Among the studies reviewed, the antitrust remedies discussed mainly refer either to the US or Europe. Relative to the US, Abramson (2014) discusses the relationship between the spread of NPEs' patent monetization activities and the antitrust interface, arguing that the period of strong IPRs policy started in the 1980s ultimately led to instances of anticompetitive abuses by NPEs. More generally, Young (2016) discusses the harms posed by NPEs to the stability of the IP system, and the ways in which antitrust law can be designed to defend against abuses. More specifically, the author also discusses how patent aggregators monopolistic power makes them susceptible of antitrust violations in the US (Young, 2016). On the same line, Heinecke (2015) suggests that PAEs exhibit anticompetitive behavior in certain areas of the patent system, such that they became a major target of the Federal Trade Commission (FTC) (Heinecke, 2015; FTC, 2016b). The author then proposes several avenues of interventions and advocates for a more active role of the FTC in order to control for anticompetitive behaviors (Heinecke, 2015).

On the European side, Gagnon (2013) discusses PAE business models through the lens of competition law and proposes a theory of harm that aligns with EU competition law.[60] From this standpoint, PAEs are accused of hindering both dynamic competition, by reducing incentives to innovate, and static competition, by increasing prices and potentially removing products from the market (Gagnon, 2013). Similarly, Boscheck (2016) bridges the gap between competition law and NPE business models, drawing on US regulatory antitrust standards to analyze novel antitrust interfaces for the EU. Finally, Geradin (2019) discusses the potential competitive harm stemming from from both "pure" PAEs and "hybrid" PAEs. Hybrid PAEs, which maintain contractual relationships with the original patent holder, raise concerns regarding potential exclusionary practices and harm to downstream competitors (Geradin, 2019).

1.3.4.4 Marketplace solutions and managerial implications

A residual category of solutions to mitigate the frequency of NPEs patent litigation consists in marketplace recommendations. Hemphill (2014a) suggests a combination of insurance products and crowd-sourcing services to review prior art. Similarly, Ganglmair et al. (2022) empirically explore the effects of the

[60] More specifically, Gagnon (2013) tries to determine whether PAEs can qualify as restraints of competition under European competition law — in particular in light of the *Treaty on the Functioning of the European Union*, 2008 O.J. C-115/47 (TFEU), particularly art. 102 — and under which circumstances. The author suggests that PAEs patent litigation may take advantage of the hold-up value of a technology (Lemley and Shapiro, 2007).

subscription of defensive litigation insurance products on the behavior of both NPEs and infringers, showing a substantial negative effect of the insurance on the likelihood of subsequent litigation of the insured patents. Finally, some scholars see in patent aggregators a possible defense against nuisance patent assertions (Schwartz and Kesan, 2014; Kwon and Drev, 2020).

On the operating companies side, some suggestions directed to managers are proposed (Reitzig et al., 2007; Fischer and Henkel, 2012; Ryu et al., 2016; Lee et al., 2019). First, operating companies are advised to adopt an active approach against possible NPEs' litigations. Specifically, operating firms should implement advanced patent clearing processes and closely monitor the technology landscape in order to minimize the risk of inadvertent infringement (Reitzig et al., 2007; Lee et al., 2019). Additionally, while in the short run practicing companies are called to actively engage in strategic patent acquisitions before NPEs do, in the long run they are advised to establish new forms of cooperation (Ryu et al., 2016), such as consortia and alliances with the objective of consistent patent acquisitions (Fischer and Henkel, 2012).

1.4 Case studies

As emphasized in both the bibliometric analysis carried out in Section 1.2 and the broader literature review presented in Section 1.3, the empirical economic literature analyzed reports and analyzes various types of data. Different data sources are used to investigate, for instance, NPEs incentives, assess the direction of the interplay between NPEs and patent quality, and estimate the effects of NPEs on technology diffusion (Shrestha, 2010; Lu, 2012; Fischer and Henkel, 2012; Cheng et al., 2017; Appel et al., 2019; Leiponen and Delcamp, 2019; Cohen et al., 2019; Feng and Jaravel, 2020; Gossart et al., 2020; Sterzi et al., 2021; Sterzi, 2021; Chari et al., 2022; Chen et al., 2023). Key sources of information consist in patent filings, acquisitions and litigation data, often combined with patent quality characteristics proxied by patent indicators. In the legal field instead, case law and legal changes are analyzed in details (Chien, 2010; Yang, 2012; Abramson, 2014; Gabison, 2015; Sung, 2015; Meng, 2016; Jenweeranon, 2017; Layne-Farrar, 2017; Volik et al., 2019; Lemley and Zyontz, 2021).

However, two main limitations emerge. First, patent licensing deals represent fundamental sources of data and information on NPEs business models and strategies (Lu, 2012). Such data are, however, extremely difficult to access due to their secrecy (Thumm, 2018; Comino et al., 2019).[61] Another relevant limitation that emerges from the review of the relevant literature is the tendency of several studies to treat different NPE business models uniformly when assessing their activities and impacts on technology

[61] Licensing deals information are generally not available for use and peer review. Therefore, data on licensing agreements are largely unexplored in the literature, with the exception of Lu (2012).

markets.[62] Overall, a consistent part of the literature tends to broadly classify companies as either NPEs or non-NPEs. Moreover, the review of the literature has highlighted the need to gain more insights on the factors that induce innovators to commercialize technologies via NPEs (JRC, 2016; Thumm, 2018; Comino et al., 2019).

Given these data limitations and the under-explored differences between NPE business models, case studies can be particularly suited to provide new knowledge and new understandings of real-world NPEs.[63] Therefore, we complement the present systematic literature review by providing three case studies to further investigate in details how NPE business models operate in practice. In fact, in the absence of key licensing data, our case studies can help us to empirically explore the functioning and the incentives of several types of NPEs and shed light on the main drivers behind NPEs activities, and provide new knowledge on NPEs business models (Larson, 2013). Moreover, we also aim to clarify the role and the benefits that NPE intermediaries can bring to the market of technologies.

Specifically, the case studies provided on NPE business models have been empirically investigated through three semi-structures interviews with high-level experts in the IP licensing field and complemented by secondary data (Patton, 1990; Shaban, 2009). The interviews involved three different representatives and IP experts of European-based NPEs, active at both the European and the international level. The focus on European-based NPEs was justified by the need to collect more information on the European NPE phenomenon, which is not only the central research theme of the present thesis, but it also represents an under-explored topic of research. In fact, many of the contributions reviewed mainly focus and report instances of large and well-known US-based NPEs (Chien, 2010; Pohlmann and Opitz, 2013; Hagiu and Yoffie, 2013; Lim, 2015; Caviggioli and Ughetto, 2016).

The interviews have been conducted between January 2023 and April 2023, and were approximately from twenty to sixty minutes long. When requested, the company and experts' names have been anonymized to ensure confidentiality, enhance trust and assure a transparent information flow, as in the case of the second and the third case study. Interviewees were presented beforehand with a standard interview template consisting of 19 questions (reported in Appendix 1.7.4).[64] The template was not strictly implemented, but it rather served as a reference for a flexible discussion on the following four main subjects: (1) degree of

[62] With few notable exceptions that have been reported and discussed in the previous sections. See, for instance, among other: Fischer and Henkel (2012), Pohlmann and Opitz (2013), Thumm (2018), Leiponen and Delcamp (2019).

[63] In the words of Shaban (2009), a case study is an "empirical inquiry that investigates a contemporary phenomenon (the "case") in depth and within a real-world context, especially when the boundaries between phenomenon and context may not be clearly evident" (Larson, 2013).

[64] Semi-structured interviews provide the investigator with a flexible framework that allows for open-ended responses and exploration of specific topics. The presence of an interview template ensures consistent questions across interviewed subjects, it and provides a baseline for comparison across interviews (Adeoye-Olatunde and Olenik, 2021).

company's involvement in direct R&D activities; (2) intensity, frequency and objective of the company's patent acquisition; (3) the company's patent licensing and portfolio management; (4) intensity, frequency and objective of the company's patent assertions. In addition, secondary sources—such as US and EU courts decisions and patent laws, press releases, company websites and reports—have been investigated to provide a comprehensive understanding of the NPEs business models. As presented in Section 1.3.2, patent quality can be defined and assessed from multiple viewpoints (Higham et al., 2021). In this context, the heterogeneity and complexity displayed by the companies that employ the interviewees provides novel insights on such a relevant topic. More specifically, the three stakeholders were asked to provide a definition of patent quality, and to elaborate on topic. In addition, interviewees were asked if specific patent quality indicators are adopted in the industry, or taken into account for the firms' activities.[65]

Finally, to further explore the companies' business models, interviewed subjects were asked in some instances to provide their perspective on a broader range of topics, such as the dynamics and timing of patent licensing negotiations in the context of potential hold-out, the company's litigation strategies, and the influence of different jurisdictions features on the company's enforcement activities.

1.4.1 Case study 1: France Brevets

The interviewee is a qualified European patent attorney and intellectual property rights expert who held the position of Chief Executive Officer (CEO) of France Brevets.[66] France Brevets is a former French government-backed patent fund and patent monetization entity (i.e., a sovereign patent fund).

Overview and business model of the company

The company was founded in 2011 in the context of the national technology and innovation investment plan "Programme d'Investissement d'Avenir", promoted by the French government and managed by the General Secretariat for Investments (*Secrétariat général pour l'investissement*). France Brevets was established as a private entity with two main public shareholders: from the one side the French government, from the other a French public financial institution (*Caisse de Dépôt et Consignations*), which contributed with an endowment of €100 million. With respect to the investment plan's general objective of supporting French innovation, the company was conceived to collaborate with the already existing technology transfer

[65] As a benchmark, common patent quality indicators used in the economic literature were presented to the interviewees, such as: number of forward and backward citations, number of patent claims, family size, legal status of the patent, etc (Squicciarini et al., 2013). See Appendix 1.7.3 for the complete list of benchmark patent quality indicators presented to the interviewees.

[66] The interviewee has been at head of the company from 2017 to 2022.

offices (TTOs), the institutes for technology research (*instituts de recherche technologique*), and the energy transition institutes (*instituts pour la transition énergétique*).

Therefore, the mission of France Brevets was to transform IP assets into value by aggregating patents and providing monetization services to French patent owners, in both the public and private sectors. In this respect, France Brevets main activities involved establishing transactions and creating licensing programs to generate revenue from unused, dormant, or pending patents.

However, after some years, France Brevets' monetization strategy suffered from a setback that pushed the company to undergo a transformation of its business model. The interviewee elaborates on the topic, and he points out two simultaneous limitations constraining the company monetization approach as initially conceived. First, France Brevets had to face a lack of substantial volume in patenting among the French innovative actors. Second, the limited number of patents available were considered to have insufficient quality to establish robust monetization programs.

After a considerable evolution of its business model, in 2019 France Brevets was transformed into a strategic consulting firm, in order to assist the government in the development of a series of intellectual property recommendations for the "France 2030" national investment program. Eventually, in 2022 France Brevets sold its patent portfolios and shut down its operations.

R&D activity

The interviewee outlines the process that led the firm to intensify its direct R&D efforts. The expert interviewed explains that, during that period, the company's management regarded the national patent landscape as inadequate for successful patent monetization activities. Specifically, the interviewee underscores the importance of having a substantial volume of patents to establish competitive patent portfolios. Regarding the ICT sector, the interviewee indicates that a minimum of thirty to fifty patent families is necessary.[67] According to the expert, the French innovation ecosystem was not fully prepared at that time as it was primarily focused on developing complex technologies, thus resulting in an insufficient number of patents to support effective monetization programs.

To overcome this limitation, the former CEO explains how the company initiated the funding multiple research programs with a specific focus on connectivity, and in particular on 5G technology. In this context, the Institut Mines Télécom (IMT) played a pivotal role as the primary research partner and the patent assignee of the technology development project. France Brevets provided the financial support for

[67] However, the expert acknowledges that rare exceptions may exist, such as in the case of breakthrough pharmaceutical innovations.

the training initiatives and the establishment of a structured patenting process. During this phase, France Brevets operated as a research fund and patent portfolio organization, generating patents aligned with the company's predefined standards of quality. Additionally, given the nature of the technologies being developed (i.e., technologies with broad applications in the telecommunication sector), France Brevets aimed for standardization.

Overall, the primary objectives of these R&D activities were to fund the development of (standardized) technologies that could be easily adopted by a large number of implementers, and generate a sufficiently volume of patents to enable the creation of competitive monetization programs.

Patent acquisition activity

No information regarding the firm's patent acquisition activity was provided during the interview.

Information on patent portfolios and portfolio management

The company provided the Institut Mines Télécom with the necessary financial backing to support the development of cutting-edge connectivity technologies, specifically 5G, as well as supporting the associated patenting process. The expert reports that the firm successfully generated approximately €90 million in revenues through three monetization programs. Given the involvement of the public sector in its operations, France Brevets consistently implemented a revenue sharing policy that maintained a 50-50 structure with the patentee.

Considerations on patent quality

The discussion during the interview extensively covered the topic of patent quality. It first arose when addressing the initial challenges encountered by the company, particularly the scarcity of both quantity and quality in the patents available to France Brevets for monetization purposes. The interviewee delves into the concept of patent quality from his perspective and offers a definition within the context of patent monetization. According to his viewpoint, a crucial aspect is the inherent relativity of patent quality. In other words, the interviewed expert asserts that patents can be deemed of higher quality only within a specific context. To illustrate further, the expert underscores how "the 'environment' determines the value of a patent," meaning that patent quality evaluations can differ if the patent is used, for instance, in the courtroom in the case of patent litigation or, more broadly, in the licensing process.

According to the expert, while providing a single, definitive definition of patent quality is not feasible, he suggests that two critical characteristics can serve as indicators of higher patent quality. Firstly, a high-quality patent is one that protects a "discoverable" technology. In this context, "discoverable" implies

that the functionalities of such technology are more intuitive to understand, and they can also be easily identified through reverse engineering. As an example, the interviewee cites the Amazon's "one-click" or the Apple's "swipe to unlock" patents, whose protected technologies are considered "discoverable" because, in the event of an infringement lawsuit, it is relatively straightforward to demonstrate to judges which technology features are being infringed upon and where they are located within the product that implements these technologies.[68] Secondly, a patent of good quality is one that protects an "intelligible" technology, meaning that its claims can be easily understood by individuals without specialized technical knowledge, including court judges who may not possess in-depth technological expertise.

In addition, the interviewed expert offers an economic perspective on patent quality, in particular in terms of patent value. For a successful monetization business model, the patented technology is particularly valuable if it has the "potential for widespread adoption" by multiple technology-implementers. For this reason, a patent portfolio made of patents declared essential to a technology standard (i.e., standard-essential patents, or SEPs) may potentially hold considerable value for monetization purposes.

The expert also suggests that patent quality also varies based on technology market conditions. For instance, software patents are now highly demanded, and therefore valuable, due to the current fast development of artificial intelligence (AI), while currently patents covering diesel engines are less attractive.

Additionally, patent quality is influenced by the chosen monetization strategy. For instance, in the case of assertive legal monetization, the interviewee states that to the eye of legal experts patents display specific intrinsic characteristics. That is, in the courtroom, patent quality aligns with legal robustness, meaning that legal requirements for patentability must be respected so that the patent can survive invalidation procedures. A high-quality patent also features clearly written claims, enabling also non-technology specialists to understand its technological content. Therefore, considering the context of legal enforcement, a firm's patenting activity should be pursued with the courtroom in mind.[69] At the same time, patents used in litigation may not be suitable bargaining tools during licensing negotiations, and vice versa.

As a concluding remark, the interviewee reflects on the evolution of the intellectual property domain. In his opinion, the various professions connected to IPRs have been evolving in a rather isolated manner. Consequently, the topic of patent quality becomes highly specific and dependent on the perspective adopted. From the interviewee viewpoint, the patent quality indicators traditionally used in the economics

[68]The interviewee explains: "These are very discoverable patents because it will simply be enough to show the judges by bringing the computer or the phone; they will swipe their fingers over it and say, 'Ah yes, that's it (the technology)!'. Conversely, technologies such as quantum computing or signal processing are too complex to be considered discoverable."

[69]The interviewee mentions as an additional example the so-called "litigation-grade patents", which are patent rights prosecuted with a focus on assertive monetization. In this case, the patenting process generates patent rights that are legally robust and easy to understand.

literature (Squicciarini et al., 2013) have limited applicability outside academia and within other IP professions. For instance, in the event of a lawsuit, IP legal professionals may be relatively less interested in such indicators and in the technical features given that their quality criteria mainly correspond to the legal requirements for patentability or validity.

Patent enforcement activity

No specific information about litigation cases that directly involved France Brevets was provided. However, the interviewee referred to examples of patent litigations within the ICT industry to explain patent assertion in the context of technology transfer. In doing so, the expert highlights that the company conceived patent assertion as a last resort when negotiations did not yield significant progress or reached a dead end. The former company CEO highlights how these discussions could extend over several months and involve a considerable exchange of technology-related information. The expert reports that in the licensing context, at times, potential licensees may employ a strategy of intentionally prolonging negotiations to avoid these contractual commitments (i.e., patent hold-out).

Then the interviewee elaborates on the different judicial systems worldwide, and discusses the factors contributing to the uneven distribution of litigation cases. The experts delves into the importance of predictability within a legal system. Predictability of judgment explains the attractiveness of some jurisdictions as compared to others. For instance, Germany is considered a predictable legal system that is particularly favorable to patent-owners. More specifically, the German courts of Mannheim, Düsseldorf, and Munich are known within industry practitioners for delivering a decision over patent infringement in a rapid manner and at a reasonable cost. On the other hand, US courts tend to award high damages in litigation proceedings, however litigation costs are generally high. Finally, according to the interviewee, Asian jurisdictions, and China in particular, are becoming popular litigation venues. In fact, China is a strategic jurisdiction due to the generally fast system, its injunctive system (similar to Germany) and the practice of granting anti-suit injunctions (ASIs).

The dissolution of France Brevets

The interviewee points out several reasons that, in his opinion, led to the dissolution of France Brevets in 2022. First, since its establishment, the company's monetization and technology diffusion activities were carried alongside other institutions with similar competences, such as the technology transfer offices (TTOs) of universities and research centers. These TTOs have exclusive responsibility on the regional technology transfer of the valuable patents resulting from the research efforts of renowned academic institutions and research centers, such as the National Scientific Research Center (*Centre Nationale de la Recherche Scientifique*), the Commission for atomic energy and alternative energies (*Commissariat à*

l'énergie atomique et aux énergies alternatives), or the Pasteur Institute. Consequently, France Brevets could not engage with these institutions, which are nonetheless responsible for a considerable number of patented and valuable technologies.

After France Brevets increased its involvement in funding technology development projects, notably in the domain of ICT and connectivity, the interviewee explains the reasons that led to the definitive dissolution of the company. From the interviewee viewpoint, France Brevets lacked the necessary financial resources to further support the standardization process of 5G technology patents. In fact, for connectivity patents to be monetizable, they must be declared essential to the 5G standard, which requires the patent holder's participation in the technical discussions within the standard development organizations (SDOs).

IPRs and technology policy considerations

The interviewed expert believes that the national IPRs and technology policies should be more finely tuned to align with the dynamics of the international patent market. In this respect, the interviewee argues that an excessive emphasis on the development of complex technologies might lead to patents that are not only challenging to monetize but also to technologies that diffuse with more difficulties.

1.4.2 Case study 2: Patent licensing company and patent pool administrator

To ensure confidentiality, both the company and the interviewee names are anonymized. The interviewee is an intellectual property expert in charge of the legal operations of the company.

Background information and business model of the company

The company was established in Italy in the early 1980s as a spin-off of an operating company. Nowadays, the firm has two main lines of business. First, it engages in patent acquisition and licensing. Second, it acts as an independent administrator of patent pools and licensing programs in the connectivity domain, the Internet of Things (IoT), and video coding technology.

Consequently, the firm is positioned as an intermediary in the technology market. Its clients consist of different types of patent-holding companies, such as operating companies, research institutes, universities, and other non-operating companies. More specifically, the company collaborates with these patent owners to set up patent pools and licensing programs reading on specific technologies with the aim to reach potential downstream licensees. In addition, the company is a patent owner itself and its consistent patent acquisition activity is described as a key feature of the firm, which provides a competitive advantage that sets it apart from other competing patent pools.

Compared to other patent licensing administrators, the interviewee highlighted a second distinction: the substantial technical expertise within the company. In this respect, the company's human capital is considered as an essential asset. In fact, the interviewee explains that the company employs approximately thirty technology experts, typically engineers and patent attorneys, who possess extensive knowledge of the licensed technologies. These technical experts engage with different stakeholders and are involved in crucial tasks. First, they support the licensing team by clarifying the features of the technology to prospective licensees. Second, in the event of patent infringement, they assist the legal department in presenting clear explanations of patent claims in the courtroom. Third, they assist the company's clients by providing patent quality and patent market intelligence services, in this way they help patent owners to identify the patents that are best suited to converge into the appropriate pool or licensing program. Fourth, they provide technology consultancy during the company's R&D operations and during the standardization process.

R&D activity

In explaining the role of the in-house technical team with respect to technology development, the interviewee elaborates further on the involvement of the company in direct R&D. In this respect, the company's R&D subsidiary collaborates with research institutes, universities and research foundations worldwide, both in the public and the private sector. In particular, the R&D branch provides a wide range of IPRs services, such as IP development, patent portfolio evaluations, and validity assessment along with technical testing on the technological equipment. Moreover, the resulting patented technologies may be taken into account to further enrich the company's existing pools and licensing programs.

Patent acquisition activity

The interviewee thoroughly explains the importance of the patent acquisition activity for the company's business. In particular, patent acquisition is critical to the company business for three reasons. First, targeted patent acquisitions aim to bolster the company's portfolios, ultimately increasing the competitiveness of its licensing programs. In addition, the interviewee refers that the company primarily focuses its acquisition efforts on standardized technologies. Second, patent acquisition reinforces the independence of the company as a patent pool administrator by increasing its influence over the other patent owners participating in the pools. Lastly, the acquisition activity strengthens the company's bargaining position when engaging with prospective licensees.

Furthermore, the interviewee discusses the two main sources of acquisition. On the one side, acquired patents may originate from operating companies divesting (part of) their portfolios. Operating companies portfolio sales may be due to several reasons. In fact, manufacturing companies may fail in a business

after considerable R&D and patenting investment. Other times, an operating company may decide to capitalize patent portfolios reading on technologies that do not fit the firm's business anymore. The other source of patents consists in research and development institutes. In this context, the interviewee refers of several ongoing R&D partnerships in Asia on cellular connectivity standards and video coding that match the company's technical focus. In addition, the interviewee explains the reasons for which startups are not considered a suitable acquisition source for the firm. With respect to the technologies managed by the company, startups tend to generally focus on specific technologies, which are defined by the interviewee as "private technologies", as opposed to the "collaborative technologies" the company is specialized in, meaning the standardized cellular connectivity and video coding.

Information on patent portfolios and portfolio management

Patent portfolios are generally described as pertaining standardized technologies in the connectivity space and video coding technology. No specific information on royalty sharing policies or contractual arrangements are provided.

Considerations on patent quality

When shown the list of patent quality indicators (Squicciarini et al., 2013),[70] the interviewee affirms that the industry is not aligned on a common definition of patent quality. Similarly to what stated by the IP expert interviewed in case study 1, also the second interviewee argues that patent quality is best assessed in relation to a broader system of patents. Therefore, the interviewee argues that patents are best assessed only by adopting an more holistic approach that accounts for the whole technology. Nevertheless, the expert also explains that several patent indicators, among the ones presented during the talk, are relevant for the company business and can provide valuable patent quality information.

As a primary requirement, patent validity is thoroughly assessed by the company's in-house legal department during the patent acquisition process. After validity checks, both structure and content of patent claims are analyzed. In this respect, the interviewee explains how simpler claims are generally seen as a sign of higher patent quality, as compared to longer claims describing complex technologies with a high level of abstraction. Patents presenting simpler claims generally convey the technological content in a more straightforward manner. Thus, both licensing and assertion activities are facilitated.[71]

[70]The full list of indicators discussed during the interview is reported in Section 1.7.4.

[71]The company faces the constant need to asses the technological content of patent claims in all its activities: acquisitions, licensing and enforcement. For example, for the firm it is essential to explain the technical features protected

Patent family information, and in particular the geographical composition of a family, is an important indicator for the company as it defines the geographical extension of its operations. The interviewee reports that for the company is relevant the presence of US patent family members, and the possibility of filing divisional patents.[72] The presence of European family members is also key for the business of the company. In particular, patent families considered of particular value are the ones with patents filed in Germany, the UK, and France. Additional valuable patents are the ones granted in Italy, the Netherlands, Spain and Poland. The presence of Asian patent family members is also becoming increasingly important, and particularly valuable are Chinese, Korean, Japanese, Indonesian and Vietnamese patents. Finally, the presence of Brazilian patent family members represents an additional bonus. The age of the patent is considered by the firm as an extremely important characteristic. In this respect, the interviewees explains that as the time between the prosecution process, the granting and the implementation of a patent can be extremely long, the actual licensing window is shorter than the nominal 20 years of patent protection.[73] Finally, bonus patent quality characteristics are for instance the survival to opposition and invalidation challenges.

Patent enforcement activity

The company actively engages in patent litigation, which is considered an intrinsic component of the licensing business, especially in the case of standardized technologies and more generally in the ICT sector. In this respect, the interviewee elaborates on the dynamics of the licensing process between licensors and licensees with divergent interests at stake. From the one hand, licensors aim to monetize their IP assets and companies directly investing in the development of their patented technologies seek fair compensation for their inventive efforts. On the other hand, licensees and technology implementing companies aim to minimize royalty payments. In this context, the interviewee explains common strategies adopted by licensees, such as evading licensing commitment, prolonging the negotiations (known as *patent hold-out*), or allocating consistent budgets to lobbying activities to advocated for an overall devaluation of intellectual property.

Furthermore, the interviewee clarifies the difference between the licensing of standard essential patents (SEPs) and non-essential ones. In the first case, technology standards are by nature readily available

by the claims of its patents to both implementers and the courtroom. Moreover, in the context of litigation, with simpler patent claims that clearly read on the technology it is easier to find evidence of infringement.

[72]With respect to divisional applications, the company sees is as a further possibility to fine-tune the patent, by clarifying the claims to avoid invalidation challenges.

[73]In particular, the interviewee explains that the typical number of years in which the patented technology can be actually used is around 5, and generally not more than 10 years.

on the technology market. For such technologies, the licensing process generally happens "ex post," meaning the technology has already been used by producing companies in their end-products. In this case, patentees are in a weaker bargaining position, as technology implementers lack the incentives to engage in negotiations to access the technology. Moreover, patent owners are already required by the IPR policies of standard development organizations (SDOs) to commit to fair, reasonable and non-discriminatory (FRAND) terms and conditions for the licensing of SEPs. On the other hand, in the case of non-essential technologies, the interviewee notes that the licensing process is more straightforward and occurs "ex ante," coinciding with the moment in which the technology is actually transferred.[74]

The interviewees highlights the experience of the company's in-house litigation team relatively to the US and Europe. Then he discusses the jurisdictional features of the venues in which the company's litigation activity is more intense.

A notable jurisdiction is the UK (England and the Wales), which the company appreciates for its recent case law developments on FRAND determination. However, the interviewee points out the drawback of the UK's relatively small market size compared to its high litigation costs, which at times may exceed the ones foreseen in the US, notably one of the most expensive venues. The expert also explains the popularity of Germany for patent assertion. In particular, the courts of Düsseldorf, Mannheim and Munich and considered among the most efficient in terms of caseload, rapidity, and predictability of the legal process. Additionally, in Germany injunctions are frequently granted in favor of patent owners in case of proven infringement. The possibility of getting injunctions is also an attractive feature of both Spain and Italy, which are considered by the firm as venues that traditionally value intellectual property.

Regarding the US system, the interviewee underlines the strategic relevance of US courts, in particular the Eastern District of Texas court, and the many legal advantages for patentees as compared to the EU jurisdictions. When asked about the possibility of obtaining injunctions in the US (as in the case of other European systems), the interviewee explains that US enforcement activities follow a different strategy. In fact, in the US damages are more relevant than the possibility of injunctive orders. First, patent owners can rely on the legal discovery phase to support their infringement claims. During discovery, defendants are required to exchange information concerning the infringing products upon the opponent's request. This allows plaintiffs to prove patent infringement not only for the contested product, but also for other infringing goods manufactured by the same defendant. At that point, if infringement is proven, damages can include other infringing products of the defendant, in the whole US market, accounting for past years

[74] In other words, in the case of standardized technologies, technology adoption and implementation happened *"ex ante"*, meaning before technology licensing. On the contrary, in the case of non-essential patents, the licensing process coincides with technology adoption and implementation into end-products happens *"ex post"*.

of sales. Furthermore, if the court finds willful infringement, the amount of the damages awarded to the plaintiff can be increased up to three times. Therefore, the US system, which already provides higher damages than in the EU, can grant damages that can significantly rise during the trial, reaching consistent amounts in one of the biggest product markets in the world. Consequently, US patent licensing strategies are driven by damages and settlements. In fact, most cases settle even before seeing trial, as during litigation much of the information is available given the discovery phase, which allows parties to see the respective positions and know where the settlement should lie. Settlement are instrumental against the risk of jury trial and potentially high damages.

As far as the timing of litigation is concerned, the interviewee notes that it varies depending on the situation and on the behavior of the operating company involved. In fact, the interviewee provides past examples where the licensing company engaged in discussions over several years before starting litigating. However, with other market actors, litigation started just after few months, as it became clear to the licensee that the licensor was uninterested in concluding a licensing agreement. As a general practice, the company engages for at least one year in licensing discussions with cooperative licensees.

IPRs and technology policy considerations

Throughout the interview, several pressing topics in the technology and intellectual property space are discussed. The expert presents what from the company's perspective are potentially disruptive policies, which may endanger the stability of the market for technologies.

First, geopolitical tensions, in particular the ongoing trade and technology competition between the US and China, are causes of concern in the licensing business. One example highlighted is the overnight US ban on sales of Chinese communication equipment, which addressed two manufacturing powerhouses such as Huawei and ZTE. The company perceives this ban as a disruptive event that considerably changed the licensing landscape in the US technology market. In the present changed context, banned manufacturers lack the incentives to engage in technology licensing.

Additionally, the interviewee mentions recent legislative and policy actions at the EU level. For instance, the *Huawei v ZTE* 2015 decision is criticized for having dramatically influenced the European licensing landscape by having delayed by several years the licensing discussions taking place at that time.[75]

[75] *Huawei v ZTE, Court of Justice of the European Union, 6 July 2015, Case No. C-170/13.* With its ruling, the Court of Justice of the European Union (CJEU) ended a series of patent litigation cases started in Germany in 2009 that concerned the infringement of standard essential patents (SEPs). The lawsuits concerned the circumstances in which an infringer of a standard-essential patent (SEP) may assert a competition law defense when prior licensing negotiations on fair, reasonable and non-discriminatory (FRAND) terms have failed. Due to conflicting views between the German Federal Court of Justice and the European Commission, the Düsseldorf Regional Court sought clarification by posing five

At present, the company fears a similar setback in its licensing deals after the recent leak of the European Commission proposal for the establishment of a standard essential patents (SEPs) licensing framework. Commenting the leaked draft, the interviewee states that the suggested framework, as structured in its initial draft, imposes a set of impractical obligations that may hinder technology transfer. Finally, the expert cautions against the active lobbying efforts within the European Union, which seek to broadly devaluate IPRs.

1.4.3 Case study 3: Small and medium-sized technology development company

The interviewed stakeholder is the co-founder, CEO and chairperson of a small and medium-sized enterprise (SME), headquartered in southern Europe, and specialized in the development and commercialization of innovative wireless technologies. In order to maintain confidentiality, the names of both the company and the interviewee have been anonymized.

Background information and business model of the company

Established in late 1990s, the company originated from a university spin-off focused on the development of wireless technologies since the late 1980s. Today the company has evolved into a specialized entity that performs intense R&D in the field of wireless solutions for smartphones, tablets and wireless Internet of Things (IoT) devices. Therefore, the core business of the company centers around the R&D of cutting-edge wireless and the subsequent licensing of its patented technologies. The company's licensees are device original equipment manufacturers (OEMs) and network equipment manufacturers worldwide, but primarily in the US, Europe and Asia.

R&D activity

The interviewee highlights that R&D is crucial for the company's business. The R&D activities are performed in-house and several research projects received financial support and awards from both national innovation initiatives and the European Union. The company has also collaborated with research centers and universities, privates companies and public institutions.

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questions to the Court of Justice of the European Union (CJEU). On July 16 2015, the CJEU addressed these questions and set the so-called *Huawei framework.*, which outlines the conditions for the admissibility of a FRAND defense in SEP infringement cases.

Patent acquisition activity

Currently, the company in not considering the option of purchasing patents. In this regard, the interviewee notes that the company has never purchased IP assets since acquisition is not its core activity. However, the CEO acknowledges the possibility of a shift in this policy in the future.

Information on patent portfolios and portfolio management

The interviewees does not provide details regarding royalty sharing policies, nor any contractual information. However, on its website, the company maintains an accessible list of its proprietary technologies, and it reports the composition of its patent portfolio. The firm owns more than 100 patents reading on forty innovations developed in-house. Generally, several patents owned by the company have been internationally filed under the PCT application route, and followed up by regional applications in Europe, the US and Asia.[76]

Patent enforcement activity

The interviewee provides insights into the objectives of the company's patent enforcement activities. As the firm develops patented technologies through its intense R&D investments, it aims to secure a return on these investments by obtaining royalties for the use of their proprietary technologies.

The company's approach consists in analyzing the technology market landscape to identify potential technology users, as well as technology infringers. In both situations, the company begins licensing discussions by contacting the prospective licensees, and providing them with technical information about the technology. However, if the ongoing discussions fail to make substantial progress or reach a deadlock, the company may decide to pursue patent enforcement. This impasse situation can occur in two scenarios. Firstly, in the case of a clearly infringing manufacturer that disregards the company's attempts to establish a contact. Secondly, the deadlock can arise after a more intense and detailed exchange of information between the licensor and the licensee. In both cases, patent enforcement is seen by the company as an additional tool to obtain a fair compensation for its past R&D investments.

Although the company has litigation experience in several countries, such as Spain, China and India, the interviewee highlights that the enforcement activity is primarily concentrated in the US.

[76]The Patent Cooperation Treaty application route enables patentees to seek patent protection for their inventions simultaneously in several countries by filing a single "international" patent application instead of filing separate national, or regional, patent applications. However, the effective granting of patents remains under the control of the national or regional patent offices in what is called the "national phase." See https://www.wipo.int/pct/en/faqs/faqs.html.

When directly asked on the reasons behind the extensive firm's enforcement activity in the US, the interviewee offers a comparison with the European legal system. From the perspective of a small R&D-intensive company, the complexity and fragmentation of the European judicial system poses challenges to legal enforcement. In addition, unlike larger firms, the company lacks the necessary resources to engage in multiple parallel lawsuits across the EU. On the other hand, patent enforcement in the US is more predictable and court decisions have a unitary effect throughout the country, which is also a crucial market for the company. Furthermore, the interviewee emphasizes that the decision to initiate a lawsuit derives from the anticipated returns—in terms of damages awarded—from a favorable ruling, which in the US tend to be considerably higher as compared to Europe.

Considerations on patent quality

The interviewee describes the company's approach to assessing patent quality, which involves in-house evaluations based on three key patent features: validity, technological content, and the potential for widespread technology adoption and infringement. Due to the firm's small size, its technological specialization, and the lack of consistent patent acquisitions, the firm evaluates licensing opportunities exclusively based on the aforementioned patent features.

The interviewee also notes that the industry often relies on various patent quality analysis tools, models and indicators. However, given the limited scale of the company, he does not consider such tools necessary to evaluate the current patent portfolio. Instead, the interviewee explains that patent quality assessment is performed on a patent-by-patent basis.

IPRs and technology policy considerations

When discussing the European technology licensing market, the interviewee acknowledges that its legal fragmentation represents an important barrier for smaller innovative companies with limited financial resources. In this respect, the interviewee welcomes the introduction of the Unitary Patent (UP) and the Unified Patent Court (UPC), which is believed to reduce the fragmentation of the European technology market and patent enforcement system.

1.5 Limitations & Future research

This study brings attention to the relevant heterogeneity of the NPE phenomenon. Both the literature review and the case studies, derived from the interviews with industry stakeholders, have brought attention to the diverse range of NPE business models stemming from the observed heterogeneity in their activities.

The present systematic literature review is no without limitations. The bibliometric and content analyses reveal a polarized discourse within the academic literature, with a prevailing negative perspective. This viewpoint may be an intrinsic limitation of our preferred search strategy. In fact, we included among the searched terms the key-word "patent troll" (and its variants as reported in Appendix 1.7.1).[77] In this regard, future research may conduct a database search with more neutral terms, thus excluding the "troll" key-term.

In addition, in this study a comprehensive and broad overview of the scientific production on NPEs was provided by combining searches from both Scopus and Web of Science (WoS). While Scopus and WoS are renown databases of peer-reviewed scientific articles of high publication quality, they may not include all the relevant publications on the subject. In this respect, as discussed in the broader literature review in Section 1.3, it may happen that some relevant documents are not indexed even in the richest bibliographic databases. Future research efforts may try to integrate new ways of literature search and discovery alongside the more traditional and structured approaches, such as the one adopted in this study. From the one side, many databases are freely available to researchers, common examples are Google Scholar, Microsoft Academic, and Open Alex.[78] On the other hand, innovative web interfaces designed to assist researchers in literature discovery are emerging. For instance, *Connected Papers*, *Elicit*, and *Research Rabbit* are build to search for papers and provide scholars with visual representations of literature citation networks.[79] Such tools could be deployed to identify missing references and complement standard database searches.

Another limitation involves the choice of the keywords necessary to build an efficient search query. The challenge with the construction of the proper query for the database searches lied in the identification of the optimal balance between wide coverage and specific focus. As reported in Section 1.2.2, the adopted search query presents a two-step structure: in the first step, key-terms broadly identifying NPEs (such as, "non-practicing entit*", "patent assertion entit*", "patent troll*", and respective acronyms)[80] are searched in the titles, abstracts and keywords; in the second step, we imposed the contemporary search in the abstracts (through the "AND" operator), of more characterizing terms (such as, "patent qualit*", "business

[77] However, the choice was justified by the fact that "patent troll" is a common a popular term often used interchangeably with the general term "NPE". Moreover, the inclusion of this term increases the chances of collecting all the relevant research contributions on NPEs.

[78] See: https://scholar.google.com/; https://microsoft.academia.edu/; https://openalex.org/.

[79] In this study, these tools have been deployed to double-check the results obtained from the Scopus and WoS searches, although not in a systematic way. See: https://www.researchrabbit.ai/; see also: https://elicit.org/, and https://www.connectedpapers.com/.

[80] The "*" characters is a wildcard used to include in the search all the possible variants of the term. For instance, with the key-terms "non-practicing entit*" we automatically include "non-practicing entity" and "non-practicing entities".

model*", "patent monetization", etc.) together with the same terms searched in the first step.[81] Although we conducted an accurate manual check on the titles, abstracts and keyword fields of the retrieved records before moving to the final selection, this strategy has two main potential drawbacks. First, although the list of terms searched in the second step is already exhaustive, more terms could have been included to cover all the possible nuances of the NPEs phenomenon, and therefore capture a broader range of articles. Second, this search strategy automatically, but inadvertently, excludes potentially relevant contribution that lack abstract information.[82]

Finally, the strict focus adopted on peer-reviewed articles and reviews to conduct our bibliometric analysis in Section 1.2 may represent another potential limitation for a truly complete bibliometric analysis. As discussed in Section 1.3, this choice resulted in the exclusion of other types of relevant scientific documents, such as book chapters, policy and consultancy reports, that have been nonetheless analyzed in details in the literature review presented in Section 1.3. In this case, future research may integrate such documents to produce a more fine-grained bibliometric analysis.

In conducting the present study, it emerges how different avenues for future research on NPEs are still largely unexplored. For instance, to gain a comprehensive understanding of the NPE phenomenon and its implications for the technology market, it is essential to delve into crucial areas that have yet to be thoroughly investigated. In this respect, in-depth examination of NPEs' licensing terms, as well as settlements agreements, are crucial in providing a definitive picture of the NPE landscape. In this context, researchers could also gain additional insights on patent licensing dynamics by adopting a systematic and broad qualitative research approach to NPEs. For example, further research could expand the set of stakeholders analyzed through interviews, surveys and questionnaires, to include industry actors and policy makers.

Other questions remain unanswered in relation to NPEs. In particular, a relevant research gap remains in assessing the interplay between the transfer of standard essential patents (SEPs), their assertion bu NPEs and the applicability of the FRAND commitment to the new patent owners. In addition, the recent entering into force of the Unified Patent Courts (UPC), which has exclusive jurisdiction for disputes relating to infringement and validity of Unitary Patents (UPs) and European patents (EPs), is expected to be a game-changer in the European enforcement system. Future research can explore the evolution of NPE patent enforcement activities across European jurisdictions after the introduction of the UPC. Furthermore, there is still a consistent research gap in the exploration of NPE assertions in Asian and

[81] The search rationale is presented in more details in the Appendix 1.7.1.

[82] Only a minority of documents is concerned in this case, however this is a potential drawback that may lead to the exclusion of relevant publications.

Latin American legal regimes that may present appealing features for patent owners, such as China or Brazil. Finally, researchers interested in advocacy and policymaking may explore the existence of policy influences on academic research on the NPE topic. For instance, by analyzing the type of research funding received by scholars investigating the NPE phenomenon. The type of funding may reveal the presence of NPE-sensitive actors whose interests and policy position may influence, in both directions, the research viewpoint on NPEs.

1.6 Conclusions

The present study offers a comprehensive overview of the extant literature on NPEs. We provide insights into the bibliometric characteristics of the literature analyzing NPE business models, their impact on technology markets and the complex interplay with the broad topic of patent quality. Our findings suggest that research on NPEs has witnessed a terrific growth from 2011 and contributions have peaked in 2016. Nowadays, despite a less intense scientific output in the past four years, research on NPEs is nonetheless attracting original contributions, especially from empirical economic research and in emerging IP markets, such as China. The identified literature presents interesting characteristics. First, the studies selected display a high level of interdisciplinarity, encompassing various research fields, such as law, economics and disciplines at the intersection of these two. Second, even within the same research area, there is significant heterogeneity in contributions, with diverse methodologies and focal points coexisting. Third, the various research themes identified exhibit varying degrees of overlap across research areas. Finally, research on NPEs appears to be fragmented in terms of collaborative patterns and types of contributions, with studies often focusing on highly specialized topics and addressing interrelated research questions.

This study also highlighting how, over the past recent years, there has been an intense academic and policy debate surrounding NPE activities. In fact, from this systematic literature review, it emerges that the policy discourse has mainly focused on the potential negative effects for companies operating further down in the value chain and technology implements. If it is true that NPEs, because of their non-manufacturing nature, may enjoy asymmetrical advantages compared to operating companies (i.e., potential for patent hold-up), it is important to acknowledge their role in technology licensing and monetization, which more clearly emerges from our outlined case studies. It is also crucial, in order to maintain a balanced policy perspective, to recognize the potential negative effects of some delaying tactics adopted by technology-implementers to avoid patent licensing (i.e., patent hold-out), which emerges in in both the review of the literature and in the interviews with the NPE stakeholders. Moreover, this polarized debate sometimes seems only partially backed-up by empirical evidence. In fact, only a relatively small, and recent, number of studies have delved into the business models of NPEs. These studies have nonetheless provided various taxonomies that are undoubtedly useful to guide and inform more objectively

policymakers and regulators.

This research acknowledges that the NPE phenomenon is characterized by significant heterogeneity and complexity that still has to be fully explored. As a result, qualitative research becomes essential in providing a comprehensive understanding of NPE business models. In this respect, the case studies outlined in this research provide the often overlooked viewpoints of the industry stakeholders. Therefore, this study empirically contributes to the extant research on NPE business models by reporting three real-world case studies of prominent European-based NPEs. The results of this qualitative research confirms that NPEs employ diverse business models for strategically managing and monetizing patent rights. These case studies help capture diverse perspectives on the incentives behind NPEs' activities, and it also contribute to a more balanced economic and policy analysis of NPE business models on the market for technologies and patents.

1.7 Appendix to Chapter 1

1.7.1 Search rationale and database queries

We identify the first sample of scientific production by querying Web of Science and Scopus databases. To develop the most efficient query, we define a search strategy by identifying and isolating the main concepts — and corresponding key terms — in our research question as reported in Table 1.7. Our first research objective is to analyze NPEs' business models and to study the connection between these different patent monetization strategies and the quality of the patents owned by NPEs. Our second research objective is to further explore the impact of the different NPEs' business models on the markets for technology, in particular on technology diffusion.

Table 1.7: Concept structure of the search strategy.

Concept 1		**Concept 2**
Terms connected by OR	AND	Terms connected by OR
"non-practicing entit*" OR "NPE*" OR "patent assertion entit*" OR "PAE*" OR "patent troll*" OR "troll*" OR "nonpracticing entit*"		"patent qualit*" OR "quality* characteristic*" OR "business model*" OR "patent moneti?*" OR "patent licen?ing model*" OR "patent litigation*" OR "technology diffusion" OR "market* for technolog*"

Our search strategy is based on the main concepts we address in our research question: (1) NPEs' business models, and (2) the interplay of patent quality characteristics and the impact on markets for technology. Therefore, our research query is based on two sets of key terms researched in a combined approach: first, we search a first set of keywords in the title, abstract, and keywords (authors and databases' keywords); second, we impose that a second set of key terms is also present in the abstracts. The rationale for searching for some initial key terms (e.g., "non-practicing entit*", "patent assertion entit*" and "patent troll*") also in the abstracts lies in the necessity of excluding studies retrieved only because these key terms were present in the articles key-words. Then additional filters — i.e., time-span (2000-2023), research areas, type of document searched and language — have been applied to the search results of the two baseline query specifications. The preferred queries — with the additional search filters — are reported below, for Web of Science and Scopus respectively. The automated databases searches were performed the 13th of April 2023:

Web of Science:

(TS=(“non-practicing entit*” OR “NPEs” OR “patent assertion entit*” OR “PAEs” OR “patent troll*” OR “nonpracticing entit*”) AND AB=(“non-practicing entit*” OR “patent assertion entit*” OR

“patent troll*” OR “patent qualit*” OR "qualit* characteristic*" OR “business model*” OR “tipolog*” OR “categor*” OR “model*” OR “taxonomy” OR “patent troll model*” OR “patent moneti?* model*” OR “patent licen?* model*” OR "patent litigation*" OR “technolog* diffusion” OR “market* for technolog*” OR “technolog* adoption”)) and 2023 or 2022 or 2021 or 2020 or 2019 or 2018 or 2017 or 2016 or 2015 or 2014 or 2013 or 2012 or 2011 or 2010 or 2009 or 2008 or 2007 or 2006 or 2005 or 2004 or 2003 or 2002 or 2001 or 2000 (Publication Years) and Article or Review Article (Document Types) and Law or Economics or Management or Business (Web of Science Categories) and English (Languages)

Scopus:

(TITLE-ABS-KEY ("non-practicing entit*" OR "NPEs" OR "patent assertion entit*" OR "PAEs" OR "patent troll*" OR "nonpracticing entit*") AND ABS ("non-practicing entit*" OR "patent assertion entit*" OR "patent troll*" OR "patent qualit*" OR "qualit* characteristic*" OR "business model*" OR "tipolog*" OR "categor*" OR "model*" OR "taxonomy" OR "patent troll model*" OR "patent moneti?* model*" OR "patent licen?* model*" OR "patent litigation*" OR "technolog* diffusion" OR "market* for technolog*" OR "technolog* adoption")) AND (LIMIT-TO (PUBYEAR , 2023) OR LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012) OR LIMIT-TO (PUBYEAR , 2011) OR LIMIT-TO (PUBYEAR , 2010) OR LIMIT-TO (PUBYEAR , 2009) OR LIMIT-TO (PUBYEAR , 2008) OR LIMIT-TO (PUBYEAR , 2007) OR LIMIT-TO (PUBYEAR , 2006) OR LIMIT-TO (PUBYEAR , 2005) OR LIMIT-TO (PUBYEAR , 2004) OR LIMIT-TO (PUBYEAR , 2003) OR LIMIT-TO (PUBYEAR , 2002) OR LIMIT-TO (PUBYEAR , 2001) OR LIMIT-TO (PUBYEAR , 2000)) AND (LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "BUSI") OR LIMIT-TO (SUBJAREA , "ECON") OR LIMIT-TO (SUBJAREA , "DECI")) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re")) AND (LIMIT-TO (LANGUAGE , "English"))

1.7.2 Selected studies

Table 1.8 lists of the selected sample of scientific documents with their main characteristics, sorted by total number of citation received:

Table 1.8: Selected studies

Authors	**Title**	**Journal**	**Publ. Year**	**Type**	**DOI**	**Total Cit.**
Reitzig M; Henkel J; Heath C	On sharks trolls and their patent prey — Unrealistic damage awards and firms strategies of being infringed	Research Policy	2007	Article	10.1016/J.Respol.2006.10.003	119
Mann R	Do patents facilitate financing in the software industry?	Texas Law Review	2005	Article	#N/A	113
Fischer T; Henkel J	Patent trolls on markets for technology: An empirical analysis of NPEs patent acquisitions	Research Policy	2012	Article	10.1016/J.Respol.2012.05.002	87
Bessen J; Meurer M	The direct costs from NPE disputes	Cornell Law Review	2014	Review	#N/A	85
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Sung H	An analytic study on permanent injunction in patent litigations	Ntut Journal Of Intellectual Property Law And Management	2015	Article	10.6521/NTUTJIPLM.2015.4(2).2	0
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1.7.3 List of keyword synonyms

To conduct the keywords co-word analysis in Section 1.2.3.2 and to map the co-occurrences between authors' keywords reported in Figure 1.7, keywords representing the same concept or theme have been grouped to avoid duplication:

npes: npes, npe, non-practicing entities, nonpracticing, non practicing entities, non-practicing entity, non-practicing entity (npe), non-practising entities, nonpracticing entities (npe), nonpracticing entities (npes), non-practicing entities (npes).

paes: paes, pae, patent assertion entities, patent-assertion entities, patent assertion entity, patent assertion entity (pae).

patent litigation: patent litigation, litigations, patent-infringement litigation, assertion, patent assertion, litigation, patent enforcement, enforcement, dispute, patent dispute, enforcements, patent dispute, patent disputes.

troll: troll, trolls, patent troll, patent trolls, patent shark, shark.

patents: patents, patent, IPR, intellectual property rights, ip, intellectual property, intellectual property (ip), IPRs, patents and intellectual property rights, patent rights.

business model: business model, business models.

standard essential patents: standard essential patents, SEPs, sep, frand standard-essential patents, frand, frand framework, standard essential, essential ipr, essential iprs.

market for technology: market for technology, markets for technology, market for technologies, technology market, technology markets, market for ideas, market for patents, markets for patents, markets for patent, patent markets, patent market.

patent quality: patent quality, low quality, high quality, quality, patent value.

anti-trust: anti-trust, antitrust, anti trust, anti-unfair competition law, anti-monopoly law, competition.

federal trade commission: federal trade commission, ftc.

forum shopping: forum shopping, forum, shopping.

ict: ict, icts, it industry, it, ict industry, information and communication technology.

infringement: infringement, patent infringement.

innovation innovation, innovations.

invention: invention, inventions.

startup: startup, start up, start-up, startups, start-ups.

licensing: licensing, patent licensing.

unified patent court: unified patent court, upc.

unitary patent: unitary patent, unified patent.

1.7.4 Interview structure and framework

1.7.4.1 List of quality indicators

The reference list of patent quality indicators — referred to *patent quality list* or simply *the list* — is partially compiled from the OECD patent quality indicators developed by Squicciarini et al. (2013):

1. Number and content of patent claims;
2. Patent family size and geographical scope;
3. Forward citations;
4. Backward citations;
5. Essentiality (i.e., the patent has been declared a "standard essential patent", or SEP);
6. Legal status (e.g., granted, pending, withdrawn);
7. Grant lag;
8. Age (expiration term);
9. Survival to opposition or invalidation;
10. Scope (see, Squicciarini et al. (2013));
11. Non-patent literature, or NLP (citations to non-patent literature) (Squicciarini et al., 2013);
12. Other OECD patent quality indexes: 1. *originality*, 2. *radicalness*, 3. *patent quality composite index* (Squicciarini et al., 2013).

1.7.4.2 Standard structure of the interview

The main structure of the interview consists of 19 questions in total.

Introduction (2 questions):

- What services does the company provide to its clients?
- What differentiate the firm from other competitors (if any)?
- Is the company operating independently from the industries related to its patent portfolio or is there some degree of affiliation?

Section 1: Information on direct R&D activities and patent filing (3 questions)

- Does the company directly engage in research activities?
- If yes, to what extent with respect to technology/patent acquisition?
- If yes, what are the goals of the research activity? (e.g., achievement of sufficient portfolio diversification, identification of technological areas with significant potential for future revenues)

Section 2: Information on technology/patent acquisition (2 questions)

- What are the main sources of patent acquisition? (e.g., small inventors, failed start-ups, technology companies divesting in some line of business)
- Which patent quality characteristics (indicators) are considered in the acquisition process? Could you point out to me some key indicators from the *patent quality list*?

Section 3: Patent licensing and portfolio management (6 questions)

- What are the characteristics of the company's patent portfolio? What does define the quality of your portfolio? (e.g., US, European and Asian patents related to electrical engineering)
- What is the company's licensing approach? Could you elaborate about the types of licensing programs available to potential licensees? (e.g., licensing programs of patent portfolio vs bilateral agreements)
- Which patent quality characteristics (indicators) are evaluated for licensing? Which are the most important? (See the list)

- How do you present your patent portfolio to prospective licensees? Which indicators do you point out to them? (See the list)
- What are the main challenges the company faces in the licensing process?

Section 4: Patent assertion strategy (5 questions)

- How do you identify the party/parties against whom you assert the patent(s)?
- What is the patent assertion approach? And how do you generally contact the third party? (e.g., formal letter, email, phone call, etc.)
- What is the timing? In other words, how much time elapses between the first time the company approaches the licensee and the first lawsuit?
- What is the typical reaction of potential infringers?
- Are patents asserted different in terms of patent quality characteristics (indicators) compared to non-litigated ones? (See the list)

Closing (1 question)

- Thank you very much for your time, is there anything else you would like to elaborate on?

Chapter 2

Non-Practicing Entities in Europe: An Empirical Analysis of Patent Acquisitions at the European Patent Office

Co-authored with Gianluca Orsatti, Valerio Sterzi and Andrea Vezzulli

2.1 Introduction

The sharp rise in patent applications observed in the last three decades indicates a significant shift towards an economy that relies more and more on intellectual property rights (IPRs). IPRs have a widespread influence on our society, and intangible assets, particularly patents and trade secrets, represent the most valuable elements of a company's market value (Elsten and Hill, 2017). Intangible assets are crucial, as leading industries heavily depend on knowledge and proprietary innovations. However, in today's knowledge-driven economy, the utilization of patents has evolved far beyond their original purpose of promoting and rewarding innovative development, especially in the field of Information and Communication Technology (ICT). In this sector, patents are increasingly being employed as strategic tools by various companies (Blind, 2021). This environment has created lucrative opportunities for new intermediaries in the technology market, who can capitalize on these developments (Hagiu and Yoffie, 2013). Among these, non-practicing entities (NPEs)—firms whose business model is focused on using patents either to extract licensing fees or to enforce them against alleged infringers to obtain damages or settlement payments (Golden, 2007; Lemley and Shapiro, 2007; Chien, 2008)—have emerged as key actors (Feldman and Ewing, 2012). Their growing active presence in the patent market has sparked a debate about their impact on business performance and innovation. The primary question revolves around whether NPEs, through

litigation or the mere threat of litigation, extract unjustified rents from innovators or, instead, they might function as efficient intermediaries in the market, facilitating technology transfer and the development of new products.

To date, the interest in NPE activities has been largely US-centered, where NPEs have been subject to patent law reforms and Supreme Court rulings.

In contrast, European policymakers have shown relatively less concern towards NPEs, and only a few studies have thoroughly examined their activities in the European context. Notably, Fusco (2013) stands out as the inaugural empirical inquiry into NPE activities in Europe, meriting recognition for its pioneering contribution. Fusco (2013) shows that NPEs were already present in Europe in the early 2000s, even if their activity was modest compared to the US. Love et al. (2016) analyze patent infringement lawsuits filed in the UK in the years 2000-2013 and in three large regional courts in Germany in the years 2000-2008. They find that litigation initiated by NPEs accounts for approximately 9 percent of the cases examined. Moreover, their analysis shows a notable surge of NPE cases in Germany during the study's recent years, culminating in an remarkable peak of over 30 percent in 2008. Lastly, Thumm et al. (2016) study the impact of NPEs on innovation in Europe by interviewing selected groups of academics, industry experts and representatives from NPEs operating in Europe in the ICT field. They find that the majority of patents asserted in Europe originated from large practicing firms operating in the Telecommunication sector, and they identify in the lack of patent ownership transparency one of the key success factors of the NPE business model in Europe.

All these studies agree on a relatively low presence of NPEs in Europe compared to the US. They attribute this discrepancy to a range of factors including, but not limited to, the superior standards upheld by the European Patent System, reduced costs associated with litigation, greater access to financial resources, and the application of the "English rule," which entails awarding attorney's fees to the successful litigant. Nevertheless, it is worth to acknowledge two notable constraints that limit the scope of these studies. First, they analyze mostly NPE activities that become visible through litigation, or provide a non-systematic descriptive evidence of the presence of NPEs in the ICT industry. Second, the examined time-frame predates the recent amalgamation of judicial rulings and legislative modifications in the US, which have undeniably eroded certain vital mechanisms accessible to NPEs for capitalizing on their patents.[1] On the contrary, in the last decade large patent portfolio acquisitions by NPEs in Europe have

[1]For example, Love et al. (2016) see in the continent's fee-shifting regimes one of the main reasons explaining the low attractiveness of Europe for patent monetization compared to the US, where fee awards are rare (though permitted by statute). NPEs deciding whether to file suit in Europe must consider the very real possibility that they will not only fail to win damages and recoup their own legal fees, but also that they will have to pay the accused infringer at least a large portion of the cost of defense. However, this difference has disappeared after Octane Fitness. LLC v. ICON Health &

made headlines in the media. For example, Inside Secure (nowadays Verimatrix), a French semiconductor (nowadays software) company, licensed out in 2012 its entire near field communication (NFC) patent portfolio to France Brevets, a French state-owned NPE; Technicolor, a French media and entertainment company, sold its Patent Licensing Business to Interdigital in 2019, a US-based NPE active in the telecommunication industry.[2] Finally, a significant number of European product companies have also refocused their business strategy and moved one step closer to the IP monetization business, which is becoming an important source of revenues.[3]

The first contribution of this chapter is to assess the presence of NPEs in Europe in a more comprehensive and precise manner than it has been done so far in the literature, and to extend the period of analysis to more recent years. For this purpose, we build a brand-new database of patent applications filed at the European Patent Office (EPO) where NPEs appear to be the last patent owner. Precisely, we rely on an extensive list of more than six hundreds groups and 3,508 related subsidiaries that are considered to be NPEs by experts in the patent litigation and licensing field (Clarivate-Darts-IP and Allied Security Trust). Our analysis shows that the presence of NPEs in Europe is far from being negligible. Indeed, we find that NPEs own almost 20,000 patents filed at the EPO. When restricting the sample to patents transacted over the period 2010-2020, we identify around 7,000 patents acquired by NPEs (corresponding to 3% of transacted patents). Moreover, we show that NPEs are particularly active in the Electrical Engineering field, where they acquired around 9% of the transacted patents.

Our second contribution entails delving into the patent acquisition strategies employed by NPEs through a detailed examination of the characteristics of the patents they acquire. Specifically, we juxtapose the patents acquired by the identified NPEs against a random selection of patents acquired by practicing entities in the same technological classes and years. Contrary to studies that rely only on specific samples of patents acquired by large and known NPEs (e.g. Fischer and Henkel, 2012; Leiponen and Delcamp, 2019), our data allow for a wider and more systematic identification and analysis of the activity of NPEs, by including subsidiaries and small entities that often escape the media's attention. Our empirical analysis shows that, in many respects, NPEs differ significantly from practicing companies with respect to the characteristics of the patents they acquire (Fischer and Henkel, 2012). In particular, OLS and Logit

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Fitness, LLC (2014) Supreme Court decision that relaxed the standard for awarding fees in patent suits.

[2]Interdigital has acquired more than twenty thousand global patent applications from Technicolor for a total deal of $475 million (including an upfront payment of $150 million and 42.5% of the future royalties from Interdigital's licensing activities in the Consumer Electronics field). See https://www.technicolor.com/news/technicolor-agrees-sell-interdigital-its-patent-licensing-business.

[3]Ericsson and Nokia have created dedicated business licensing units and subsidiaries in order to monetize their patent portfolio. See for example companies like Avanci, Unwired Planet, PanOptis, Core Wireless and Vringo/FORM Holding.

estimates show that NPEs target patents of relatively high technological quality (as proxied by the number of forward citations).

Finally, we investigate possible heterogeneity due to diverse business models among NPEs, contributing extant literature in two ways. First, we build upon Leiponen and Delcamp (2019) and we develop a taxonomy of NPEs based on two dimensions: (1) the propensity of NPEs to acquire (rather than to file) patents, and (2) their patent litigation intensity.[4] Depending on the relative position in the distribution, each NPE is assigned to one of the following three categories: "Technology" (if the NPE portfolio consists in large part of filed patents - rather than acquired patents), "Litigation" (if the NPE portfolio consists in large part of acquired patents that are used relatively often in litigation activities), "Portfolio" (if the NPE portfolio consists in large part of acquired patents that are used relatively rarely in litigation activities). Second, our study delves into the effect of NPE patent acquisitions on innovation, exploring both the attributes of the acquired patents and how these patents are utilized. We interpret a negative correlation between the number of forward citations received by acquired patents after the transaction and the likelihood that the patent buyer is an NPE as a signal of the reduced use of the patent after transfer (Abrams et al., 2019; Orsatti and Sterzi, 2023). Our empirical analysis shows that the heterogeneity observed among NPE business models is correlated with distinctive approaches employed in the acquisition of patents. In particular, we find that "Litigation" NPEs acquire patents at high risk of infringement, but of similar technological quality if compared with patents acquired by practicing companies. This is not the case of other types of NPEs that, instead, acquire highly-cited patents. Furthermore, our econometric results point out a heterogeneous correlation of patent acquisition strategies with follow-on innovation across NPE business models. In particular, we observe that the number of citations drops significantly, in after-transfer periods, only for patents acquired by "Litigation" NPEs. This suggests that both the use of these technologies and the overall level of innovation around them reduce when more aggressive NPEs enter the market for technology through the means of patent acquisition.

The remainder of the chapter is organized as follows. In Section 2.2, we provide the literature background and present the hypotheses. In Section 2.3, we describe the methodology used to build the database of NPE patents filed at the EPO, and we report the key figures of the database, listing the most active NPEs and their main sources of patents. In Section 2.4, we analyze NPEs' patent acquisitions, by investigating the difference between patents acquired by NPEs and those acquired by PEs. In Section 2.5, we test whether NPE licensing models correlate with the characteristics of the acquired patents and downstream innovation. Section 2.6 concludes.

[4]For this purpose, we complement data on patent acquisition with patent litigation data.

2.2 Background and hypotheses

2.2.1 Extant research on NPEs

Is the patent enforcement activity pursued by NPEs an efficient mechanism for technology transfer and innovation? Or, instead, is it only a means of collecting money under the threat of litigation, constituting a hidden cost for innovators and reducing incentives to perform R&D? The positive view is that NPEs reduce matching costs, help the enforcement of patent rights and inject liquidity. Therefore, as intermediaries in the patent market, they positively contribute to making the secondary market for inventions more efficient. Opponents argue, instead, that NPEs behave opportunistically and exploit frictions in the market for patents, extracting unjustified rents: an 'unwanted tax' that leads to inefficient extra costs and deadweight loss.

From a theoretical point of view, both arguments are sound. On the empirical ground, results are sometimes conflicting and depend on the type of data used and on the definition of NPEs adopted. Most of extant studies use data on litigation cases to evaluate the direct and indirect impact of NPEs on targeted firms and their licensing strategies. In this respect, some studies find that NPEs significantly affect the costs for targeted firms, resulting in a reduction of R&D investments (Tucker, 2014; Cohen et al., 2019; Mezzanotti, 2021). Chen et al. (2023) show that the response of technology peers to litigation risk from NPEs involves ramping up R&D investments in order to create alternative technologies, but also that this boost in R&D efforts leads to a gradual decrease in the value of resulting patents. Furthermore, other studies find that NPEs make use of weak patents to engage in frivolous litigation (Lu, 2012; Feng and Jaravel, 2020), and that they often behave opportunistically by providing incomplete information regarding patent ownership, obfuscating the extent of their rights and gaming the system (Menell and Meurer, 2013; Morton and Shapiro, 2013; Feldman, 2014; Sterzi, 2021; Sterzi et al., 2021).

By contrast, other empirical analyses suggest that NPEs litigate patents of similar or higher quality than practicing companies, concluding that they do not engage in frivolous litigation (Shrestha, 2010; Risch, 2012) but, rather, increase liquidity and the efficiency of the patent market (Haber and Werfel, 2016). For example, Chari et al. (2022) find that PAE brokerage helps small inventors to monetize their patented inventions, even if this favors only incremental innovations.

Beyond the somehow conflicting results, the shortcoming of relying only on patent litigation data to investigate the effects of NPE activities is that it gives only a partial monitoring of the presence of NPEs in the patent market (Morton and Shapiro, 2013; Lemley and Feldman, 2018): anecdotal evidence suggests that NPEs go through litigation only when they are forced to do so, while they prefer to set royalty demands strategically below litigation costs in order to force defendants to settle (Leslie, 2008;

Morton and Shapiro, 2013).

Only a few papers focus directly on patent filings and acquisitions involving NPEs. Among them, Fischer and Henkel (2012) analyze the characteristics of a sample of 392 US patents acquired by a few large and known NPEs between 1997 and 2006. Their findings suggest that the probability that a patent will be acquired by an NPE, rather than by a practicing company, increases with the scope and with the technological quality of the patent. Similarly, Sterzi et al. (2021) investigate the business model of small NPEs registered as dormant companies in the UK and find that their portfolios consist of patents that are at a higher risk of being infringed than the average, and that are acquired with the purpose of launching litigation campaigns. However, contrary to Fischer and Henkel (2012), Sterzi et al. (2021) find that their patents are not more cited than the average, suggesting that the empirical results on patent quality are sensitive to the definition of patent quality and to the sample used.

2.2.2 Hypotheses

In this paper, we contribute the literature on the market for patents by analyzing data on patent transactions involving NPEs in Europe, in order to provide a better understanding of their effect on innovation.

The NPE business model revolves around the acquisition and utilization of patents for generating income through licensing and enforcement, rather than through traditional business operations (Morton and Shapiro, 2013). This definition encompasses at least two types of companies: those that primarily act as intermediaries, procuring patents from inventors and licensing them to commercial entities, and those whose core business model is only to enforce patents. In both scenarios, NPEs invest in IP assets to leverage their efficiency advantage in deploying and enforcing patents (Steensma et al., 2016). Therefore, they have the incentives to target high-quality patents, which are easier to license out and more difficult to invalidate in court. Conversely, practicing entities may acquire patents for several other reasons, such as the need to reconfigure the technological resources (Desyllas and Hughes 2010; Karim and Mitchell 2000), to capture important synergies in the process (Chondrakis 2016; Grimpe and Hussinger 2014), or even to consolidate ownership of substitute technologies and enhance market power (Scott Morton and Shapiro 2014). Furthermore, patents acquired by practicing entities can be simply the consequence of acquisitions of R&D units of other firms. Hence, patents acquired by NPEs are expected to be on average of higher technological quality than patents acquired by practicing entities.

Hypothesis 1: *The probability of a patent acquisition by an NPE increases with the technological quality of the targeted patent and, therefore, with its probability of being upheld in court and of being enforceable.*

NPEs that focus primarily on asserting patents as their core business model are expected to acquire

broader patents that cover a wide range of technologies or products. This gives them a stronger position to assert infringement claims against potential defendants. With a large-scope patent, they can target a broader market and potentially secure more licensing or settlement agreements. This increases the pool of potential targets, thereby maximizing the chances of generating revenue through licensing fees or settlements. We thus posit the following hypothesis:

Hypothesis 2: *The probability of a patent acquisition by an NPE increases with the scope of the targeted patent and, thus, with its probability of being infringed upon.*

In contrast to most of the literature which focuses only on a small subset of large and well-known NPEs, our richer dataset allows to capture business model differences between NPEs. NPEs consist in fact of multiple types of entities with different licensing models. Following Federal Trade Commission (2016) and Leiponen and Delcamp (2019), we consider three main different NPE business models. First, NPEs may strategically exploit the loopholes of the patent system, by shielding the inventor should she lose a court action (Sterzi et al., 2021)[5] and engage in aggressive patent assertion activities (Kiebzak et al., 2016). In the empirical analysis we refer to this type of entities as "Litigation" NPEs. Secondly, NPEs may perform a necessary intermediary function in the secondary market for technology, facilitating patent licensing and technology transfer (Papst, 2012; Steensma et al., 2016). We refer to this type of entities as "Portfolio" NPEs. Thirdly, NPEs can be technology companies that pursue R&D activities and commercialize their own inventions via licensing and patent assertion (Reitzig et al., 2010; Leiponen and Delcamp, 2019). We refer to this type of entities as "Technology" NPEs. In Section 2.5.1 we describe the empirical approach used to allocate each NPE to one of the three business models. We hypothesize that there are varying correlations between different business models of NPEs and the characteristics of the patents they acquire. Furthermore, we believe that the heterogeneity in business models is also linked to diverse uses of the acquired patents.

About the relationship between different NPE business models and the characteristics of acquired patents, "Litigation" NPEs are usually suspected of buying weak patents that protect technologies that are no longer useful. Furthermore, since their main business model consists in asserting alleged infringers rather than developing new inventions or commercializing related products, they are expected to target broad and "cheap" patents for obtaining quick settlements. On the contrary, NPEs that aggregate patents in large numbers without aggressively litigating them in courts ("Portfolio" NPEs) are expected to acquire high-quality patents, since they aggregate complementary patents in order to negotiate licensing

[5]For example, in Germany, under Section 144 of the Patent Act, individuals facing financial constraints can ask for a reduction in court and attorney fees if they are unable to afford them..

contracts. Lastly, "Technology" NPEs invest in direct, in-house R&D and, therefore, are expected to target high-quality patents that are at the core of their technology development in order to complement their patent portfolios.

Hypothesis 3: *Various patent acquisition strategies are indicative of distinct business models employed by NPEs. "Portfolio" and "Technology" NPEs focus on acquiring high-quality patents, whereas "Litigation" NPEs primarily seek patents with broader scope that are more likely to be infringed upon.*

About the impact of NPE patent acquisitions on downstream innovation, our claim is that different NPE business models show heterogeneous impacts on the use of the acquired protected technologies. Chen et al. (2023) investigate the effects of litigation initiated by NPEs on the market value and innovation strategies of technology peers of the defendants. Their findings show a significant and negative impact on the stock prices of peer companies following lawsuits brought by PAEs. This suggests that litigious PAEs affect not only the defendants involved in patent litigation, but also their technology peers. We thus posit that the acquisition of patents by "Litigation" NPEs may push innovators active in related technologies to reduce their use of these technologies, since the risk of being sued is significantly higher. Conversely, "Portfolio" and "Technology" NPEs play (mainly) as middleman in the market; therefore, the use of the technologies they acquire is expected to increase (or, at least, to be unchanged) after the acquisition.

In the empirical analysis we proxy downstream innovation by means of patent forward citations: when one patent cites another patents, this means that a specific portion of the technological information protected by the cited patent qualifies as prior art for the citing patent. For this reason, patents that stop from being cited are very likely to be no longer used in further innovation activities (Abrams et al., 2019; Orsatti and Sterzi, 2023). Consequently, the increase in the number of a patent's forward citations received after its acquisition by an NPE (with respect to the case in which the buyer is a practicing entity) would signal a broader technological exploitation of the invention.

Hypothesis 4: *Different NPE business models are associated with different impact on downstream innovation. The use of the patents acquired by "Litigation" NPEs reduces after the acquisition, compared to acquisitions by practicing entities. This is not the case for "Portfolio" and "Technology" NPEs.*

2.3 Data

To assess the presence of NPEs in Europe and to investigate their patent acquisition strategies, we use and combine data from three different sources. First, we rely on two extensive proprietary lists of NPE names

provided by Clarivate Darts-ip and AST.[6] Second, we employ the Bureau van Dijk's Orbis Intellectual Property Database (ORBIS IP) to retrieve information on European patents currently owned by business entities, distinguishing between first filings and acquired patents.[7] Third, we collect information on patent characteristics from the OECD Patent Quality Database, 2021 Version (Squicciarini et al., 2013) and PATSTAT (Version October 2019).

Furthermore, we complete our data collection with information on patent litigation cases initiated by NPEs in Europe, provided by Clarivate Darts-IP, in order to characterize NPE business models. Precisely, we collect information on EPO patents used in infringement actions initiated by NPEs in the six largest European jurisdictions (i.e. Germany, the UK, France, Italy, Spain and the Netherlands).

2.3.1 List of NPE names

In order to identify patent holders that are NPEs, we rely on an extensive list provided by Clarivate Darts-IP and AST.[8] The list includes all NPE groups, together with their subsidiaries. We double-check the list of NPEs names in order to exclude universities (and individuals), defensive patent aggregators (such as, for example, RPX), and we obtain an initial list of NPEs that consists of 652 NPE groups and 3,508 related subsidiaries.

The advantage of relying on the Clarivate Darts-IP and AST list of NPEs is twofold: first, NPEs have been identified as such by a group of IP specialists; second, it also includes small NPEs and subsidiaries ignored by previous studies and whose omission can lead to a substantial underestimation of the presence of NPEs in the patent market.

NPEs are defined by Clarivate Darts-IP as legal entities that "own or purchase patents filed by or granted to other companies or individual inventors without the intent of producing and/or commercializing the related products or processes".[9] This broad definition includes heterogeneous and in some cases too-distant business models. For this reason, with the aim of appreciating this heterogeneity, we further differentiate (in Section 2.6) NPEs into three categories: (i) *Portfolio NPEs*, that aggregate patent

[6] Please visit https://clarivate.com/darts-ip and https://www.ast.com/ for information about Clarivate Darts-ip and AST, respectively.

[7] The ORBIS IP database is a commercial database that provides economic and administrative data for more than 360 million companies and information on approximately 115 million patents worldwide, including publication information, ownership, industry, history of transfer, and opposition.

[8] We consider all NPE names from Clarivate Darts-IP and NPE groups from AST with more than 45 purchased US patents, corresponding to the top 90% of NPEs listed by patent portfolio size.

[9] A similar definition is also used by AST.

portfolios and negotiate licensing agreements; (ii) *Litigation NPEs*, that acquire patents frequently used in litigation activities; (iii) *Technology NPEs*, that mainly develop and commercialize their own patents.

2.3.2 NPE patent applications

In a second step, we rely on ORBIS IP to collect patent applications where NPEs appear to be the last owners of EPO and European patents. We thus perform a company name search on ORBIS IP for every single NPE group contained in the list of NPE names, together with their respective subsidiaries. The goal is to collect all patent applications where an NPE turns out to be the last owner.[10] We limit our search strategy to patent applications filed at the EPO and in the following European national patent offices: Germany, France, Italy, Spain, the UK and the Netherlands. This cross-reference search between the initial list of 652 NPE group names and the ORBIS IP database leads us to identify 188 NPE groups that are the last owners of 31,713 patent documents (expired patents included). The most targeted patent office is the EPO, with 19,213 patent applications. In the subsequent analysis we thus focus only on EP patents. However NPEs also acquire German patents (where they result to be the last owners of 7,810 patents), while their presence is lower in other patent offices (see Table 2.11 in Appendix).

Together with the patent number, we collect extensive patent ownership data, along with details on acquisitions and transfers. Reconstructing patent ownership history can be challenging, and this is especially true for European patents. As pointed out by Ciaramella et al. (2017), identifying with precision the patents owned by NPEs, both at national patent offices and at the EPO, is a complex task for at least two main reasons. First, the EPO does not register patent reassignments after the patent is granted. Second, each national patent office operates according to a different legal framework with regard to both the obligation to register changes in patent ownership and to the categorization of these patents, with the effect that some NPEs keep the transactions secret and avoid registering the ownership change with the patent office (Sterzi et al., 2021). However, ORBIS IP makes up for the first shortcoming, as it gathers information from diversified data providers and sources, and applies the ownership changes to the entire patent family whenever this information is available.[11] This means that, after the granting, we do observe a transfer related to an EPO patent whenever in its patent family a patent has been transferred, and its transaction has been recorded at the national patent office.[12]

[10]The match is done automatically by ORBIS IP but the accuracy of the match is checked manually by the authors.

[11]The possibility of exploiting patent transaction details is a recent implementation in ORBIS IP, https://www.bvdinfo.com.

[12]To reassure the reader about the quality of the data, we have taken 30 random patents from our list of NPE-acquired patents and we have checked whether the same reassignments were reported on Google Patent Search. We observed a discrepancy in only two cases.

As we focus on patent acquisitions, in order to remove false transactions, we exclude transactions that ORBIS IP identifies as "Intra-company" and "Others". In addition, we also develop an algorithm to further remove residual incorrect transactions, given that sometimes ORBIS IP does not accurately identify intra-company transactions, or that the information on the transaction type is missing.[13]

In summary, our database contains all patent applications filed at the EPO whose last owner is an NPE. These patents come with their complete ownership history and information concerning their specific features, such as the relative technological field of application and quality characteristics.

2.3.3 The NPE-EPO database: Key figures

2.3.3.1 Quantifying the presence of NPEs in Europe

We have built a final dataset comprising 19,213 patent applications (referred to as "patents" hereafter) filed at the EPO. These patents specifically belong to NPEs, and we have identified a total of 176 NPEs that hold at least one patent.[14] Since a patent can be owned simultaneously by more than one NPE, our database includes 19,323 NPE-patent pairs.

Consistent with prior research, the vast majority of patents held by NPEs are concentrated in the ICT sector. Based on the macro IPC patent classification (WIPO, 2020), which consists of eight classes, Electricity (60%) and Physics (23%) emerge as the two predominant technological domains in which NPEs are active.[15]

It is important to point out that we focus here on European patents, which do not always cover European inventions. In fact, some of the identified patents owned by NPEs can be part of international families in which the same invention has also been patented outside Europe. We observe that about 50% of the patents filed in the last decade have no inventors residing in Europe (see Figure 2.3 in Appendix). Furthermore, in some cases the original application is not an application filed at the EPO: in our data 26.6% of NPE-patents have a US priority application.

Furthermore, our data show that about 60% of identified NPE patents were first filed rather than acquired by NPEs. This can be explained by three factors. First, our definition of NPEs includes entities

[13]Section 2.7.1 in the Appendix describes the process of identification of patent transfers.

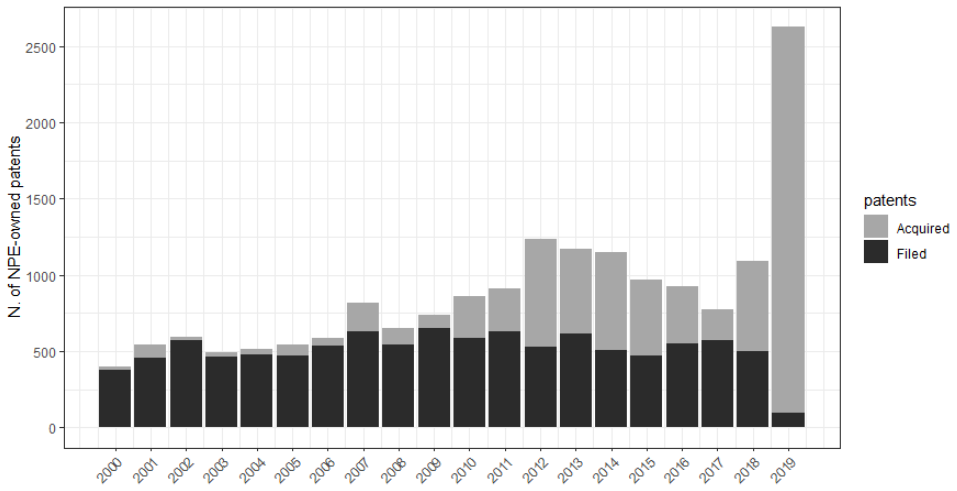
[14]Twelve NPEs in our list do not hold any EPO patents in their portfolios, but only patents granted by national European patent offices. For a comprehensive account of the selection process used to finalize the analysis of 176 NPE groups, please refer to Section 2.7.1 in Appendix.

[15]Table 2.12 in Appendix reports, for each macro technological area, the number and the share of EPO patents owned by NPEs.

that invest in R&D. Second, in certain instances, NPEs might acquire companies that continue to operate as subsidiaries within the NPE group. In such cases, the NPEs may decide not to register at the patent office the change of ownership of the patents of the acquired firm. Consequently, these acquired companies still appear as the current owners of the patents in our database. As a result, we categorize these patents as initially filed by NPEs since we identify the acquired companies as subsidiaries of NPEs. Third, some patents are in families where the priority is a US patent application (around 25% of the cases). In this scenario it is likely that the NPE acquires the US patent prior to its extension to the EPO.

Figure 2.1 shows the total number of EPO patents in which an NPE is the last owner by calendar year, which corresponds either to the transaction year, if the patent changed ownership to an NPE, or to the priority year if the patent has been filed by an NPE. Although we observe that the majority of NPE patent portfolios consists of patents directly filed by NPEs, since 2010 the number of patents acquired by NPEs has increased significantly, while the number of first filings has remained stable, indicating an increasing attention of NPEs towards the European patent market.

Figure 2.1: Distribution of NPE-owned EPO patents: number of filed and acquired patents by calendar year



The figure plots the distribution of EPO NPE-owned patents by calendar year, which correspond to the acquisition year for acquired patents (in light gray) and to the priority year for filed patents (in dark gray).

By focusing only on transacted patents in the years 2010-2019,[16] we identify 6,727 patents acquired by NPEs, which correspond to about 3% of all transacted patents in the same period.[17] By further restricting

[16]We anticipate here a result based on the data regarding all transactions of EP patents that we present in Section 5.

[17]Using similar data on NPEs and looking at the US context since the early 2000s we find that the number of patents

the sample to the Electrical Engineering field[18], our data show that NPEs acquire about 8.7% of the transacted patents, with peaks above 15% in 2014 and 2019 (see Figure 2.4 in Appendix).

2.3.3.2 Identifying Top NPEs and the sources of their patents

The NPE patenting activity in Europe is largely driven by a few large groups: the CR4 concentration index is approximately 50% and the 10 largest NPEs account for over 75% of the total. Table 2.1 displays the top 30 NPEs by patent portfolio size, reporting for each NPE the percentage of litigated patents in the portfolio.[19] The significant concentration can be largely attributed to Interdigital's acquisition of the Technicolor patent portfolio (as discussed in Section 2.2). Other NPEs with large portfolios (more than 1,000 EPO patents) are Dolby Laboratories, Xperi, Provenance Asset Management, and Intellectual Ventures.

NPEs enter the European patent market in different ways. While some NPEs—as it is the case, for example, of Yeda R&D Company—build their portfolios (almost) exclusively on first filings, other NPEs - such as Gerald Padian, Form Holdings, France Brevets and Panoptis Holdings - acquire the vast majority of their patents in the secondary market.

Our data on patent acquisitions show that NPEs tend to buy relevant stacks of patents mainly from large firms that sell considerable portions of their patent portfolios (Table 2.2 reports the top 30 EPO patent transactions with an NPE as the acquirer). Contrary to common thinking, small firms and individual inventors represent only a tiny share of vendors. Furthermore, most of the transactions concern European companies selling their patents to North-American NPEs, mainly US-based.[20]

Lastly, we observe a significant heterogeneity in the propensity to litigate in Europe. Some NPEs—such as Ipcom, Acacia Research Company and Form Holdings—litigate their patents with relative high intensity (more than 5% of their portfolio consists of patents asserted in infringement cases). Other NPEs, instead,

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filed at the USPTO between 1990 and 2010 and purchased by NPEs between 2000 and 2015 is 31,484, around 4% of all US patents filed and transacted over the same time span.

[18]The Electrical Engineering field includes the following sectors: Electrical machinery, apparatus, energy; Audio-visual technology; Telecommunications; Digital communications; Basic communication processes; Computer technology; IT methods for management; Semiconductors

[19]In what follows, since a patent application can be owned by more than one NPE group at the same time (for example, we identify in our database 14 patent applications simultaneously owned by both Acacia Research and Optimum Power Technology, 51 patents owned by both Inception Holdings and Panoptis, 8 patents owned by both Sonrai Memory and Gerald Padian, 36 patents owned by both Tq Delta and Techquity Capital Management and one patent owned by both Finjan and Fortress Investment Group) our unit of analysis will be the patent-NPE group pair.

[20]Table 2.2 also shows that, occasionally, the transactions identified in or sample are not proper market transactions, but merely changes in company names that our algorithm is unable to capture, such as in the case of Rovi Guides transferring to Xperi 59 EPO patents.

do not litigate at all (at least in Europe), which means that either their patent acquisitions are too recent to observe a rise in litigation cases or their business diverges substantially from the mainstream view of NPEs as aggressive entities constantly involved in patent litigation.

Table 2.1: Top 30 NPEs per patent portfolio size (EPO): number of patents in portfolio, share over total patents belonging to NPEs, and proportion of litigated patents in each NPE portfolio

	NPE Group	Tot. portfolio	% over tot.	Cum. of portfolio	% Cum.	% acquired	% litigated
1	Interdigital	5569	28.82 %	5569	28.82 %	39.74 %	0.00 %
2	Dolby Laboratories	1545	8.00 %	7114	36.82 %	10.87 %	0.13 %
3	Xperi	1406	7.28 %	8520	44.09 %	36.49 %	0.57 %
4	Provenance Asset Group	1192	6.17 %	9712	50.26 %	78.86 %	0.00 %
5	Intellectual Ventures	1072	5.55 %	10784	55.81 %	51.77 %	0.56 %
6	Michael Gleissner	1062	5.50 %	11846	61.31 %	17.51 %	0.00 %
7	Yeda R&D Company	934	4.83 %	12780	66.14 %	1.39 %	0.21 %
8	Panoptis Holdings	821	4.25 %	13601	70.39 %	82.22 %	0.97 %
9	Quarterhill (Wilan)	569	2.94 %	14170	73.33 %	55.36 %	0.53 %
10	Rambus	503	2.60 %	14673	75.94 %	14.12 %	0.00 %
11	Mosaid Technologies	470	2.43 %	15143	78.37 %	54.04 %	1.49 %
12	Universal Display	455	2.35 %	15598	80.72 %	36.04 %	0.00 %
13	Sisvel	317	1.64 %	15915	82.36 %	74.13 %	3.15 %
14	Global Oled Technology	284	1.47 %	16199	83.83 %	51.06 %	0.00 %
15	Pendrell	234	1.21 %	16433	85.04 %	52.14 %	0.00 %
16	Ipcom	195	1.01 %	16628	86.05 %	48.72 %	8.21 %
17	Innovative Sonic	189	0.98 %	16817	87.03 %	12.17 %	0.00 %
18	Rockstar Consortium	163	0.84 %	16980	87.87 %	92.64 %	0.00 %
19	Virginia Tech IP	160	0.83 %	17140	88.70 %	8.75 %	0.00 %
20	France Brevets	124	0.64 %	17264	89.34 %	84.68 %	2.42 %
21	Flagship Ventures 2004 Fund	121	0.63 %	17385	89.97 %	0.83 %	0.00 %
22	Acacia Research	104	0.54 %	17489	90.51 %	29.81 %	6.73 %
23	Intellectual Discovery	100	0.52 %	17589	91.03 %	67.00 %	0.00 %
24	Fractus	88	0.46 %	17677	91.48 %	3.41 %	1.14 %
25	Gerald Padian	81	0.42 %	17758	91.90 %	96.30 %	0.00 %
26	Invue Security Products	71	0.37 %	17829	92.27 %	4.23 %	0.00 %
27	Form Holdings	69	0.36 %	17898	92.63 %	91.30 %	5.80 %
28	Seven Networks	68	0.35 %	17966	92.98 %	14.71 %	0.00 %
29	Uniloc	61	0.32 %	18027	93.29 %	19.67 %	3.28 %
30	Key Patent Innovations	59	0.31 %	18086	93.60 %	45.76 %	0.00 %
Total		18086	-	-	-	-	-

The sample consists of 19,323 pairs of EPO patent applications and 176 NPE groups.

Table 2.2: Top 30 NPE transactions per number of EPO patents acquired

	Vendor Company	Vendor country	Acquirer Company (NPE Group)	Acquirer country	N. EPO patents acquired
1	Technicolor	FR	Interdigital	US	2002
2	Alcatel Lucent	FR	Provenance Asset Group	US	557
3	Ericsson	SE	Panoptis Holdings	US	431
4	Nokia	FI	Mosaid Technologies	CA	201
5	United Video Properties	US	Xperi	US	160
6	Eastman Kodak Company	US	Global Oled Technology	US	145
7	Alcatel	FR	Provenance Asset Group	US	114
8	Nortel Networks	CA	Rockstar Consortium	CA	111
9	Lucent Technologies	US	Provenance Asset Group	US	104
10	Matsushita Electric Industrial	JP	Panoptis Holdings	US	103
11	Robert Bosch	DE	Ipcom	DE	87
12	Nokia	FI	Provenance Asset Group	US	86
13	Siemens	DE	Quarterhill Aka Wilan	CA	86
14	Basf	DE	Universal Display	US	67
15	Orange	FR	Sisvel	IT	67
16	Philips	NL	Pendrell	US	65
17	Fujifilm Corporation	JP	Universal Display	US	64
18	Nokia	FI	Form Holdings	US	60
19	Rovi Guides	US	Xperi	US	59
20	Daewoo Electronics	KR	Quarterhill Aka Wilan	CA	58
21	Ericsson	SE	Interdigital	US	51
22	Nokia	FI	Provenance Asset Group	US	50
23	Ericsson	SE	Panoptis Holdings	US	47
24	Nxp	NL	Intellectual Ventures	US	45
25	Infineon Technologies	DE	Quarterhill Aka Wilan	CA	43
26	Nokia	FI	Sisvel	IT	43
27	Daewoo Electronics	KR	Quarterhill Aka Wilan	CA	41
28	Starsight Telecast	US	Xperi	US	39
29	Verimatrix	FR	Rambus	US	39
30	Micron Technology	US	Round Rock Research	US	37
Total		-	-	-	5062

The sample consists of 7,607 patent applications acquired by 176 NPE groups. If a patent is jointly owned by two NPEs, it is counted twice.

2.4 Characteristics of NPE-acquired patents

In this section, we investigate NPE patent acquisition strategies, specifically addressing hypotheses 1 and 2. We focus on the subset of transacted patents and we complement our database of NPE patent acquisitions by including patents acquired by entities other than NPEs that we label as practicing entities (PEs). Data on patent transactions are from ORBIS IP and have been further cleaned in order to remove

false transactions, that is, intra-company transactions and changes of name.[21] For each patent history, we consider only the most recent acquisition. We then restrict the analysis to patents filed between 1995 and 2015 and transacted between 2010 and 2020, which corresponds to the period in which NPEs acquire most of their patents.[22] Our final dataset comprises 203,964 transacted patents, of which 6,383 are patents acquired and currently owned by NPEs (3.1% of all transacted patents in our sample). NPEs are mostly active in Electrical Engineering, where they acquired 5,859 patents (8.8% of all patents traded in that field over the period analyzed).

A key issue when it comes to NPE patent acquisitions and litigation is patent quality because their impact on innovation significantly changes if they target low-quality rather than promising and high-quality technologies. Given that NPEs acquire patents with the intention of licensing them rather than producing related products, it is expected that they will target patents of high technological quality (Hypothesis 1). Moreover, NPEs whose core business is asserting patents will find broad patents especially appealing (Hypothesis 2). We thus focus on the two following patent characteristics: patent quality and patent breadth. We proxy patent quality with the number of forward citations (calculated over 5-year time windows since publication), and patent breadth with patent scope, measured by the number of four-digit International Patent Classification (IPC) classes assigned to the invention (Lerner, 1994). Precisely, our two variables of interest are:

1. *Five-year Citations*: the number of times a given patent is cited by other patent documents in the five years after its publication. Patent citations are included in the patent document to delimit the scope of the property right. At the EPO, citations are added by both the patent applicant and the patent examiner during the examination process. Known as "forward citations," citations received by a patent imply that the invention protected by the patent is being used for the creation of new inventions. Hence, it is common to consider a patent that receives a large number of citations to be of high technological quality. Forward citation counts presented here take into account patent equivalents (patent documents protecting the same invention at several patent offices).

2. *Patent Scope*: the number of distinct four-digit sub-classes of the International Patent Classifications (IPC). Broad-scope patents are more likely to be infringed and litigated (Merges and Nelson, 1990; Lerner, 1994) and can be exploited for rent-seeking purposes by NPEs (Fischer and Henkel, 2012; Sterzi et al., 2021).

[21] For a detailed description of the intra-company transactions and the identification of name changes, see Appendix 2.7.1.1.

[22] We exclude patents filed later than 2015 because we use the number of forward citations received in a five-year window after patent publication as a proxy of the technological quality of the protected invention.

Other patent characteristics are also expected to correlate with the probability of an NPE patent acquisition. Therefore, we include the following control variables in the empirical analysis:

- *Age* measures the age (in years) of the patent from filing to acquisition. NPEs buy patents for reasons different than producing companies; for example, they acquire from inventors who failed to exploit and monetize their inventions, or target technologies that are no longer useful for developing or commercializing new products. As a consequence, NPEs are expected to acquire patents later in their patent life compared to practicing entities.

- *Family size* is computed as the number of patent offices in which the same invention obtained a patent grant. This variable controls for the possibility that the original invention is protected also in patent offices other than EPO. Since most of NPEs in the sample are not European, *Family size* is expected to be positively correlated with NPE patent acquisition.

- *Claims* is the number of patent claims. It is a proxy of the legal sustainability of the patent (Lanjouw and Schankerman, 1999; Reitzig, 2003), since a patent with a large number of claims has, on average, a greater chance of at least one claim surviving an invalidation procedure. Since NPEs acquire patents that can be frequently challenged in courts, this variable is expected to be positively correlated with NPE patent acquisition.

- *Backward citations* is computed as the number of patent citations made by the focal patent. This variable measures the number of protected technologies the focal patent relies on in terms of prior art (Sampat and Ziedonis, 2004; Ziedonis, 2004).[23]

- Non-Patent Literature citations (*NPL dummy*) indicates whether the focal patent cites non-patent literature (e.g. scientific publications). It is considered a proxy for the proximity of the patent to science (Meyer, 2000; Narin, 1987; Narin et al., 1987).

- Moreover, we include (i) filing year dummies, to control for cohort effects, and (ii) technology dummies to control for technology-specific effects.[24]

Table 2.3 reports the summary statistics of the variables used in the analysis, distinguishing between patents acquired by NPEs and patents acquired by PEs, along with the mean differences between these two groups and the p-values of the corresponding t-test statistics. We observe significant differences between

[23]The number of backward citations has also been used as a measure of the scope of the patent (e.g. Harhoff et al., 2003). However, this correlation vanishes as we include the variable "patent scope" in the regression analysis.

[24]We follow the WIPO taxonomy and consider 35 unique technology fields.

the two groups for all variables used, confirming the findings reported in extant studies (Fischer and Henkel, 2012; Leiponen and Delcamp, 2019). On average, patents acquired by NPEs receive more citations than patents acquired by PEs in the first five years since publication (five-year Citations). However, contrary to our expectations, the former show fewer possible technological fields of application (Patent Scope) than the latter. Moreover, NPE-acquired patents are on average older (Age), closer to science (NPL dummy), have fewer family members (Family Size) and cite fewer extant patents (Backward Citations). We also find significant differences with respect to technology field and cohort between the two groups of acquired patents. Precisely, NPEs acquire 92% of their patents in Electrical Engineering (only 31% for PEs), and NPE-acquired patents are, on average, two years older than patents acquired by PEs.

Table 2.3: Summary statistics (mean values)

	Practicing Entity (PE)	NPE	Mean difference	P-value
Age	8.80	10.87	-2.07	0.00
5-Year Citations	1.03	1.45	-0.42	0.00
Patent Scope	1.92	1.84	0.08	0.00
Family Size	6.47	6.35	0.12	0.05
Filing year	2006.72	2005.13	1.59	0.00
Claims	13.37	14.19	-0.82	0.00
Backward Citations	6.65	4.50	2.15	0.00
NPL (dummy)	0.30	0.47	-0.18	0.00
Electrical Engineering	0.31	0.92	-0.61	0.00
Observations	197541	6386		

The sample consists of EPO patent applications filed 1995-2015 and acquired by either NPEs or PEs over the period 2010-2020. Only the last recorded transaction is accounted in the statistics; p-values are computed from the two-samples t-test statistics for differences in means.

2.4.1 Econometric analysis

Differences in the patent quality reported in Table 2.3 might reflect distribution differences between the two groups across technological domains and years of filing and acquisition. In order to address this issue, we estimate a series of linear probability models (LPMs) and logit models, where the dependent variable takes value 1 when the patent is acquired by an NPE, 0 when it is acquired by a PE. We report the results of this analysis in Table 2.4.

Since our dependent variable is strongly unbalanced (i.e. the share of NPE-acquired patents in the sample is about 3%), logit models should be preferred over LPMs. Moreover, in order to better deal with the potential problem of low-frequency or rare events in matched samples affecting the standard maximum likelihood estimation (King and Zeng, 2001), we follow three additional strategies. First, in Column 3 we estimate the model only for patents in Electrical Engineering, where NPEs acquire about 9% of all transacted patents. Second, in Columns 4 and 5 we match the sample of patents acquired by NPEs with two distinct control groups of patents acquired by PEs. Precisely, in Model 4 each NPE-acquired patent

is randomly matched to a control group of at most two patents acquired by PEs that are classified in the same technological field (WIPO 35 classes) and filed in the same year. In Model 5 we impose the additional condition that the patents in the control groups must be acquired in the same year as those acquired by NPEs to enter the sample. The advantage of relying on matched control groups of patents is that it also decreases the influence of potential confounding factors, as we control not only for the linear terms of the covariates, but also for any arbitrary combination of them. Third, we estimate rare events logit models with the Firth logit approach, which is a penalized likelihood method taking into account the low shares of 1 in the outcome variable (Firth, 1993).[25]

Finally, since in our analysis we focus only on transacted patent applications, our econometric results might suffer from selection bias if the probability of being transacted differs between patents attractive to NPEs and those attractive to PEs. To control for this possible bias, we follow Fischer and Henkel (2012) and estimate a selection equation to compare transacted and non-transacted patent applications (Heckman, 1979). Precisely, for every transacted patent resulting from the previous matching procedure (where every NPE-acquired patent was matched to a PE-acquired patent in the same technological field, transferred and filed in the same year - corresponding to the sample reported in Column 5, Table 2.4), we randomly select up to three non-transacted patents in the same technological field, filed in the same year and active (i.e. pending or granted) in the year of transaction of the matched transacted patent. Then, for each transacted patent, the instrument is a dummy that is equal to 1 if the patent was already granted at the time that it was acquired, and 0 otherwise; for the patent in the control group, the same dummy is equal to 1 if it was granted when its matched patent was acquired. The rationale of this instrument is that this variable should have an influence on the probability of the patent being transacted (selection equation), as the patent grant reduces the uncertainty about the value of the legal right (Gans et al., 2008), but it should not have any influence on the type of buyer (outcome equation) since NPEs can also use patents that are still pending to seek settlement payments (Fischer and Henkel, 2012).

Table 2.4 reports the baseline results of our analysis, expressed as marginal effects at the mean values. With a few exceptions, results are consistent across models. In particular, in line with Hypothesis #1, the probability of a patent acquisition by an NPE increases with the technological patent quality, proxied by the log-transformed number of five-year forward citations: marginal effects reported in Model 2 show that for a 1% increase in the number of forward citations, the probability of a patent being acquired by an NPE (rather than acquired by a practicing company) increases by 0.2%. Conversely, Hypothesis #2 is not verified: Patent scope does not correlate with the probability of an NPE patent acquisition. This

[25] Results are available upon request from the authors.

result is not consistent with extant literature (Fischer and Henkel, 2012; Sterzi et al., 2021). One reason for this result might be the heterogeneous sample of NPEs used in our analysis, which encompasses not only litigious NPEs (as commonly studied) but also patent aggregators and technology companies. We investigate the business model heterogeneity of NPEs in Section 2.5.

Table 2.4: NPE-patent acquisition, baseline estimation (marginal effects)

	(1) OLS	(2) LOGIT	(3) LOGIT Electrical Eng.	(4) LOGIT Matched Sample 1	(5) LOGIT Matched Sample 2	(6) Sample Selection PROBIT
Age	0.0022***	0.0020***	0.0068***	0.017***	-0.0010	0.0013
	(0.00014)	(0.00013)	(0.00039)	(0.0012)	(0.0014)	(0.00087)
5-year Citations (ln)	0.0037***	0.0022***	0.0061***	0.020***	0.014**	0.012***
	(0.00071)	(0.00057)	(0.0017)	(0.0052)	(0.0058)	(0.0036)
Patent scope (ln)	0.0011	-0.000079	-0.0072**	-0.0011	0.0030	0.0023
	(0.0011)	(0.0012)	(0.0036)	(0.011)	(0.012)	(0.0076)
Family size (ln)	0.0099***	0.012***	0.040***	0.11***	0.11***	0.084***
	(0.00064)	(0.00076)	(0.0023)	(0.0072)	(0.0081)	(0.0066)
Claims (ln)	0.000060	0.00062	0.0023	0.012**	0.015**	0.0012
	(0.00063)	(0.00058)	(0.0017)	(0.0054)	(0.0058)	(0.0038)
Backward Citations (ln)	-0.0074***	-0.0060***	-0.018***	-0.048***	-0.036***	-0.018***
	(0.00068)	(0.00070)	(0.0020)	(0.0065)	(0.0070)	(0.0049)
NPL (dummy)	0.012***	0.0062***	0.014***	0.046***	0.059***	0.040***
	(0.0012)	(0.00082)	(0.0024)	(0.0074)	(0.0081)	(0.0058)
Observations	190,357	190,357	61,847	18,176	15,054	15,054
R-squared (Pesudo R-squared)	0.10	0.28	0.12	0.03	0.02	

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The dependent variable takes value one if the patent buyer is an NPE, zero if the buyer is a PE. All variables – except patent Age and the dummy NPL – are augmented by one and log-transformed. The constant term in the models is included but not reported. Marginal effects are computed at the mean values. In Model (4) each patent acquired by an NPE is randomly matched to a control group of (up to two) patents acquired by practicing companies that are classified in the same technology field (WIPO 35 classes) and have been filed in the same year. In model (5) we impose the additional condition that the control patents must be acquired in the same years as patents acquired by NPEs. Model (6) reports the estimated marginal effects from the sample selection probit; 15,054 Selected patents, 39,887 Non-selected patents; estimated coefficients of the selection equation are reported in Appendix, Table 2.13.

When we use the matched sample, in which we impose the condition that both NPE-acquired and PE-acquired patents belong to the same technology (i.e. same WIPO 35 class), to the same cohort (i.e. same year of first filing) and are transacted in the same year (Column 5), we estimate stronger marginal effects of patent technological quality (0.014) than before. Lastly, the sample selection probit model[26]

[26]We use the STATA command "Heckprobit".

(Column 6) yields qualitatively the same results as the Logit models based on matched samples.[27]

Overall, the coefficient for technological patent quality is positive and significant, although it is found to be lower than in Fischer and Henkel (2012), where the estimated marginal effect is almost three times larger than in our sample (0.049). With respect to other patent characteristics, our results suggest that the probability of an acquisition by an NPE increases with patent family size, with the number of claims and with the presence of non-patent literature cited in the patent document.

2.4.2 Robustness checks

Results reported in Table 2.4 suggest that NPEs target patents are of a higher intrinsic technological quality compared to practicing companies, when quality is proxied by the number of citations received by the patent in a fixed five-years window since publication. This result points to a positive role played by NPEs in the patent market. However, NPEs are often accused of buying old technologies that are no longer useful for developing new inventions and commercializing new products. In this respect, the number of citations a patent receives at the beginning of its life might not be indicative of the actual usefulness of the invention at the time of acquisition.

In this section, we thus investigate whether NPEs target patents are highly used at the time of the acquisition. We consider a citation received by a patent in a given year as an evidence that the knowledge embodied in the patent has been exploited somehow to generate a recent invention. Therefore, the higher the number of citations received around the patent acquisition, the higher the present usefulness of the patent for other innovators at the time it changes ownership. We proxy the usefulness of the patent at the time of the acquisition with the number of citations received in the two (or, alternatively, three) years before the transaction.[28] Data on patent citations are from PATSTAT.[29,30] While fixed windows of five-years since publication proxy for the intrinsic technological quality of a protected technology, the number of citations computed close to the transaction date captures the extent to which the patent is used *at the time of the acquisition*.

Results are reported in Table 2.5 and are based on the matched sample where patents acquired by NPEs are exactly matched to patents acquired by practicing companies on: i) technological field, ii) filing

[27] Results of the selection equation are reported in the Appendix in Table 2.13.

[28] To compute the number of citations received before the transaction, we restrict the analysis to patents transacted at least three years after filing.

[29] Since we use the October 2019 version of PATSTAT, we exclude patents transacted after 2018 from the analysis.

[30] We consider only EP-to-EP citations.

year, and iii) transfer year. Logit results show that patents acquired by NPEs receive a higher number of citations than patents acquired by PEs not only in the first five years since filing (model 1), but also in the two (model 2) or three years (model 3) before the transfer. The estimated marginal effect of the number of citations in the two or three years before the transaction is about 0.038, meaning that, for a 1% increase in the number of forward citations, the probability of a patent being acquired by an NPE (rather than a PE) increases by 3.8%.

Table 2.5: NPE-patent acquisition. Patent quality (marginal effects)

	(1) LOGIT Matched Sample 2 Age>2	(2) LOGIT Matched Sample 2 Age>2	(3) LOGIT Matched Sample 2 Age>2
Age	-0.0014	0.0013	0.0011
	(0.0022)	(0.0023)	(0.0022)
5-year Citations (ln)	0.020***		
	(0.0044)		
2-yr Cit. before acquisition (ln)		0.038***	
		(0.0074)	
3-yr Cit. before acquisition (ln)			0.033***
			(0.0062)
Patent scope (ln)	0.020	0.020	0.020
	(0.014)	(0.014)	(0.014)
Family size (ln)	0.12***	0.12***	0.12***
	(0.0096)	(0.0095)	(0.0096)
Claims (ln)	0.037***	0.038***	0.038***
	(0.0068)	(0.0067)	(0.0067)
Backward Citations (ln)	-0.0036	-0.0038	-0.0041
	(0.0085)	(0.0085)	(0.0085)
NPL (dummy)	0.067***	0.067***	0.067***
	(0.0096)	(0.0096)	(0.0096)
Constant			
Observations	10497	10497	10497
Adjusted R^2			
Pseudo R^2			

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The sample is the same used in Table 2.4, Column 5, where each patent acquired by an NPE is randomly matched to a control group of (up to two) patents acquired by practicing companies that are classified in the same technology field (WIPO 35 classes), have been filed in the same year (i.e. patents in the same cohort) and have been acquired in the same year. The only difference is that we consider only transactions occurring at least three years after the filing date. The variable "2-yr Cit. before acquisition" refers to the number of citations received in the two years before the acquisition year, while the variable "3-yr Cit. before acquisition" refers to the total number of citations received in the three years before the acquisition year. Data on forward citations are from PATSTAT, version October 2019 (therefore, we excluded patents that changed ownership after 2018). The dependent variable takes value one if the patent buyer is an NPE, zero if the buyer is a PE. All variables—except patent Age and the dummy NPL—are augmented by one and log-transformed. The constant term is not reported. Marginal effects are computed at the mean values.

2.5 NPE business model heterogeneity

Overall, our results point to a possible positive role of NPEs in the patent market as they acquire, on average, highly cited patents. How do our results reconcile with other studies that find NPEs acquiring and asserting weak patents? We argue that the mixed empirical evidence on the impact of NPEs on innovation can be explained by the different definitions and samples of NPEs used in extant studies. With few exceptions, most of the literature has considered NPEs as a homogeneous group. However, NPEs encompass various types of entities with distinct business models, all of which share the common trait of not practicing their patents.

Our hypothesis is that different NPE business models show different correlations with the characteristics of targeted patents (Hypothesis #3a) and that are associated with heterogeneous impacts on downstream innovations (Hypothesis #3b).

2.5.1 NPE taxonomy

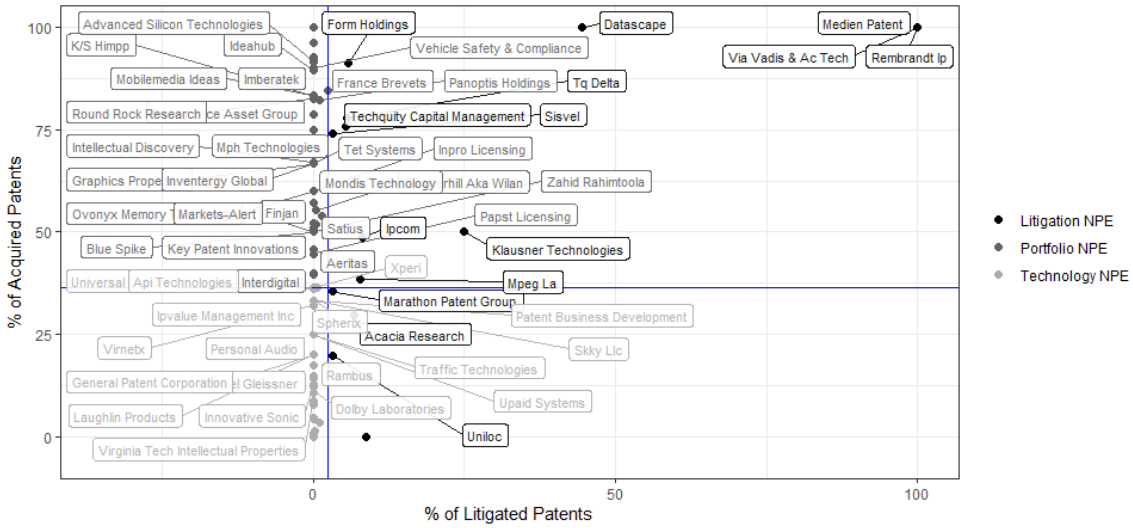
Extant studies have already reported evidence of a fit between NPEs business models and their patent acquisition strategies. For example, Leiponen and Delcamp (2019) analyze the characteristics of four types of NPE licensing models: independent patent licensing companies, patent aggregators, technology development firms, and NPEs affiliated with practicing companies. They find high heterogeneity in terms of propensity to litigate, and in the age and the quality of acquired patents. In our analysis, we extend their work by relying on a larger sample of NPEs and proposing a taxonomy based on two main observable dimensions: (i) the proportion of litigated patents and (ii) the proportion of acquired patents in their patent portfolio. We thus distinguish three types of NPEs based on their relative position in with respect to these dimensions. In particular, we argue that a high litigation rate is associated with NPEs that are particularly aggressive and litigious (*Litigation NPEs*).[31] Among non-litgious NPEs, we then distinguish between *Technology NPEs*, whose patent portfolios are largely built on patents filed (rather than acquired) - these NPEs invest in R&D, and develop and commercialize their own patents - and *Portfolio NPEs* that, on the contrary, aggregate different extant patent portfolios. Our definitions of *Litigation NPEs*, *Portfolio NPEs* and *Technology NPEs* closely correspond, respectively, to the three categories "Independent licensing companies", "Patent aggregators" and "Technology development firm" proposed by Leiponen and Delcamp (2019).

[31] If it is not true that all aggressive NPEs need to litigate a high share of their patents, it is difficult to consider not aggressive those that litigate intensively in court. Data on licenses would be particularly useful to detect aggressive NPEs that do not litigate their patents at high rates, but unfortunately this information is confidential in most of the cases.

We assign the 176 NPEs in our sample to one of the three types of business models described above depending on their relative position in the distribution of the two variables considered. Figure 2.2 provides a graphical visualization of the NPE taxonomy proposed, according to the percentage of litigated patents (x-axis) and the percentage of acquired patents (y-axis). The lines forming the quadrant are drawn according to the average values of the two variables (2.47% and 32.52%, respectively). We therefore distinguish between:

- *Litigation NPEs*: NPEs with a percentage of litigated patents in their portfolio which is above the average (2.46%). They are placed in the right-hand side of Figure 2.2.
- *Portfolio NPEs*: NPEs with a percentage of acquired patents in the portfolio which is above the average (36.32%) and with a percentage of litigated patents lower than the average. They are placed in the top left side of Figure 2.2.
- *Technology NPEs*: residual category including NPEs with a percentage of both acquired and litigated patents below the average. They are placed in the bottom left side of Figure 2.2.

Figure 2.2: NPEs' taxonomy by acquisition and litigation propensity



The vertical line and the horizontal line are drawn, respectively, at the mean of the percentage of litigated patents in portfolio on the x-axis and at the mean of the percentage of acquired patents in portfolio on the y-axis. Mean of the percentage of litigated patents = 2.47. Mean of the percentage of acquired patents = 36.52.

Table 2.6 reports the names of the five largest NPEs, by type of business model and size of patent portfolio. Table 2.7 reports the number of NPEs, the total number of patents in the portfolio and the total number of acquired patents, by type of business model.

Table 2.6: Top five NPEs per acquired patents by type of business model

	NPE Group	N. acquired patents	N. patents in portfolio	NPE Type
1	Sisvel	235	317	Litigation NPE
2	Ipcom	95	195	Litigation NPE
3	Form Holdings	63	69	Litigation NPE
4	Acacia Research	31	104	Litigation NPE
5	Techquity Capital Management	28	37	Litigation NPE
6	Interdigital	2213	5569	Portfolio NPE
7	Provenance Asset Group	939	1192	Portfolio NPE
8	Panoptis Holdings	675	821	Portfolio NPE
9	Intellectual Ventures	555	1072	Portfolio NPE
10	Quarterhill Aka Wilan	315	569	Portfolio NPE
11	Xperi	513	1406	Technology NPE
12	Michael Gleissner	186	1062	Technology NPE
13	Dolby Laboratories	168	1545	Technology NPE
14	Universal Display	164	455	Technology NPE
15	Rambus	71	503	Technology NPE

The table shows the five largest NPEs by number of acquired patents for each type of NPE.

Table 2.7: Total number of patents, number of acquired patents and number of NPEs by NPE type

NPE Type	N. patents	N. acquired patents	N. NPEs per type	Average portfolio size
Litigation NPE	916	235	15	61.07
Portfolio NPE	11123	2213	62	179.40
Technology NPE	7284	168	99	73.60
All NPEs	19323	2616	176	109.79

The table shows the number of patents, the number of NPE groups and the average portfolio size by NPE type.

As discussed in Section 2.2, we test two hypotheses. First, different NPE business models are correlated with different patent acquisition strategies (Hypothesis #3a). Second, different NPE business models exhibit heterogeneous associations with follow-on innovation around targeted patents (Hypothesis #3b).

2.5.2 NPE business model and patent acquisition strategies

With respect to Hypothesis #3a, extant studies stress that NPEs that assert patents as their core business target mainly weak patents that protect technologies no longer useful neither to develop new inventions nor to commercialize related products. Therefore, our expectation is that *Litigation NPEs* target patents with a high probability of being infringed, while technological quality plays a less important role in the choice of the patent to purchase (or even a negative role when high-quality patents are particularly expensive). Conversely, *Technology NPEs* differ from the other types of NPEs in the way they have access to technological capabilities. In particular, since *Technology NPEs* file a large share of their patents (instead of acquiring patents in the market), we expect them to target high-quality patents to complement

their patent portfolios (Leiponen and Delcamp, 2019). Similarly, NPEs that aggregate patent portfolios without aggressively litigating in courts (*Portfolio NPEs*) are expected to target valuable patents, since their main business consists in maximizing licensing fees.

Our goal is to estimate the probability that a patent will be acquired by one of the three types of NPEs, rather than acquired by a PE. Therefore, we estimate a Multinomial Logit model whose reference category is a PE patent acquisition. Table 2.8 reports the estimated coefficients (and associated standard errors in parenthesis) calculated as relative risk ratios (RRR). An estimated RRR > 1 for a variable of interest indicates that the risk of an NPE category acquiring a patent compared to the risk of a PE acquiring a patent (the reference group) increases as the variable of interest increases. An estimated RRR < 1 indicates the opposite. The sample used to perform this analysis is the same of Table 2.5, formed by matched pairs of NPE-acquired and PE-acquired patents (control group) on filing year, transaction year and technology.

Referring to Model 1, we estimate a positive and significant coefficient of technological quality for *Technology NPEs* and for *Portfolio NPEs*. Precisely, the RRR for a one-unit increase in the number of citations (computed in the 5-year window since filing) is 1.12 when the patent is acquired by a *Technology NPE* and 1.11 when it is acquired by a *Portfolio NPE*. This means that these two types of NPEs are more likely to target patents more cited than patents targeted by PEs. We estimate similar coefficients for the number of citations received by the patent at the time of its acquisition (2-yr and 3-yr Cit. before acquisition): both *Technology NPEs* and *Portfolio NPEs* acquire patents highly cited in the first 5 years since filing and around the transaction year.

Conversely, technological quality does not correlate with the likelihood that the patent buyer is a *Litigation NPE*. In this case, we estimate an RRR for a one-unit increase in the number of citations (5-year Citations (ln)) lower than one, although not significant, and non significant coefficients also for the number of citations received two and three years before acquisition. However, rather than targeting high-quality patents, *Litigation NPEs* target patents with broader patent scope (RRR between 1.50 and 1.59).

Overall, our results point to a strong heterogeneity with respect to the relationship between NPE business models and patent acquisition strategies, thus corroborating Hypothesis #3a.

Table 2.8: Business model heterogeneity: patent acquisition strategy

	(1)			(2)			(3)		
	Litigation NPE	(Age>2) Portfolio NPE	Technology NPE	Litigation NPE	(Age>2) Portfolio NPE	Technology NPE	Litigation NPE	(Age>2) Portfolio NPE	Technology NPE
5-year Citations (ln)	0.97	1.11***	1.12***						
	(0.052)	(0.026)	(0.048)						
2-yr Cit. before acquisition (ln)				1.00	1.10**	1.53***			
				(0.091)	(0.044)	(0.087)			
3-yr Cit. before acquisition (ln)							1.00	1.10***	1.43***
							(0.077)	(0.036)	(0.073)
Patent scope (ln)	1.59**	1.00	1.24*	1.59**	1.02	1.20	1.59**	1.02	1.21
	(0.31)	(0.076)	(0.16)	(0.31)	(0.077)	(0.15)	(0.31)	(0.077)	(0.15)
Family size (ln)	2.70***	1.35***	3.66***	2.71***	1.36***	3.63***	2.71***	1.36***	3.61***
	(0.34)	(0.068)	(0.35)	(0.34)	(0.069)	(0.34)	(0.34)	(0.069)	(0.34)
Claims (ln)	1.30***	1.18***	1.15**	1.28***	1.20***	1.13**	1.29***	1.20***	1.13**
	(0.12)	(0.043)	(0.071)	(0.12)	(0.044)	(0.070)	(0.12)	(0.044)	(0.070)
Backward Citations (ln)	0.89	0.85***	1.61***	0.88	0.86***	1.58***	0.88	0.86***	1.58***
	(0.10)	(0.037)	(0.12)	(0.100)	(0.037)	(0.12)	(0.10)	(0.037)	(0.12)
NPL	1.62***	1.19***	1.29***	1.61***	1.20***	1.28***	1.61***	1.20***	1.28***
	(0.15)	(0.046)	(0.078)	(0.15)	(0.046)	(0.078)	(0.15)	(0.046)	(0.078)
Constant	0.00020***	0.11***	0.0043***	0.00020***	0.12***	0.0046***	0.00020***	0.12***	0.0045***
	(0.00025)	(0.033)	(0.0019)	(0.00025)	(0.035)	(0.0020)	(0.00024)	(0.035)	(0.0019)
Filing year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Technology FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10497			10497			10497		
Pseudo R^2	0.082			0.083			0.083		

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The table reports the estimated coefficients (and associated standard errors in parenthesis) calculated as relative risk ratios. The reference category is the acquisition by a PE. We exclude patents traded after 2016 (citation data are from PATSTAT, version October 2019). The variable "X-year Cit. before acquisition" is the number of citations received by the patent X years before the patent acquisition; the variable "X-year Cit. after acquisition" is the number of citations received by the patent X years before the patent acquisition. We restrict the analysis to patents transacted at least seven years from the filing date to avoid overlapping between the count of citations received in the first five years from the filing date and citations received two years before the acquisition.

2.5.3 NPE business model and follow-on innovation

The last step of the empirical analysis is dedicated to investigate whether different NPE business models are associated with different uses of acquired patents after transfer (Hypothesis #3b). We look at the number of forward citations received by transacted patents *after* the acquisition to investigate whether the three groups of NPEs differ in terms of follow-on innovation with respect to practicing entities. Precisely, we include the number of citations received in the two (or three) years after the transfer among the explanatory variables. The rationale is that a negative correlation between the number of forward citations received by acquired patents after the transaction and the likelihood that one of the three types of NPEs is the patent buyer is a signal of the reduced use of the patent after transfer (Abrams et al., 2019; Orsatti and Sterzi, 2023). Conversely, a positive correlation would indicate a more effective use of patents targeted by NPEs after transfer compared to (similar) patents acquired by practicing entities, suggesting patent acquisitions by NPEs enhance technological exploitation around targeted technologies.

Our hypothesis is that patents experience a reduction in their use when they are acquired by entities involved in the business of patent enforcement and not necessarily in technology transfer. Therefore, our expectation is to estimate a higher likelihood of observing a patent acquisition by a *Litigation NPE* when the drop in after transfer citations is higher. Conversely, we do expect positive (or non-significant) correlations between the number of citations received by a patent after transfer and the likelihood that the patent acquisition is made by either *Portfolio NPEs* or *Technology NPEs*. Indeed, these entities act, respectively, as intermediaries and technology providers in the market.

Table 2.9 reports the results. We estimate a negative and significant correlation between the number of citations received by the patent after the transaction (both two and three years after the patent acquisition) and the likelihood that the buyer is a *Litigation NPE*. If patents acquired by *Litigation NPE* show a similar number of citations to those acquired by practicing entities, the number of forward citations is lower after the transaction. This result suggests that patent acquisitions by these entities are associated with a significant reduction in the use of the patent compared to patents acquired by practicing companies, thus corroborating the first part of Hypothesis #3b.

However, we can only partially confirm the second part of Hypothesis #3b. In fact, contrary to our expectations, we estimate a negative correlation between the number of citations received in a 3-year window after the transfer and the likelihood that the patent buyer is a *Portfolio NPE*. A possible explanation for this result is that *Portfolio NPEs* amass large stocks of patents that, at least in part, necessitate time to be allocated through licensing agreements. This means that, on average, patents targeted by these entities will show a drop in their follow-on use after transfer.

Table 2.9: Business model heterogeneity: acquisition strategy and follow-on innovation

	(1)			(2)		
		(Age>2)			(Age>2)	
	Litigation_NPE	Portfolio_NPE	Technology_NPE	Litigation_NPE	Portfolio_NPE	Technology_NPE
2-yr Cit. before acquisition (ln)	1.03	1.19***	1.52***			
	(0.11)	(0.056)	(0.11)			
3-yr Cit. before acquisition (ln)				1.04	1.20***	1.46***
				(0.091)	(0.048)	(0.092)
2-yr Cit. after acquisition (ln)	0.70**	0.92	0.91			
	(0.10)	(0.059)	(0.091)			
3-yr Cit. after acquisition (ln)				0.74**	0.90*	0.88
				(0.10)	(0.053)	(0.079)
Patent scope (ln)	1.51**	1.03	1.13	1.51**	1.03	1.13
	(0.30)	(0.085)	(0.15)	(0.30)	(0.084)	(0.15)
Family size (ln)	2.66***	1.47***	3.49***	2.66***	1.46***	3.46***
	(0.34)	(0.080)	(0.34)	(0.34)	(0.080)	(0.34)
Claims (ln)	1.34***	1.24***	1.12*	1.34***	1.23***	1.13*
	(0.12)	(0.049)	(0.070)	(0.12)	(0.049)	(0.070)
Backward Citations (ln)	0.94	0.89**	1.63***	0.94	0.89**	1.63***
	(0.11)	(0.043)	(0.13)	(0.11)	(0.043)	(0.13)
NPL	1.59***	1.13***	1.29***	1.59***	1.13***	1.29***
	(0.15)	(0.049)	(0.082)	(0.15)	(0.049)	(0.082)
Constant	0.00023***	0.098***	0.0043***	0.00023***	0.097***	0.0042***
	(0.00029)	(0.030)	(0.0020)	(0.00029)	(0.030)	(0.0019)
Filing year FE	Yes	Yes	Yes	Yes	Yes	Yes
Technology FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9047			9047		
Pseudo R^2	0.089			0.089		

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The table reports the estimated coefficients (and associated standard errors in parenthesis) expressed in terms of relative risk ratios. The reference category is the acquisition by practicing companies. Yearly citations are computed by using PATSTAT (Version October 2019); Patents transacted after 2016 are excluded from the analysis in order to compute citations after the patent acquisition. The variable "X-year Cit. before acquisition" is the number of citations received by the patent X years before the patent acquisition; the variable "X-year Cit. after acquisition" is the number of citations received by the patent X years before the patent acquisition. We restrict the analysis to patents transacted at least seven years from the filing date to avoid overlapping between the count of citations received in the first five years from the filing date and citations received two years before the acquisition.

Lastly, we do not estimate significant correlations between after transfer citations and the likelihood that the patent buyer is a *Technology NPE*, as proposed by the last part of Hypothesis #3b.

Although our econometric model does not claim causality, it provides evidence of the fact that technologies acquired by *Litigation NPEs* are less used than similar technologies acquired by practicing companies. Furthermore, our results also show that other types of NPEs (e.g. *Portfolio NPEs*) do not necessarily act as intermediaries: the technologies they acquire are indeed less cited after transfer with respect to similar technologies acquired by practicing companies (at least in the short run). However, since *Portfolio NPEs* and *Technology NPEs* (as opposed to *Litigation NPEs*) acquire high-quality and widely used patents, they can enhance market efficiency and incentives to innovate by fostering demand and injecting liquidity.

2.6 Concluding remarks

The proliferation of NPEs has become a topic of intense academic debate and an important public policy issue in the US, upon which academic researchers have focused most of their attention. In contrast, NPEs in Europe have been relatively overlooked, with only a few studies investigating their activities within the European landscape. Our analysis demonstrates that this lack of attention is unjustified. Indeed, we show that NPEs have filed and acquired a large number of patents in the last decade in Europe, in particular in the Electrical Engineering domain, where they account for approximately 9% of EPO patents transacted during the period spanning from 2010 to 2019.

Our contribution to the literature is threefold. First, our contribution lies in analyzing the expansion of NPEs beyond the US patent market, presenting novel evidence based on their patenting activities in Europe, a region where the patent assertion landscape is growing rapidly and where the introduction of the Unified Patent Court (UPC) and the Unitary Patent (UP) are likely to be groundbreaking events that could possibly increase the amount of patent litigation activities initiated by NPEs.

Second, we contribute the literature on NPEs and markets for technology by bringing fresh data on patent acquisitions to a heretofore literature that focuses mainly on litigation data to assess the impact of NPEs on innovation. For this purpose, we build a brand-new database of patent applications filed at the EPO where NPEs are identified as the last owners. To build this database, we have leveraged a comprehensive list of over 600 groups and 3,508 affiliated subsidiaries recognized as NPEs by industry experts specialized in patent litigation and licensing. Our empirical analysis reveals substantial differences between NPEs and practicing companies regarding the attributes of the patents they acquire. Specifically, through OLS and Logit models, we show that NPEs target patents that are relatively old and with a high level of technological quality. These findings support the idea that NPEs strategically invest in IP assets

to capitalize on their efficiency advantage when it comes to implementing and enforcing patents, thereby assisting inventors in monetizing their inventions.

Our final contribution lies in presenting evidence that highlights the significant heterogeneity among NPE business models, including their diverse patent acquisition strategies and their varying impacts on innovation. Precisely, we analyze the composition of NPEs' patent portfolios, and observe that there is a strong heterogeneity between NPE types in terms of litigation intensity and R&D investments (that we proxy with the number of patents filed - rather than acquired - in their portfolio). Moreover, we investigate also the heterogeneity of NPE types with respect to the attributes and the subsequent utilization (that we proxy with forward citations) of targeted patents. Our empirical analyses show that the type of licensing business model adopted by the NPEs correlates with the dynamics of innovation. NPEs that commercialize their own inventions via licensing and patent assertion acquire high-quality inventions whose after-transfer use does not diverge substantially from the after-transfer use of similar patents purchased by practicing entities. Conversely, NPEs that primarily focus on asserting patents as their core business acquire patents similar to the patents targeted by practicing entities in terms of technological quality; furthermore, their acquisitions are associated with a reduction in the use of the acquired patents. Finally, nuanced results are found for NPEs that commercialize patents that they acquire in the secondary market without litigating them aggressively. On one hand, these NPEs acquire high-quality patents; on the other hand, their patent acquisitions correlate with a decrease in the use of the protected technology.

Our study is not without limitations. First, it would be worth adding data on licensing deals that may complement the data on patent transfers, allowing for a better understanding of the presence and impact of NPEs in Europe. Licensing deals would allow for a better identification of the different NPE licensing models and their impact on innovation dynamics. Unfortunately these deals are often secret.

Second, our analysis does not allow assessing the net impact of NPEs in the market for technologies in Europe: while our econometric results suggest that NPEs do not act as intermediaries in the market, we cannot rule out that NPEs may nonetheless foster innovation by providing innovators with effective patent monetization options. On one hand, anecdotal evidence from the US market holds that NPEs collect high royalties and settlement amounts received, and pass on little to end-inventors; on the other hand, Chari et al. (2022) show that individuals and small inventors are responsive to increasing PAE intermediation, although only by producing greater numbers of incremental inventions. However, the available evidence on this mechanism is not sufficient to draw general conclusions.

A few last remarks concern the policy implications of our work and future research. Our results point out the significant heterogeneity in NPE licensing business models; policy attention should thus go beyond the PE versus NPE distinction, focusing instead on market frictions that favor profitable opportunistic behavior. Moreover, since the UPC system could make the European patent market more attractive

to litigate, policymakers should closely monitor specific types of entities, in particular those pursuing aggressive patent litigation and opportunistic monetization and assertion. Finally, we also note that a significant share of patents acquired by NPEs in Europe originate from large practicing companies operating in the ICT industry. This was largely due to a number of European handset manufacturers that failed in the market in the mid-2000s. Among the various reasons behind NPEs' patents being primarily sourced from large practicing companies, one is the possibility that NPEs may act as patent privateers, asserting patents against competitors of the practicing companies from which their patents were transferred. In this case, by using patent privateers against its rivals, a practicing company minimizes reputational harms of direct assertion, avoids contractual commitment (as in the case of FRAND licensing) and reduces its antitrust exposure, either to public enforcement actions or in private litigation. This calls for serious consideration of the possible consequences that such behavior may have on technology transfer and innovation in Europe.

2.7 Appendix to Chapter 2

2.7.1 NPE groups identified for the empirical analysis

This section aims to provide a detailed description of the process through which we restricted our initial sample of NPE groups to then proceed to the empirical analysis of NPEs' presence at the European Patent Office (Section 2.4). Table 2.10 describes this process:

Table 2.10: NPE groups analyzed in the empirical analysis: process of selection of the NPE groups analyzed in the empirical analysis

Step	N. NPE groups removed	N. NPE groups	Comment
		652	The starting sample is the merge of two lists of NPEs (Darts-IP) and AST. It consists of 653 NPE groups (and 3,508 related subsidiaries).
1	94		NPE groups that could not be found in Orbis IP Database.
2	370		NPE groups found in Orbis IP Database but that do not hold neither any EPO nor European patents at the time of the search.
3	12		NPE groups found in Orbis IP Database that do not hold any EPO-filed, but hold only European patents filed at national patent offices.
		176	The final sample consists of 176 NPE groups with EP patents in their portfolio.

The starting number of NPEs, which consists of 652 NPE groups (and 3,508 related subsidiaries), is the result of an append of two different lists that have been compiled at different times by Clarivate Darts IP and Allied Security Trust (AST). The first list of NPEs we adopted was provided to us by Darts IP, that we then expanded with the more recent list provided by AST in July 2021.

Some NPEs could not be found in the ORBIS IP Database; these NPEs are presumably missing because of changes in the company name (the first step removes 94 NPE groups). Some of the NPEs

found in ORBIS IP do not hold EPO nor European patents (defined as patents filed at the national patent offices of Germany, Spain, Italy, France, the UK and the Netherlands) in their patent portfolio at the time of the search (the second step removes 370 NPE groups); most of the time these are entities operating only in the United States. Finally, some of the NPEs in our list do not hold EPO patents in their portfolio but only patents granted by European national patent offices (the third step removes 12 NPE groups). Thus, we restrict the final number of NPE groups that we consider in the empirical analysis from 652 to 176 NPE groups.

2.7.1.1 Identification of NPE-acquired EPO patents

We use ORBIS-IP data to identify all EP patent applications whose last owner is an NPE. In doing so, we manually search NPE names (included the subsidiaries) in ORBIS IP and we build their patent portfolio. Thanks to ORBIS-IP, we then differentiate patents filed by NPEs from those that instead have been acquired. We then deploy a data cleaning process to progressively remove false transactions. In particular, we delete all transactions that follow company name changes or that we consider intra-company transactions.

In particular, we deploy the *stringdist* R package, whose main application is to compute various string distances and to perform approximate text matching between character vectors (Van der Loo et al., 2014). We thus apply the Levenshtein string distances between the name of the current owner (NPE) and the vendor or the first applicant. We then remove all transactions where the distance is lower than a threshold value of five.

For each NPE-acquired EPO patent we identify the last transaction date, the original patent assignee and the last vendor.

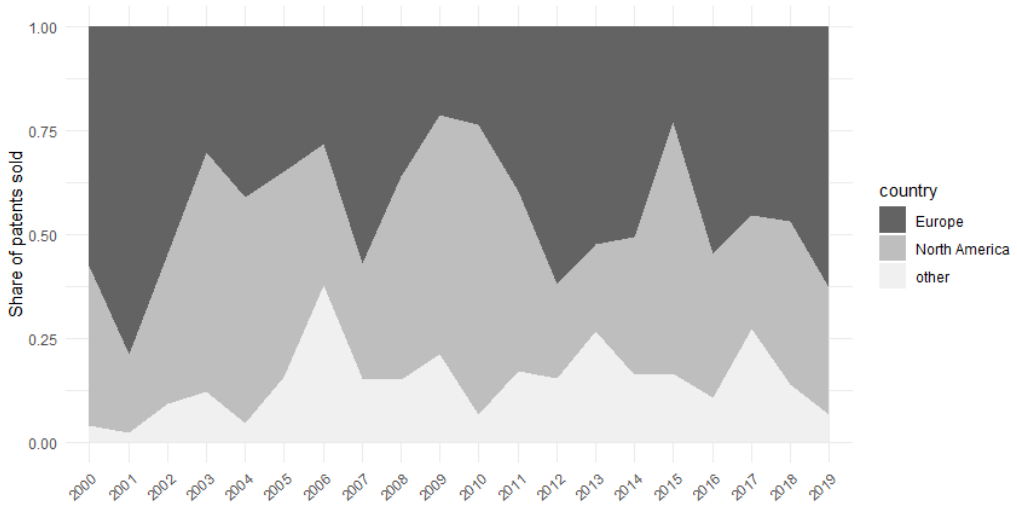
2.7.1.2 Identification of PE-acquired EPO patents

To compare quality characteristics between the NPE-acquired EPO patents and the PE-acquired ones, we retrieve from ORBIS IP all the EPO acquired patents from 2010 to 2020. Since we have already identified the NPE-acquired EPO patents, our objective at this stage is to identify the PE-acquired ones only, and to retrieve the same quality variables as for the NPEs' EPO patents from the OECD Patent Quality Indicators Database 2021 (Squicciarini et al., 2013).

From this list, we exclude patents that we already have in the sample of NPE-acquired patents but that ORBIS-IP consider to be acquired by practicing companies. We then identify and remove intra-company transactions applying a cleaning algorithm similar to the ones employed before.

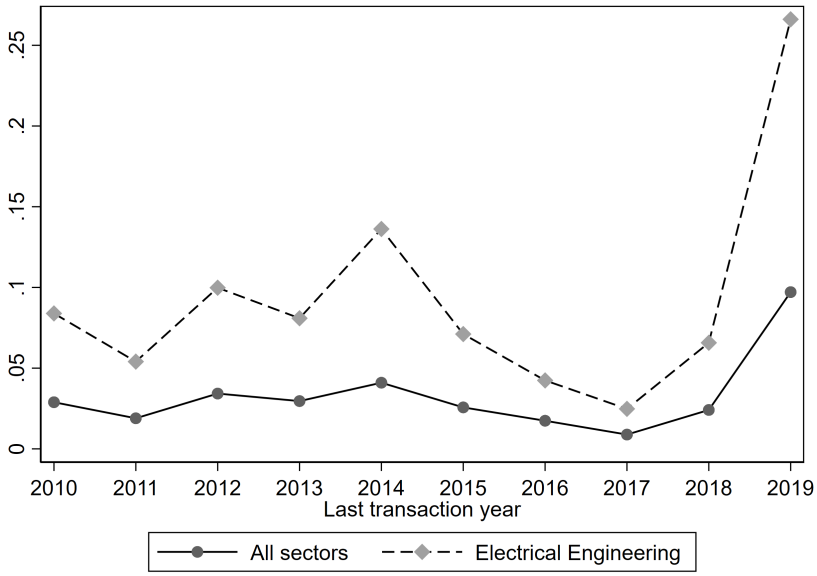
2.7.2 Additional figures and tables

Figure 2.3: Share of patents acquired by NPEs by country of residence of the inventors



The figure shows the share of patents sold by country of residence of the inventors. Patents filed by inventors residing in two or more macro-regions are counted more than once. Geographical regions are constructed as follows: "Europe" gathers the most active countries in the European geographical space in terms of innovative activity (Germany, France, Italy, the UK, the Netherlands, Spain, Sweden, Finland, Austria, Belgium, Denmark, Luxembourg, Switzerland, Norway, Ireland); "North America" encompasses the US and Canada; all other countries are grouped together under the "other" label.

Figure 2.4: Contribution of NPEs to patent acquisitions (EPO data)



The figure plots the shares of patents acquired by NPEs over the total number of acquired patents by last transaction year. The Electrical Engineering field includes: Electrical machinery, apparatus, energy; Audio-visual technology; Telecommunications; Digital communications; Basic communication processes; Computer technology; IT methods for management; Semiconductors

Table 2.11: Total number of NPE-owned patent documents by patent office

	Jurisdiction of filing	N. of patents
1	EP	19213
2	DE	7810
3	ES	2016
4	GB	1375
5	FR	578
6	IT	501
7	NL	220
	Total	31713

Figures include patent documents whose priority years span up to 2020. The same patent can be counted twice if filed in two patent offices.

Table 2.12: Number and share of NPE patents by technology sector (EPO)

IPC Sector	Macro-label	N. of patents	% over tot.
H	Electricity	11726	60.68 %
G	Physics	4564	23.62 %
A	Human Necessities	1043	5.40 %
C	Chemistry; Metallurgy	1011	5.23 %
B	Performing Operations; Transporting	631	3.17 %
F	Mechanical Engineering; Lighting, Heating, Weapons, Blasting	313	1.62 %
E	Fixed Constructions	33	0.16 %
D	Textiles; Paper	13	0.07 %
NA	-	7	0.04 %
Total		19323	100.00 %

The Table shows the number of patent applications owned by NPEs by technological class (WIPO IPC scheme).

Table 2.13: Heckprobit selection equation

	(1) Selection Equation Heckprobit
Granted	0.35***
	(0.012)
5-year Citations (ln)	0.060***
	(0.0094)
Patent scope (ln)	0.016
	(0.019)
Family size (ln)	0.21***
	(0.011)
Claims (ln)	-0.066***
	(0.0090)
Backward Citations (ln)	0.056***
	(0.010)
NPL (dummy)	0.062***
	(0.013)
Constant	-0.91***
	(0.072)
Filing year FE	Yes
Technology FE	Yes
Observations	54941
Pseudo R^2	0.031

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1. The dependent variable takes the value of one if the patent is traded, zero otherwise. For a transacted patent, the instrument ("Granted") is a dummy that captures if the patent is already granted at the time when it is acquired. For a control group patent, the dummy captures if it is granted at the point in time when its matched patent is acquired.

Chapter 3

Forum Shopping and NPEs in Europe: Does Patent Quality Explain Patent Litigation Strategies?

Co-authored with Andrea Vezzulli and Valerio Sterzi

3.1 Introduction

Traditionally, the European patent market has been dominated by operating companies that acquire patents for the purpose of manufacturing end-products that implement the protected technology (Chien, 2008; Geradin et al., 2012). However, during the past recent decades, with the rapid evolution of the patent system and the unprecedented advancement of technologies, there has been a significant surge in patenting and a flourishing of patent trading (Shrestha, 2010; Cotropia et al., 2013; Danguy et al., 2014). As a result, new market players specialized in the trade and enforcement of intellectual property rights (IPRs) have emerged (Chien, 2010; Hagiu and Yoffie, 2013; Kesan et al., 2019). Among these new entrants, non-practicing entities (NPEs) have become controversial in the industries they touch, sparking heated debate about their effect on innovation dynamics (Feldman and Ewing, 2012; Orsatti et al., 2018).[1]

[1] Over time, a number of definitions of NPEs have been presented. These definitions cover a broad spectrum, including individuals and research institutions that own patent portfolios for their inventions but do not engage in product development or commercialization, to IP asset management firms whose primary focus is asserting patents to extract substantial fees from companies operating downward in the value chain (Fusco, 2013).

The recent global patent wars within the information and communications technology (ICT) industry (Graham and Vishnubhakat, 2013; Gupta and Snyder, 2014), and the involvement of NPEs in such disputes (Teece et al., 2014), have shown the potential for patent litigation to become a disruptive force for innovation and market competition (Helmers and McDonagh, 2013; Chen et al., 2023). Consequently, NPEs have often been accused of accumulating patents to initiate opportunistic lawsuits, targeting businesses that allegedly use the patented technologies (Lemley and Melamed, 2013). A rich body of empirical literature shows how NPEs' litigation activities may negatively affect entrepreneurial funding activities (Kiebzak et al., 2016), start-up employment and access to capital (Appel et al., 2019), firms' research and development (R&D) capacity (Smeets, 2014; Cohen et al., 2019; Mezzanotti, 2021), technology transfer (Lemley and Feldman, 2016), follow-on innovation (Orsatti and Sterzi, 2019), and ultimately society-level innovation performance (Kwon and Motohashi, 2014).[2]

While NPEs initially emerged in the US, their presence is on the rise in the European patent market over the past decades (Sterzi et al., 2020). Furthermore, patent litigation in Europe is highly cross-jurisdictional (Cremers et al., 2017), meaning that litigants may encounter different procedural rules and practices (Graham and Van Zeebroeck, 2013) giving rise to *forum shopping* opportunities (Gäßler, 2016).[3] Despite the surge of NPE-initiated litigations in Europe, only a limited number of scholars have investigated the phenomenon (Fischer and Henkel, 2012; Fusco, 2013; Love et al., 2016; Helmers et al., 2016; Thumm et al., 2016; Sterzi et al., 2020).

In this context, the present chapter aims to analyze NPEs' litigation activities in the European patent market by establishing a novel connection between patent quality characteristics and the choice of a specific jurisdictions where to initiate a patent infringement lawsuit (i.e., forum shopping). The objective is to explore how different types of legal regimes in Europe, in combination with patent quality characteristics, shape the patent litigation strategies employed by NPEs, as compared to operating companies (here often referred to as practicing entities, or PEs).

We present evidence based on a comprehensive dataset of infringement actions of patents filed at the European Patent Office (EPO), combined with patent quality information from the OECD-EPO Patent Quality Database (Squicciarini et al., 2013). We focus on patent infringement litigations that have been initiated in the most popular litigation venues in Europe in terms of litigation proceedings initiated

[2]Some NPEs have expanded their enforcement practices beyond targeting companies whose R&D may infringe their patents. They have also sent their notification of infringement to small businesses implementing the final product that incorporates the patented technology (Wright and Ginsburg, 2013), thus targeting a broad array of actors active in the technology value chain.

[3]Provided that the criteria for territorial jurisdiction are met in multiple courts, forum shopping denotes the practice where plaintiffs can freely choose the jurisdiction offering the most advantageous conditions to assert patent rights (Moore, 2001).

(Cremers et al., 2017; Graham and Van Zeebroeck, 2013), namely: Germany, France, Italy and the UK (England and the Wales), between 2007 and 2020.

This chapter proceeds as follows. Section 3.2 provides the background of our study. This section presents the emergence of NPEs in the European patent litigation system, it discusses patent litigation and forum shopping at the European level and illustrates the two key institutional features (i.e., the types of remedies available and the overall cost of patent litigation) that motivate plaintiffs to engage in forum shopping. Section 3.3 presents our hypothesis. Specifically, we propose that the incentives guiding the cross-jurisdictional litigation strategies of NPEs diverge from those of practicing entities (PEs), and that such difference depends on the quality characteristics of the asserted patents. Section 3.4 describes the data used, while Section 3.5 outlines the research methodology adopted and discusses the results obtained. Section 3.6 provides the conclusions and presents the limitations and avenues for future research. Additionally, some policy implication in light of the recently introduction of the Unified Patent Court (UPC) are discussed.

3.2 Background

3.2.1 Non-practicing entities' activities in Europe

Over the past three decades, the global patent litigation landscape has undergone significant changes, partially due to the emergence of NPEs (Cotropia et al., 2013; Cheng et al., 2017). In the US, it is in the late 1990s that news regarding such companies—often referred to as Patent Assertion Entities (PAEs) or pejoratively "patent trolls" (Chien, 2008)—started to make the headlines,[4] while the term "non-practicing entity" itself appeared for the first time in 2003 in a US Federal Trade Commission report (FTC, 2003). In Europe, a similar attention to the NPE phenomenon only emerged around 2010 (Fusco, 2013; Strowel and Léonard, 2020), when NPEs started to engage more actively in the European patent and technology

[4]The National Public Radio reportage on Intellectual Ventures, defined the largest US patent "troll", appeared in the episode called "When Patents Attack!" of the radio program "This American Life" aired on July 22, 2011. Available at: https://www.thisamericanlife.org/441/when-patents-attack.

market due to a combination of US court decisions[5] and legislative reforms[6] that significantly reduced some of their strategic advantages (Taylor, 2014; Love et al., 2016).

Despite this lag, there is evidence that NPEs' operations have become firmly established in Europe. The region not only serves as one of the largest markets for patents, but it also holds a prominent position in terms of technology development (Pohlmann and Opitz, 2013; Love et al., 2016; Thumm, 2018; Leiponen and Delcamp, 2019). Furthermore, in the recent years, two patterns have been emerging. On the one hand, an increasing number of European patents have been acquired by NPEs (Sterzi et al., 2021). On the other hand, a growing number, and share, of patent litigation cases against European companies, both within and outside Europe, have been initiated by NPEs (Sterzi et al., 2021).[7]

For what concerns their activities on the secondary market for patents, several NPEs have recently acquired large patent portfolios from European operating companies. For example, in 2015 the Canadian WiLAN acquired thousands of semiconductor patents from Qimonda, a German spin-off of Infineon Technologies (Thumm et al., 2016). At the same time, also operating companies have entered into negotiations with NPEs (Sterzi et al., 2020). For instance, Inside Secure (nowadays Verimatrix) in 2012 licensed out its near-field communication (NFC) patent portfolio to France Brevets. Similarly, in 2018 Technicolor, a French media and entertainment company, sold its patent licensing business unit to Interdigital, a US-based NPE active in the wireless and connectivity sector (Sterzi et al., 2021).[8] In addition, some operating companies have created dedicated business licensing units with the purpose of patent portfolio monetization. For instance, Ericsson has established patent licensing subsidiaries, such as Unwired Planet and PanOptis, while Nokia has created licensing units such as Core Wireless and Vringo/FORM Holding (Sterzi et al., 2021). The recent study by Sterzi et al. (2021) analyzes the presence

[5]The landmark *eBay Inc. v. MercExchange L.L.C., 547 U.S. 388 (2006)* Supreme Court decision ended the practice of quasi-automatic injunction, a key NPEs' leverage available in the U.S. patent litigation system until 2006. The decision held that permanent injunctions in patent cases should be determined using the same four factor test that courts have historically used in other contexts when deciding whether to issue an injunction. The newly introduced test requires courts to account for: (1) whether the plaintiff will suffer irreparable harm without the injunction; (2) whether there is an adequate remedy at law; (3) the balance of hardships on the respective parties; and (4) whether granting an injunction would disservice the public interest. After *eBay*, successful patents plaintiffs cannot obtain permanent injunctions as a matter of course, instead, they will have to satisfy the four factor test (Chao, 2008). See also the *Alice Corp. Pty. Ltd. v. CLS Bank Int'l - 573 U.S. 208, 134 S. Ct. 2347 (2014)*.

[6]The Leahy–Smith America Invents Act (AIA) enacted in 2011, with full effects in place in 2014. Moreover, the subsequent 2015 amendment specifically addressed the increase of patent litigation initiated by NPEs in the US (Agarwal, 2015).

[7]With the broad term "European patents", Sterzi et al. (2021) refer to both patents filed at the European Patent Office (EPO), and the corresponding patents filed at the national patent offices of the members of the European Patent Organization.

[8]In this patent transaction, Interdigital has acquired more than 20,000 global patent applications from Technicolor for a total deal of $475 million—including an upfront payment of $150 million and 42.5% of the future royalties from Interdigital's licensing activities in the Consumer Electronics field. See: https://www.technicolor.com/news/technicolor-agrees-sell-interdigital-its-patent-licensing-business.

of NPEs in the European patent market by reconstructing their patent portfolios and investigating their main patent acquisition sources. The authors shows that the presence of NPEs in the European patent market is far from being negligible. In fact, in early 2021, NPEs are found to be the owners of almost 20,000 EPO-filed patents. Out of all the EPO-patents transacted from 2010 to 2019, NPEs acquired a total of 6,727 patents—which accounts for roughly 3% of all the EPO-patents transacted during this time frame. Additionally, focusing on the electrical engineering sector, Sterzi et al. (2021) find that NPEs' acquisitions represent almost 9% of all the transacted patents in the past decade, with peaks of over 15% in 2014 and 2019.

On the litigation side, only a few empirical studies have shed light on the frequency and intensity of patent enforcement activities brought by NPEs in Europe. In this respect, Helmers and McDonagh (2013) provided a detailed analysis of the patent litigation cases heard at the Patents County Court (between 2007-2008) as well as the Patents Court (between 2000-2008) for England and Wales. The authors show that 11% of patent lawsuits during the 2000-2010 period involved an NPE (Helmers and McDonagh, 2013). Similarly, Love et al. (2016) found that, between 2000 and 2008, NPEs accounted for approximately 19% of patent litigations in Germany, while from 2000 to 2013, they were responsible for 9% of the assertions initiated in the UK. In addition, Contreras et al. (2017) quantified the level of standard essential patents (SEPs) litigation initiated by NPEs in Germany and in the UK and found that approximately 78% of SEPs cases in Germany between 2000 and 2008 were brought by NPEs.[9] These results are in line with the qualitative study previously conducted by the European Commission's Joint Research Centre (JRC), which suggested how NPEs in Europe, particularly in the telecommunications sector, have acquired large quantities of SEPs that have been regularly asserted (Thumm et al., 2016). In this context, concerns regarding the potential disruptive impact of NPE patent litigations have intensified in recent years (Bessen et al., 2011). NPEs have frequently faced allegations of opportunistic practices, including incomplete disclosure of patent ownership and exploitation of the loopholes of the patent system (Feldman and Ewing, 2012; Morton and Shapiro, 2013; Sterzi et al., 2020,?). More specifically, NPEs may engage in what is commonly known as "ex post" patent transfer and licensing, where patent licenses are negotiated after the accused company has already developed a product incorporating the patented technology (Arora et al., 2001; FTC, 2011; Fischer and Henkel, 2012).[10] This practice has raised policy concerns regarding the role of NPEs in promoting innovation and economic growth (FTC, 2016a). In particular, there is concern

[9]The authors also found that NPEs display higher success rates in proving infringement as compared to operating companies (Contreras et al., 2017).

[10]This is in contrast with "ex ante" patent transactions and licensing, where technologies, and the associated patent rights, are transferred from inventors to manufacturers before the product is developed and commercialized (Arora et al., 2001).

that NPEs may target companies engaged in R&D activities that only potentially infringe their patents (Lemley and Feldman, 2016). In such scenarios, the accused companies would face increased costs, as they either pay an unexpected licensing fee or bear the burden of defending themselves in a costly litigation lawsuit (Fusco, 2013). As costs escalate, the final output—in terms of innovations and end-products brought to the market—would decline (Lemley and Melamed, 2013). Additionally, NPEs display a key advantage over manufacturing companies. Given their non-operating nature, NPEs are immune to patent infringement counter-claims, and they are thus able to prolong litigation at a lower cost compared to operating companies (Chien, 2008).

3.2.2 Patent litigation and forum shopping in Europe

The effective functioning of the patent system relies on the patentees' ability to enforce their patent rights, including resorting to litigation in court (Weatherall and Webster, 2014). States grant the legal right to patent-owners to exclude others from the unauthorized use of their intellectual property, however it is the responsibility of patent-owners to enforce their patents through the established institutions. Therefore, patentees are required to monitor and take action against the infringement of their intellectual property, and when faced with a potential infringement they can seek judicial relief in court (Helmers and McDonagh, 2013).

When a patent infringement case meets the requirements to be heard in more than one court or across different geographic regions or jurisdictions, the plaintiff gains the opportunity to freely choose the preferred venue where to seek judicial relief (Gaessler and Lefouili, 2017). Thus, plaintiffs can strategically decide to file a lawsuit in a specific court that they believe will be the most favorable to their case, rather than in other potentially available ones (Lerner and Tirole, 2006; Offen-Brown, 2010; Jacobsmeyer, 2018). This practice is commonly referred to as *"forum shopping"* and can take place at different levels (Moore, 2001). For instance, it can occur between two or more courts within the same jurisdiction, and in this case plaintiffs engaging in *domestic* forum shopping seek judgement among different national courts. Alternatively, as two or more jurisdictions have territorial competence over the same infringing act, plaintiff may engage in *international* forum shopping (Whytock, 2010). In patent infringement cases, international forum shopping is considered common practice as the infringing act—typically, the manufacturing and commercialization of infringing products—usually occurs at the international level (Moore, 2001; Gaessler and Lefouili, 2017).

Forum shopping has predominantly been examined and discussed in the US, where over the past decades certain court districts have gained substantial popularity in patent disputes (Bell, 2003; Whytock, 2010; Offen-Brown, 2010; Woodhouse, 2010). Notably, the Eastern District of Texas has emerged as a favored venue among patent plaintiffs due to its reputation for expedited trials and a plaintiff-friendly

approach (Whytock, 2010; Offen-Brown, 2010). Along with potential drawbacks related to an excessive concentration of infringement lawsuits in only few venues, forum shopping has also been criticized for aggravating the problems of opportunistic patent litigations brought by NPEs, who tend to initiate lawsuits in plaintiff-friendly fora (Woodhouse, 2010; Cohen et al., 2016; Gaessler and Lefouili, 2017). A turning point occurred in 2017 with the *TC Heartland* decision,[11] where the US Supreme Court restricted the option for choosing the court for patent infringement cases. The court ruled that a domestic corporation could only be sued in a judicial district where it is incorporated or maintains a regular and established place of business (Woodhouse, 2010). As a result of the *TC Heartland* case, the concentration of patent cases in the Eastern District of Texas notably decreased (Woodhouse, 2010).

In Europe, concerns about forum shopping driven by opportunistic litigation, especially targeting SMEs, have been a longstanding subject of legal debate (Graham and Van Zeebroeck, 2013; Gaessler and Lefouili, 2017). At the same time, greater legal harmonisation has long been a crucial goal at the European level (Walsh, 2019). After years of negotiations, the adoption of the Unitary Patent (UP) and the establishment of the Unified Patent Court (UPC) in 2023 represents a significant development toward addressing these pressing concerns for the European patent system.[12] The Court consists of a Court of First Instance, a Court of Appeal, and a Registry, while a Patent Mediation and Arbitration Centre is also established to facilitate amicable settlements. Specifically, the UPC has exclusive jurisdiction on the infringement and validity of both Unitary Patents (UPs) and on "classic" European Patents (i.e., patents filed at the European Patent Office).[13] However, the exclusive jurisdiction over “classic” European patents (EPO patents) is subject to exceptions during the current transitional period, which will last seven years. Within this time-frame, actions concerning the "classic" European patents may still be initiated in front of the national courts. Furthermore, it is possible to entirely opt-out "classic" European patents from the

[11] *TC Heartland LLC v. Kraft Foods Group Brands LLC, 581 U.S. Supreme Court (2017).*

[12] The "Agreement on a Unified Patent Court" (UPC Agreement, or UPCA), which established the Unitary Patent (UP) and the Unified Patent Court (UPC), has entered into force on 1 June 2023. A Unitary Patent (UP) is a type of patent designed to provide uniform protection for inventions across multiple countries in Europe. The adoption of Unitary Patents (UPs) is strictly interconnected with the establishment of the Unified Patent Court (UPC), which provides a centralized and specialized court for handling patent disputes within participating European member states. At present, it has been ratified by seventeen EU Member States. More detailed information on the countries that signed the UPCA can be found at: https://www.consilium.europa.eu/en/documents-publications/treaties-agreements/agreement/?id=2013001. For an historical overview of the European patent harmonization process, see Plomer (2015, 2020).

[13] The UPC will go beyond the 2004 "IPR Enforcement Directive" (IPRED). The IPRED objective was to ensure a "high, equivalent and homogeneous level of protection" throughout the EU, but it set only minimum requirements regarding patent enforcement. In 2008 the Directive was eventually implemented by all EU Member States, however with drastically different interpretations of the rules, therefore keeping significant disparities between jurisdictions (Mejer and Van Pottelsberghe de la Potterie, 2012). *Directive 2004/48/EC of the European Parliament and of the Council on the enforcement of intellectual property rights (29 April 2004).*

UPC's jurisdiction.[14]

Before the establishment of the UPC, patent disputes were handled at the national level following distinct patent litigation procedures and rules in each country. The litigation structure of "classic" European patents reflected the functioning of the European patent system. Notably, once a "classic" European patent is granted by the European Patent Office (EPO), it is issued in identical form as a bundle of national patents.[15] For this reason, post-grant enforcement actions followed distinct national procedures and litigation practices across the contracting member states of the European Patent Convention (EPC) (Gougé and Torrecilla, 2017). This situation greatly allowed for forum shopping, and often gave rise the incongruous decisions (Mejer and Van Pottelsberghe de la Potterie, 2012). Studies reporting inconsistent court decisions across European jurisdictions regarding the same European patent have suggested how, given that no unifying law covering patent infringement across the EU prior the UPC existed, different applications of patent law were into force at the European level (Mejer and Van Pottelsberghe de la Potterie, 2012; Cremers et al., 2016; Jacobsmeyer, 2018). It is in this context that the UPC was designed with the objective to create a centralized court system for patent disputes across European countries.

Additionally, NPEs have been found to frequently forum shop across jurisdictions (Liang, 2010; Chuang, 2011; Cohen et al., 2019).[16] Patent litigation, in fact, plays a central role to the NPE business model (Allison et al., 2009; Chien, 2008), as it represents an essential leverage to obtain licensing revenues (Liang, 2010). Thus, NPEs often sue multiple defendants while they cannot be counter-sued for infringement as they have no products of their own (Chuang, 2011). In Europe, the series of patent infringement lawsuits initiated by France Brevets in 2013 is representative of NPEs' forum shopping strategies. France Brevets is a former French sovereign patent fund created in March 2011 by the French government and a public bank, the *Caisse des Dépôts et Consignations* (CDC).[17] In 2012, Inside Technologies S.A.,

[14] Unless an action has already been brought before the UPC, patent-owners have the possibility to opt-out their patents during the transitional period. Specifically, the opt-out is effective for all of the EPC states for which the European patent has been granted, or which have been designated in the application. For more information regarding the UPC functioning, please visit: `https://www.unified-patent-court.org`.

[15] The *European Patent Convention (EPC)*, also known as *The Convention on the Grant of European Patents*, of 5 October 1973. The art. 64(1) recites: "A European patent shall, subject to the provisions of paragraph 2, confer on its proprietor from the date on which the mention of its grant is published in the European Patent Bulletin, in each Contracting State in respect of which it is granted, the same rights as would be conferred by a national patent granted in that State.". In this context, forum shopping is governed by both the functioning of the European patent system (e.i., the bundle of national patents mirroring the EPO-filed parent patent) and the existence of different legal regimes among European countries (Jacobsmeyer, 2018).

[16] NPEs' forum shopping activities have been first studied in the US, see for instance Chien (2008), Allison et al. (2009), Chuang (2011),Liang (2010), Cohen et al. (2015), Cohen et al. (2019)

[17] The *Caisse des Dépôts et Consignations*, whose establishment dates back to 1816, is a French public sector financial institution and part of the government institutions under the control of the Parliament. It is regulated in the French Monetary and Financial Code as "a public group serving the general interest and the economic development of the country" (Article L. 518-2 of the French Monetary and Financial Code).

a former semiconductor French company, licensed-out to France Brevets its near field communication (NFC) technology patent portfolio consisting of 70 EPO-filed patents, validated in different European countries.[18] The following year, France Brevets, as the exclusive manager of the NFC licensing program, initiated a series of patent infringement lawsuits in Germany against the German subsidiaries of two international manufacturers of consumer electronics, LG Electronics and HTC (Wild, 2013). Specifically, France Brevets brought actions before the District Court of Düsseldorf, claiming the infringement of the German counterparts of three of the licensed-in EPO-filed patents, the EP1163718B1, litigated against both LG Electronics and HTC, and the EP1758049B9 and the EP1855229B1 litigated against HTC (4iP Council, 2019).[19] In 2014 France Brevets prevailed in the case related to the infringement of EP1163718B1 against HTC. For the other cases, meaning the infringement case of EP1163718B1 against LG Electronics, and the litigation of EP1758049B9 and EP1855229B1 against HTC, the parties reached a settlement.[20]

3.2.3 Key institutional characteristics across European jurisdictions

Despite the promising start of the UPC,[21] there are still opportunities for forum shopping given the option to opt-out from the UPC system within the ongoing seven-year transitional period. In the event of opt-out, in fact, patent litigation cases are still settled at the national level, meaning that each European country applies its own jurisdiction, while recourse to the European Court of Justice (CJEU) is possible only on questions pertaining to EU-wide directives (Love et al., 2016; Khuchua, 2019). In this context, in deciding whether to bring a patent litigation lawsuit in one forum as opposed to another, owners of infringed opted-out patents may still consider different national institutional features across European jurisdictions to increase the likelihood of a favorable litigation outcome.

More specifically, the decision of a plaintiff to engage in patent litigation in one European jurisdiction over another mainly depends on two key factors: the available remedies, particularly the potential for securing an injunction against the alleged infringer, and the costs associated to the patent litigation action. Within this framework, we outline the main jurisdiction-specific features—that existed before the establishment of the Unified Patent Court (UPC) and that remain applicable today in case of litigation

[18] The company's name is nowadays Verimatrix and it is currently focused on software, rather than semiconductor.

[19] Moreover, the EP1855229B1 patent was declared essential to the "Standard LL V11.0.0, 2011-09" or "LL standard", see: *France Brevets v HTC, Regional Court of Düsseldorf 26 March 2015 - Case No. 4b O 140/13.*

[20] The authors were able to reconstruct the France Brevets' forum shopping case by means of news on specialized press, relevant case law, and case-level data from Clarivate's Darts-IP database.

[21] Joff Wild, IAM Magazine, August 2023: https://www.iam-media.com/article/jw-column-10th-august-2023-upc-early-signs-positive. See also Adam Houldsworth, IAM Magazine, August 2023: https://www.iam-media.com/article/upc-lawsuits-dominated-europe-based-corporations-and-smes.

of opted-out European patents—in the most popular European litigation venues in terms of patent infringement proceedings, meaning Germany, France, Italy and the UK (England and Wales) (Helmers and McDonagh, 2013; Cremers et al., 2016, 2017; Jacobsmeyer, 2018), and we report such characteristics in Table 3.1.

Firstly, these litigation venues present distinct court structures and procedural rules. More specifically, in Germany twelve regional courts (*Landgerichte*) hear patent infringement claims. Such courts are the ones of: Berlin, Braunschweig, Düsseldorf, Erfurt, Frankfurt, Hamburg, Leipzig, Magdeburg, Mannheim, Munich, Nuremberg-Fürth and Saarbrücken. During the opposition phase, patent validity is exclusive competence of the European Patent Office (EPO) for European patents, and of the German Patent and Trademark Office (*Deutsches Patent und Markenamt* or DPMA) for German patents. After the opposition phase, patent validity is ruled by the German Federal Patent Court (*Bundespatentgericht*, or BPatG) (Cremers et al., 2017). In France first instance patent infringement and validity actions are both brought before the Paris Court of First Instance (*Tribunal de Grande Instance de Paris*), while appeals are handled by the fifth division of the Paris Court of Appeal (*Cour d'Appel de Paris*) (Agé and Prothière, 2016).[22] In Italy, patents can be enforced before specialised sections of the ordinary courts, the Enterprises Courts (*Tribunali delle imprese*), which have exclusive jurisdiction over IP litigation (Sterpi and Fosson, 2022).[23] The patent litigation system in the UK foresees two courts depending on the complexity of the infringement or validity case: the *Intellectual Property Enterprise Court* (IPEC) for cases of lower complexity, and the *Patent High Court* (PHC), which is the specialised court of the Chancery Division of the High Court of Justice of England and Wales and hears more complex cases (Cremers et al., 2017; Khuchua, 2019).

3.2.3.1 Types of remedies in patent litigation: Injunction-based and fee-based jurisdictions

Remedies, meaning what the owner of an infringed patent is entitled to claim if successful in court, are at the core of every patent litigation system (Kitch, 1977). Remedies typically consist of either monetary compensations, generally calculated on the value of the infringed patented technology as a per-unit license fee or royalty, or injunctions (Cotter, 2013; Brander and Spencer, 2021). More specifically, an injunction

[22]The French Patent Office (Institut National de la Propriété Industrielle, or INPI) has no jurisdiction in patent litigation, and French patents cannot be subject to opposition proceedings before the INPI (Agé and Prothière, 2016).

[23]These Enterprises Courts are located in: Ancona, Bari, Bologna, Bolzano, Brescia, Catania, Catanzaro, Campobasso, Cagliari, Florence, Genoa, L'Aquila, Milan, Naples, Palermo, Perugia, Potenza, Rome, Turin, Trento, Trieste, and Venice. However, only 11 of these have jurisdiction over cases in which a foreign company is a party to the proceedings, that are: Bari, Bolzano, Cagliari, Catania, Genoa, Milan, Naples, Rome, Trento, Turin, and Venice (Sterpi and Fosson, 2022). The Italian Patent and Trademark Office, or any other government body, do not have any jurisdiction over patent litigation and validity issues (Sterpi and Fosson, 2022).

refers to a court-issued order that restricts a party from engaging in the infringing act related to a patented invention (Calabresi and Melamed, 1972). Therefore, injunctions are commonly sought by a patent-owner with the purpose of preventing the infringing party from continuing the unauthorized manufacture, use, sale, or distribution of its proprietary patented product or technology (Merges, 1994). Injunctions can be either permanent (following a final determination that one or more patent claims are infringed), or preliminary (interim), thus occurring before such a final determination on the merits.[24] Usually granted early in the proceeding, several patent litigation systems allow preliminary injunctions to restrain the defendant from infringing the patent during the pendency of the litigation (Cotter, 2019).[25] If the plaintiff prevails at the trial, the preliminary injunction usually becomes permanent, otherwise this remedy is removed and the defendant can seek recovery from the costs and losses derived from the grant of the temporary injunctive relief (Ottoz, 2022).

While the 1995 Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) foresees both injunctions and monetary damages as possible remedies to patent infringement, signatory states are the ones responsible for the implementation of the specific legal procedures, and the determination of the thresholds, to award such remedies (WTO, 1995).[26] As a consequence, jurisdictions may exhibit varying inclinations regarding the preference for granting injunctions as opposed to damages. Such propensities gives rise to distinct jurisdictions, or legal regimes, that may prioritize either injunctions or monetary compensation as the predominant remedy for patent infringement (Cremers et al., 2017).

In this respect, two main types of legal regimes can be identified among European jurisdictions prior the establishment of the UPC, and outside its jurisdiction: *"fee-based regimes"* and *"injunction-based regimes"*.[27] In a fee-based regime, courts typically award monetary damages based on a per-unit license fee, or royalty, which reflects the marginal value of the infringed patented innovation (Brander and Spencer, 2021). In injunction-based regimes (or injunctive regimes), instead, the typical remedy consists in granting injunction orders. Thus, a court grants an injunction relief requiring the infringing party to cease using

[24] Applications for preliminary injunction can be *"ex parte"* or *"inter partes"*. In an *"ex parte"* application, only the party seeking the injunction has the opportunity to put its case to the Court. On an *"inter partes"* application, the Court will hear both sides' arguments (Perkins, 2018).

[25] Cotter and Golden (2015) highlights how historically permanent injunctions have tended to issue as a matter of course in patent cases in which a patent holder has prevailed on the merits. In contrast, preliminary injunctions have typically been more difficult to obtain, in part because the patent claims' scope, or validity, is frequently not as clear as courts believe necessary to justify such relief before a full trial.

[26] For example, at the European level, the Directive 2004/48/EC on the Enforcement of Intellectual Property Rights (IPRED) requires Member States to make certain measures, including remedies and injunctions, available to patent owners (Articles 9 and 11) (EUIPO, 2022).

[27] In the legal jargon, damages are awarded under a *liability rule*, while injunctions are imposed under a *property rule*. The nature of these rules, and the justification for employing a property rule rather than a liability rule, have been discussed at length in the literature, often with respect to other types of intellectual property rights as well. See, for instance Calabresi and Melamed (1972), Merges (1994), Kaplow and Shavell (1996) and Lemley and Weiser (2006).

the patented technology, or stop the commercialization of the products deriving from the unauthorized use (Brander and Spencer, 2021).[28]

Injunctions represent highly valuable legal remedies for patent-owners as they can leverage such orders to effectively halt the activities of the alleged infringing company (Contreras and Husovec, 2021). This is particularly relevant when the infringer has already undergone considerable costs in technology implementation and manufacturing (Cotter, 2019; Cotter et al., 2019). This situation gives patent-owners significant leverage in court disputes and considerable bargaining power in negotiations, as the mere threat of an injunction can prompt the infringing firm to settle or to speed up the *ex post* licensing of the allegedly infringed patented technology to avoid the potential disruption caused by a court-ordered cease of activities (Chien, 2012; Lemley and Feldman, 2016; Brander and Spencer, 2021).

Among the most popular European litigation jurisdictions, the UK and France can be identified as fee-based regimes, as both jurisdictions are more prone to the grant of monetary damages as opposed to injunctions, which are rarely granted (Graham and Van Zeebroeck, 2013; Cremers et al., 2017).[29] Conversely, Germany and Italy can be categorized as injunctive-based regimes (Contreras and Husovec, 2021). Both jurisdictions, in fact, tend to grant injunctions in patent infringement cases (Cremers et al., 2017).

However, contrary to centralized systems where validity and infringement issues are heard by the same court,[30] Germany presents a particular *bifurcated* court structure. In a bifurcated system, patent infringement and validity actions are decided independently of each other in separate proceedings, before different courts, and thus at different times (Love et al., 2016). Several scholars couple the popularity of Germany as a litigation venue with its *bifurcated system* (Schliessler, 2015; Love et al., 2016; Cremers et al., 2016; McDonagh, 2016).[31] On one hand, by relying on the robust presumption of validity and the confidence placed in the patent examination processes conducted by patent offices, bifurcation implies

[28]The literature has extensively discussed the optimal balance between the two legal remedies in order to preserve both patent holders' right to protect their invention and the licensee's right to use the patented technology, thereby fostering technology adoption and subsequent innovation. For a discussion on the topic, see: Merges (1994), Kaplow and Shavell (1996), Blair and Cotter (1997), Schankerman and Scotchmer (2001), Anton and Yao (2007), Shapiro (2016).

[29]In some rare instances, courts in the UK have granted injunctions after engaging in proportionality assessments, for instance in the case of the so-called FRAND injunctions (Léonard, 2019). See, *Unwired Planet International Inc. v. Huawei Technologies Co Ltd. [2017] EWHC 1304 (Pat)* confirmed on appeal in *Unwired Planet v. Huawei Technologies [2018] EWCA Civ 2344*.

[30]Such as in the case of France, Italy and the UK.

[31]In Germany, 12 regional courts (*Landgerichte*) hear patent infringement claims. Such courts are the ones of: Berlin, Braunschweig, Düsseldorf, Erfurt, Frankfurt, Hamburg, Leipzig, Magdeburg, Mannheim, Munich, Nuremberg-Fürth and Saarbrücken. Patent validity, during the opposition phase, is exclusive competence of the European Patent Office (EPO), and for German patents the German Patent and Trademark Office (*Deutsches Patent und Markenamt* or DPMA), afterwards, validity is ruled by the German Federal Patent Court (*Bundespatentgericht*, or BPatG).

specialized courts (McDonagh, 2016), which ensures fast decisions on patent infringement (Cremers et al., 2017).[32] In fact, a bifurcated enforcement system prioritizes resolving uncertainty regarding infringement over uncertainty regarding validity (Cremers et al., 2017). On the other hand, bifurcation is accused of imposing remedies for infringement on the basis of a patent that can later be revoked by the court hearing the validity defence. For instance, it is possible for one of the 12 regional courts in Germany, which hear infringement claims, to grant an injunction against a potential infringer of a patent that can be later found to be invalid by the Federal Patent Court, which have jurisdiction over validity (Love et al., 2016).

The existence of the so-called "injunction gap" has significant implications for the litigation strategies of patent-owners and alleged infringers (Gäßler, 2016; Dijkman, 2021). Firstly, during the lawsuit the defendant may challenge the infringement action but the potential invalidity of a patent does not constitute an admissible defense (Cremers et al., 2016). Secondly, Cremers et al. (2016) found that between 2000 and 2008, a patent was considered infringed and later invalidated in 41.3% of German proceedings. Similarly, Henkel and Zischka (2019) found that between 2010 and 2012, German courts fully invalidated 45% of patents and partially invalidated 33% more. As a consequence, a bifurcated system can potentially lead to situations in which a patent found to be infringed can be subsequently found to be invalid (i.e., it should have not been granted in the first place) (Cremers et al., 2016), thus increasing the uncertainty of patents as property rights (Lemley and Shapiro, 2005).[33]

As discussed previously, injunctions may grant patent-owners considerable leverage in negotiations with the alleged infringer and this power imbalance may be magnified by the injunction gap (Cremers et al., 2016).[34] Additionally, this situation can be particularly pronounced in the case of NPEs, which do not directly engage in the manufacturing of the final product and cannot therefore be counter-sued by the alleged infringer (Chien, 2012). Moreover, cases where the infringed patent protects a technology that is a minor component within a more complex system can also exacerbate the negative impact of the injunction gap (Tochtermann, 2019). Such instances frequently involve the patented chip technology of the control units of larger machinery, like in the case of connected cars, or when the patent infringement by a minor

[32] Apart from Germany, also Austria, Bulgaria, Czech Republic, Hungary, Poland, Portugal, Romania, and Slovak Republic present similar bifurcated systems that assess validity and infringement separately (Harhoff, 2009).

[33] Moreover, the injunction gap can last for a considerable amount of time. In fact, Cremers et al. (2016) report that in cases where validity was challenged before the German Federal Patent Court, the infringement decision was on average enforceable for more than a year before the patent was invalidated in first instance. In cases in which validity was challenged before the German Patent and Trademark Office or the EPO, the length of the injunction gap is on average three times as large.

[34] In February 2014, a coalition of large firms spanning various industries (including Adidas, AFDEL, Apple, ARM, BlackBerry, Broadcom, Bull, Cisco Systems, Dell, Deutsche Post DHL, ESIA, Google, HP, Huawei, Microsoft, Samsung, SFIB, Telecom Italia, and Vodafone) released a joint statement expressing concerns that "[...] the potential exists for a court to order an injunction prohibiting the importation and sale of goods even though the patent may ultimately be found invalid. This result unduly reduces competition, can increase the cost of products in the market and reduce product choices, all negatively impacting consumers" (Cremers et al., 2016).

part stops the distribution of a complex system (Tochtermann, 2019).[35] These issues are particularly pressing and relevant in the context of the current ICT technologies, as smartphones and complex devices notably incorporate thousands of patented components, thus complicating the identification and clearance of relevant patents prior to product manufacturing (Cotter, 2019).

3.2.3.2 Litigation costs and allocation of legal expenses

Alongside the differences in the remedies available, the costs associated with patent enforcement significantly vary across European jurisdictions. Among the first comprehensive studies on the cost of bringing a patent lawsuit in Europe was conducted by Harhoff (2009). The study shed light on the significant disparities between European countries regarding patent enforcement costs, also accounting for the various stages of litigation. For example, first instance costs in Germany and France may range from €50,000 to €200/250,000, while in the UK similar proceedings are estimated to cost between €150,000 to €1,500,000. Analyzing infringement proceedings more specifically, the comparative study conducted by Graham and Van Zeebroeck (2013) reports relevant differences across European jurisdictions, suggesting that the average cost of first instance infringement hearings range from €40,000 to €250,000.

Currently, the German legal system allows for a relatively affordable enforcement. Litigation costs are expected to range from €50,000 to €90,000 at first instance, and from €90,000 to €150,000 at second instance (Papst, 2010; Cremers et al., 2017). In France, the costs of first instance infringement hearings may vary significantly depending on the complexity of the case, but generally they are estimated to range between €50,000 and €250,000 for cases of average difficulty, and up to €500,000 for the most complex matters (Graham and Van Zeebroeck, 2013; Agé and Prothière, 2016). In Italy, enforcing a patent costs on average between €75,000 and €400,000 depending on the complexity of the case (Graham and Van Zeebroeck, 2013). Such relatively higher costs are attributed to the lengthy nature of Italian proceedings and the higher fees paid for technical experts (Sterpi and Fosson, 2022). Traditionally, the UK has been recognized as the most costly European jurisdiction for patent litigation. According to McDonagh and Helmers (2013), the fees incurred by both parties in the period from 2000 to 2008 ranged from £1 million up to £6 million. Recent estimates by Helmers et al. (2021) suggest that, on average, parties spend between €150,000 to €1,500,000 for an infringement case. Moreover, the higher costs in the UK can be attributed, at least in part, to the "loser-pays" provision, also known as the "English Rule" or "fee-shifting" (Spier, 2007; Forsyth and Watts, 2011; Helmers et al., 2021). With the English Rule the loser, together with its own legal fees, must pay for the winner's legal expenses (Cremers et al., 2017).

[35] See the *Wärmetauscher* case, Federal Court of Justice of Germany, X ZR 114/13, 10 May 2016.

This provision, based on the traditional treatment of costs in the UK, practically has the effect of shifting the cost of the attorneys' fees from the prevailing party to its opponent (Helmers et al., 2021).

Table 3.1: Overview of the main institutional characteristics of the most popular European patent litigation venues

Jurisdiction feature	**Germany**	**France**	**Italy**	**The UK**
Court structure	12 Regional Courts hearing infringement (*Landgerichte*); Federal Patent Court hearing validity (*Bundespatentgericht*)	Paris Court of First Instance (*Tribunal de Grande Instance de Paris*) and Paris Court of Appeal (*Cour d'Appel de Paris*)	*Tribunali delle imprese*: 22 enterprises courts in total, 11 of which have exclusive jurisdiction over cases in which a foreign company is a party to the proceedings.	Two courts depending on the complexity of the case: *Intellectual Property Enterprise Court* (IPEC) (lower complexity); *Patent High Court* (PHC) (higher complexity)
Injunctive-regime	Yes	No	Yes	No
Bifurcation	Yes	No	No	No
Average costs (at first instance)	from €40,000 to €250,000	from €50,000 to €500,000	from €75,000 to €200,000	from £100,000 to £1,000,000

Notes: The table presents the key institutional features of the most popular European jurisdictions (own elaboration).

3.2.4 Litigation of standard-essential patents (SEPs)

Nowadays, smartphones, tablets and computers from different manufacturers are able to connect and exchange information in a coordinated way without any efforts from the end-user. Such interoperability is assured by the adoption of technology standards, which are generally developed by private firms collaborating in standard-development organizations (SDOs), also referred to standard-setting organizations (SSOs), and are built upon numerous technical advances (Abdelkafi et al., 2021). Examples of prominent SDOs in the ICT sector are, among others, the European Telecommunications Standards Institute (ETSI), the International Telecommunication Union (ITU), the Institute of Electrical and Electronics Engineers (IEEE) (Blind and Kahin, 2018).[36] By disclosing their proprietary technologies during the development process within SDOs, firms obtain patents that are deemed to be essential to the implementation of a specific standard, therefore called standard-essential patents (SEPs) (Abdelkafi et al., 2021).

Generally, SEPs cover foundational technologies, such as the different generations of cellular connectivity standards (2G, 3G, 4G, and 5G), WiFi technology, Bluetooth, and Near Field Communication (NFC)

[36] Nonetheless, standards may also arise from market domination or widespread acceptance of some practices. This is the case of the so-called *de facto* standards, that have not undergone a formal consensus-based process. A common example of *de facto* standard is the widespread use of the QWERTY keyboard. Conversely, a *de jure* standard is one that is endorsed by a formal standard-development organization (Rada, 1993; Abdelkafi et al., 2021).

technology (Contreras et al., 2017). Therefore, SEPs read on technologies that must be necessarily used by end-product manufacturers in order to comply with a given standard that defines the interface to connect, communicate, work on, or with, other products and platforms (Blind and Kahin, 2018). In other words, implementers of standardized technologies cannot invent around (Pohlmann and Blind, 2016).

Given their characteristics, SEPs have a special role in the technology value chain as they may generate market power imbalances and potentially lead to exclusive effects (Pohlmann and Blind, 2016). For this reason, SDOs have developed specific set of rules and best practices to ensure the efficient licensing of SEPs with the ultimate goal to promote a broad adoption of technical standards (Bekkers and Updegrove, 2012). Specifically, several SDOs require contributing firms to disclose their potentially essential patents and to license their SEPs under fair, reasonable and non-discriminatory (FRAND) terms and conditions (Sidak, 2013, 2015).[37] FRAND terms are designed to achieve the greatest possible accessibility to the standard by implementers, providing at the same time an adequate monetary return on technology developers' R&D efforts (Contreras, 2015).[38]

However, over the past few years, intense global SEP litigations have emphasized the existing disagreement over the precise interpretation of FRAND licensing terms by SEPs-owners on the one side, and implementers on the other (Contreras, 2019b).[39] More specifically, contemporary SEPs disputes involve both technical and legal matters. These encompass issues such as the methodologies to calculate FRAND royalties, the definition of a proper royalty base for the application of a FRAND royalty rate, the licensing level, at the production chain, at which licensing should take place, the possibility for SEP-owners to obtain injunctions against potential infringers, and the application of competition law doctrines to the SEP-owners' conduct (Nikolic, 2022a).

Additionally, a recent controversial trend in SEPs litigation involves the issuance of anti-suit injunctions (ASI) (Geradin and Katsifis, 2022). Generally granted in one jurisdiction, an ASI prohibits a party from initiating, or continuing, a SEP litigation in other jurisdictions (Raphael, 2008; Nikolic, 2022a)[40] This

[37] FRAND terms and conditions, sometimes just referred to RAND (reasonable and non-discriminatory) (Abdelkafi et al., 2021), are commonly foreseen by the most prominent SDOs, such as the European Telecommunications Standards Institute (ETSI), the Institute of Electrical and Electronics Engineers (IEEE), and the Joint Electron Device Engineering Council (JEDEC) (Sidak, 2013, 2015).

[38] As an example, the ETSI specifies in its IPR Policy, Clause 3, that: "the ETSI IPR Policy seeks a balance between the needs of standardization for public use in the field of telecommunications and the right of the owners of IPR. IPR holders [...] should be adequately and fairly rewarded for the use of their IPR in the implementation of Standards [...]."

[39] For an overview of prominent recent SEPs lawsuits, see Pentheroudakis (2015) and Nikolic (2022b).

[40] Anti-suit injunctions (ASIs) are not directed at a foreign court and do not stop foreign proceedings automatically. The scope of ASIs is to address the parties, who will be practically obliged to withdraw, or not pursue, enforcement in a foreign court, otherwise the infringer will incur in punishment for non-compliance (Raphael, 2008). In response to ASIs, an interesting development is the issuance of anti-anti-suit injunction (AASI) that prohibit the party from applying for, or enforcing, an ASI (Nikolic, 2022a).

increased tendency to grant ASIs may signal opportunistic litigation practices at the global scale as parties may prefer to initiate litigation in a favourable jurisdiction and secure an ASI, instead of proceeding with licensing negotiations (Contreras, 2019a). As a consequence, ASIs may lead to a race to the bottom between courts to attract litigants to their jurisdictions by adopting approaches that may be viewed as more favourable to one of the parties (Contreras, 2021). In fact, courts that are perceived as granting lower FRAND royalties would attract implementers to sue first and request an ASI preventing the SEP-owner from initiating a parallel SEP litigation in other jurisdictions. Similarly, SEP-owners may bring litigation in a country seen as having stronger IP protection and determining higher FRAND royalties (Nikolic, 2022a).

That is, given the specificity of SEPs and their complex enforcement, jurisdictions are, once more, differently attractive for plaintiffs in SEP disputes. In recent years, SEPs have been highly litigated across European jurisdictions,[41] to the extent that the landmark *Huawei v. ZTE* European Court of Justice (CJEU) decision has limited the ability for FRAND-encumbered SEP-owners to seek injunctive relief, confining this possibility within a specific framework (Contreras et al., 2017).[42] Currently, the European jurisdictions in which prominent SEP litigations have been heard are the UK, Germany, and, although in a much more limited way, France (Contreras, 2019c; Nikolic, 2022a). However, for what concern the recent emergence of ASIs, European courts are at present generally reluctant to intervene in parallel foreign SEPs litigations by means of ASIs (Nikolic, 2022a). Nonetheless, with the aim to protect their own jurisdictions, European courts have increasingly responded against foreign ASIs by granting anti-anti-suit injunctions (AASIs) (Nikolic, 2022a).[43]

More specifically, English courts have become a desirable jurisdiction for SEP-owners, especially after the prominent 2020 Supreme Court decision of *Unwired Planet v Huawei* (Burdon, 2019).[44] To date, the UK stands out as a jurisdiction where significant decisions on SEPs are being made, while courts have gained considerable experience regarding issues such as global FRAND rate setting and SEPs injunctions (Pocknell, 2022; Nikolic, 2022a).[45] In recent years, patent litigation of SEPs plays an notable

[41] Moreover, several cases of SEP litigation brought by NPEs in particular in the UK and Germany have recently attracted attention from both scholars and policy makers (Contreras et al., 2017).

[42] The Huawei v. ZTE case, a complex SEP patent litigation initiated in Germany and culminated in the European Court of Justice (CJEU) decision that established the so-called "Huawei framework". The framework's objective is to balance the interests of SEP-owners, subject to FRAND commitment seeking injunctive relief, and alleged infringers. See, *Huawei v ZTE, 16 July 2015 - Case No. C-170/13.*

[43] For instance in Conversant v Huawei and ZTE (UK 2018); IPCom v Lenovo (UK 2019); IPCom v Lenovo (France 2019); Nokia v Continental (DE 2019); Sharp v Oppo (DE 2020); Interdigital v Xiaomi (DE 2021); IPBridge v Huawei (DE 2021). Relevant cases involving ASIs and AASIs are reviewed more in details by Nikolic (2022a).

[44] *Unwired Planet v Huawei [2020] UKSC 37.*

[45] For instance, the impact of the UK Supreme Court's position on SEPs injunctions has had broad global implications:

role also in Germany, with German courts witnessing a growing demand to address disputes related to FRAND-related disputes (Nikolic, 2022a). However, the question of the criteria that implementers of standardized technologies need to meet to be recognized as willing licensees remains in a state of evolution, and across German courts the interpretation of such doctrine appears to be diverging (Schönbohm and Ehlgen, 2022). In particular, the stance taken by German courts over the possibility for an implementer to invoke a FRAND defence and cite their supplier's willingness to license the SEP is still under development (Schönbohm and Ehlgen, 2022).[46] In France, SEP litigation is still relatively low, however the issue of the FRAND undertakings is of significant importance for French courts as the ETSI's IPR Policy is governed by French law (Abdelkafi et al., 2021). Issues concerning SEPs are resolved by the Paris Court, which between 2020 and 2021 ruled on two relevant SEP-related matters regarding the topic of the conflict of jurisdictions (Debré and Merdrignac, 2022). Specifically, in TCL v. Koninklijke Philips (2020) and Xiaomi v. ETSI & Philips (2021), the French court confirmed its jurisdiction over the determination of global FRAND terms under the ETSI undertakings (Debré and Merdrignac, 2022). In the reasoning of the court, the dispute at stake was of a contractual nature and ETSI's status as a French entity was emphasized, irrespective of the fact that the claim for infringement and the setting of a FRAND royalty rate has been previously filed by Philips before a court in the UK.[47] For what concerns the propensity towards ASIs, in 2020 in the *Lenovo v. IPCom* case the Paris Court of Appeal neutralised by means of an AASIs a US-issued ASI (Debré and Merdrignac, 2022).[48]

3.3 Research question & Hypothesis

Given the opportunities for plaintiffs to engage in forum shopping at the European level—in particular before the introduction of the UPC system, and, although in a more limited way, still today outside its jurisdiction—this chapter aims to explore the potentially different incentives for NPEs to initiate a patent infringement lawsuit in one jurisdiction over another, as compared to producing companies' (PEs) incentives. Thus, we aim to investigate the following research question: is the patent enforcement and forum shopping activity pursued by NPEs across European jurisdictions influenced by the quality of

see the *IPCom* case that, leveraging on the threat of injunction, forced HTC to withdrawn products from the UK market. *Ipcom GmbH & Co KG v HTC Europe Co Ltd & Ors [2017] EWCA Civ 90 (28 February 2017).*

[46] According to Schönbohm and Ehlgen (2022), it may be that such uncertainties are appealing to SEP-owners, which are active players before German courts that have issued several injunctions against implementers over the past recent years.

[47] Paris Judicial Court, 6 February 2020, 19/02085 in TCL v. Koninklijke Philips NV (in the presence of ETSI)); Paris Judicial Court, 7 December 2021, 20/12558 in Xiaomi v. ETSI & Philips.

[48] *Paris Court of Appeal, 3 March 2020, 19/21426 (Lenovo v. IPCom).*

the asserted patents? Specifically, we hypothesize that NPEs and PEs' incentives in initiating a patent litigation in one European jurisdiction over another are different, and that such differences in litigation strategies depend on the quality of the asserted patents.

With respect to patent quality, there is a growing empirical literature that examines such topic in relation to NPEs' activities. Focusing on their patent acquisition activities, Fischer and Henkel (2012) suggest that the probability that a patent is acquired by a NPE, rather than a producing entity (PE), increases with the scope of the patent, the density of its technology field, and its overall technological quality measured by forward citations. Similarly, Shrestha (2010) and Risch (2012) report analogous findings, and indicate that NPEs generally hold patents of comparable, if not even higher, quality than operating companies. For what concerns the NPE-litigated patents, Leiponen and Delcamp (2019) compare different types of NPEs' business models and find that the frequency of assertion, the parties involved, and the court outcomes are heavily influenced by patent quality. In reconstructing NPEs' portfolios and investigating their business models, Sterzi et al. (2021) discover that NPEs categorized as *Litigation NPEs*, in contrast to *Portfolio NPEs* or *Technology NPEs* (Ramirez et al., 2016; Leiponen and Delcamp, 2019), acquire patents with a higher likelihood of infringement, yet of comparable technological quality to patents obtained by producing companies. Additionally, Feng and Jaravel (2020) found that patent assertion entities (PAEs) disproportionately acquire and litigate patents that are of lower quality, in terms of legal robustness, compared to PEs. The authors explain this difference in terms of the quality of the patent prosecution, as patents acquired by NPEs have been granted by "lenient" examiners, who require applicants to make minimal changes to patent claims.[49] With respect to patent monetization strategies Steiner and Guth (2005), suggest that more litigious NPEs acquire patents and wait until a product that reads on those patents takes off. In this way, once irreversible investments in manufacturing have been made, it becomes burdensome for PEs to bypass the technology at use (Chien, 2008). Therefore, NPEs may obtain compensations that are higher than what potential licensees would have been willing to pay before technology adoption (Reitzig et al., 2007).

3.3.1 Our hypothesis

As previously discussed in Section 3.2.2, both NPEs and PEs have opportunities to engage in forum shopping across European jurisdictions. In Section 3.2.3, we also highlighted how two key factors play a

[49] Feng and Jaravel (2020) define "lenient" examiners as patent examiners who tend to ask the applicant to make only a few changes to the patent during the prosecution process, such as clarifying or withdrawing a claim deemed to be obvious, or to bear on non-patentable subject matter. Eventually, "lenient" examiners are more likely to issue patents that have a higher chance to be litigated and invalidated in court.

fundamental role for patent plaintiffs when faced with the decision to forum shop. First, the available remedies—in particular the possibility for plaintiffs to leverage on an injunction order against the alleged infringer (bargaining power). Second, the overall cost of the patent litigation action—i.e., the potential net revenues that can be obtained from the litigation action.

We consider four European patent litigation venues, which are also the most affected by patent litigation activities brought by NPEs, namely: Germany, France, Italy, and the UK (Cremers et al., 2017; Darts-IP, 2018). As discussed in Section 3.2.3, such jurisdictions can be broadly categorized in two types of legal regimes. In fact, in patent infringement litigation, French and English courts traditionally tend to favor fee-based remedies over injunctions (Cremers et al., 2017; Tochtermann, 2019; Cotter, 2019), and can be therefore defined as fee-based regimes (Brander and Spencer, 2021). On the contrary, patentees can easily obtain injunctions in Germany and Italy (Cremers et al., 2017), where such remedy is commonly preferred over fee-based remedies. In addition, because of its bifurcated system, preliminary injunctions are readily available in Germany (Helmers and McDonagh, 2013). For this reason Germany and Italy are categorized as injunction-based regimes (Brander and Spencer, 2021).

Building upon the insights of Brander and Spencer (2021),[50] we suggest that PEs and NPEs have different incentives—in terms of bargaining power and overall costs (net revenues)—in litigating in one type of regime, as opposed to the other, depending on the quality of the asserted patents.

PEs, in fact, while competing product development, design, production and commercialization, often infringe or challenge each other's patents by initiating litigations in different courts (Lanjouw and Schankerman, 2001a; Mezzanotti, 2021). Therefore, PEs have two primary motivations for engaging in forum shopping. Firstly, PEs aim to market their products and generate revenues through their sales. Therefore, their primary interest is the *technology* protected by the litigated patents, which enables manufacturing and technology implementation. Secondly, while PEs may also consider certain jurisdictional factors (Cremers et al., 2017), their litigation strategies are primarily driven by market competition dynamics, such as the size of the market, market share, and the presence of competitors (Weatherall and Webster, 2014; Gaessler and Lefouili, 2017). More specifically, practicing firms primarily employ patent litigation to identify and disrupt imitation while safeguarding their proprietary technology (Somaya, 2012). By initiating patent infringement lawsuits, these firms challenge the *use of technology* they patented. Patent litigation is thus motivated by the substantial investments in R&D, often undertaken before patent protection is granted for the developed technology. Furthermore, there is generally a considerable time gap

[50] Brander and Spencer (2021) develop a theoretical model to compare the economic properties of legal regimes in a Nash bargaining over a possible license fee between an infringing producing entity and a patent assertion entity (PAE), after the latter has initiated an infringement lawsuit.

between such investments and the production of a marketable product (Rudy and Black, 2018). Therefore, patent assertion by PEs offers an opportunity to observe strategic interactions among firms and their competition for market power (Rudy and Black, 2018). Additionally, reputation building may influence the decision to litigate, as the act of litigation itself conveys information to competitors regarding the patent owner's commitment to defending its technology (Lanjouw and Schankerman, 2001b).

Conversely, NPEs acquire patents to generate revenues through licensing and litigation, rather than relying on manufacturing and its related business operations (Morton and Shapiro, 2013). Therefore, as patents provide their owners the right to exclude others from manufacturing, using, and commercializing the patented technology in the jurisdictions where patent protection has been granted (De Rassenfosse et al., 2022), NPEs are exclusively interested in the *right to exclude* conferred by the patent, and not in the actual technology protected by the patent claims.

For this reason, given the two different types of legal regimes across the European countries analyzed, we hypothesize that NPEs may assert lower-quality patents in injunctive-based regimes and higher-quality patents in fee-based regimes.

Specifically, for lower-quality patents, NPEs may prefer an injunction-based regime where they would enjoy a higher bargaining power during the negotiations with the infringing firm. In this context, NPEs can leverage on the threat of injunction towards the defending firms, thus exploiting patent hold-up strategies (Lemley and Shapiro, 2006; Shapiro, 2010; Mezzanotti, 2021).[51] Thus, for lower-quality patents, if the injunction is granted by the court, the NPE would suffer a lower relative loss in terms of foregone licensing fees compared to the loss suffered by the infringing firm. In this scenario, the infringing company would face a disruptive effect on its production and investment efforts (Seaman, 2015).[52] In this way, the NPE may exploit the producing entity's reduced flexibility to negotiate higher licensing fees, as compared to a situation of bargaining between two operating companies (Chien, 2014).[53] Additionally, the NPE's increased bargaining position is reinforced by the fact that NPEs are immune to infringement counter-claims (Golden, 2006), and they are also uninterested in cross-licensing as they do not need the

[51] According to Lemley and Shapiro (2006), the so-called *hold-up* problem occurs in the context of licensing negotiations between a patent holder and an implementer when "ex ante" licensing is impractical and when the patent holder enjoys a larger bargaining power in "ex post" negotiations. The situation that separates "ex ante" from "ex post" arises when the defending company has already invested heavily to design, manufacture, market, and sell the product with the allegedly infringing technology (Mezzanotti, 2021).

[52] NPEs may sue a firm when it is most vulnerable—i.e. after investments have been made and it is too late for the defendant to change course given the path-dependent nature of technology-related investments (Chien, 2014).

[53] The threat of an injunction frequently induces firms accused of infringement to agree to seemingly excessive settlements rather than risk a costly disruption of business arising from an injunction (Brander and Spencer, 2021). For example, in early 2006, smartphone producer Research in Motion (RIM) settled a questionable patent infringement case filed by NTP for a license fee of $612.5 million rather than face a possible injunction that would suspend its U.S. sales (Mezzanotti, 2021).

defendants' patents to secure product development and manufacturing (Mezzanotti, 2021). Therefore, even when a lawsuit is based on relatively weak claims, the threat of injunction may force the defendant into costly settlements to avoid an uncertain court outcome (Mezzanotti, 2021).[54]

For higher-quality patents, NPEs may prefer a fee-based regime. In fact, in such jurisdiction NPEs can seek to obtain by the court monetary damages that are proportional to the higher-quality of the patented technology (Perkins and Mills, 1996; Brander and Spencer, 2021). In the counterfactual scenario in which a higher-quality patent is asserted in an injunctive regime, and an injunction is actually granted by the court prior to a settlement between the parties, the economic loss of NPEs in terms of foregone licensing fees would be higher given the higher-quality of the patent. In other words, for higher-quality patents, the injunction-based regime weakens the NPE's bargaining power when seeking a private settlement with the infringing firm, and the expected loss deriving from an injunction decision—in terms of foregone licensing fees—is higher for the NPE than for the PE (Brander and Spencer, 2021).[55] While an injunction is still a disruptive threat for the infringing PE, it is also harmful to the NPE. In fact, a reasonable royalty close to the technology higher value would be highly profitable to the NPE, however that profit would be lost in case of injunction (Brander and Spencer, 2021). Summarizing, our hypothesis is the following:

Hypothesis 1: *As NPEs are exclusively interested in the right to exclude conferred by the patent, they may prefer to assert lower-quality patents in injunctive-based regimes, and higher-quality patents in fee-based regimes.*

It follows that in Europe NPEs may prefer to strategically litigate lower-quality patents in Germany and Italy, where an injunctive-based regime applies, while they may enforce higher-quality patents in the UK and France, where injunctions are not the practical rule and fee-based remedies are generally preferred (Graham and Van Zeebroeck, 2013).

[54] In addition, the innovative process is frequently long and costly (Lemley and Shapiro, 2006), and cases of involuntary infringements, or alleged infringements mistakenly granted by court decisions, tend to be common (Lemley and Shapiro, 2005). Therefore, even an injunction granted for the violation of a an incremental technology can deeply damage the producing company's operations (Mezzanotti, 2021).

[55] In an injunctive-based regime, the court imposes an injunction that prevents production by the infringing firm, and neither the infringing firm nor the NPE earns any revenue. Thus, if the injunction is granted, no negotiation will arise between the NPE and the infringing firm. Given the higher quality of the infringed patent, this situation forces the NPE to give up to profitable licensing revenues (Brander and Spencer, 2021).

3.4 Data

In the present study, we use and combine three different data sources. First, we gather information on patent infringement lawsuits from Clarivate Darts IP database.[56] More specifically, we focus on patents that have been filed at the European Patent Office (EPO) and litigated between 2007 and 2020 in the European jurisdictions where patent litigation is more concentrated, i.e. in Germany, France, Italy and the UK. Additionally, we select infringement cases in such a way that there is at least one NPE or producing company among the plaintiffs.[57] Together with the information on the patent infringement cases, we also gather key information on the characteristics of the parties involved, the timing of the legal action, and patent information such as the patent number and technological fields.

Second, we collect information on patent quality characteristics from the OECD Patent Quality Database (2021 version) (Squicciarini et al., 2013). In particular, we considered the following indicators:

1. *Five-year forward citations*: the number of times a focal patent receives a citation by other patents during the five years after its publication. The accumulation of forward citations signals that the patented invention is actively contributing to the development of new innovations. As a result, a patent with a substantial number of forward citations suggests that the protected innovation holds significant technological value (Squicciarini et al., 2013).

2. *Backward citations*: the number of citations listed in the application of the focal patent to other patents, scientific work, and sources of knowledge at the basis of the protected invention. Therefore, backward citations measure the number of protected innovations the focal patent relies on in terms of prior art (Ziedonis, 2004). Previous studies have found a negative, or nonexistent, relationship between backward citations and patent value (Sneed and Johnson, 2009; Vimalnath et al., 2018). Additionally, a large numbers of backward citations may signal that the innovation is more incremental in nature (Lanjouw and Schankerman, 2001b; Harhoff et al., 2003).

3. *Family size*: the number of patent offices at which the same invention has received protection (Martinez, 2010; Squicciarini et al., 2013). This variable accounts for the possibility that the original invention is protected in patent offices beyond the EPO. Given that protecting, and maintaining, an

[56] For more information, please visit: https://clarivate.com/darts-ip/.

[57] Clarivate Darts IP considers NPEs as independent organizations that own, or benefit from, patent rights but that do not sell or manufacture goods or services associated with them. In addition, Darts IP notes that NPEs actively assert their patent rights, acting as plaintiffs in patent enforcement proceedings (Darts-IP, 2018).

innovation in multiple countries entails high costs for the patentee, *Family size* is expected to be positively correlated with patent value.

4. *Non-Patent Literature (NPL) citations*: it indicates whether the focal patent cites non-patent literature, such as scientific publications, peer-reviewed scientific papers, conference proceedings and databases setting the boundaries of patents' claims for novelty, inventive activity and industrial applicability (Squicciarini et al., 2013). The number of NPL citations is considered a proxy for the proximity of the focal patent to science (Callaert et al., 2006). Moreover, patents that cite science may contain more complex and fundamental knowledge (Cassiman et al., 2008), and this may be associated with higher technological quality (Branstetter, 2005).

Finally, we control for the age of each EPO patent at the time of the litigation—calculated as the number of years elapsing between the patent priority date and the first filing date of the infringement case—to control for the litigation time effect. In addition, we also control for the patent's declared essentiality to a technology standard (i.e., if the patent is declared essential to a standard or not). SEPs, in fact, have been found of being of higher technological quality and great strategic value as compared to patents that are not declared essential (Gupta and Snyder, 2014; Bekkers et al., 2020). Information on patents' essentiality is retrieved from PATSTAT (2019 version) and the Bureau van Dijk's Orbis Intellectual Property Database (Orbis IP).[58]

Given that patents granted by the EPO consist of bundles of national European patents (OECD, 2009), the necessary condition a plaintiff has to satisfy to be entitled to seek legal action in a specific European jurisdiction is that the EPO-litigated patent has been validated at the national patent office of that specific country (Van Zeebroeck et al., 2009). For instance, as in the aforementioned case of France Brevets against the German subsidiaries of LG Electronics and HTC (Section 3.2.2), to access the German legal system there must exist a German counterpart to the EPO-filed patent under dispute. Therefore, since an EPO patent can be litigated in multiple cases across different European jurisdictions to the extent that it has been validated in that jurisdictions,[59] and since each litigation case can involve the infringement of several patents, the unit of observation in our dataset is the patent-case pair. Table 3.3 shows the number of EPO litigated patents asserted in infringement cases over the period 2007-2020 in the different European jurisdictions considered in the analysis. During the period 2007-2020, Germany has the highest number of EPO patents litigated in infringement cases, followed by France, Italy and the

[58] For more information see https://www.bvdinfo.com/orbis-intellectual-property.

[59] Considering our litigation data, we find that nearly the entirety (95%) of the EPO-litigated patents identified have been validated in all four of the countries analyzed. This means that there is a national counterpart in Germany, Italy, France and the UK.

UK. Overall, approximately 11% of the EPO-filed patents involved in infringement disputes have at least one NPE among the plaintiffs, while the remaining 89% exclusively consist of producing companies (PEs).

Table 3.3: Number of EPO litigated patents in infringement cases in the EU jurisdictions analyzed

Jurisdiction	Plaintiff PE	Plaintiff NPE	Total
Germany	2476	337	2813
France	1028	66	1094
Italy	277	55	332
United Kingdom	211	45	256
Total	3992	503	4495

Notes: The table shows the number of EPO litigated patents (infringements only) over the period 2007-2020 in different European jurisdictions per type of plaintiff: operating companies (PEs) and non-practicing entities (NPEs). Source: own elaboration based on data retrieved from Clarivate Darts IP.

Table 3.4 and Table 3.5 show respectively the descriptive statistics of the main patent quality variables aggregated and across the different European jurisdictions considered. Because of the very high level of skewness in the distribution of the patent indicators considered—five-year forward citations, backward citations, NLP citations, and family size—we also computed the $\log(1 + x)$ transformation of these variables.

Table 3.4: Descriptive statistics

	Mean	SD	Min	Max	N
forward citations	4.272	15.742	0.000	525.000	4,495
log forward citations	1.000	0.991	0.000	6.265	4,495
backward citations	7.503	9.420	0.000	206.000	4,495
log backward citations	1.871	0.692	0.000	5.333	4,495
family size	10.951	7.721	1.000	47.000	4,495
log family size	2.184	0.642	0.000	3.850	4,495
NPL citations	2.811	10.081	0.000	306.000	4,495
log NPL citations	0.591	0.959	0.000	5.727	4,495
age	11.828	4.793	0.000	20.000	4,495
SEP	0.061	0.240	0.000	1.000	4,495
plaintiff:NPE	0.112	0.315	0.000	1.000	4,495

Notes: The table shows the aggregated descriptive statistics of the main patent quality variables analyzed. Source: own elaboration based on data retrieved from Darts-IP and OECD-EPO Patent Quality Database 2021 (Squicciarini et al., 2013).

Table 3.5: Mean (standard deviation) of patent quality indicators across selected EU jurisdictions

	FR	DE	IT	UK	Total
forward citations	4.042	4.177	3.027	7.918	4.272
	(7.465)	(15.974)	(7.564)	(34.994)	(15.742)
log forward citations	1.011	0.999	0.835	1.185	1.000
	(1.003)	(0.976)	(0.897)	(1.170)	(0.991)
backward citations	6.736	7.899	6.533	7.684	7.503
	(7.840)	(10.273)	(5.780)	(9.366)	(9.420)
log backward citations	1.822	1.903	1.806	1.805	1.871
	(0.622)	(0.709)	(0.639)	(0.826)	(0.692)
family size	12.826	9.906	10.861	14.543	10.951
	(9.282)	(6.461)	(8.639)	(9.161)	(7.721)
log family size	2.318	2.112	2.124	2.480	2.184
	(0.683)	(0.600)	(0.712)	(0.647)	(0.642)
NPL citations	1.566	3.029	2.202	6.527	2.811
	(4.772)	(11.042)	(6.641)	(16.432)	(10.081)
log NPL citations	0.436	0.628	0.488	0.987	0.591
	(0.792)	(0.982)	(0.891)	(1.257)	(0.959)
age	12.577	11.635	11.015	11.816	11.828
	(5.127)	(4.629)	(4.887)	(4.612)	(4.793)
SEP	0.017	0.077	0.006	0.152	0.061
	(0.131)	(0.266)	(0.077)	(0.360)	(0.240)

Notes: The table shows the average (and standard deviation) of the main patent quality indicators across the analyzed EU jurisdictions. Source: own elaboration based on data retrieved from Darts IP and the OECD-EPO Patent Quality Database 2021 (Squicciarini et al., 2013).

3.5 Methodology & Results

This study aims to investigate the influence of patent quality on the litigation and forum shopping strategies of NPEs, as opposed to PEs. Thus, we aim to empirically investigate two complementary research questions: first, are the characteristics of the litigated patents significantly associated with the presence of at least one NPE among the plaintiffs in infringement cases? Second, does patent quality explain NPEs' litigation strategies across different European jurisdictions?

To answer the first question, we compute the difference in means (and associated t- statistics) of the main patent quality indicators, across the selected European jurisdictions and between patents litigated in infringement cases in which there is at least one NPE among the plaintiffs vs. cases in which the plaintiffs are only PEs. Specifically, Table 3.6 shows that, on average, the overall quality (measured by the logarithm of the number of 5-years forward citations and NPL citations) of patents litigated by NPEs in

infringement cases is higher in France and slightly lower in Germany, with respect to the quality of patents in infringement cases sued by PEs in the same countries. In general, in all the jurisdictions considered, patents litigated by NPEs in infringement cases tend to have a lower degree of incrementality (measured by the logarithm of the number of backward citations), and belong to smaller patent families with respect to patents litigated by PEs. Overall, patents asserted by NPEs in infringement cases tend to display a higher degree of complexity and proximity to science (measured by the number of NPL citations) as compared to patents litigated by PEs. Additionally, patents litigated by NPEs in infringement cases tend to be on average older (in therms of the number of years between the priority date and the first litigation) with respect to patents litigated by PEs. These results hold in particular for patents litigated in France and Germany. Finally, NPEs tend to generally assert standard-essential patents (SEPs) more frequently than PEs, in particular in Germany and in the UK.

Table 3.6: Difference in means (NPE-PE) of patent indicators across selected EU jurisdictions

	(1) All juristictions	(2) FR	(3) DE	(4) IT	(5) UK
log forward citations	0.0305	1.041***	-0.110*	-0.165	-0.277
	(0.64)	(7.19)	(-2.02)	(-1.42)	(-1.73)
log backward citations	-0.273***	-0.160*	-0.271***	-0.360***	-0.439***
	(-9.22)	(-2.30)	(-7.30)	(-4.52)	(-3.73)
log family size	-0.106***	0.194*	-0.0828**	-0.441***	-0.247**
	(-3.70)	(2.14)	(-2.60)	(-4.56)	(-3.26)
log NPL citations	0.136**	0.333**	0.0595	0.241	-0.0722
	(3.06)	(3.08)	(1.09)	(1.77)	(-0.39)
age	1.581***	5.530***	1.592***	-1.238*	0.250
	(7.79)	(18.49)	(6.78)	(-2.01)	(0.41)
SEP	0.204***	0.0783*	0.233***	0.0146	0.354***
	(10.53)	(2.18)	(9.35)	(0.79)	(4.57)
Observations	4495	1094	2813	332	256

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: The table shows the difference in mean (and associated t- statistics) of the main patent indicators, across selected EU jurisdictions, between patents litigated in infringement cases in which there is at least one NPE among the plaintiffs vs. cases in which the plaintiffs are only PEs. Source: own elaboration based on data retrieved from Darts-IP and OECD-EPO Patent Quality Database 2021 (Squicciarini et al., 2013).

To answer the second question, that is whether patent quality characteristics affect NPEs' choice over the jurisdiction in which to file a patent infringement lawsuit, we compare the regression results over two groups of jurisdictions presenting similar legal characteristics: that is, the UK and France (namely, the fee-based jurisdictions) on the one side, and Germany and Italy (namely, the injunctive-based jurisdictions) on the other. Therefore, we estimate a set of linear probability models (LMP) and Logit models with a dummy dependent variable (UK_FR) coded as 1 if the EPO patent is litigated in a fee-based jurisdiction

(namely, France or the UK), and 0 if it is litigated in an injunctive-based jurisdiction (namely, Germany and Italy). The independent variables are the dummy variable NPE (coded as 1 if there is at least one NPE among the plaintiffs, and 0 otherwise), and the QUALITY variable indicating one of the patent indicators alternatively. More specifically, we separately estimate our model with each of the patent quality indicators analyzed in the previous section—i.e., five-year forward citations, backward citations, NPL citations and family size. We then control for the age of the patent at the time of the litigation (counting from its priority date) to account for the litigation year trend (age), and we also control for the fact that the patent has been declared standard-essential (or not). Finally, we also include in our model a set of dummy variables to further control for the patent's technological fields and the filing year to capture the cohort effect. In addition, given the panel structure of our dataset, in which the units of observation are the patent-case pairs, we estimate our set of regression models using plaintiffs fixed effects. Hence, we exploit the within source of variability of the dependent and independent variables arising from the fact that a given patent can be litigated several times by a given plaintiff in different years and in different jurisdictions (the Logit-FE model is indeed estimated only for the restricted subset of group of plaintiffs that can exploit this within source of variability). The goal of this approach is to control for possible unobserved plaintiff-level characteristics (e.g. their bargaining power over the defendant) that are omitted from the model. Our econometric model is expressed by the following equation (3.1):

$$Y = \beta_0 + \beta_1 NPE + \beta_2 QUALITY + \beta_3 age_{it} + \beta_4 SEP + FilingYearFE + TechFieldFE + PlaintiffFE + \varepsilon_{it} \quad (3.1)$$

Table 3.7 shows the main effects of the linear probability model (LPM) estimated using the dummy dependent variable (UK_FR) coded as 1 if the patent is litigated in a fee-based jurisdiction (France or UK) and 0 if the patent is litigated in an injunctive-based jurisdiction (Germany and Italy). The independent variables are the dummy variable NPE (coded as 1 if there is at least one NPE among the plaintiffs, and 0 otherwise) and the patent indicators estimated in separate regressions (the logarithms of the five-year forward citations, backward citations, NPL citations and patent family size). The estimation results show that, on average, NPEs are less likely to assert their patents in fee-based jurisdictions (France or the UK) than in injunctive-based jurisdictions (Germany or Italy). For what concerns the patent quality indicators, no considerable main effect seems to emerge, on average, between these two types of jurisdiction, a result which is in line with the preliminary findings shown in Table 3.4, where only small differences emerge when comparing the unconditional averages of these patent indicators across the EU jurisdictions considered.

Table 3.7: Fixed Effects Linear Probability Model: main effects estimates

VARIABLES	(1) UK_FR	(2) UK_FR	(3) UK_FR	(4) UK_FR
plaintiff:NPE	-0.685***	-0.695***	-0.684***	-0.709***
	(0.142)	(0.142)	(0.142)	(0.142)
log forward citations	0.018***			
	(0.007)			
log backward citations		-0.008		
		(0.011)		
log family size			0.020	
			(0.015)	
log NPL citations				-0.017**
				(0.008)
age	-0.003	-0.003	-0.003	-0.003
	(0.003)	(0.003)	(0.003)	(0.003)
SEP	-0.056**	-0.067**	-0.071***	-0.064**
	(0.027)	(0.027)	(0.027)	(0.027)
Constant	0.674***	0.726***	0.683***	0.677***
	(0.257)	(0.257)	(0.258)	(0.257)
Observations	4,495	4,495	4,495	4,495
R-squared	0.086	0.084	0.084	0.085
Number of Plaintiff_n	1,473	1,473	1,473	1,473
Tech. Field FE	YES	YES	YES	YES
Filing Year FE	YES	YES	YES	YES
Plaintiff FE	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: The table shows the main effects of the linear probability model estimated using the dummy dependent variable (UK_FR), coded as 1 if the patent is litigated in a fee-based jurisdiction (namely France or the UK) and 0 if the patent is litigated in an injunctive-based jurisdiction (namely Germany and Italy). The independent variables are the dummy variable NPE (coded as 1 if there is at least one NPE among the plaintiffs, and 0 otherwise) and the set of patent indicators (forward citations, backward citations and age). Source: own elaboration based on data retrieved from Darts-IP and OECD Patent Quality Database 2021 (Squicciarini et al., 2013).

However, interesting results emerge from the interaction effects estimates between the dummy variable NPE and the different patent quality indicators (forward citations, backward citations, NPL citations and family size), which are reported in Table 3.8. In fact, the dummy variable NPE has a positive and significant interaction with both the number of five-year forward citations and NPL citations, and a negative and significant interaction with the number of backward citations. The interaction between the dummy NPE and the family size indicator is negative but not statistically significant. This suggests that the propensity of NPEs to assert their patents in fee-based jurisdictions (France or the UK), rather than in injunction-based jurisdictions (Germany or Italy), increases with patent quality (proxied by forward citations and NPL citations) and decreases when the patent is of lower quality and more incremental in nature (proxied by backward citations).

Table 3.8: Fixed Effects Linear Probability Model: interaction effects estimates

VARIABLES	(1) UK_FR	(2) UK_FR	(3) UK_FR	(4) UK_FR
plaintiff:NPE	-0.687***	-0.613***	-0.602***	-0.729***
	(0.141)	(0.146)	(0.162)	(0.142)
log forward citations	0.009			
	(0.008)			
NPE*log forward citations	0.044***			
	(0.016)			
log backward citations		0.004		
		(0.012)		
NPE*log backward citations		-0.056**		
		(0.025)		
log family size			0.028*	
			(0.017)	
NPE*log family size			-0.035	
			(0.033)	
log NPL citations				-0.025***
				(0.009)
NPE*log NPL citations				0.029*
				(0.017)
age	-0.004	-0.003	-0.003	-0.003
	(0.003)	(0.003)	(0.003)	(0.003)
SEP	-0.047*	-0.068**	-0.070***	-0.062**
	(0.027)	(0.027)	(0.027)	(0.027)
Constant	0.706***	0.711***	0.663**	0.661**
	(0.257)	(0.257)	(0.259)	(0.258)
Observations	4,495	4,495	4,495	4,495
R-squared	0.088	0.086	0.085	0.086
Number of Plaintiff_n	1,473	1,473	1,473	1,473
Tech. Field FE	YES	YES	YES	YES
Filing Year FE	YES	YES	YES	YES
Plaintiff FE	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: The table shows the main and interaction effects of the linear probability model estimated using the dummy dependent variable (UK_FR), coded as 1 if the patent is litigated in a fee-based jurisdiction (namely France or the UK) and 0 if the patent is litigated in an injunctive-based jurisdiction (namely Germany and Italy). The independent variables are the dummy variable NPE (coded as 1 if there is at least one NPE among the plaintiffs, and 0 otherwise) and the set of patent indicators (forward citations, backward citations and age). Source: own elaboration based on data retrieved from Darts-IP and OECD Patent Quality Database 2021 (Squicciarini et al., 2013).

These results are also confirmed by the estimates of the Logit-FE model reported in Table 3.9. The effect of forward citations on the probability to start a patent infringement action in the UK or France is significant only for NPEs. However, the effect of backward citations and family size on the probability to start a patent infringement action in fee-based jurisdictions (the UK or France) is not significant for both NPEs and PEs, while NPL citations negatively affect the probability of litigating in France, or the UK, only for producing entities (PEs). However, the Logit-FE model is estimated on a smaller number of observations, since it exploits only the within variability of the sub-sample of plaintiffs that have litigated a patent at least once in both types of jurisdictions (fee-based and injunction-based).

Table 3.9: Fixed Effects Logit Model: NPE vs. PE estimates

VARIABLES	(1) UK_FR	(2) UK_FR	(3) UK_FR	(4) UK_FR
plaintiff:NPE	-16.099	-17.468	-16.713	-18.258
	(1,353.647)	(3,532.165)	(2,558.752)	(2,995.520)
PE*log forward citations	0.047			
	(0.138)			
NPE*log forward citations	0.298*			
	(0.180)			
PE*log backward citations		0.110		
		(0.205)		
NPE*log backward citations		-0.316		
		(0.299)		
PE*log family size			0.165	
			(0.309)	
NPE*log family size			-0.105	
			(0.386)	
PE*log NPL citations				-0.389**
				(0.164)
NPE*log NPL citations				0.122
				(0.185)
age	0.004	0.009	0.012	0.022
	(0.045)	(0.046)	(0.046)	(0.046)
SEP	-0.926**	-1.123***	-1.158***	-1.139***
	(0.414)	(0.399)	(0.400)	(0.399)
Observations	1,150	1,150	1,150	1,150
Number of Plaintiff_n	77	77	77	77
Filing Year FE	YES	YES	YES	YES
Tech. Field FE	YES	YES	YES	YES
Plaintiff FE	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: The table shows the estimates of the linear Logit model using the dummy dependent variable (UK_FR), coded as 1 if the patent is litigated in a fee-based jurisdiction (namely, France or UK) and 0 if the patent is litigated in an injunctive-based jurisdiction (namely, Germany and Italy). The coefficients associated to the set of patent indicators (forward citations, backward citations and age) are estimated separately for NPEs and PEs. Source: own elaboration based on data retrieved from Darts-IP and OECD Patent Quality Database 2021 (Squicciarini et al., 2013).

Therefore, our analysis of patent litigation and forum shopping strategies indicates that patent quality plays a prominent role for NPEs, while for PEs there seems to be irrelevant. In fact, the estimated effect of an increase in the overall quality of the patent (proxied by the number of five-year forward citations and NPL citations) on the probability of initiating an infringement lawsuit in a fee-based regime, such as France or the UK (vs. an injunction-based regime, such as Germany or Italy), is positive and significant for NPEs. At the same time, the estimated effect of an increase in the overall *incrementality* of the patent, which may signal an overall lower patent quality, (captured by the number of backward citations) on the probability of being asserted in a fee-based regime, such as France or the UK, (vs. an injunction-based regime, such as Germany or Italy) is negative and significant for NPEs. We do not find a similar effect of patent quality on producing entities' (PE) litigation behaviors. These results are in line with our hypothesis.

3.6 Conclusions

Patent litigation and forum shopping activities brought by NPEs have become a topic of intense policy and academic debate in the US. Conversely, at the European level, NPE litigation activities have been relatively less explored as only a few studies have empirically assessed this phenomenon. In this respect, our contribution to the literature is twofold.

Firstly, we provide fresh and extensive data on patent litigation initiated in the most popular European jurisdictions for disputes concerning patent infringement, that are Germany, France, Italy and the UK. Our analysis demonstrates that NPE patent litigation activity in Europe is far from being negligible. In particular, we discover that 11% of the infringement cases heard in Europe in the 2007-2020 period as been initiated by NPEs.

Secondly, this study tries to make a step forward in understanding patent litigation and forum shopping strategies from a data-driven approach, and provides a first empirical evidence in support of the predictions of the recent theoretical model developed by Brander and Spencer (2021). Specifically, we try to assess the role of patent quality in the incentives to bring a patent litigation in one jurisdiction as opposed to another (forum shopping) for NPEs vis-à-vis practicing entities (PEs). In this regard, our empirical analysis reveals substantial differences between NPEs and PEs litigation and forum shopping strategies when we account for the quality characteristics of the asserted patents. Specifically, through a set of linear probability models (LPM) and Logit models, we find that the probability for an NPE to start an infringement case in fee-based jurisdictions (France or the UK) is higher when patents of higher quality (proxied by the five-year forward citations and the NPL citations quality indicators) are asserted. Conversely, the probability for an NPE to bring a litigation in an injunctive-based jurisdictions (Germany or Italy) is higher when the asserted patent is of overall lower quality (proxied by the backward citations indicator). Finally, there seem to be no effect of patent quality on the producing entities' (PEs) forum shopping and litigation activities.

These findings support the hypothesis that NPEs may engage in opportunistic litigation across several countries taking advantage of patent quality differences. In particular, NPEs may leverage upon an increased bargaining power—derived from the threat of an injunction relief against alleged infringers available in injunctive-based jurisdictions—and litigate patents of lower quality to obtain out-of-the-court settlements that exceeds the actual value of the technology protected by the asserted patent. Alternatively, NPEs may assert patents of higher quality in fee-based jurisdictions, thus obtaining a remedy that mirrors the higher value of the technology protected by the asserted patent.

3.6.1 Limitations and future research

This study is not without limitations. In particular, by adopting a specific framework to analyze patent litigation incentives based on the plaintiff's increased bargaining power (deriving from the availability of injunctions) and the costs associated with the litigation proceeding, we may have overlooked other dimensions that are likely to influence forum shopping.

In this paper, for instance, we do not explore in details the different types of fee-based remedies available in some European jurisdictions. In particular, European courts may award different types and amounts of damages, generally assessed based on the calculation of either lost profits, a reasonable royalty, or infringers' profits (Harhoff, 2009; Graham and Van Zeebroeck, 2013; Ottoz, 2022).

Another under-explored dimension in this study is the differences in the caseload and duration of the infringement proceedings, which may substantially vary across European jurisdictions (Jacobsmeyer, 2018). In fact, with respect to the number of cases processed every year, German courts hear by far the largest number of infringement cases (Cremers et al., 2017; Darts-IP, 2018). Additionally, in Germany despite the existence of twelve regional courts most of the patent infringement claims are heard by the courts of Düsseldorf, Munich, Mannheim and Hamburg (Khuchua, 2019). Furthermore, German proceedings before Regional Courts (*Landgerichte*) tend to be speedy and the first oral hearing is scheduled after 6–12 months on average, while judgment is reached after a period of 1 to 3 months after the second oral hearing (Cremers et al., 2017; Darts-IP, 2018). Revocation decisions by the German Federal Patent Court (*Bundespatentgericht*) take generally 18 months on average after the filing of the revocation suit before the same court (Cremers et al., 2017). Similarly, patent infringement proceedings are quick also in the UK, with an average duration of 1 year and a half (Darts-IP, 2018). In the UK, first instance trials initiated before the Patent Court take 12 months to reach a conclusion and the court judgment is usually handed down within 2–12 weeks of the conclusion of the trial (Cremers et al., 2017). In France, first instance actions take on average 18 to 24 months from claim to judgment before the Paris Court of First Instance (*Tribunal de Grande Instance de Paris*), and 24 months for appeal proceedings before the Paris Court of Appeal (*Cour d'Appel de Paris*) (Agé and Prothière, 2016). As regards the duration of proceeding in Italy, anecdotal evidence suggests that courts take more time to deliver a verdict compared to the other European countries analyzed (Sterpi and Fosson, 2022). Although preliminary injunction can be issued rapidly, generally within one week from the filing of the application for preliminary injunction relief, a final judgement for patent infringement is reached on average after 4 years (Darts-IP, 2018; Sterpi and Fosson, 2022).

Finally, future research may further explore and systematize the differences in the expertise of court judges. In fact, judges who are specialized in the assessment of the technical content of the patent claims may represent a critical element in the explanation of the popularity of certain jurisdictions (Jacobsmeyer,

2018). Arguably, patent cases are among the most complicated cases to hear as judges are called to engage not only with the evolving legal doctrine, but also with highly technical engineering knowledge contained in the patent claims (Jacobsmeyer, 2018). It is therefore likely that litigants seek both legally and technically qualified judges to speed up the resolution of the patent lawsuits and lower legal uncertainty (Helmers and Love, 2022). From this point of view, judicial expertise may reasonably explain the popularity of Germany for patent litigation. In fact, Germany's bifurcated system creates a highly specialized court system for patent cases (Cremers et al., 2016). This is because the Federal Patent Court is specialized in invalidity decisions, while the twelve Regional Courts all have panels of patent judges with technical expertise to assess infringement claims (Kellenter et al., 2020). Similarly, English courts are known for their technical expertise in evaluating the content of patent claims (Nikolic, 2022a).

3.6.2 Discussion and policy implications

The recent introduction of the Unified Patent Court (UPC) marks a significant transformation of the European patent enforcement system (Love et al., 2016; McDonagh, 2016; Thumm, 2018). Officially launched on June 1st, 2023, the UPC is currently operational in seventeen European Member States that have ratified the Agreement on a Unified Patent Court (UPCA), while the other European Member States have the option to ratify the agreement at any time. At present, the UPC consists of a Court of First Instance and a Court of Appeal. The Court of First Instance presents a decentralised structure, with local divisions in several European Member States, and a central division in Paris with a section in Munich. The Court of Appeal has its sit in Luxembourg and decides on appeals against decisions of the Court of First Instance. In addition, a Patent Mediation and Arbitration Centre is foreseen to incentivize amicable settlements (Council, 2013).[60]

Designed to address both the high costs of patent enforcement and the tendency to engage in forum shopping across Europe (Mejer and Van Pottelsberghe de la Potterie, 2012; Jacobsmeyer, 2018), the UPC establishes a single coordinated European patent litigation framework. The Court, in fact, has exclusive jurisdiction over infringement actions, invalidity actions and counterclaims over Unitary Patents (UPs)—including actions for provisional measures and preliminary injunctions. Additionally, the Court has temporary concurrent jurisdiction with national courts in disputes over the "classic" European patents issued by the EPO for a transitional period of seven year, while nationally granted patents will remain under national jurisdiction (Hartmann-Vareilles, 2022).

[60] For further information, please visit https://www.unified-patent-court.org/en/court/presentation.

However, some potential drawbacks may emerge from the new system, primarily because UPs will allow for pan-European injunctions (Thumm, 2018). Specifically, as both preliminary and final injunctions are available alongside vast potential damages, patents with a European coverage may likely become incredibly powerful tools in the hands of patentees (Roberts et al., 2022).

Furthermore, the UPC, at least in principle, may still allow for separate infringement and invalidity actions Cremers et al. (2017); Thumm (2018). While the UPC has adopted a non-bifurcated system similar to those of the UK and France, where infringement and validity claims are both heard together, there are certain scenarios where the decision on infringement and validity may be made by different UPC bodies within the same proceedings. This could inadvertently result in a form of bifurcation, where, for instance, a revocation action is handled by the Central Division and the infringement pertaining to the same patent is managed by a Local division.[61] That is, new forms of forum shopping are likely to emerge if Local Divisions will systematically differ in their propensity to grant pan-European injunctions Thumm (2018).

Ultimately, despite the fact that in the long term the UPC may alleviate the litigation outcome inconsistency problem (Swanson, 2012; McDonagh, 2014, 2016; Simsek, 2017), general fears regarding patent litigation by NPEs have been voiced by both market participants[62] and the academia. These concerns primarily revolve around the prospect of NPEs exploiting the new UPC framework to obtain Europe-wide injunctions (Contreras et al., 2017; Strowel and Léonard, 2020). In fact, given the possibility of pan-European injunctions, the UPC has the potential to strengthen the patent-owner's bargaining power, potentially leading manufacturers to get licenses even when the value of the claimed patent is dubious (Strowel and Léonard, 2020). Consequently, the new system may boost the NPEs' incentive structure in Europe (Thumm, 2018), thus favoring aggressive patent litigation activities (Comino et al., 2019). In fact, litigation-focused patent-owners may derive great benefits from the vast territorial coverage of UPs (Comino et al., 2019), while technology-implementers may be incentivized to build their own defensive patent portfolios (Roberts et al., 2022).

[61] See: https://www.hlk-ip.com/key-features-of-litigation-at-the-upc/.

[62] On September 26, 2013, a consortium of prominent corporations (including Adidas, Apple, Google, Hewlett-Packard, Samsung, Microsoft, etc.) expressed concerns to both European Union Member States and institutions regarding potential adverse consequences of the UPC's introduction in relation to litigation practices of NPEs (Cremers et al., 2017). More details can be found here: https://graphics8.nytimes.com/packages/pdf/business/26trolls-letter.pdf.

3.7 Appendix to Chapter 3

3.7.1 Additional tables

Table 3.10 reports the estimated effects of each of the patent indicators considered in a separate regression (five-year forward citations, backward citations, NPL citations and family size) on the probability to assert a patent in a fee-based jurisdiction (vs. an injunction-based jurisdiction), separately for infringement cases in which there is at least one NPE among the plaintiffs (NPE) vs. cases in which the plaintiffs are producing companies only (PE).

Table 3.10: Fixed Effects Linear Probability Model: NPE vs. PE effects

VARIABLES	(1) UK_FR	(2) UK_FR	(3) UK_FR	(4) UK_FR
plaintiff:NPE	-0.687***	-0.613***	-0.602***	-0.729***
	(0.141)	(0.146)	(0.162)	(0.142)
PE*log forward citations	0.009			
	(0.008)			
NPE*log forward citations	0.053***			
	(0.014)			
PE*log backward citations		0.004		
		(0.012)		
NPE*log backward citations		-0.053**		
		(0.022)		
PE*log family size			0.028*	
			(0.017)	
NPE*log family size			-0.007	
			(0.030)	
PE*log NPL citations				-0.025***
				(0.009)
NPE*log NPL citations				0.005
				(0.015)
age	-0.004	-0.003	-0.003	-0.003
	(0.003)	(0.003)	(0.003)	(0.003)
SEP	-0.047*	-0.068**	-0.070***	-0.062**
	(0.027)	(0.027)	(0.027)	(0.027)
Constant	0.706***	0.711***	0.663**	0.661**
	(0.257)	(0.257)	(0.259)	(0.258)
Observations	4,495	4,495	4,495	4,495
R-squared	0.088	0.086	0.085	0.086
Number of Plaintiff_n	1,473	1,473	1,473	1,473
Tech. Field FE	YES	YES	YES	YES
Filing Year FE	YES	YES	YES	YES
Plaintiff FE	YES	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: The table shows the estimates of the linear probability model using the dummy dependent variable (UK_FR), coded as 1 if the patent is litigated in a fee-based jurisdiction (namely, France or the UK) and 0 if the patent is litigated in an injunctive-based jurisdiction (namely, Germany and Italy). The coefficients associated to the set of patent indicators (forward citations, backward citations and age) are estimated separately for NPEs and PEs. (Source: own elaboration based on data retrieved from Darts-IP and OECD Patent Quality Database 2021).

These results confirm that, on the one side, the number of five-year forward citations increases the probability to start a patent infringement lawsuit in a fee-based jurisdiction only when the plaintiff is an NPE, while no significant effect is found when the plaintiff is a PE. On the other side, the number of backward citations decreases the probability to start a patent infringement litigation in an fee-based jurisdiction, and again, only when the plaintiff is a NPE while there is still no significant effect when the plaintiff is a PE. Interestingly, the size of the patent family increases the probability to start an infringement litigation in a fee-based jurisdictions only for PEs, while there is no effect for NPEs. Finally, the number of NPL citations increases the probability to start a litigation in fee-based jurisdictions for NPEs but the result is not significant.

Conclusion

This thesis explored the relevant and fascinating phenomenon of NPEs. While extensive research has been conducted in the United States on such prominent actors, this thesis aims to explore the relatively overlooked phenomenon of NPEs within the European context.

In the first chapter, I undertake a systematic literature review of NPE business models, guided by the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) protocol. Through the extensive bibliometric analysis of the scholarly contributions collected, I identify four main research themes: (i) the diverse nature of NPEs, (ii) the challenges of assessing their overall impact on R&D and subsequent innovation, (iii) the intricate relationship between patent quality and NPE business models, and (iv) the many policy concerns and remedies discussed. Furthermore, I contribute to the debate on the role of NPEs in the European context through three case studies with the aim to shed light on specific NPE licensing models. This chapter serves to offer an updated and nuanced perspective on the NPE phenomenon, while bridging the existing research gap by addressing the often-neglected dynamics of patent licensing.

In the second chapter, co-authored with Gianluca Orsatti, Valerio Sterzi, and Andrea Vezzulli, we delve deeper into the empirical examination of NPE business models in the European patent market. We create a new dataset of NPE patent filings and acquisitions at the European Patent Office (EPO), and we categorize NPEs into three distinct business models: "Litigation," "Portfolio," and "Technology" NPEs. Our comprehensive analysis outlines the substantial footprint of NPEs in the European patent market, owning nearly 20,000 patents filed at the EPO and acquiring approximately 9% of all transacted patents in the Electrical Engineering sector over the past decade. We also reveal significant differences in the characteristics and use of patent rights among NPEs. Notably, we empirically confirm higher litigation propensity for "Litigation" NPEs and superior technological quality for "Portfolio" and "Technology" NPEs. Furthermore, our empirical results suggest that patent acquisitions by "Litigation" and "Portfolio" NPEs are associated with a reduction in follow-on innovation.

In the third chapter, co-authored with Prof. Valerio Sterzi and Prof. Andrea Vezzulli, we further explore more closely NPE litigation activities, a subject much debated and discussed. Specifically, we focus on how patent quality interacts with NPE forum shopping in Europe. We argue that both NPEs and producing entities (PEs) engage in forum shopping but with differing motives. NPEs focus on exploiting patents' exclusionary rights, while PEs are concerned with the technology protected by such patents. Consequently, we aim to empirically investigate our hypothesis that NPEs may strategically engage in forum shopping, leveraging lower-quality patents in jurisdictions favoring injunctions, such as Germany and Italy, and higher-quality patents in fee-based regimes like the UK and France. Our empirical analysis,

drawn from Clarivate's Darts IP and the OECD's Patent Quality Database, goes into the direction of our hypothesis. Specifically, it reveals that, compared to PEs, higher-quality patents are more likely to be asserted by NPEs in fee-based jurisdictions, while lower-quality patents are more likely to be litigated by NPEs in injunction-based jurisdictions.

In summary, this thesis extensively explores the multifaceted landscape of NPEs, offering both fresh qualitative and quantitative data, while it also tries to fill the extant research gap with respect to the relatively under-explored European context. Additionally, this work aims to foster a more comprehensive understanding of the different NPE business models, their role, impact, and strategies within the European patent ecosystem, thus going beyond the generally polarized policy debate that sees NPEs as a unique phenomenon.

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