

**Managing Intellectual Property:
IP outsourcing and the supply side of IP Management**

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The President:

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Abbreviations

AB	Absorptive capacity
AT	Automotive
CH	Chemistry
CU	Cultural
e.g.	exempli gratia, for example
EF	Efficiency
EL	Electronics
EP	European patent
EPO	European Patent Office
et al.	et alii, and others
etc.	et cetera, and so on
EU	European Union
FA	Factor cost
HC	Human capital
i.e.	id est, that is
IF	Infrastructure
IN	Information System
IP	Intellectual Property
IPC	International Patent Classification
IPIMS	Integrated Management System
IPR	Intellectual Property Right
IT	Information Technology
IWS	Industry Wage Survey
KN	Knowledge sharing routines
M&A	Mergers and Acquisitions
MA	Machinery
MO	Monitoring
n/a	not available
NPD	New product development
OED	Office of Enrollment and Discipline
OI	Open Innovation
OR	Odds ratio
OTH	Other
PATSTAT	Patent database of the European Patent Office

PCT	Patent Cooperation Treaty
PH	Pharmacy and biotech
R&D	Research and Development
RBV	Resource Based View
RE	Relationship
ROI	Return on Investment
SE	Selection and contracting
SE	Standard Error
SLA	Service Level Agreement
SME	Small and Medium-sized Enterprise
TC	Telecom
TCE	Transaction Cost Economics
TMT	Top management team
TOPSIE	Database of an IP service provider
TRIPS	Trade-Related Intellectual Property Rights agreement
USA	United States of America
USD	US Dollar
USPTO	United States Patent and Trademark Office
VIF	Variance Inflation Factor

Abstract

In recent years, firms have been turning marginal innovations into patents more frequently than previously. All major patent offices worldwide are facing a “patent explosion” (Harhoff et al., 2007). The role of Intellectual Property (IP), particularly of patents has moved from a purely legal barrier to a strategic matter. Although issues and challenges related to strategic patenting are increasingly subject of research and management practice, relatively less attention has been paid to outsourcing strategies and the management of IP by means of IP intermediaries. Therefore, my thesis empirically investigates how firms define IP outsourcing strategies, what kind of IP intermediaries they utilize, and how these IP intermediaries affect firms’ IP strategy and IP performance.

My thesis is a compilation of an introductory chapter and three individual, self-standing research articles. While the introductory chapter outlines in detail the motivation of the thesis and provides an overview of the current state of the art in literature, the subsequent three articles investigate distinct research questions focusing on outsourcing of IP and the management of IPR with IP intermediaries. The first article investigates the phenomenon of IP outsourcing and explores, firms’ IP outsourcing strategies. The second article focuses on the supply side of IP management by introducing the IP service provider as a highly specialized IP intermediary and by exploring firms’ choices regarding IP intermediaries. Finally, article three concentrates on the question how external patent attorneys and their level of experience influence patent filing strategies. By investigating the above questions in the respective studies my thesis contributes to existing literature by focusing on the supply side of intellectual property management and by exploring so far unanswered questions. Furthermore, this thesis contributes to management practice by providing practical recommendations on how IP can be managed effectively with external IP intermediaries.

Zusammenfassung

Seit einigen Jahren kann beobachtet werden, dass Unternehmen zunehmend marginale Innovationen in Patente umwandeln. Alle wichtigen Patentämter weltweit sind mit einer regelrechten „Explosion von Patentanmeldungen“ konfrontiert (Harhoff et al., 2007). Die Rolle von geistigem Eigentum – englisch: Intellectual Property (IP) – vor allem von Patentmanagement hat sich von einem rein rechtlichen Konstrukt, hin zu einem Bereich von strategischer Bedeutung entwickelt. Obwohl Fragestellungen in Hinblick auf strategisches Patentmanagement zuletzt Gegenstand zunehmender Forschung und Praxis geworden sind, mangelt es bislang an dedizierter Forschung zu IP Outsourcing und deren Einfluss auf das Management von Patenten. Aus diesem Grunde, untersucht meine Dissertation empirisch folgende wichtige Fragestellungen: Wie Firmen Outsourcingstrategien definieren, welche Typen von IP Intermediären im Umfeld von IP existieren und wie diese IP Intermediäre die IP Strategien von Unternehmen beeinflussen.

Meine Dissertation besteht aus einem Einleitungskapitel und drei individuellen Forschungsartikeln. Das Einleitungskapitel erläutert die Motivation der Arbeit und gibt einen Überblick über den aktuellen Stand der Forschung. Desweiteren untersuchen die nachfolgenden drei Artikel spezifische Forschungsfragen zum Thema IP Outsourcing und dem Management von IP unter Zusammenarbeit mit IP Intermediären. Der erste Artikel betrachtet das Phänomen IP Outsourcing näher und analysiert Unternehmensstrategien in Bezug auf IP Outsourcing. Der zweite Artikel fokussiert sich auf IP Intermediäre, indem unterschiedliche IP Dienstleister vorgestellt werden und sowohl Motive, als auch Determinanten für die Auswahl von IP Dienstleister untersucht werden. Der letzte Artikel befasst sich mit der Frage, wie externe Patentanwälte und deren Erfahrung auf die Patentanmeldestrategie von Unternehmen Einfluss nehmen. Meine Dissertation leistet durch Beantwortung wichtiger Fragestellungen in Hinblick auf IP Outsourcing und die Lieferantenseite von IP Management, sowie durch Erarbeitung von Managementempfehlungen zum praxisrelevanten Thema IP Outsourcing und IP Dienstleitern einen Beitrag zur aktuellen Forschung.

1 Introduction

1.1 Motivation

The global economy becomes increasingly knowledge-based and intangible assets such as Intellectual Property rights (IPR) represent a strategically important subject and the basis for rivalry and disputes between industry players (Granstrand, 2000). Moreover, the role of patent management has changed from creating a purely legal barrier for competitors to a sophisticated utilization of patents, i.e. via blocking, licensing, building fences and thickets, and preventing litigation (Cohen et al., 2000, Sternitzke, 2013; Cohen et al., 2002; Blind et al., 2009). This new role of Intellectual Property (IP) has been increasingly subject of discussion in research and practice. An indication of this development is the continuous growth in patent applications in all major patent offices during the last decades (van Zeebroeck, 2009), although R&D expenditure growth was only modest (Blind et al., 2009). Clearly responsible for the increase in patent applications is the alternative uses of patents, also referred to as strategic patenting (Ayerbe et al., 2014, Somaya, 2012; Granstrand, 2000; Hanel, 2006). As IP portfolios are growing firms face new challenges to cope with this “patent race” and have to establish ways to organize and manage IPR by leveraging internal resources with external capabilities. Latter, is reflected by the existence of IP intermediaries, such as patent attorneys. IP work is characterized by highly specialized and narrowly defined formal roles, for instance technologists focus solely on IP generation, attorneys focus solely on IP protection, and imperfect process interfaces between these functional areas require structures or means which enable efficient IP management (Gassmann et al., 2012).

Within this context, firms started more and more to outsource patent activities to highly specialized patent attorneys and IP service providers. Thales Group for instance, a French corporation in the defense industry outsourced major parts of its IP department to an external IP supplier and successfully established a new knowledge division (Ayerbe et al., 2014). Well known benefits of outsourcing are cost reductions, efficiencies, and profitability improvements (Jiang, 2006). In context of IP however, capability aspects are particularly important. Patent attorneys or IP experts are specialists in their technological areas and represent a relevant resource for patent strategy. On the other side, many firms are still unsure which IP tasks to outsource (Bader, 2007) and which IP suppliers to select.

Overall, the growing interest in IP from a strategic view, its role for a firm’s success, and the need to utilize and leverage external IP intermediaries leave research with many unanswered questions. To gain a deeper understanding how outsourcing in the context of IP works, what

challenges firms are facing with regard to outsourcing of knowledge-based work, and how the suppliers affect firms IP performance and IP management represent an important gap in current literature. The purpose of my thesis is to contribute to the field of IP management by exploring firms' outsourcing strategies and by elaborating IP intermediaries' impact on companies' IP management.

This introductory chapter is structured as follows: The subsequent sections 1.2 to 1.4 present an overview of the theoretical background of my thesis by outlining relevant literature regarding strategic patenting, IP outsourcing, and patent indicators. Section 1.5 describes the research questions addressed in the individual articles of this cumulative dissertation thesis and provides an overview of the thesis structure.

1.2 Strategic Patenting

In a knowledge-based economy, patents represent a powerful instrument of firms' corporate strategy. For instance, the patent explosion observed in several patent offices can be attributed to greater globalization of IPR rather than an increase in research productivity (Danguy, 2014). Also, the growing number of patent applications in industries which are not traditionally associated with patenting are an indication for patenting as a strategic approach (Harhoff et al., 2007). Previous research has discussed various reasons of strategic patenting (Bader et al., 2014; Blind et al., 2009; Thumm, 2003), the positive impact of patent strategy on firm performance (Ernst, 1998; Ernst, 2001; Lerner, 1994), and the influence of strategic patenting on companies' patent portfolios (Blind et al., 2009). Further, Somaya (2012) categorizes in his review article three generic patent strategies into proprietary (e.g. protection), defensive (e.g. blocking), and leveraging (e.g. licensing) approaches that impact firms' overall IP management.

Additionally, there is a growing interest in *filing strategies* within the strategic patenting framework. Research on filing strategies analyzes the impact of filing strategies on patent value (van Zeebroeck & van Pottelsberghe de Potterie, 2011), or analyze firms' filing behaviors (Berger et al., 2012; Harhoff et al., 2007). Other studies have defined filing dimensions and classified filing strategies, such as (Harhoff, 2006c) and (Stevnsborg & van Potterie, 2007). Experiences with patent systems, the drafting practices of patentees, and the impacts of such practices on diverse patent indicators have also been the subject of analysis (van Zeebroeck, 2009). Also, the impact of patent attorneys on patenting output becoming increasingly important. Somaya (2012) show that patent attorneys have been demonstrated to have the same proportional impact on a firm's patenting output as R&D spending. They

suggest that innovation research may be enhanced by considering the role of in-house patent law expertise in generating patents, and conclude that patent law expertise affects the firm's patenting performance positively. Several authors (Cohen et al., 2000; Hall & Ziedonis, 2001) highlight that the translation of technological inventions into patents is an imperfect process that is impacted by various factors: attorneys have an especially important role in the patent application process.

Table 1 provides a tabular overview of selected publications in the strategic patenting domain and summarizes the key findings which are particularly relevant for my thesis.

Table1: Selected literature on strategic patenting

Author(s) Year	Title	Methods	Key Findings
Laplume et al. (2015)	The organizational advantage in early inventing and patenting: Empirical evidence from interference proceedings	Procedural patent data of 650 US patents and patent applications between 2005 and 2013 based on USPTO database	<ul style="list-style-type: none"> ▪ Individual inventors produce less valuable inventions than those operating within organizational boundaries ▪ Public and private corporations invent faster than individual inventors, whereas public and private corporations, universities, and research institutes patent their inventions earlier than individuals ▪ Individual inventors lack resources as well as functional and integrative capabilities needed to invent and patent as quickly as organizations
Danguy et al. (2014)	On the origins of the worldwide surge in patenting: an industry perspective on the R&D–patent relationship	Econometric data of 18 industries in 19 countries between 1987 - 2005	<ul style="list-style-type: none"> ▪ Patent propensity, are related to the research productivity and filing strategy ▪ Increase in patent filings also due to filing strategies and greater globalization of IP rights rather than surge in research productivity
Frietsch, Rothengatter (2013)	Which road to take? Filing routes to the European Patent Office	Procedural patent data of 2 million patent filings of EPO database	<ul style="list-style-type: none"> ▪ Industrial structure of an economy, are related to the choice of a filing route to the European Patent Office (EPO) ▪ The choice of a filing route is associated with the outcome of the examination process

Cotropia et al. (2013)	Do applicant patent citations matter?	Procedural patent data of US patents issued in 2007 based on USPTO database	<ul style="list-style-type: none"> ▪ Examiners citations used in a rejection is related to applicant citation ▪ Examiners rarely use applicant submitted art in their rejections to narrow patents, relying almost exclusively on prior art they find themselves
Sternitzke (2013)	An exploratory analysis of patent fencing in pharmaceuticals: The case of PDE5 inhibitors	Inductive case studies with 3 firms	<ul style="list-style-type: none"> ▪ A model of patent fencing strategies in pharmaceuticals industry ▪ Patents with defensive blocking potential are filed early in the lifecycle ▪ Patents with offensive blocking potential are filed late in the lifecycle
Berger et al. (2012)	Filing behaviour regarding essential patents in industry standards	Procedural patent data of 291 patents from EPO, OECD, and ETSI database	<ul style="list-style-type: none"> ▪ Essential patents contain significantly more claims ▪ Essential patents are amended 25% more often than patents not relevant for the standardization context ▪ Time about final decision about the application reached is longer for essential patents
Somaya (2012)	Patent strategy and management: an integrative review and research agenda	Conceptual paper based on literature review	<ul style="list-style-type: none"> ▪ Framework of generic patent strategies and strategic patent management ▪ Three domains in patent strategies: proprietary, defensive, and leveraging strategy ▪ Patent management is closely linked to a firms' overall value creation strategy
van Zeebroeck, van Pottelsberghe de Potterie (2011)	Filing strategies and patent value	Econometric data of 250,000 EPO patents between 1990 - 1995	<ul style="list-style-type: none"> ▪ Introduction of new value determinants in form of filing strategies: filing routes, drafting styles, divisional filings ▪ Filing strategies are positively related to patent value

Blind et al. (2009)	The influence of strategic patenting on companies' patent portfolios	Quantitative survey data from 457 German firms	<ul style="list-style-type: none"> ▪ Companies' patenting strategies are related to the characteristics of their patent portfolios ▪ Companies which protect their technological knowledge base receive a higher number of forward citations for their patents ▪ Offensive blocking is related to a higher incidence of oppositions whereas ▪ Companies using patents as bargaining chip in collaborations receive fewer citations and fewer oppositions to their patents
Somaya et al. (2007)	Combining Patent Law Expertise with R&D for Patenting Performance	Econometric data of Fortune 500 firms between 1990 - 2000	<ul style="list-style-type: none"> ▪ Combination of patent law expertise with R&D affects firm patenting performance ▪ In-house patent law expertise is a significant predictor of firm-patenting performance ▪ Firms leverage patent law expertise to generate patents better if they have Top Management Team members with a patent-law background ▪ Firms in systems-based industries, who faced increasing pressures to patent in the time period, were most likely to generate patents through the use of in-house patent law attorney
Blind et al. (2006)	Motives to patent: empirical evidence from Germany	Quantitative survey data from 522 German firms of all sizes	<ul style="list-style-type: none"> ▪ Large firms have stronger incentives to patent (negotiation position, incentive for R&D personnel, performance indicator) ▪ Patents often have a strategic reason
Gassmann, Bader (2006)	Intellectual property management in inter-firm R&D collaborations	22 case studies with successful practice firms Five in-depth case studies	<ul style="list-style-type: none"> ▪ Identification of knowledge areas before, during, and after R&D collaborations which have to be considered for managing IP ▪ Managing IP already in the early stage of the R&D collaboration increases the collaboration success
Reitzig (2004)	Strategic management of intellectual property	Interviews with senior IP representatives Secondary sources:	<ul style="list-style-type: none"> ▪ The increasing corporate value of IP requires to take a strategic approach towards IP management

		publications, IP databases	<ul style="list-style-type: none"> ▪ Identification of fundamental strategic aspects of IP management in internal and external firm contexts
Hall, Ziedonis (2001)	The patent paradox revisited: an empirical study of patenting in the U.S. semiconductor industry between 1979-1995	Interviews with seven semiconductor firms Econometric data from 95 semiconductor firms	<ul style="list-style-type: none"> ▪ Patents have an increasing value as bargaining chips ▪ Blocking competitors and preventing suits are the second and third most important motivation to patent after preventing from imitation ▪ Patents are important in attracting venture capital funds
Ernst (1995)	Patenting strategies in the German mechanical engineering industry and their relationship to company performance	Quantitative survey from 50 German mechanical engineering firms	<ul style="list-style-type: none"> ▪ Identification of four types of patenting strategies ▪ Patent active firms reach higher economic performance ▪ The number of international patent applications, the rate of valid and highly cited patents positively impacts firm performance

1.3 IP outsourcing

In today's fast moving environment firms are facing challenges of globalization and high cost pressure. One of the most recent management strategies in response to demands for more efficient ways to address organizational competitiveness is outsourcing. Prior research suggests that firms can improve their innovative and financial performance by interacting with different suppliers (Garcia et al., 2014). Most outsourcing studies refer to the outsourcing impact as a conceptual combination of cost reduction, productivity growth, and profitability improvements (Jiang, 2006). Companies are concentrating on their core competencies and are thus choosing the outsourcing solution rather than the in-house one (Le Dain et al., 2011). Firms externalize a wide range of activities, ranging from product design to assembly, from research and development to marketing, distribution, and after-sales services (Ho, 2009). The main motivation for outsourcing is still cost reduction, which is achieved through outsourcing the firm's access to economies of scale and the unique expertise that a large outsourcing supplier can deliver (Anderson & Weitz, 1986; Roodhooft & Warlop, 1999).

Literature on patent management has only recently focused on outsourcing. Reitzig and Wagner (2009) empirically show that a firm's performance in turning patent applications into patent grants increases linearly with the rate of outsourcing of patent applications to external law firms. Major specialization advantages of the external lawyers are likely to account for

this finding. The recent study of Moeen et al. (2013) adds further insights into the highly specific nature of IP and the challenges of managing outsourcing of IP. The authors examine factors that influence the concentration of a firm's supply portfolio for IP legal services. One finding of their study is that the outsourcing of patent filing activities is closely linked to significant firm-specific knowledge and concentration of outsourcing of patent legal services into the hands of a few suppliers. Another important contribution is the study of Mayer et al. (2012). These authors distinguish three types of human capital relevant for knowledge work activities: firm-specific human capital, industry-specific human capital, and occupational human capital. They conclude that firms prefer to outsource knowledge work in highly contested areas. They recognize the value of law firms' occupational expertise, which is a major driver of outsourcing decisions for patents that are likely to be litigated and require the expertise of specialized suppliers.

Nevertheless, research on outsourcing has also presented contradictory findings, e.g. R&D outsourcing is associated with a high risk of information leakage (Ho, 2009). Also, several authors highlight that managers walk a fine line with their firm boundary choices: excessive outsourcing can "hollow out" the firm's knowledge, and can decrease organizational learning (Mayer et al., 2012; Reitzig & Wagner, 2010). On the other hand, outsourcing is associated with increasingly geographically dispersed sources of innovation (Mahnke et al., 2008), a tendency to include a greater number of technologies per product class (Brusoni et al., 2001), and increased product development speed (Tran et al., 2011; Mahnke et al., 2005). Thus, firms face within their boundary decision trade-offs particularly regarding their IP outsourcing decisions, which we conceptualize and discuss in the next section.

Table 2: Selected literature on IP Outsourcing

Ketata et al. (2015)	The role of internal capabilities and firms' environment for sustainable innovation: evidence for Germany	Qualitative survey of 1,1024 manufacturing firms	<ul style="list-style-type: none"> ▪ Firms need to invest in internal absorptive capacities and to draw both broadly and deeply from external sources for innovation ▪ Investments in employee training turn out to be more important than technological R&D expenditures
Ayerbe et al. (2014)	The new challenges of organizing intellectual property in complex industries: a discussion based on the case of Thales	Single case study of Thales Group	<ul style="list-style-type: none"> ▪ Identification of a new (external) division of knowledge and the need to develop new capabilities to deal with IPR ▪ Clear sharing of capabilities needed for managing IP in complex industries

Moeen et al. (2013)	Supply portfolio concentration in outsourced knowledge-based services	Patent data of 129 technology based Fortune 500 firms over the period 1990 - 1995	<ul style="list-style-type: none"> ▪ Outsourced knowledge-based service work is concentrated in the hands of fewer suppliers when: (1) it requires greater firm-specific knowledge; (2) there is a higher level of interrelatedness across outsourced projects; (3) the firm's reliance on outsourcing is high; (4) its outsourced projects are focused on a narrower (capability) domain; and (5) the technological dynamism of this domain is low
Mayer et al. (2012)	Firm-specific, industry-specific, and occupational human capital and the sourcing of knowledge work	Patent data of 129 technology based Fortune 500 firms over the period 1990 - 1995	<ul style="list-style-type: none"> ▪ Framework of capability development and sourcing decisions in knowledge work ▪ Three types of Human Capital (HC): firm-specific, industry-specific, and occupational HC ▪ The knowledge project is less likely to be outsourced when it requires higher levels of firm-specific HC ▪ Outsourcing decisions are influenced by how firms develop their HC in various industry-specific domains ▪ Firms prefer to outsource knowledge work in highly contested areas to access the potentially superior occupational HC of external suppliers
LeDain et al. (2011)	Measuring supplier performance in collaborative design: proposition of a framework	Interviews with NPD project teams of Schneider Electric representatives, Literature review	<ul style="list-style-type: none"> ▪ Framework for the measurement of supplier's performance in the context of NPD projects ▪ Identification of four performance areas combined with three involvement stages, to provide an improved understanding of the supplier performance within an inter-organizational product development context
Mol et al. (2011)	Overcoming Inertia: Drivers of the Outsourcing Process	Econometric data of Dutch firms of 21 industries between 1993 - 1998	<ul style="list-style-type: none"> ▪ Outsourcing inertia, when companies are slow to adapt to changing circumstances that accommodate higher outsourcing levels, may undermine a firm's performance ▪ Five drivers behind outsourcing process: managerial initiative (using outside experience); hierarchy (foreign headquarters); imitation (of competitors and of similar firms); outsider advice (from external institutions); knowledge sources (using external information)

Reitzig, Wagner (2010)	Hidden costs of outsourcing: evidence from patent data	Econometric data of 504 firms between 1980 - 2001 based on EPO database	<ul style="list-style-type: none"> ▪ Firms' downstream performance (ability to detect competitors for proactive litigation purposes) decrease (increase) the more (less) they outsource the proceeding vertically related upstream services (patent filings) ▪ Firms with less downstream dependence, need to rely less on downstream activities ▪ Outsourcing downstream activities to litigation experts increases downstream performance
McIvor (2009)	How the transaction cost and resource-based theories of the firm inform outsourcing evaluation	Conceptual paper, 3 in-depth case studies	<ul style="list-style-type: none"> ▪ Framework for outsourcing integrating TCE and RBV ▪ The findings have shown that the RBV is an effective theory for understanding the link between outsourcing and performance at the operations level ▪ Performance considerations also extend to the management of suppliers in the case of outsourced activities
Roodhooft, Warlop (1999)	On the role of sunk costs and asset specificity in outsourcing decisions: a research note	Quantitative survey data from 156 Belgium managers	<ul style="list-style-type: none"> ▪ Asset specificity investments and the presence of sunk costs reduced the likelihood of outsourcing ▪ Managers were more reluctant to opt for outsourcing if the outsourcing option was associated with asset specificity investments
Abraham, Taylor (1996)	Firms' Use of Outside Contractors: Theory and Evidence	Qualitative survey data from 13 manufacturing Industry Wage Surveys (IWS), and Econometric data	<ul style="list-style-type: none"> ▪ Important factors in the decision to outsource are: Saving costs, economics of scale ▪ There is a growing trend towards outsourcing because of improvements in communication and infrastructure, greater specialization of supplier firms, and greater economies of scale

1.4 Patent indicators

The empirical research of my dissertation is partly based on patent indicators, for which I want to provide a review in the following.

There is a wide variety of empirical studies based on patent indicators. All patent variables are drawn from publicly available information such as the USPTO, EPO, or WIPO. One

prominent research stream is focusing on the value of patents using proxies such as citation counts (Harhoff et al., 1999; Hall et al., 1993; Harhoff et al., 2003), renewal fees (Schankerman & Lanjouw et al. 1999, Bessen 2008), or auction value (Fischer & Leidinger, 2014). A second literature stream uses patent information as strategic indicator to proxy strategic R&D planning (Ernst, 1998), strategic technology management (Ernst, 2003; Park et al., 2013), or R&D investment strategies (Song, 2009). There are several contributions on patent quality, i.e. Lanjouw and Schankerman (1999) construct a measure for patent quality based on patent claims, citations and family size. Saint-Georges and van Pottelsberghe de Potterie, (2013) construct a patent quality index using a composite of multiple patent indicators. Lanjouw and Schankerman (2004) use patent quality to proxy research productivity, and Chen and Chang (2010) use patent quality to proxy for market value. Another line of research use patent indicators to proxy for technological diversification (Leten et al., 2007), technological life cycle analysis (Gao et al., 2013, Haupt et al., 2007, Järvenpää et al., 2011), and research productivity (Lanjouw & Schankerman, 2004). Literature using patents as economic and innovation indicators are answering questions about sources of economic growth, rate of technological change, innovativeness and competitive position of different firms and countries (Griliches, 1990; Nagaoka et al., 2010). A further stream of research is sparked by the growing interest in spillovers and knowledge flows and uses patent citations as indicator of knowledge transmission between inventors (Jaffe & Trajtenberg, 1993; Park & Park, 2006). Figure 1 summarizes above literature by type of indicators, proxy variables, and unit of analysis.

Out of the extensive body of publications only few refer to obvious limitations patent indicators impose due to “institutional rules” of the patent system, and examiners’ or attorneys’ influence on patent indicators. Reitzig (2004) differentiated patent indicators into three generations. The first generation of patent indicators, contain mostly citation counts, claims, family size, backward citations, and forward citations. All first generation indicators lack in in-depth knowledge of institutional details of the patent system. The second generation of patent indicators uses patent-specific procedural information which is included in observable information from patent databanks. In this context, some authors analyzed patent-specific strategic indicators such as filing strategy or legal contents of backward citations (Guellec & van Pottelsberghe de Potterie, 2000; Harhoff et al., 2007). Recently, more and more scholars exploit the third generation of patent indicators that are included in the patent full text, which is the patent draft itself. For instance, Reitzig (2004) validated patent value indicators by analyzing application rationale and Somaya (2007) combines patent law experience with R&D and draws conclusions on the firm patenting performance.

Figure 1: Overview on patent indicators

	<i>Patent-level</i>	<i>Firm-level</i>	<i>Indicators</i>
Strategic indicators	<ul style="list-style-type: none"> ▪ Patent strategy ▪ Filing strategy ▪ Technology planning 	<ul style="list-style-type: none"> ▪ R&D planning ▪ R&D collaboration ▪ Innovation strategy ▪ Competitor strategy 	<ul style="list-style-type: none"> ▪ Citations, family size, multiple inventors ▪ Patent infringements ▪ Patent full text indicators, etc.
Value indicators	<ul style="list-style-type: none"> ▪ Patent value ▪ Auction value ▪ Value of patent litigation 	<ul style="list-style-type: none"> ▪ Firm value ▪ Project value ▪ Market value 	<ul style="list-style-type: none"> ▪ Citations, family size, claims ▪ Renewal fees ▪ Oppositions ▪ Auction value, etc.
Quality indicators	<ul style="list-style-type: none"> ▪ Patent quality 	<ul style="list-style-type: none"> ▪ Research productivity ▪ Portfolio quality 	<ul style="list-style-type: none"> ▪ Citations, IPC, family size, etc.
Technology indicators	<ul style="list-style-type: none"> ▪ Technological diversification ▪ Technology life cycle ▪ Technological structure 	<ul style="list-style-type: none"> ▪ Innovation performance ▪ Research productivity ▪ Technology spin-offs 	<ul style="list-style-type: none"> ▪ Citations, family size, IPC, patent thickets ▪ Technology keyword cluster, co-patents, etc.
Economic/Innovation indicators		<ul style="list-style-type: none"> ▪ Economic growth ▪ Competition position ▪ Technological change ▪ Innovativeness 	<ul style="list-style-type: none"> ▪ Growth rates of patent applications & grants ▪ Technology classes ▪ Etc.
Knowledge indicators		<ul style="list-style-type: none"> ▪ Knowledge spillovers ▪ Knowledge flows 	<ul style="list-style-type: none"> ▪ Patent stock, citations, patent renewal, etc.

Source: Albert et al. (1991); Alcácer & Gittelman, (2006); Bergek & Bruzelius, (2010); Chen & Chang, (2010); Choi & Park, (2009); Ernst, (2003); Fischer & Leidinger, (2014); Gao et al., (2013); Graevenitz et al., (2013); Griliches, (1990); Hall et al., (2001); Hall et al., (2007); Harhoff et al., (2003); Harhoff et al., (2007); Haupt et al., (2007); Jaffe & Trajtenberg, (1993); Kang, (2015); Lanjouw & Schankerman, (2004); Lee et al., (2008); Leten et al., (2007); Marco, (2007); Maurseth, (2005); Nagaoka et al., (2010); Park et al., (2013); Rassenfosse, (2013); Reitzig, (2004); Saint-Georges & van Pottelsberghe de Potterie, (2013); Wagner, (2009).

1.5 Research questions and structure of the thesis

1.5.1 Purpose of my thesis and research gap

The literature review in the previous sections gives an overview of the current state of the art regarding IP outsourcing, strategic patenting, and research using patent indicators. Although IP management issues are increasingly important in business and academic literature, research on IP outsourcing is rare. Also, research on strategic patenting is currently predominantly focused on applicants and examiners. Thus, many questions related to IP outsourcing strategies and the utilization and impact of external IP suppliers remain unanswered. My research is inspired by the practical need for assisting firms in developing a comprehensive view on IP outsourcing, to better understand the role of IP intermediaries, and to leverage a greater level of value from external capabilities.

In detail, my research aims to answer three distinct research questions that are addressed in Paper 1, Paper 2, and Paper 3. These papers are presented in the following chapters of my thesis. Prior to that, I want to introduce the three research questions briefly.

The first research question focuses on IP outsourcing. As I have noted, questions concerning how firms outsource IP related work have thus far been addressed in the existing research to only a small degree. Most studies focused on analysis of outsourcing based on transaction costs and capabilities. With the exception of Ayerbe et al. (2014), outsourcing has not been studied with a particular focus on IP. To close this gap we investigate the phenomenon of outsourcing of IP and ask the following research question:

Research question 1: Why and what kind of outsourcing strategies do firms pursue?

The second research question sheds some light on intermediaries in the field of IP. Within the context of IPR literature the few studies existing mainly focus on patent attorneys or law firms. Thus, literature lacks insights about which other highly specific IP intermediaries exist and what determines a firm's choice for one intermediary versus the other. This leads to the following research question:

Research question 2: What determines firms' preference for outsourced IP work?

The third research question focus on external patent attorneys and their impact on filing strategies. In line with growing interest in strategic patenting there has been an emerging interest in firms' filing strategies and effects. As pointed out, most studies focus on the behavior of applicants and examiners and their influences on filing strategies. Thus, we seek

to contribute to existing literature by specifically focusing on patent attorneys by asking the following research question:

Research question 3: How dependent is the filing strategy and the outcome of the patent process on the skills and experience of the patent attorney?

Table 3 provides an overview of all papers and summarizes the research questions, the methodology applied, the sample, and key findings of each individual paper.

Table 3: Overview of the research questions and paper summaries

<i>Research question</i>	<i>Focus</i>	<i>Research Design/Sample</i>	<i>Key findings</i>
Paper 1	Why and what kind of outsourcing strategies do firms pursue?	IP Outsourcing <i>Strategic level</i> Conceptual, case studies N=36 Four in-depth case studies	<ul style="list-style-type: none"> ▪ An IP outsourcing typology can be identified based on a cost model and firms' IP outsourcing strategy: Non-Outsourcer, Cost Outsourcer, Expertise Outsourcer, and Strategic Outsourcer. ▪ A differentiated approach based on the type of IP work and outsourcing breadth needed in order to manage IPR with external suppliers most efficiently. ▪ Managerial implications including five important lessons for the outsourcing of IP activities.
Paper 2	What determines firms' preference for outsourced IP work?	IP intermediaries <i>Firm level</i> Quantitative N=67,111	<ul style="list-style-type: none"> ▪ A potential definition of the IP service provider is proposed. ▪ The choice of IP supplier is affected by: (1) the firm's own IP management capabilities, (2) the firm's IP knowledge base, and (3) the IP complexity. ▪ IP service providers are more likely to be selected if the firm's own IP management capabilities are well established, while IP law firms are more likely to be selected if the firm's IP complexity is high.
Paper 3	How dependent is the filing strategy and the outcome of the patent process on the skills and experience of the patent attorney?	IP intermediaries <i>Patent level</i> Quantitative N=67,111	<ul style="list-style-type: none"> ▪ Patent attorneys have a positive impact on the area of protection, and more experienced patent attorneys are using a differentiated filing strategy, i.e. drafting narrower and more focused patent applications. ▪ Patent attorneys tend to have a negative effect on the development of a patent portfolio and/or thickets of relatively similar patents related to one innovation. ▪ Patent attorneys follow a strategy to reduce lag and accelerate patenting speed independent from their experience.

1.5.2 Thesis structure

The above described research questions are answered in self-standing research articles which are reproduced in the subsequent chapters of my thesis. Figure 2 presents the structure of my thesis which is broken down into four chapters: the introduction followed by three scientific articles, one for each research question. The articles follow the sequence and logic of the sub-research questions presented above.

In chapter 2, the *first paper* addresses research question 1 and provides answers to motives and outsourcing strategies firms pursue. The paper investigates the phenomenon of outsourcing of knowledge-based work, particularly of Intellectual Property (IP). Using data from 36 cases, the analysis reveals a distinct typology of IP outsourcers based on a cost model and the firms' IP outsourcing strategy. Four in-depth case studies are analyzed: Non-Outsourcer, Cost Outsourcer, Expertise Outsourcer, and Strategic Outsourcer. The differentiated analysis reveals trade-offs and both negative and positive effects of the IP outsourcing strategy. We suggest that firms need a differentiated approach based the type of IP work (legal versus non-legal) and outsourcing breadth (number of outsourced IP services) in order to manage Intellectual Property Rights (IPR) with external suppliers most efficiently. We conclude by providing practitioners five important lessons for the outsourcing of IP activities.

In chapter 3, the *second paper* answers research question 2. Studies focusing on the supply side of IP management, particularly the outsourcing of patent related work, are relatively rare. This paper aims to contribute to the IP literature in two ways. First, I propose a potential definition of the IP service provider, which offers IP related services similar to the classic IP law firms. Second, I analyze three main factors that determine a firm's preference for outsourced IP work, specifically, outsourced patent renewal work. Using data on the outsourcing of patent renewal payments, I found evidence that the choice of IP supplier is affected by: (1) the firm's own IP management capabilities, (2) the firm's IP knowledge base, and (3) the IP complexity. Moreover, the study shows that IP service providers are more likely to be selected if the firm's own IP management capabilities are well established, while IP law firms are more likely to be selected if the firm's complexity is high. By providing insights into the outsourcing of patent related work and the supply side of IP management, this study represents a useful complement to more typical IP research, which commonly focuses on applicants and/or examiners.

In chapter 4, the *third paper* investigates research question 3. In the intellectual property rights literature, the question of how external patent attorneys impact patent filings has been

relatively understudied. We seek to advance this area of research by examining how external patent attorneys and their experiences influence patent filing strategies. We provide insights into filing dimensions which are affected by patent attorneys' work and decision making. Using data on the outsourcing of patent application services, we find empirical evidence that external patent attorneys' work has an effect on: (1) patent scope; (2) international scope, and (3) filing speed. Moreover, we show that external patent attorneys have a positive impact on the area of protection, and more experienced patent attorneys are using a differentiated filing strategy, for instance drafting narrower and more focused patent applications. Our study suggests that effective filing strategies have to be communicated and aligned between all IP stakeholders, including external patent attorneys. We develop a patent filing typology accounting for patent attorneys' decision options. In providing insights into patent attorneys' work and their impacts on IPR management, our study is a useful complement to prior research, which has predominantly focused on applicants or examiners.

Figure 2: Overview of the thesis structure

<i>Thesis structure</i>		
Chapter 1	Introduction	Literature review on IP outsourcing, strategic patenting, and patent indicators
Chapter 2	Paper 1	Outsourcing Intellectual Property Rights: Leveraging Competencies or Losing the Crown Jewels?
Chapter 3	Paper 2	The supply side of IP management: understanding firms' choices regarding IP intermediaries
Chapter 4	Paper 3	Role of external patent attorneys on patent strategy and its effectiveness

2 Outsourcing Intellectual Property Rights: Leveraging Competencies or Losing the Crown Jewels?

Co-authored by Oliver Gassmann

Outsourcing has gained much importance in managerial practice and academic discussion. This paper investigates the phenomenon of outsourcing of knowledge based work, particularly of Intellectual Property (IP). Using data from 36 cases, the analysis reveals a distinct typology of IP outsourcers based on a cost model and the firms' IP outsourcing strategy. Four in-depth case studies are analyzed: Non-Outsourcer, Cost Outsourcer, Expertise Outsourcer, and Strategic Outsourcer. The differentiated analysis reveals trade-offs and both negative and positive effects of the IP outsourcing strategy. We suggest that firms need a differentiated approach based the type of IP work (legal versus non-legal) and outsourcing breadth (number of outsourced IP services) in order to manage Intellectual Property Rights (IPR) with external suppliers most efficiently. We conclude by providing practitioners five important lessons for the outsourcing of IP activities.

2.1 Introduction

Managing the corporation's intellectual property (IP), and its patents in particular, has become a challenge in strategic planning, research and development, and other corporate functions related to innovation on a global scale (Gassmann & Bader, 2006). IP as a strategic and cross-functional topic creates the need for intelligent and efficient ways to manage intellectual property rights (IPR) within the organization. Studies on the organization of IP focus mostly on the internal organization of IP: for example, Daizadeh (2007) proposed an IP Integrated Management System (IPIMS) to take advantage of the unique position of the IP Department, and Carlsson et al. (2008) proposed a semi-centralized organizational structure which ensures a reasonable depth of IP knowledge by creating a centralized IP team while sharing costs among divisions. However, there remains a need for research on how firms manage their IP in regard to vertical integration. Outsourcing within the IP department is not a new phenomenon. The first outsourcing providers in IP were established in the late 1960s. The highly specialized legal aspects of IP regulations created a market for external suppliers such as law firms and specialized IP service providers. Still many firms are unsure about which IP tasks should be outsourced and which should be kept in-house (Bader, 2007). Somaya, (2012) summarized the existing literature on Strategic Patenting and identified opportunities to address important unanswered research questions, such as those concerning the interplay between the firm's internal resources and its externally available capabilities with suppliers, and the hiring and development of expert patent managers and attorneys. Especially little theory exists on how firms strategically use and organize IP outsourcing (Ayerbe et al., 2014). The present research contributes to IPR literature in three ways. First, several authors highlight the lack of recent studies on IPR management on firm level (Ayerbe et al., 2014; Somaya, 2012; Candelin-Palmqvist et al., 2012). These authors point out that the majority of published studies have focused on macro-level and secondary data, and encourage and call for more qualitative studies to answer the how and why questions related to IPR management. Our article fills this gap by studying the IP outsourcing phenomenon based on case studies, and by identifying the implications of outsourcing for IPR management. Secondly, we extend current theory by providing an IP outsourcing typology describing firms' outsourcing strategies. In particular, we discuss aspects of firms' boundary choices revealing trade-offs between costs and capabilities associated with IP outsourcing. Finally, regarding content, only recently have studies with a particular focus on IP outsourcing been published. The main contributions to be mentioned are: Reitzig and Wagner (2010) highlight the hidden cost of outsourcing, Mayer et al. (2012) study the development of various types of human capital and their impact on legal services outsourcing, Moeen et al. (2013) study the factors that influence the concentration of a firms' supply portfolio of outsourced prosecution work, and Ayerbe et

al. (2014) conducted a case study of Thales, a French group in the defense industry to explore how IP is organized via outsourcing. All these studies center on outsourcing of patent filings, patent prosecution, and the organization of IPR using external patent law firms. The present paper fits well into the recently published literature but extends the work to include legal and non-legal IP work provided by law firms and other IP suppliers, such as IP service providers. The paper aims to gain a deeper understanding why firms decide to outsource IP work, what challenges firms face with regard to the outsourcing of IP work, what kind of outsourcing strategies they pursue, and which managerial implications these strategies have for IPR management. As transaction costs and capabilities are the main underlying theories of outsourcing (Williamson, 1987; Grant, 1996; McIvor, 2009) we develop our IP outsourcing typologies based on an IP outsourcing cost framework, which we discuss based on case studies of Air Liquide, Cuboro, Siemens, and Schindler.

The paper is structured as follows: In Section 2, the theoretical framework and an IP outsourcing cost model are presented. Section 3 presents the research methodology and describes the firm sample. In Section 4, we develop the IP outsourcing typology and discuss its characteristics based on four cases each of which relates to one “ideal type” from the typology. Finally, theoretical and managerial implications are discussed, and we conclude by providing a brief overview of further research possibilities.

2.2 Theoretical Framework

2.2.1 Literature review

In today’s fast moving environment firms are facing challenges of globalization and high cost pressure. One of the most recent management strategies in response to demands for more efficient ways to address organizational competitiveness is outsourcing. Prior research suggests that firms can improve their innovative and financial performance by interacting with different suppliers (Garcia Martinez et al., 2014). Most outsourcing studies refer to the outsourcing impact as a conceptual combination of cost reduction, productivity growth, and profitability improvements (Jiang, 2006). Companies are concentrating on their core competencies and are thus choosing the outsourcing solution rather than the in-house one (Le Dain et al., 2011). Firms externalize a wide range of activities, ranging from product design to assembly, from research and development to marketing, distribution, and after-sales services (Ho, 2009). The main motivation for outsourcing is still cost reduction, which is achieved through the outsourcing firm’s access to economies of scale and the unique expertise

that a large outsourcing supplier can deliver (Anderson & Weitz, 1986; Roodhooft & Warlop, 1999).

Specialization is another significant motivator of outsourcing. Firms contract out services with the objective of smoothing production cycles and benefiting from specialization (Abraham & Taylor, 1996). Managing IPR requires specific capabilities: for instance, technologists focus on IP generation, while attorneys focus on IP protection. As Ayerbe et al. (2014) state, IPR calls for specific capabilities to identify and negotiate different rights between stakeholders. According to a study of Reitzig and Wagner (2009) firms are more successful in turning patent applications into patent grants the higher their outsourcing rate to external law firms is. The recent study of Moeen et al. (2013) examines factors that influence the concentration of a firm's supply portfolio for IP legal services. The authors find empirical evidence that the outsourcing of patent filing activities is closely linked to significant firm-specific knowledge and concentration of outsourcing of patent legal services into the hands of a few suppliers. Access to expertise of specialized suppliers is another motivation to outsource patent work to external attorneys. Mayer et al. (2012) distinguish in their study three types of human capital relevant for knowledge work activities: firm-specific human capital, industry-specific human capital, and occupational human capital. They confirm that firms prefer to outsource knowledge work in highly contested areas. Also the authors recognize that IP law firms' possess occupational expertise, which is a major driver of firms outsourcing decision for IP work.

Nevertheless, research on outsourcing has also presented contradictory findings, e.g. R&D outsourcing is associated with a high risk of information leakage (Ho, 2009). Also, several authors highlight that managers walk a fine line with their firm boundary choices: excessive outsourcing can "hollow out" the firm's knowledge, and can decrease organizational learning (Mayer et al., 2012; Reitzig & Wagner, 2010). On the other hand, outsourcing is associated with increasingly geographically dispersed sources of innovation (Mahnke et al., 2008), a tendency to include a greater number of technologies per product class (Brusoni et al., 2001), and increased product development speed (Tran et al., 2011; Mahnke et al., 2005). Thus, firms face within their boundary decision trade-offs particularly regarding their IP outsourcing decisions, which we conceptualize and discuss in the next section.

2.2.2 A cost model of IP outsourcing

Several theoretical arguments have been used to explain outsourcing, e.g.: property rights (Coase, 1937), principal agency (Ross, 1973), transaction costs (Williamson, 1987), and in the last decade, the resource based view of the firm (Barney, 1991). These classic theories

have shaped the understanding of the vertical integration of the firm and frame firms' make or buy decisions. The "buy decision" is preferred if the firm's advantages from using external markets and benefits from supplier economies of scale and specialization outweigh risks such as the loss of knowledge (Somaya, 2012). According to Transaction Cost Economics (TCE), three critical factors determine the level of transaction costs: Frequency of transactions, uncertainty, and asset specificity (Williamson, 1987). Asset specificity plays a particularly important role in managing IP because it involves knowledge of both legal and technological areas. For instance, strategically developing a patent portfolio requires a high level of technological expertise, but also legal expertise in order to file and enforce the patents (Ernst, 2001; Lerner, 1994). The RBV considers resource heterogeneity as antecedent to performance and diversification. Resources which are rare, valuable, non-imitable and not substitutable enable firms to achieve sustainable competitive advantage (Barney, 1991). It is expensive and time consuming to develop resources. Therefore, Resource Based View (RBV) arguments propose that firms should only outsource those activities which are not critical to competitive advantage (Odagiri, 2003). TCE focuses primarily on the role of efficient governance through transaction analysis, whilst the RBV focuses on the search for competitive advantage through resource analysis. McIvor (2009) argues that neither transaction cost economics nor the resource-based view alone can fully explain the complexities of outsourcing. In line with McIvor (2009) and Ayerbe et al. (2014) we suggest a complementary approach based on capabilities to address the new ways of managing IPR via outsourcing. As organizations increasingly outsource more critical IP activities such as filing, prosecution, trading and licensing, they are seeking to leverage a greater level of value from outsourcing. Although cost concerns are still important motivations for outsourcing in many contexts, the implications for the long-term capabilities of the company have to be considered. We base our study on the combined approach developed in the analytical framework by McIvor (2009) to understand firms' IP outsourcing strategies. This combined approach (combining TCE and RBV) is based on transaction costs, which are centered on organizational arrangements and their modes of governance, and capability analysis of the firm's performance based on its know-how and resources.

As noted earlier the most discussed drivers of outsourcing in the literature are financial i.e. cost reductions, technical i.e. IS infrastructure improvements, strategic i.e. the focus on core competencies, and political i.e. dissatisfaction with internal resources (Mahnke et al., 2005). Firms outsource in order to achieve a combination of these benefits (Willcocks et al., 2002). At the same time outsourcing shows negative effects: Risks include loss of control, declining rate of innovation, low performance, or other hidden costs including loss of key employees and relevant knowledge (Earl, 1996). The optimal degree of IP externalization can be

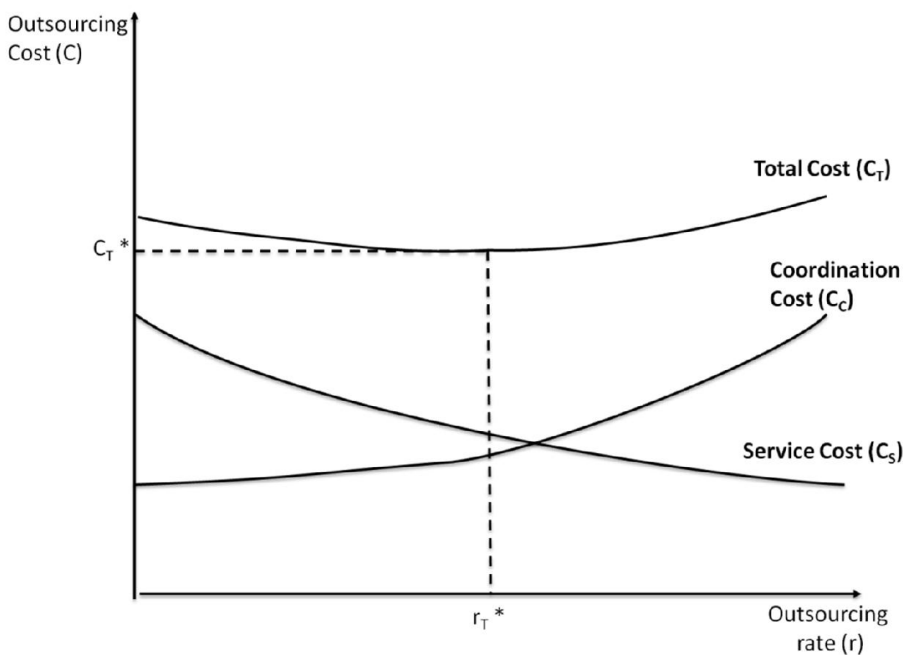
described in a formal cost model. We outline in our cost model benefits and risks of IP outsourcing. We identified two basic types of costs curves, service costs (C_s) and coordination costs (C_c). C_s represents the cost curve for providing the service, and C_c represents the cost curve for coordination. There is a trade-off between the lower service costs and higher coordination costs associated with outsourcing (Shy & Stenbacka, 2003; Shy & Stenbacka, 2005). The two cost curves are influenced by several cost drivers. The service costs for IP services (C_s) are driven by factor costs, costs of achieving efficiencies, costs of gaining IP knowledge, costs of losing absorptive capacity. *Factor costs (FA)* are costs of labor, material, and capital. Gaining efficiencies has a positive effect on service costs. Major factors for *achieving efficiencies (EF)* are process and infrastructure efficiencies. Well defined and stringent processes optimized by sophisticated *information systems (IN)* enable maximum automation of process steps. This enables a scale-up of the service volume at the same for low additional fixed costs. Another cost driver is *costs of gaining IP knowledge (KN)*. Assuming learning by doing has a positive impact on service costs, a firm that outsources its IP activities may lose much of its IP knowledge over time. The erosion of the firm's IP expertise will increase the firm's marginal IP service costs (Cha et al., 2009). Consequently higher outsourcing rates reduce the firm's learning-by-doing experience. Zirpoli and Becker (2011) in a 10-year empirical study of a major European automotive manufacturer, found that an increase in the outsourcing rate of design and engineering tasks led to a loss of component-specific knowledge. Learning by doing increases a firm's absorptive capacity (Cohen and Levinthal, 1990). Therefore an increased outsourcing rate may lead to learning traps (March, 1991) and thus create costs associated with *losing absorptive capacity (AB)*. However, on the other hand, there is the possibility that the firm acquires new and useful service knowledge from its highly skilled and specialized outsourcing supplier (Cha et al., 2009). Ketata et al. (2015) recommend for companies to follow an open culture that allows exposure to a diversity of external knowledge sources, such as a company's suppliers may feed it with new ideas and suggestions, which could help companies to be proactive and to prevent them from missing important opportunities in their business environment.

Coordination costs for IP services (C_c) include selection and contracting, costs for infrastructure, costs for monitoring, costs for lack of relatedness, relationship, and cultural costs. Unlike service costs, these coordination costs are independent of the scale of the services. The higher the outsourcing rate, the higher coordination costs between the firm and the supplier. The *selection and contracting (SE)* of the outsourcing supplier plays an important role. Due diligence in the assessment of several suppliers identifies which fits best. This is particularly important if information asymmetry and knowledge gaps are large between outsourcer and vendor (Mahnke et al., 2005). Therefore, firms are faced with agency costs associated with structuring, monitoring, and enforcing the contract. Investments in

infrastructure (IF) between the outsourcer and the supplier are often needed to master the challenge of system integration and harmonization of the activities (Teece et al., 1997). Both contract partners can work on IP files within the same IP management system, connected by bilateral interfaces, which has the advantage of on-time data exchange and decreases the risk of missing knowledge transfer. The *organizational monitoring costs (MO)* for management and quality control have a high impact on coordination costs. Monitoring costs and costs for quality control increase with an increasing outsourcing rate. Monitoring activities might include the development of a quality control system (Shy & Stenbacka, 2005). Equally important is the degree of relatedness between the IP outsourcer and the supplier. According to Dyer and Singh (1998) a high degree of strategic relatedness results when the focal firm and specialized firm share common or similar knowledge sharing routines. Knowledge sharing routines are defined as regular patterns of interaction that permit the transfer, assimilation, and integration of new knowledge (Grant, 1996). A lack of *knowledge-sharing routines (KN)* increases coordination costs. For successful IP outsourcing a relationship with a strong level of intensity between the outsourcer and the supplier should also be established. Accordingly, *relationship costs (RE)* are incurred in order to enhance partnership quality. Lee and Kim (1999) find a positive relationship between partnership quality and outsourcing success. Partnership quality is determined by participation, joint action, communication quality, information sharing, age of the relationship, mutual dependence, top management support, and cultural similarity (Lee, 2001). *Cultural costs (CU)* are associated with the adaptation processes employed by outsourcer and supplier to develop common organization and work practices. Cultural similarity is determined by similarities in factors such as corporate values, organizational structures, reward and incentive systems, leadership styles, decision-making processes, corporate history (Dyer & Chu, 2000).

Hence, the total costs of IP outsourcing, C_T , can be summarized by the two cost aggregates: service costs C_S and coordination costs C_C .

$$C_T = C_S (FA, EF, IN, KN, AB) + C_C (SE, IF, MO, KN, RE, CU)$$

Figure 3: Minimal outsourcing cost at optimal outsourcing rate

The general behavior of the cost curves depend on the outsourcing rate and can be described as follows. The service costs C_S decrease with increasing outsourcing rates, whereas the coordination costs C_C increase with increasing outsourcing rates. The outsourcing rate r of a firm is the quantity q of IP services that the firm decides to outsource to external IP suppliers relative to the total quantity of IP services. The optimal outsourcing rate is at the minimum of the total cost curve C_T . Figure 3 illustrates, in simplified form, the cost curves as a function of the outsourcing rate. The optimal outsourcing rate r^* is reached at the minimum of the total cost curve C_T^* . The mathematical formulation is only an attempt to explain the observed relation between the cost aggregates and their behavior towards the total costs of IP outsourcing. There are limitations due to the complex nature of IP outsourcing, and impacting factors which cannot be determined exactly.

2.3 Research methodology and firm overview

As we have noted, questions concerning how firms outsource IP related work have been addressed to only a small degree in the existing research. Most studies focused on analysis of outsourcing based on transaction costs and capabilities. With the exception of Ayerbe et al. (2014), outsourcing has not been studied with a particular focus on IP. Since our research goal is to understand firms' IP outsourcing strategies, we used a qualitative research approach, employing case studies. The case study approach is an appropriate research tool when boundaries between phenomena have not yet been clearly identified (Yin, 1994). In order to

precisely study distinct outsourcing strategies associated with IP related work, we used data from an internal patent database of an IP service provider. This service provider offers IP related services along the life cycle of a patent (e.g. filing, prosecution, renewal and other legal and non-legal services). First, we selected from this database 36 companies (“clients”) that hold European patents and are contracting out IP related tasks to third parties (IP service providers, law firms, IP software providers). Second, we used archival data gathered from the Espacenet database of the European Patent Office (European Patent Office, 2010). This allowed us to validate the service providers’ data and obtain further information, such as the firm’s total patent portfolio size. Third, we conducted 18 semi-structured interviews with managers from different areas, including CTOs, IP managers and IP experts, in order to further deepen our understanding of how firms handle IP outsourcing. This allowed us to receive information about the organization, the IP relevant firm strategy and the IP outsourcing strategy in specific. We completed the data using secondary research, analyzing corporate annual reports, and company journals.

Four companies were chosen by the authors for qualitative cases studies in order to analyze IP outsourcing strategies. These cases were analyzed using standard procedures for qualitative analysis (Eisenhardt, 1989).

Table 4: Overview of companies

<i>Employees</i>	<i>Overall (%)</i>	<i>IP Outsourcing breadth</i>			<i># patents</i>
		Low (%)	Moderate (%)	High (%)	
1-100	22.2 (8)	35.3 (6)	12.5 (2)		50
101 - 1000	5.55 (2)	5.9 (1)	6.3 (1)		1.356
1001 - 5000	13.8 (5)	11.8 (2)	6.3 (1)	67.7 (2)	1.589
> 5000	58.3 (21)	47.1 (8)	75.0 (12)	33.3 (1)	93.940
Total	100 (36)	100 (17)	100 (16)	100 (3)	96.935

<i>Employees</i>	<i>Industries</i>						
	AT (%)	CH (%)	PH (%)	MA (%)	EL (%)	TC (%)	OTH (%)
1-100		33.3 (2)	40.0 (2)	20.0 (1)			27.3 (3)
101 - 1000				20.0 (1)	20.0 (1)		
1001 - 5000		16.7 (1)	20.0 (1)	20.0 (1)	20.0 (1)	50.0 (1)	
> 5000	100 (3)	50.0 (3)	40.0 (2)	20.0 (1)	60.0 (3)	50.0 (1)	72.7 (8)
Total	100 (3)	100 (6)	100 (5)	100 (4)	100 (5)	100 (2)	100 (11)

AT: automotive; CH: chemistry; PH: pharmacy and biotech; MA: machinery; EL: electronics; TC: telecom; OTH: other

Outsourcing breadth is expressed as the number of IP related services outsourced to an external IP service provider. Low equals 1, moderate equals 2, high equals more than 3.

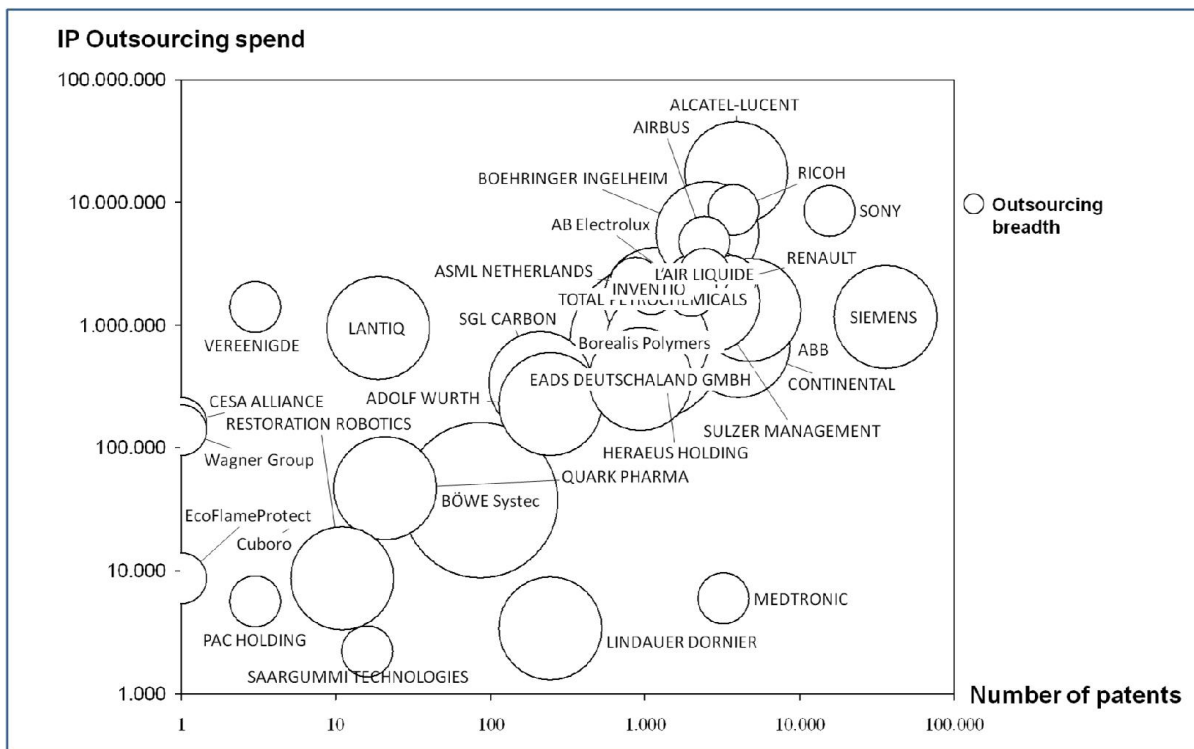
Cases were not chosen at random; rather, we chose those that would provide the most detailed information and exemplify extreme situations and polar types. As Pettigrew (1990) noted, given the limited number of cases which can usually be studied, it makes sense to choose cases such as extreme situations and polar types, in which the process of interest is "transparently observable". We selected the cases based on firms' *outsourcing breadth* and *outsourcing strategy*. We defined outsourcing breadth as the number of different IP services purchased from external service providers or law firms, and categorized this variable into low, medium and high. Although Reitzig and Wagner (2010) used outsourcing rate (also referred to as outsourcing intensity – the number of externally drafted patent applications relative to the total number of applications filed by a firm) for their study, we suggest that outsourcing breadth provides additional insights into how firms define their outsourcing strategy in regard to vertical integration. Based on transaction costs and capabilities, and in the context of IP outsourcing, asset specificity (Williamson, 1987) is critical due to the highly specific capabilities and expertise needed to perform IP work. Thus, many firms use a set of suppliers to outsource their IP work. As previous research highlighted dealing with external IP suppliers, such as patent attorneys, law firms or other IP vendors, firms need to access the most competent suppliers in each technology area (Moeen et al., 2013). Referring to the IP outsourcing cost model, this raises new challenges such as the selection, coordination, monitoring, and control of activities between outsourcing suppliers. For this reason, analyzing firms' outsourcing breadth will provide further insights into how firms manage IP outsourcing.

The sample companies ranged from SMEs to large multinationals, from 5 employees to over 50.000. Table 4 provides a brief overview of the size, patent portfolio, and industry of the organizations in our sample. To further describe the 36 companies, we positioned all companies in the sample within an IP outsourcing matrix, which is depicted in Figure 4. The vertical axis represents the firm's outsourcing spending (at the time of data extraction), while the horizontal axis reflects the firm's number of patents for outsourced services (granted European patents at the time of data extraction). For illustration purposes we logged both axes. The positioning of the companies was verified by five experts of an IP outsourcing vendor to cross-check the validity and appropriateness of our evaluation. We limited our analysis to the following IP services: Patent renewal services, patent filing services for European patents, and IP software services. This limitation was employed because, first, we were using data from an outsourcing vendor, and second, because all three of these services do not require a registered European patent attorney to represent patentees in proceedings at the EPO (see Article 133, European Patent Convention¹). This means that the firm's

¹ <https://www.epo.org/law-practice/legal-texts/html/epc/2013/e/ar133.html>

outsourcing decision is not restricted by legal regulations or institutional requirements for such IP services. As mentioned, we extend present research by analyzing firms’ outsourcing of legal and non-legal IP work, and by focusing on patent breadth to gain a deeper understanding of firms’ overall IP outsourcing strategies. In our sample, patent breadth is large if all three IP services are externalized, medium if two of three IP services are externalized and small if one IP service is externalized (as illustrated by the size of the bubbles in Figure 4).

Figure 4: IP Outsourcing-Matrix



2.4 Towards a typology of IP outsourcing

As mentioned above, we have analyzed 36 firms which outsource IP work (patent annuities, patent filings, IP software and docketing services) to external suppliers. The next step involves using this empirical data and select four cases to answer fundamental questions of this research: What triggers firm’s decision to outsource IP work? What is their IP outsourcing strategy? What kind of typologies can be identified?

Figure 4 illustrates the extent to which each company uses external IP services. For instance, Medtronic has a large patent portfolio but externalizes little IP work (low outsourcing spending, high outsourcing breadth), while Boehringer Ingelheim has also a large patent

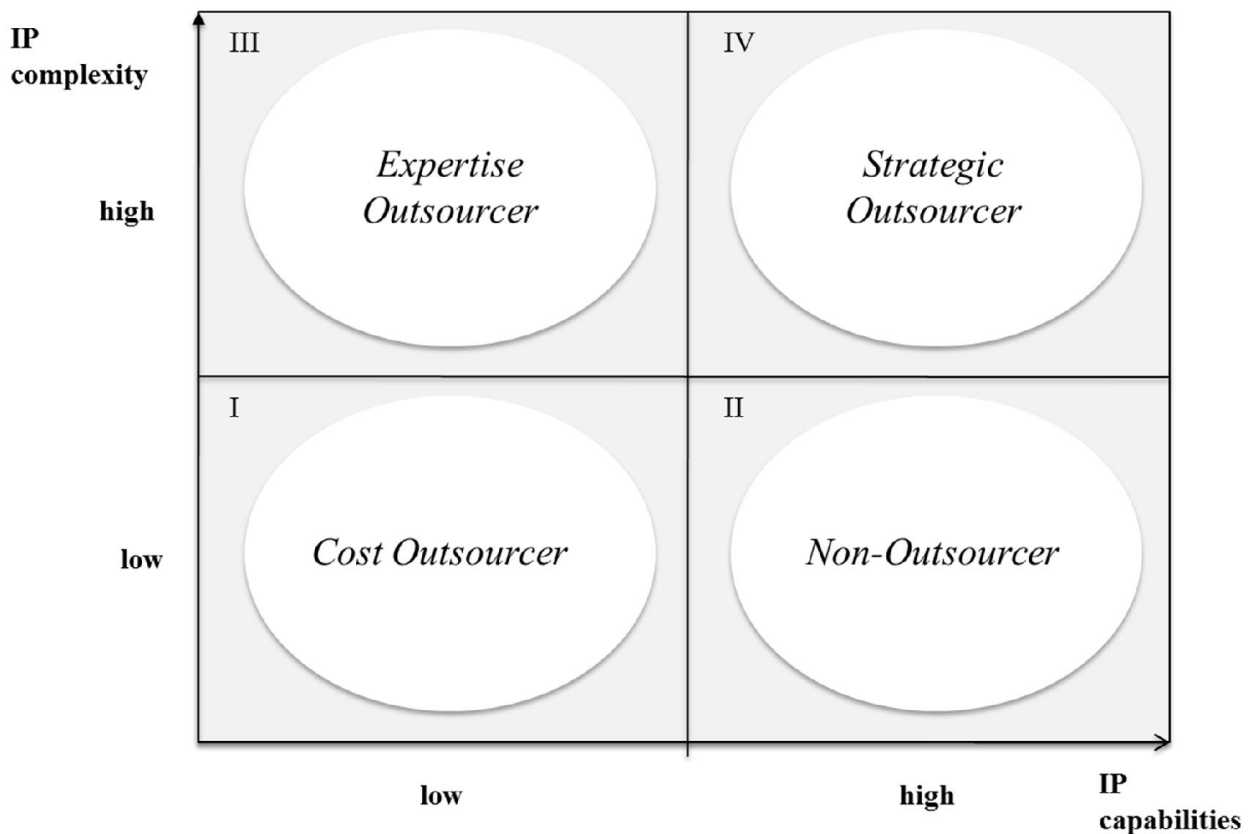
portfolio and but externalizes extensively (high outsourcing spending and breadth). The results suggested that firms pursue dedicated IP outsourcing strategies, which we endeavored to analyze through our case studies. To understand firms' outsourcing decisions and assess similarities and differences between the cases, we extended the IP outsourcing matrix by adding quantitative and qualitative criteria. Eisenhardt (1989) suggests that results of case study research should be compared to the framework of current theory. Therefore, we use our theory implications and qualitative findings to define and validate a typology.

Firms outsource a variety of IP services; however, legal and non-legal IP services require different skills and resources. To address this issue and to respond to this aspect, we identified an IP outsourcing typology which consists of two dimensions: IP complexity and IP capabilities. Both dimensions define the outsourcing typology. In line with previous studies (Somaya, 2012; Moeen et al., 2013; Li, 2011) our study highlights that firms have to develop capabilities to manage IP services with a set of external suppliers. Particularly for IPR management, a firm's outsourcing choice is made on a portfolio or project level: for instance, firms outsource annual installment payments for an entire portfolio and not only for a single patent. Similarly, IP recordals (when an IP right has to be reassigned or recorded, i.e. in case of mergers and acquisitions) are outsourced on a project level and not on a single transaction level. Consequently, the primary question is not how much IP work is outsourced, but rather what kind and how many IP activities are outsourced (outsourcing breadth). The firm's outsourcing strategy is driven by IP complexity, or by the availability of IP capabilities. More precisely, we operationalise the IP complexity dimension as a function of IP task complexity and IP structural complexity. IP task complexity is defined by the number of patents, country coverage, and scope of IP tasks. We submit that IP task complexity increases with the number of patents, number of countries, and diversity of IP scope. IP structural complexity comprises size of the organization and number of IP sites. We suggest that IP structural complexity is higher if a firm's organizational size and number of IP sites are larger. Thus IP complexity can be formally summarized as $IPC=f(\text{number of patents, country coverage, scope of IP tasks, IP organization, number of IP sites})$. In addition, it requires specific capabilities to manage IP rights (Mayer et al., 2012; Ayerbe et al., 2014). In this context, Somaya (2012) refers to "patent management capabilities", which require specific occupational human capital (Mayer et al., 2012). This type of human capital is essential for projects in highly contested areas such as IP, which involves knowledge of legal and technological aspects, and, increasingly, knowledge of strategic aspects (Mayer et al., 2012; Ernst, 2003). Therefore, we use IP capabilities (resource and know-how) as second dimension which defines IP outsourcing typologies, as shown in Figure 5.

The IP complexity and IP capabilities dimensions are differentiated into high and low values, and consequently, when combined, result in four classifications. Based on our exploratory research we identified four basic typologies of IP outsourcers: (1) Cost Outsourcer (2) Non Outsourcer (3) Strategic Outsourcer and (4) Expertise Outsourcer. The table below shows selected cases per typology by comparing industry, size (number of European Patents), and IP outsourcing strategy. Derived from our case analysis, we could identify distinct IP outsourcing strategies such as gaining scale without mass (Leavy, 2004), complementary outsourcing, knowledge based outsourcing, or in-house handling.

Table 5: Case studies

Case	Company	IP outsourcing strategy	#European patents (2013)	Industry
1	Air Liquide	Scale without mass	3.288	Chemicals
2	cuboro	In-house handling	6 (designs)	Toys
3	Siemens	Complementary outsourcing	40.413	Electronics
4	Schindler	Knowledge based outsourcing	1.287	Machinery

Figure 5: IP Outsourcing typologies

2.4.1 Cost Outsourcer

Low IP complexity and low IP capabilities characterize our first ideal type, the Cost Outsourcer. Cost Outsourcers follow a strategy to gain scale without mass (Leavy, 2004). They use outsourcing suppliers for peripheral and non-core activities. Those highly specialized IP services like the renewal of patents are managed by outsourcing suppliers in large volumes. Cost Outsourcers are highly cost sensitive and take advantage of IP outsourcing suppliers' factor costs (*FA*) and efficiencies (*EF*). The IP services sourced out are highly standardized ones, such as annual installment payments for patents. Due to low IP complexity, the risk of losing absorptive capacity (*AB*) and specific IP knowledge (*KN*) regarding the outsourced IP work is rather low. Outsourcing providers in this quadrant usually offer automated processes using sophisticated and specialized information systems (*IN*). This enables the outsourcing provider to gain economies of scale and scope. There is high price competition in this classification. IP outsourcing suppliers can only compete successfully if their own costs are low. Examples of Cost Outsourcers are Electrolux, Bayer and Air Liquide.

Air Liquide is the world leader in gases for industry, health and the environment. The firm produces and sells air gases (e.g. oxygen, nitrogen, argon, rare gases). *Air Liquide* is

headquartered in Paris, with major sites in Japan, Germany, and the USA. The company's core strategy is to focus on R&D and inventions within ten research and technology centers worldwide. Thus, patents play a very important role in the firm's strategy. The patenting strategy is to extensively monitor all potential patents at the early stage. However, Air Liquide is highly selective in the choice of patents to be registered and/or maintained subsequently. Patents are used to protect and defend the company's position as a world leader, but also to reinforce its position through innovation (Castle, 2009). Air Liquide filed 321 patents in 2013. Most of the legal IP activities are handled in-house. Internal legal experts are in charge of all IP matters, such as writing contracts, filings, oppositions, and the like. Air Liquide institutionalized a "Patents Committee". All decisions to apply for, and to maintain or abandon a patent, are made by the patents committee, which also makes decisions regarding the exploitation of patents, and whether to do so internally or externally. Furthermore, the patent portfolio is reviewed on a regular basis, and decisions are taken whether to exploit, stand-by or abandon the patent. Air Liquide is a typical Cost Outsourcer. Major IP activities are performed in-house by in-house counsels and experts, while external providers are used to perform tasks which have low impact, but are time consuming. Air Liquide targets with its outsourcing strategy to decrease transactions costs by outsourcing peripheral tasks to external IP providers.

2.4.2 Non-Outsourcer

The second type, characterized by a low IP complexity but high IP resources, is the Non-Outsourcer. The Non-Outsourcer handles all IP related tasks in-house. Typically these firms are smaller in size, act in local markets, and manage only few IPRs. Outsourcing options are either not known, or not chosen. Many start-up companies and single inventors, instead of externalizing IP related tasks, choose to invest time (*FA*) in order acquire needed know-how (*KN*) concerning, for example, how to file, how to oppose or how to renew patents. BGW and Cuboro are examples of Non-Outsourcers.

Cuboro is a producer of toys made of wood. The company is located in Switzerland, and has five employees, including the general manager, who is also responsible for IP management. Currently, cuboro sells four different products: (1) cuboro: a marble run for the entire family, (2) cugolino: a marble run for children, (3) babel: a three dimensional puzzle and (4) alhambra: a didactical puzzle. Cuboro's IP strategy is aimed at ensuring freedom to operate. In addition, cuboro is increasingly aware of the financial impact of a legally protected invention. Cuboro is a typical Non-Outsourcer. The company has a small number of IPRs, and related IP activities (e.g., filing, renewal and general management) are performed completely in-house. cuboro is well informed about its possibilities to protect its products

(Gassmann et al., 2009). Furthermore, cuboro is able to defend its products in case of infringement. So far cuboro had never chosen to abandon an IPR for its products, mainly because it has never withdrawn a game from the market. It is faced with growth rather than decline of demand. Patent and trademark attorneys play a minor role for cuboro.

2.4.3 Strategic Outsourcer

The Strategic Outsourcer is characterized by high IP complexity and high IP capabilities. Typically, these firms manage a large number of IPRs and use one or more outsourcing suppliers while also running a large in-house IP department. They follow a strategy of complementary outsourcing. The strategic outsourcer has a well-defined IP outsourcing strategy and uses external providers and law firms to complement own capabilities and resources. IP outsourcing is an important element of its overall IP and sourcing strategy. These firms develop enhanced ways of service collaboration with their IP suppliers, and continuously improve ways to develop knowledge sharing routines (*KN*) to cooperate with their external partners. Companies in this quadrant face high monitoring costs (*MO*) because they are highly demanding regarding handling procedures, quality management, monitoring, and pricing. Outsourcing suppliers in this quadrant are large players in the market, and use advanced technologies to efficiently manage the large volume of IPR in their databases. Nevertheless, these firms face costs for installing an infrastructure (*IN*) and knowledge sharing routes (*KN*) in order to exchange very specific IP work. Those IP suppliers offering highest quality and performance will attract Strategic Outsourcers. Client firms benefit from close cooperation with these outsourcing suppliers by obtaining all necessary IP related services without intense allocation of their own resources (*FA*). Trust and knowledge transfer are key elements within this relationship, which is reflected in high relationship costs (*RE*) and cultural costs (*CU*). Strategic outsourcers often can be found among large corporations. Examples include Total Petrochemicals, Borealis, ABB, and Siemens.

Siemens is one of the leading global corporations worldwide. It operates in four main sectors: (1) Energy, (2) Healthcare, (3) Industry, (4) and Infrastructure and Cities. The corporation is headquartered in Munich, Germany with locations worldwide. Around 27,800 researchers and developers within the company develop products and solutions. In 2008 the company launched an open innovation (OI) project worldwide, with more than 35,000 employees participating in nine internal OI pilot projects, and the company's external efforts have mobilized more than 1,750 external developers on 17 projects.

Siemens was second biggest patent applicant at the European Patent Office in 2013 (European Patent Office, 2014) with 1.974 filings. Thus, Siemens has a very large portfolio of patents

for IP protection against competitors and to serve as a valuable form of currency for licensing exchange contracts, company takeovers, and sell-offs. Siemens reformulates its patent portfolio every five to six years. IP projects are initiated within the Siemens Group in order to raise the quality of patents and improve their usage. Patents are evaluated and categorized, with key patents referred to as called “golden nuggets”. Siemens is a typical Strategic Outsourcer. The company uses several IP providers. All IPRs are managed within IP docketing and management software. Interfaces enable simultaneous synchronization of all IP matters, whether updated in-house or externally. Close communication with IP service providers, as well as monitoring and controlling, ensures that this large IP portfolio is exploited internally and externally to an optimal extent.

2.4.4 Expertise Outsourcer

High IP complexity and low IP capabilities characterize the Expertise Outsourcer. Such firms follow a knowledge based outsourcing strategy. They decide to use external providers mainly for tasks that need special know-how and expertise. Firms in this quadrant often do not have or desire in-house legal capabilities, especially if the patent will be protected on a global scale. To deal with the application and opposition phases, infringements, or counterfeiting activities, a local lawyer is often required. Major cost drivers are service costs due to high asset specificity (Williamson, 1985) and specific IP knowledge (*KN*). Typical providers are IP law firms that charge premium prices for very specialized IP legal services. Firms using these premium priced services conduct most tasks in-house, but use external providers for very special IP activities, such as legal work. For these firms, the benefits of receiving specific legal services in a highly contested area outweigh the risks of losing absorptive capacity (*AB*) and IP knowledge (*KN*). Examples for expertise outsourcers are Pieris, Medtronic, and Schindler.

Schindler is a worldwide leading producer of elevators and escalators, headquartered in Switzerland. Schindler employs over 48,000 employees, 430 of whom are in research and development, which accounts for approximately 20% of the total organizational budget. In 2013, the US business magazine “Forbes” included Schindler on its list of the world’s 100 most innovative companies for the third year in succession.

Schindler’s IP activities are managed within a centralized entity called Inventio AG. This entity holds all IP rights, defines IP strategies, make-or-buy decisions and identifies means of exploitation of IP rights. Inventio cooperates closely with operations and R&D. The main goals of Schindlers’ IP strategy are to protect innovation against competitors and ensure freedom-to-operate. Inventio has developed an in-house invention and patent database which

efficiently scouts, monitors, and evaluates innovations and patents. Despite having established its own IP unit, Schindler uses external outsourcing providers and law firms for IP work when it does not itself possess the relevant capabilities. External IP providers are consulted if special know-how and experience is required, such as for legal matters. Schindler/Inventio is a typical Expertise Outsourcer, which uses external expertise as required, and if internal resources are not available or capable.

2.5 Discussion and managerial implications

Our study extends current research in several important ways. First, we use case studies to understand firms' decisions concerning outsourcing, and theoretical and managerial implications of these decisions. In line with McIvor (2009) and Ayerbe et al. (2014) a transaction cost and capability based approach provides a complementary analytical framework in the specific case of IPR management. We extend current research by focusing on the firm level and respond to the call for more qualitative studies in the field of IPR management (Candelin-Palmqvist et al., 2012; Somaya, 2012; Ayerbe et al., 2014). Particularly, based on four in-depth case studies we provide insights into what kinds of legal and non-legal IP work are outsourced, and how the firm's outsourcing decisions are influenced by cost and capability aspects. Second, comparing our results to previous work in innovation management, we find that firms' outsourcing strategies are more diverse than is commonly addressed within the general framework for outsourcing. Specifically firms' outsourcing strategies differ based not only on the volume of outsourced IP work (outsourcing rate), but also on the number of outsourced IP services (i.e., outsourcing breadth). The latter point suggests that firms must face the challenges associated with identifying the most competent suppliers, and managing a set of suppliers (Moeen et al., 2013). Third, we find that cost considerations and access to capabilities as motivations to outsource IP work differs across the outsourcer types. For instance, Cost Outsourcers are mainly driven by cost considerations, while capability reasons are seen as less salient. Costs can be reduced further by increasing experience between contract partners, and through learning-by-doing. Interestingly, this contradicts the sourcing practice of many corporations, which switch outsourcing vendors on a regular basis with the aim of obtaining cost savings. Our research implies that a sustainable relationship between outsourcer and supplier leads to profitability on the long run. In contrast, we find that capabilities play an important role for Strategic and Expertise Outsourcers. A widely known infringement case is Apple versus Samsung Electronics. Both companies have been engaged in numerous patent infringement suits since 2011 regarding the design and technology of smartphones and tablet computers. Both

companies claim millions of dollars in damages and spend enormous amounts on IP experts and IP lawyers. The outcomes of these patent suits are still open. This example shows clearly that these firms' outsourcing strategies focus on capabilities rather than costs aspects. A further focus of the Strategic Outsourcer is to complement internal resources with external capabilities. Overall, firms should carefully consider costs, IP complexity and IP capabilities when defining their IP outsourcing strategy. Our research underscores prior findings that outsourcing can decrease organizational learning (Mayer et al., 2012; Reitzig & Wagner, 2010) and firms should be aware that outsourcing of IP, particularly legal work, is highly contested and cost saving aspects have to be traded off with hidden costs such as knowledge loss and loss of absorptive capacity. We suggest that IP managers should use a holistic approach, and weigh these trade-offs in order to establish a successful IP outsourcing strategy. It is important, especially in uncertain times, to assess the firm's core competencies on a regular basis. Keeping core competencies in-house will avoid dependencies on outsourcing suppliers. Benefits, of outsourcing such as leveraging external experience should outweigh risks, such as loss of internal IP know-how, or even IP rights.

Based on our findings and the experiences of interviewed IP managers, we want to emphasize five important suggestions for managers with regard to their outsourcing decision:

1. Identify the optimal outsourcing strategy
2. Access best in class capabilities by selecting and managing a set of IP suppliers
3. Focus on total outsourcing cost
4. Leverage IT and standardization to create potentials
5. Ensure service quality through tight quality control and monitoring

Identify IP outsourcing strategy

It is useful to assess the IP organization's strengths and weaknesses prior to initiating IP outsourcing. Use of an IP organization that is high in structural complexity requires the use of intense and effective communication mechanisms, (e.g. a large IP organization with many IP sites), and thus fits best with Strategic Outsourcing or Expertise Outsourcing strategies. The *IP task complexity* impacts the outsourcing breadth and outsourcing rate. Administrative tasks, such as filing of applications and oppositions, doing searches, monitoring third party filing activities, recording changes or assignments, paying annual installment fees, or docketing of IP files are typical tasks suitable for Cost Outsourcing or Strategic Outsourcing,

while sophisticated legal tasks, such as prosecution, litigation, and counterfeiting are non-standard activities and thus best match Expertise Outsourcing. Assessing the firm's own capabilities, strengths and weaknesses will help to choose the optimal IP outsourcing strategy.

Access the most capable IP suppliers

Management of IPR requires specific capabilities depending on the outsourced work. Firms should identify which kind of IP work to keep in-house and which to outsource based on their outsourcing strategy. As Moeen et al. (2013) state, firms will match outsourced projects in a given domain to suppliers based on whether the supplier possesses the required capabilities. Thus, vendor selection and contracting are essential in order to identify the correct partner and define responsibilities and deliverables. The outsourcing supplier should be capable of rendering services worldwide, offering qualified personnel, using IP software which docket and handles IP, and providing an infrastructure which is capable to integrate workflows in a flexible way. A Service Level Agreement (SLA) including a detailed description of the scope of services, task description, roles and responsibilities, and escalation paths should be addressed within a legally binding contract. A detailed SLA enables a smooth transition and agency problems, as moral hazard can be limited. The outsourcing supplier should be able to offer diverse pricing concepts (e.g. fixed fees by unit or period) and settlement periods. Standard prices and flat fees allow easy monitoring and controlling, and thus save time. Finally, risk management considerations should be covered by the contract. Even the worst case scenario of "losing the crown jewels" with resulting liability and consequential obligations should be captured within the contract.

Focus on total outsourcing cost

Outsourcing should lead to value enhancement, which is difficult to measure, and is not sufficiently reflected by indirect costs savings. Cost saving considerations must be traded off against hidden costs, such as loss of knowledge and/or loss of absorptive capacity. In order to evaluate cost saving potentials firms need to focus on total costs, including costs for implementation and transition (e.g. data transfer, servers, IP docketing software, training costs). Firms should count on unforeseen extra costs, such as cleansing and scanning of IP files or loss of key personnel (Earl, 1996). Firms should keep in mind that the outsourcing suppliers' costs are only one piece of the total cost. The IP business requires the engagement of local counsels for numerous legal activities that depend on the local legislation. A breakdown of the total costs should always include subcontractor or third party costs. IP providers can offer better rates for subcontractor fees due to high transaction volumes and vendor consolidation. Often this price differs by a factor of two or more compared to the firm's

standard prices. Therefore, either the outsourcing supplier or the client firm should negotiate prices with local councils. It is not unusual that local councils are using subcontractors for legal work; therefore an overview of the value chain participants including their cost impacts should be assessed. Finally, additional and unforeseen costs or hidden costs should be included with an estimate of the overall total cost of ownership calculation (Ellram & Siferd, 1998).

Enable high degree of IT and standardization

An IP portfolio is often a large set of data which needs to be stored and maintained. Automated data interfaces, instruction procedures, e-billing interfaces, or web-based portals will reduce the manual effort required, and result in efficiencies on both sides. Equally important are questions of hosting the data, and confidentiality. Often outsourcing suppliers are serving direct competitors; thus internal procedures and IP related data needs to be handled with strict confidentiality, and, if needed, with data storage in separated servers.

Ensure quality control and monitoring

Although costs are a major driver for IP outsourcing, quality of the services plays a critical role. Handling of IP requires accuracy. Even administrative and formal errors can lead to the lapse of IP rights. Therefore, costs should have an equal weight to service quality, continuous process improvements, or change management (Holcomb & Hitt, 2007). The IP outsourcing supplier should work as an intermediary between Patent Offices and local attorneys on the one hand and the client on the other to ensure that all relevant information is provided in a format that meets firm's requirements. Proper reporting and key performance indicators should be easy to trace and should serve as an early warning system. Bayer, for example, ensures service quality through regular IP vendor audits and continuous reviews of improvement measures. As Somaya (2012) highlights, managers play an important role in controlling and coordinating activities when the firm outsources patent work and relies on external IP suppliers.

2.6 Conclusions

Our main objective in this paper is to contribute to the understanding of IP outsourcing. We have presented cost- and capability-related factors that influence firms' IP outsourcing strategies, and described how firms outsource legal and non-legal IP work. Our findings suggest that four IP outsourcing types can be identified based on the dimensions of IP

complexity and IP capabilities: Non-Outsourcer, Cost Outsourcer, Expertise Outsourcer, and Strategic Outsourcer. Each type impacts the management of IPR within the IP department. We have discussed in-depth the most significant drivers of the outsourcing decision based on an IP outsourcing cost model. This model includes conflicting cost factors, and thus takes a total cost perspective. The managerial implications include breaking down best practices to reduce the complexity of IP outsourcing and enable successful IP outsourcing projects.

Further research is needed on developing a framework to identify optimal IP outsourcing decisions and determine how to optimally design the outsourcing organization. This optimal outsourcing strategy should minimize total costs and maximize benefits of IP outsourcing. Research is needed regarding the exact effects of different cost variables and their impacts on the benefits and profitability of IP outsourcing. The IP outsourcing types and IP outsourcing cost model are limited, and can be further extended by employing a learning perspective. This learning perspective should provide the optimal IP outsourcing model by adding knowledge parameters which limit the loss of fundamental internal IP knowledge and allow for the acquisition of service knowledge from the outsourcing provider. The cost model also does not include weightings of cost factors, and lacks any consideration of tacit or not measurable costs. According to Mol and Kotabe (2011), one major risk is that the organization may suffer from outsourcing inertia, which refers to the organization's inability to change when its environmental circumstances change through slow adaptation processes. To deepen this perspective, more research is also needed regarding the risks of IP outsourcing, including loss of control, reduced rates of innovation, low performance, or other hidden costs, including loss of key employees and relevant knowledge.

3 The supply side of IP management: understanding firms' choices regarding IP intermediaries

Single-authored

Studies focusing on the supply side of intellectual property (IP) management, particularly the outsourcing of patent related work, are relatively rare. This paper aims to contribute to the IP literature in two ways. First, I propose a potential definition of the IP service provider, which offers IP related services similar to the classic IP law firms. Second, I analyze three main factors that determine a firm's preference for outsourced IP work, specifically, outsourced patent renewal work. Using data on the outsourcing of patent renewal payments, I found evidence that the choice of IP supplier is affected by: (1) the firm's own IP management capabilities, (2) the firm's IP knowledge base, and (3) the IP complexity. Moreover, the study shows that IP service providers are more likely to be selected if the firm's own IP management capabilities are well established, while IP law firms are more likely to be selected if the firm's complexity is high. By providing insights into the outsourcing of patent related work and the supply side of IP management, this study represents a useful complement to more typical IP research, which commonly focuses on applicants and/or examiners.

3.1 Introduction

In recent years, firms have been turning marginal innovations into patents more frequently than previously, and all major patent offices worldwide are facing a “patent explosion” (Harhoff et al., 2007). This accumulation of intellectual property, and the growth of firms’ overall IP portfolios, poses several challenges for the management of IP. Somaya (2012), in his review article, summarized the existing literature on strategic patenting, and identified opportunities to address important unanswered research questions in this field of inquiry. He pointed out that the interplay between firms’ internal resources and the capabilities of externally available suppliers, and firms’ processes related to the hiring and development of expert patent managers and attorneys within the firm, are ripe areas for further research. In particular, questions related to how firms combine internal and external IP capabilities, and the performance implications of these patent-related choices, have not yet been sufficiently studied. Similarly, little theory exists on the analysis of how firms can organize themselves in order to effectively manage their intellectual property rights (IPR) in collaboration with external suppliers (Ayerbe et al., 2014).

Literature on patent management has only recently focused on outsourcing. For example, Reitzig and Wagner (2010) highlighted the hidden costs of outsourcing. Meyer et al. (2012) studied the development of various types of human capital and their impacts on outsourcing. Moeen et al. (2013) investigated the factors that influence the concentration of a firm’s supply portfolio, and Ayerbe et al. (2014) conducted a case study of Thales, a French group in the defense industry, to explore how IP is organized via outsourcing. All these studies centered on the outsourcing of patent filings, patent prosecution, or the organization of IPR with external patent law firms. Within the context of the existing IPR literature, the present research contributes in two ways: First, I extend the current focus on law firms and introduce another highly specialized IP intermediary, namely the IP service provider. The work done by Ayerbe et al. (2014) established that the development of intermediaries such as law firms specialized in managing IPR plays an important role in organizing IP; however questions of which other types of intermediaries exist, and what roles they play, have remained unanswered to date.

A second contribution relates to the need for greater understanding of firms’ strategies for the sourcing of external IP specialists, in order to gain insight into how firms organize and manage their IP. Besides the work of Moeen et al (2012), outsourcing of IP work has never been studied with a focus on how firms manage a set of IP suppliers. The aforementioned authors studied the factors that influence the concentration of a firm’s supply portfolio of outsourced prosecution work. One finding was that the outsourcing of patent filing activities is closely

linked to significant firm-specific knowledge, and to the concentration of the outsourcing of patent legal services into the hands of a few suppliers.

Firms' boundary decisions go far beyond pure make or buy decisions, questions concerning firms' choices among different IP suppliers, and regarding the interplay between a firm's internal resources and the externally available capabilities of IP suppliers, also remain unanswered. Hence, in this article I contribute in addressing this gap in the literature by studying supplier-related choices in the field of IPR management. The present paper fits well into the recent IP literature, but augments it by introducing the IP service provider as an additional IP intermediary relevant to firms' IP outsourcing strategies. I suggest that understanding the determinants of firms' choices concerning type of IP supplier is important for both management research and practice. Therefore, in this work I aim to gain a deeper comprehension of why firms choose to engage either IP law firms or IP service providers in their outsourcing of patent-related work. I assess various potential determinants of choices related to the outsourcing of patent renewal services to external IP suppliers, and analyze their impacts.

In order to study the determinants of firms' selections regarding IP outsourcing suppliers, a unique data set of European patents from the EPO database PATSTAT was matched with data from TOPSIE, the database of an IP service provider. The service provider's patent database offers unique insights into the analysis of outsourcing of IP intermediaries. Relationships between the hypothesized determinants and IP outsourcing choices were tested in the context of outsourced patent renewal work. Each year patent holders must decide whether or not to renew their patents. The unique advantage of using patent renewal data from European patents is that, with European patents, a firm's outsourcing choice is not constrained by legal requirements, such as the obligation of non-EU resident firms to use a registered patent attorney (see Article 133, European Patent Convention).

The paper is organized as follows. In Section 2, I summarize prior work in the area, and present the theoretical framework. I introduce the IP service provider as a highly specific IP intermediary, and develop and present hypotheses concerning firms' choices regarding supplier selection when outsourcing patent renewal work. In Section 3 the research methodology and data set are described. I present empirical results in Section 4, and conclude the paper with a discussion of managerial implications and possibilities for future research.

3.2 Theoretical framework and Hypotheses

The following section is in three parts. First, theory relevant to IP outsourcing is summarized. Second, the IP service provider is introduced as one IP intermediary specialized in managing IPR, and a framework explaining how client firms and IP intermediaries are related in the context of annual patent renewals is presented. Lastly, hypotheses are developed to test potential determinants of firms' sourcing decisions concerning patent renewal services. These hypotheses form the basis of my empirical tests.

3.2.1 Theoretical background

Various theories have shaped the understanding of the vertical integration of the firm. These include Transaction Cost Economics (TCE) (Coase, 1937; Williamson, 1987) and the Resource Based View (RBV) (Barney, 1991). These theories frame firms' make or buy decisions: the buy decision is preferred if the firm's advantages from using external markets and benefits from suppliers' economies of scale and specialization outweigh the risks, such as the potential for loss of knowledge (Somaya, 2012). According to TCE, three critical factors determine the level of transaction costs: transaction frequency, uncertainty, and asset specificity (Williamson, 1987). Asset specificity plays a particularly important role in managing IP because IP involves knowledge of both legal and technological areas. For instance, strategically developing a patent portfolio requires a high level of technological expertise, but also legal expertise (Ernst, 2001; Lerner, 1994). For instance Reitzig and Wagner (2009) state that a firms' sheer performance in turning patent applications into patent grants increases linearly with the rate of outsourcing of patent applications to external law firms. Major specialization advantages of the external lawyers are likely to account for this finding. A study by Moeen et al. (2013) adds further insights into the highly specific nature of IP and the challenges of managing the outsourcing of IP. They examined factors that influence the concentration of a firm's supply portfolio for IP legal services. One finding was that the outsourcing of patent filing activities is closely linked to significant firm-specific knowledge, and to the concentration of outsourcing of patent legal services into the hands of a few suppliers. One criticism of the dominant TCE viewpoint is that it focuses on one transaction at a time, and therefore lacks a systemic approach (Argyres & Liebeskind, 1999).

An alternative theory for understanding the outsourcing decision is the RBV, which views the firm as a bundle of assets and resources that, if employed in distinctive ways, can create competitive advantage (Griffith & Harvey, 2001; Barney, 1991). The RBV is important to the study of outsourcing, as superior performance achieved in organizational activities relative to competitors would explain why such activities are internalized within the organization. Also,

the core competence concept developed by Prahalad and Hamel (1990), with its distinction between core and non-core business added to the understanding of outsourcing and is firmly established in the lexicon of many practitioners (McIvor, 2009). TCE focuses primarily on the role of efficient governance through transaction analysis, while the RBV focuses on the search for competitive advantage through resource analysis. McIvor (2009) argues that neither TCE nor the RBV alone can fully explain the complexities of outsourcing. He suggests a complementary approach based on capabilities to address the new ways of managing IPR via outsourcing. As organizations increasingly outsource more critical IP activities, such as prosecution, enforcement, trading, and licensing, they are seeking to leverage a greater level of value from outsourcing. Although cost concerns are an important motivation for outsourcing in many contexts, the implications of outsourcing for the long-term capabilities of the company must also be considered. In line with Ayerbe et al. (2014), I base my study on the combined approach developed in the analytical framework of McIvor (2009) in order to understand aspects of IP outsourcing, particularly the firm's choice of suppliers when outsourcing IP work. The combined approach incorporates influences of both the organizational arrangements and modes of governance associated with TCE, and the capability analysis based on firm know-how and resources associated with the RBV.

3.2.2 An introduction to the IP service provider as IP intermediary

Throughout this paper, my conception of an IP service provider as an IP intermediary will be an organization (firm) that directly offers or facilitates patent services, and that functions as service mediator between patent owners, patent offices, and other IP intermediaries such as patent law firms and attorneys. As Ayerbe et al. (2014) noted, organizing IPR calls for specific capabilities, which enable the development of intermediaries, such as service organizations specialized in managing IPR. Given these specialist skills, organizational units that specialize in IP protection activities are typically distinct from those units that specialize in IP generation (e.g., Granstrand, 2000). Indeed, the capabilities underlying IP generation and IP protection through patents are viewed as being distinct enough to entail the frequent outsourcing of the latter via IP intermediaries. Patent jurisdiction remains a "black-box" for most patent applicants and inventors. The low transparency of diverse patent institutions, the abundance and variety of regional and international treaties, and the highly specific nature of national patent laws are all factors that create the need for specialists such as IP service providers or IP attorneys (Harhoff, et al. 2007). The IP service provider possesses a set of complementary capabilities, such as legal IP know-how and specialized resources, which allow it to facilitate correspondence between innovation stakeholders and patent offices, and to leverage economies of scale (Anderson & Weitz, 1986; Roodhooft & Warlop, 1999). IP service

providers manage IP rights for their clients at all different stages, through processes such as patent renewals, IP ownership changes, patent searches, prosecution services, and docketing of IP data. Some IP service providers offer IP management software for patent search, administration and evaluation (Gassmann et al., 2012). However, there is a critical distinction in capabilities between patent attorneys and IP service providers. Patent attorneys may often be former scientists with expertise in patent law, patent application, and patent enforcement procedures (Reitzig & Puranam, 2009). In addition, practicing before a patent office may require legal representation by a registered patent attorney. For instance, only registered patent attorneys may practice before the United States Patent and Trademark Office (USPTO), and maintaining a current address with the Office of Enrollment and Discipline (OED) is a requirement for registration (Moeen et al., 2013). The situation is similar in many other countries, such as China and Japan (Sun, 2003). This differentiation between IP service providers and patent attorneys is important for understanding the management of IP outsourcing processes, and the role of IP intermediaries in creating value in the outsourcing process. However, there is some overlap in the service offerings of IP intermediaries, especially those of IP service providers and patent law firms: for instance, patent filings, and patent annuity payments may be offered by both of these types of IP intermediaries. This raises questions concerning firms' decisions about the outsourcing of IP work, particularly with regard to the factors that determine which type of IP intermediary – IP law firm or IP service provider – is chosen.

In line with major IP outsourcing studies (Ayerbe et al., 2014; Moeen et al., 2013; Reitzig & Wagner, 2010) the study is situated in a context of specialized tasks linked to IP activities. I focus on firms' outsourcing of patent renewal work to either patent law firms or IP service providers. Expert interviews suggest that there are three major ways to perform patent renewal installments before patent offices: firms can perform patent renewal installments in-house (only if legal requirements, such as legal representation before the patent offices, are met); they can outsource patent renewal installments to law firms/patent attorneys; or they can outsource patent renewal installments to IP service providers. As the interest is in IP outsourcing, I limit my analysis to the last two sourcing scenarios. Data from the IP outsourcing providers' database, for which descriptive statistics will be provided in Section 4, confirms this. In this context, Figure 6 shows firms' outsourcing of patent renewal work directly to IP service providers, while Figure 7 depicts firms' outsourcing of patent renewal work to IP law firms or patent attorneys, which then themselves outsource the work to IP service providers. The latter situation can be viewed as indirect outsourcing to an IP service provider.

These figures illustrate several challenges associated with the outsourcing of IP-related work. First, an outsourcing firm must decide which IP intermediaries to select, based on transaction costs (Williamson, 1985) and the range and depth of their capabilities (McIvor, 2009), and must determine how to distribute work among these suppliers (Moeen et al., 2013). Second, the firm must consider the organization and management of all the various IP suppliers involved, including subcontractors. As mentioned above, the specific capabilities of IP suppliers and costs play a large role in explaining firms' IP outsourcing decisions.

Further, the development of intermediaries such as service organizations specialized in managing IPR play an increasingly active role in the new knowledge market (Ayerbe et al., 2014). Existing studies in IP outsourcing (e.g. Mayer et al., 2012; Ayerbe et al., 2014) are all based on IP outsourcing choices relating to only one type of IP intermediary which are law firms.

Considering that firms manage their IPR with a set of suppliers (Moeen et al, 2013) the question emerges as to why and how firms outsource IP activities among several IP suppliers. Addressing this question is the object of the present research.

Figure 6: Direct outsourcing of patent renewal work to IP service provider

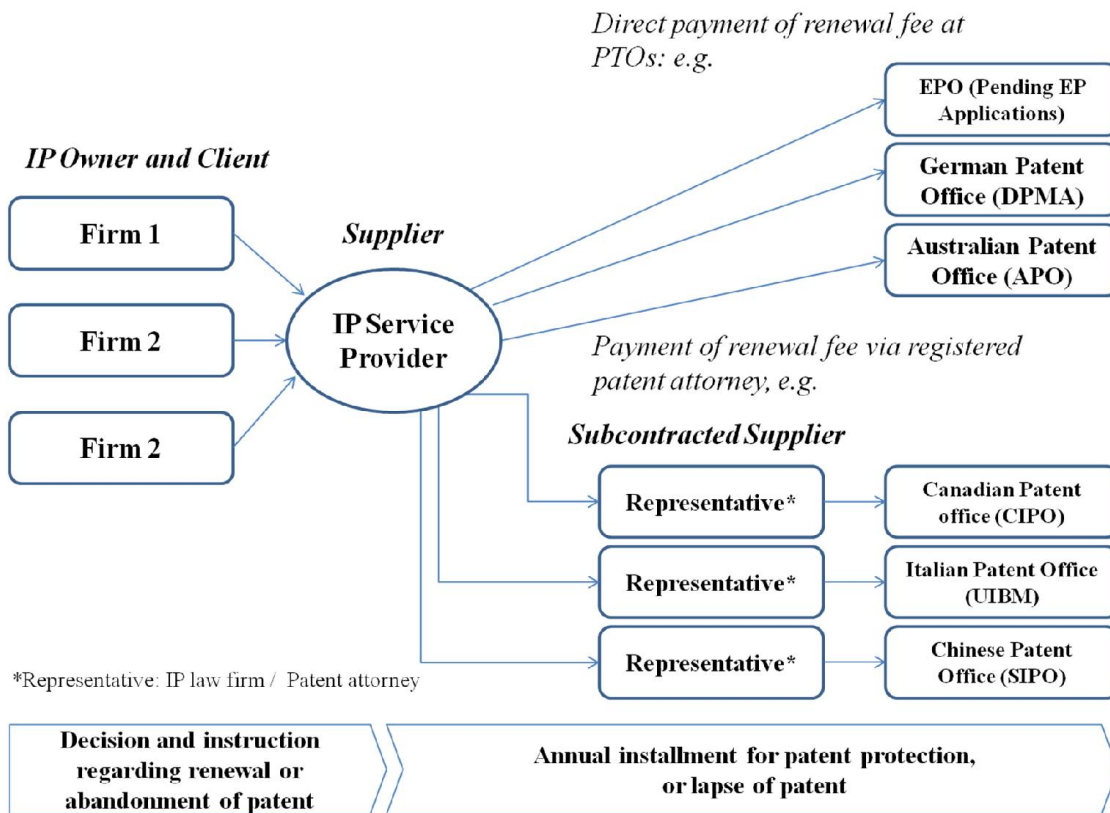
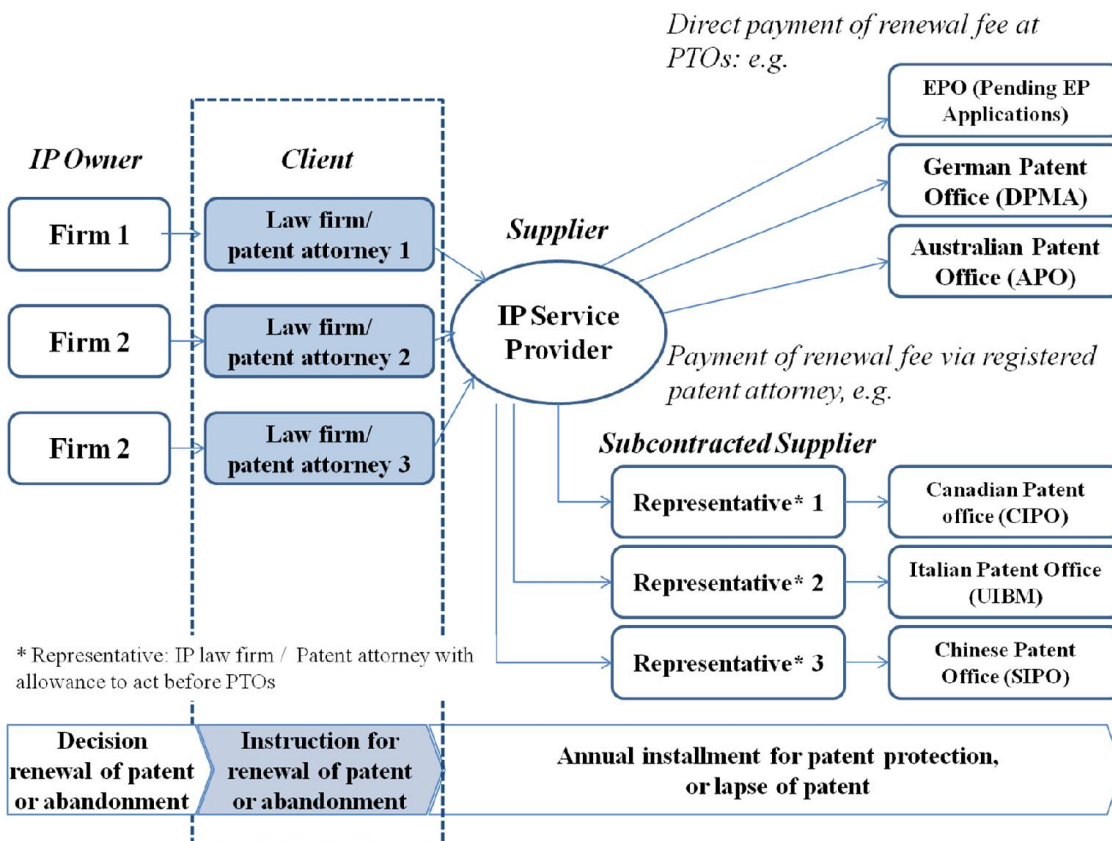


Figure 7: Indirect outsourcing of patent renewal work to IP service provider



3.3 Hypothesis development

As mentioned, a firm's access to capabilities and economies of scale and costs are main motivations for the outsourcing of knowledge-related work. IP work may need to be coordinated across suppliers in accordance with the firm's patent management requirements and the need to access the most competent supplier (Somaya, 2012). More specifically, firms have to decide which IP work to outsource, and how many (and which) IP suppliers are needed in order to access the required specialized occupational capabilities (Mayer et al., 2012) and benefit from supplier service cost efficiencies. Below, I identify factors that might determine the firm's choice between two different types of IP suppliers – IP law firms and IP service providers – in the context of outsourced annual patent installments (i.e., patent renewal work).

3.3.1 IP Management Capabilities

Recent research has highlighted the need to understand how patent-related choices are made, especially those related to developing firm capabilities through the bundling and coordination of disparate resources, building capabilities for patent management, and combining internal and external capabilities (Somaya, 2012; Conner, 1991; Lippman & Rumelt, 2003). Particularly, for patent management firms rely on external suppliers (e.g. law firms) to carry out patent work (e.g. prosecution, litigation, patent legal work). As noted by Somaya et al. (2007), a firm's capabilities regarding the management of external IP suppliers has an effect on its patenting performance. These authors showed that the use of patent attorneys has the same proportional impact on a firm's patenting output as its R&D spending does. Thus, R&D is not the only resource used in the patenting process; important additional resources include patent law expertise and patent management experience, which essentially reside in the knowledge and capabilities of patent attorneys or specialized service providers. However patent-related choices go far beyond make-or-buy decisions, and firms may combine several IP suppliers for the outsourcing of their IP work. Answering questions regarding how many and which IP suppliers to use is essential for advising firms on how to attain effective IP management, yet these questions have remained generally unanswered in the IP literature. Moeen et al. (2013) have shed some light on the question of which factors influence the concentration of a firm's supply portfolio. They identify five factors that explain the outsourcing of patent filing activities into the hands of fewer suppliers. They state that the assignment of outsourced work to different IP suppliers takes into account the supplier's capabilities in that domain, and conclude that firms utilize fewer suppliers if the outsourced projects are focused on a narrower (capability) domain. Thus, firms manage tradeoffs to select

the most beneficial distribution of IP work (domains) among different IP suppliers. The capability approach to organizational boundary choices suggests that the relative capabilities of buyers and suppliers are key factors in firms' decisions regarding vertical integration (Argyres, 1996; Leiblein & Miller, 2003). The better a firm's patent management capabilities (i.e. to manage tradeoffs), the greater its ability to access and leverage external capabilities by configuring IP work among different suppliers. It can be expected that firms select specialized IP service providers based on their specific capabilities in the domain of annual patent installments. Therefore, I hypothesize:

Hypothesis 1: Firms with greater patent management capabilities are more likely to outsource patent renewal work to specialized IP service providers

3.3.2 IP Knowledge base

In principle, the performance of annual patent installments can be provided by either IP law firms or IP service providers. As mentioned, the latter may offer patent renewal services at a more cost effective rate due to economies of scale and efficiency effects. Additionally, IP service providers benefit from lower labor costs because they offer a wide range of services around administrative IP work, which does not necessarily require attorneys. If attorneys are required as representatives for legal work, IP service providers benefit from high negotiation power with their subcontractors (law firms) due to large volumes. On the flip side, outsourcing can result in loss of knowledge, as studied by Reitzig and Wagner (2009). These authors highlight the effects of the outsourcing of patent filings on the technological and legal knowledge base of the firm, and on its ability to detect IP competitors at later stages of the value chain. They conclude that firms appear to face a trade-off, wherein they must balance the benefits of outsourcing patent filing activities to external markets against the costs of losing litigation-related knowledge. On the other hand, it can be expected that firms with a profound IP knowledge base are more capable of identifying those IP activities that bear a risk of IP knowledge loss. First, such firms are aware of specific benefits and risks associated with the outsourced work. For example, missing the payment of a maintenance fee results in the lapse of the patent, which cannot be reactivated. However, a firm with a deep IP knowledge base is in a better position than others to mitigate this risk; for example, by "asking the right questions" in order to determine which alert systems are in place to make sure patents are renewed, and whether or not subcontractors are qualified and audited. Second, firms with a profound IP knowledge base are more capable of differentiating between legal and administrative IP transactions. In IP, activities underlying the IP value chain are sufficiently distinct, which suggest significant gains from functional specialization (Reitzig & Puranam, 2009). Thus, firms can combine different IP suppliers, which possess different functional

specializations: for instance, the firm might outsource legal IP work to law firms, but use IP service providers for their annual patent payments. Thus, I hypothesize:

Hypothesis 2: Firms with a greater IP knowledge base are more likely to outsource patent renewal work to specialized IP service providers

3.3.3 IP complexity

There is a continuous trend, towards growing IP portfolios. As a consequence the management of IP is becoming increasingly complex. Also, IP involves multiple disciplines, such as technologists focusing on IP generation, and attorneys focusing on IP protection which creates a challenge to communicate and coordinate between those disciplines efficiently (Bader et al., 2012). In addition, firms' own organizational setup might add complexity. The case study of Thales Group for example, shows that IPR management can be highly complex if numerous foreign business units are involved which are not governed by a central unit (Ayerbe et al., 2014). Thus, growing patent portfolios, high multidisciplinary, and organizational complexity, require means to manage IP efficiently. One mean could be to select IP intermediaries which act as *mediators* between divers IP stakeholders. As mentioned, IP work requires a specific set of skills, representing a combination of legal and technological skills which is provided by specialized patent attorneys. Thus, a major role of the patent attorney is to act as a mediator between the patent holder and the patent office. Law firms offer legal and non-legal services, and thus operate in a broader IP service domain. In addition, prior experience plays an important role. As pointed out by scholars, the outsourcing of prior related projects (such as patent applications) may improve the performance of the focal project because the parties learn how to effectively work and contract with each other (Mayer et al., 2012; Argyres & Mayer, 2007). Prior related work such as patent filings, prosecution, or validation enables law firms to gain capabilities in a broader domain, and to learn how to coordinate and communicate effectively between the client firm and third parties such as patent offices. Therefore, I expect law firms capable of handling complex IP work due to the breadth of services they offer and their experiences with prior related projects. Thus, I hypothesize:

Hypothesis 3: Firms with greater IP complexity are more likely to outsource patent renewal work to IP law firms

3.4 Data and Methodology

3.4.1 Sample and data collection

To measure variables that might influence the firm's choice between using a law firm and using an IP service provider for patent annuity payments, I assembled a unique dataset from two sources: PATSTAT (EPO, 2010²) and TOPSIE, the internal patent database of an IP service provider. This service provider offers IP-related services along the life cycle of a patent (e.g. filing, renewal, and other legal and administrative services). The TOPSIE database contains patent data of 5,319 firms. The PATSTAT database contains data concerning patents, such as filing, granting, and renewal, while the TOPSIE database adds further information on applicants, client firm's instructions, and data on third parties such as IP service providers and IP law firms. The dataset included data related to European patents that were granted by the EPO between 1980 and 2010, which represents a total of 922,553 patents. It comprised three main sets of variables: some from PATSTAT, some from TOPSIE, and others constructed from PATSTAT and/or TOPSIE data. First, the TOPSIE database was extracted and matched with patent data from PATSTAT in order to achieve maximum data information. More precisely, patent data such as number of claims, family size, and whether the patent was filed under Patent Cooperation Treaty (PCT) were obtained from PATSTAT, and data on patent holders, renewal instructions, and suppliers were obtained from TOPSIE. For example, the TOPSIE database contains information concerning whether a renewal instruction is received by the patent holder itself, or by a law firm representing the patent holder. The database was subsequently validated to ensure the reliability and accuracy of all data. The final database contained 144,308 patent families, totaling 838,345 patents. To construct the sample a random selection of 100,000 patents from the total population was taken. July 29th, 2010 was defined as the cutoff date, and observations with missing values and those with a patent renewal due date later than the cutoff date were dropped. This reduced the sample to 67,111 observations. Finally, the database was corrected for truncation: this process is described in detail in the next section. This reduced the sample to 24,963 observations, which included data for 523 firms. In addition, I conducted interviews with 10 experts from IP service providers and IP law firms. These semi-structured interviews were performed in order to further enhance the understanding of how IP service providers and IP law firms can be differentiated based on their service offerings and value. To ensure balance, I interviewed five experts with an IP provider background, and five with a patent attorney background.

² October, 2010 version of PATSTAT is used

3.4.2 Measurement

Dependent variable

Every year a firm must decide whether or not to renew each of its patents. This choice must be made carefully, since the abandonment of a patent is not reversible (Hikkerova et al., 2014). The dependent variable in this study is the type of IP intermediary selected by the focal client company to perform the annual patent installment. I distinguish between a *direct outsourcing* of the annual patent installments to IP service providers and an *indirect outsourcing* to law firms, which forward the renewal instructions to the IP service provider. I assessed direct outsourcing using a dichotomous variable, which was coded “1” if the client firm instructed an IP service provider to pay the maintenance fee, and “0” if the client firm instructed a law firm to pay the maintenance fee. The latter represents indirect outsourcing, since the law firms in the sample provide renewal instructions to the same IP service providers as do the client firms that use direct outsourcing. From the IP service provider’s view, both the client firm and the law firm representing it are customers. In the sample, the share of firms using direct outsourcing of IP service providers to pay their maintenance fees was 62.6%.

Independent variables

To test the Hypothesis 1, the hypothesis that firms’ with greater patent management capabilities are more likely to outsource directly to specialized IP service providers, two variables were used. The first was a dummy variable that identified whether or not the maintenance fee was paid by “permanent order”. A permanent order instruction is used if the firm decides to have the patent renew automatically each year. Keeping the patent alive during its life cycle shows the patent’s value until its maturity (Hikkerova et al., 2014; Sereno, 2010). Firms will opt for the renewal of their patents only if the expected cash flows are significant enough to justify such investments (Hikkerova et al., 2014). This strategic decision, however, requires careful and sophisticated managerial planning and action (Pitkethly, 1998). It can be expected that firms that define a patent strategy, evaluate their patents, and abandon or renew their patents according to strategic and financial considerations gain IP management capabilities. Therefore, this variable is used as an indicator that firms possess IP management capabilities. The variable is coded “1” if the renewal instruction is a permanent order and “0” otherwise. For 11.2% of the observations, a permanent order had been chosen. However, not every firm acts from a strategic viewpoint: for instance, some firms automatically renew patents because they have no budget constraints, or they perceive the automatic renewal as more comfortable. To account for such cases, I eliminated from the sample any firm that renewed its entire patent portfolio automatically by permanent order. In this way, we were

able to focus on patent portfolios for which a discrete underlying decision by the firm can be assumed (because only specific patents were renewed). The second variable used to measure firms' patent management capabilities was firm IP experience. The literature attests to a positive relationship between experience and performance, which suggests that IP experience, is the dominant explanatory variable underlying patent management capability development (Teece et al., 1997). In line with previous research, I operationalize experience as the total number of patents handled by firm i in the database (Schneider, 2007; Alcácer et al., 2009). It can be expected that firms that handle more patents gain patent management capabilities because they more frequently face resource allocation decisions (Somaya, 2012) such as the choice between the renewal and the abandonment of patents. Thus, it can be anticipated that patent management capabilities should increase with increasing experience due to learning curve effects (Levitt & March, 1988; Pisano, 1990). It may also be the case that firms with relatively large patent portfolios may be more likely than others to use direct outsourcing to IP service providers in order to maximize efficiencies and access the most specialized suppliers in this domain (Cha et al., 2009; Jiang, 2006; Mayer et al., 2012) (for example, some service providers only provide patent maintenance services). Accordingly, I used a categorical variable to measure firm portfolio size, with 1 representing 1 - 500 patents, 2 representing 501 - 2,500 patents, 3 signifying 2,501 - 10,000 patents, 4 signifying 10,001 - 50,000 patents, and 5 indicating more than 50,000 patents. In the sample, the average on this variable was 2.9.

To test the Hypothesis 2, the hypothesis that firms with a greater IP knowledge base are more likely to outsource patent renewal work directly to IP service providers, I used three proxy variables: number of inventors, backward citations, and forward citations. As in previous studies, I use the number of inventors as a proxy for intellectual resources going into an invention (Guellec & van Pottelsberghe de Potterie, 2000; Reitzig, 2004). The second variable I used is the number of backward citations which is a measure of firm IP knowledge base and in-house expertise (Song, 2009) because the presence of citations illustrates the additional effort made by the applicant to check the art included in the invention (Hikkerova et al., 2014), which adds to applicants' knowledge base. In line with previous research, I used the relative citation frequency to assign a systematically higher weight to older patents. To receive an unbiased measure, the citation frequency of a patent needs to be measured in relation to the citation frequency of an average patent of the same year (Ernst, 2003). In the sample, this variable ranged in value from 0 to 12.5, with an average of 1. My final measure of firm IP knowledge base was forward citations. Forward citations received from subsequent patents are an indicator that the cited patent has contributed to the state of the art in a certain field, and are thus an indicator of the innovativeness of the patent (Jaffe & Trajtenberg, 1993; Harhoff et al., 2003; Lanjouw & Schankerman, 2001). It can be expected that more innovative

firms search for creative ways to protect their IPR, including the use of combinations of different dedicated suppliers for specific IP work. Forward citations suffer from truncation, because only citations received until the end of the dataset are observed. In accordance with previous research, I corrected for truncation. Older patents will receive on average more citations because they have had more time in which to be cited (Mayer et al., 2014). To correct for truncation and obtain an unbiased estimate of forward citations, each observation in the sample received the same chance to be cited for 20 years from the application of the patent. Values of this variable ranged from 0 to 36.2, with an average of 0.9.

To test Hypothesis 3, the hypothesis that firms with greater IP complexity are more likely to outsource patent renewal work indirectly to law firms I employed two additional variables. First, I measured IP complexity using the number of patent owners. As noted it can be expected that firms with higher IP complexity have a higher need to access IP mediation capabilities to communicate between diverse patent owners, which might belong to different disciplines and/or organizational units. Values of this variable ranged from 1 to 4, with an average of 1.01. Secondly, I used family size as a measure for IP complexity. A patent family consists of all applications related to the granted patent that have been filed in other jurisdictions. Firms which patent in many countries have to communicate and interact with numerous stakeholders, including patent offices and local IP law firms or agencies. In the sample, this value ranged 1 (a narrowly protected patent) to 19 (a widely protected patent).

Control variables

I included measures of application date, firm nationality, industry, sunk costs, and patent age to control for these variables. The database contains data from three decades. Accordingly, I included patent application date to control for any temporal influences, such as changing trends in firms' patenting strategies. I controlled for firm nationality (based on the location of its headquarters) to account for the possibility that patentees from different countries might employ systematically different outsourcing strategies. I controlled for industry using a categorical variable based on an OECD technology classification scheme. This variable was coded "1" for high-technology industries, "2" for medium-high-technology industries, "3" for medium-low-technology industries, and "4" for low-technology industries. Further, I controlled for sunk costs. Since firms can be expected to consider the costs of renewal when deciding whether or not to renew a patent, I included patent maintenance fee as a control variable. Finally, research has found out that organizational decision makers often have difficulty altering previous decisions due to escalation of commitment (Staw, 1981; Staw et al., 1997; McNamara et al., 2002). To account for any escalation-related reluctance on the part of the firm to change its outsourcing approach, I controlled for both sunk costs and patent

age. I measured sunk costs using the total maintenance fee and assessed patent age using the time period in days between the patent entry and its expiry or abandonment in days until the cut-off date of the observations.

3.5 Results

3.5.1 Descriptive Statistics and Results of Hypothesis Tests

The unit of analysis was the individual patent. I developed models to predict the dichotomous firm decision to outsource patent renewal work either (1) directly to an IP service provider, or (2) indirectly to an IP law firm. Table 6 provides the descriptive statistics for the variables. Approximately 62.6% of patents were outsourced directly to IP service providers. Thus, 37.4% of patents were indirectly outsourced to IP providers via representatives (law firms). Figure 8 shows the indirect outsourcing distribution of firms based on portfolio size. Firms owning small to medium-sized patent portfolios selected IP law firms most often, while firms with medium-sized to large patent portfolios selected IP service providers most frequently. I performed additional analyses to confirm the validity of these results. Table 7 gives the correlation matrix for all variables, which shows limited correlation among all variables. To further investigate the possibility of multicollinearity issues among the variables, I calculated Variance Inflation Factors (VIFs). Results indicated that the data were consistent with the assumption of no multicollinearity: the highest VIF was 1.16, while the mean VIF was 1.08, both of which are far below the suggested threshold of 10 (Chatterjee et al., 2015). Overall, these robustness checks provided greater confidence in the empirical results.

Figure 8: Distribution of direct vs. indirect outsourcing by patent portfolio size

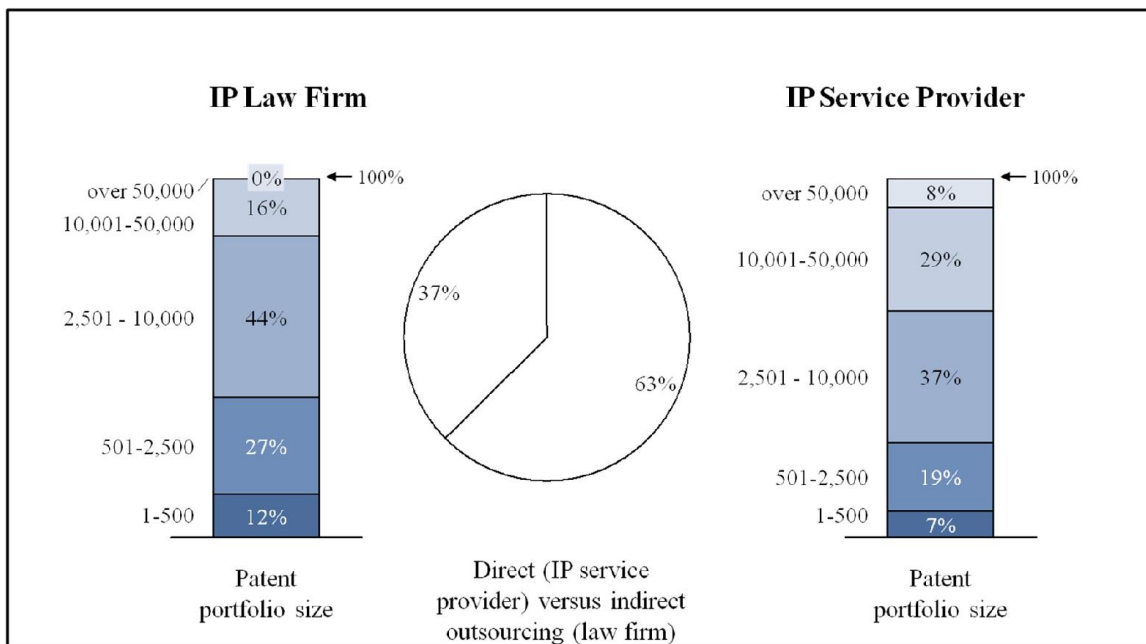


Table 8 presents the estimation results of the logit models. For ease of interpretation, the estimates are presented as odds ratios (OR) thus, values above (below) 1 indicate a higher (lower) probability of direct outsourcing to IP service providers. Model 1 in Table 8 presents the control variables: application date, firm nationality, technology, sunk costs, and patent age. Hypothesis 1 predicted that firms possessing patent management capabilities are more likely to outsource their patent renewal work directly to IP service providers. Estimation results from Model 2 indicated a positive and significant relation which supported Hypothesis 1 (in the full model $OR_{\text{permanent}}=2.49, p < 0.001$ and $OR_{\text{portfoliosize}}=1.49, p < 0.001$). Hypothesis 2 predicted that firms with a larger IP knowledge base would be more likely to outsource their patent renewal work directly to IP service providers. Of the three measures of IP knowledge base, only the variable “number of inventors” was significantly related to direct outsourcing to IP service providers (in the full model $OR_{\text{inventors}}=1.49, p < 0.001$). The variable “forward citations” is not statistically significant and the variable “backward citations” shows a significant relation to indirect outsourcing via law firms (in the full model $OR_{\text{backward}}=0.89, p < 0.001$).

The latter result could be explained in at least two ways. First, backward citations as an indicator are a biased estimate, because citations can be added by patent examiners to fill gaps and to add citations that the inventor has left out (Cotropia et al., 2013; Alcácer & Gittelman, 2006). Thus, this measure may contain “noise” that influenced the results. Second, as previous authors have noted, the number of backward citations may reflect the uncertainty of the patent applicant regarding the originality of his or her invention (Hikkerova et al.; 2014), and such

uncertainty may foster the selection of patent attorneys as applicants seek advice about whether to renew or abandon the patent. Hypothesis 3 predicted that firms characterized by high IP complexity would be more likely than others to choose to indirectly outsource their patent renewal work by selecting IP law firms. Estimation results of Model 4 supported Hypothesis 3 (in the full model $OR_{owners}=0.58$, $p<0.001$, $OR_{complex}=0.92$, $p<0.001$). Finally, Model 5 represents the full model, incorporating all the aforementioned findings. Likelihood ratio tests indicated large statistically significant improvements in model fit with the inclusion of each additional variable.

Table 6: Descriptive statistics for all variables

Variables	Measure	Mean	Std.Dev.	Min	Max
Direct outsourcing	Dummy=1 if outsourced to an IP service provider	0.625	0.484	0	1
Permanent order (H1)	Dummy =1 if an automatic renewal instruction is given	0.112	0.316	0	1
Portfolio size (H1)	No. of total patents to which the focal patents belongs	2.939	1.015	1	5
Number of inventors (H2)	No. of inventors in focal patent	2.117	1.438	0	23
Backward citations (H2)	Relative no. backward citations	1.003	0.742	0	12.586
Forward citations (H2)	Number of forward citations to focal patent	0.997	1.668	0	36.226
Number of owners (H3)	No. of owners in focal patent	1.012	0.118	1	4
Family size (H3)	Number of EP equivalents of the focal patent maintained in all jurisdictions	8.432	4.161	1	19
Application date	Date on which the focal patent application is received by the EPO (DDMMYY)	11830	1134	6860	14648
Firm origin	Geographic location of patentees headquarter	159.1	31.03	5	999
OECD technology class	1 for high-technology				
	2 for medium-high-technology	0.239	0.427	0	1
	3 for medium-low-technology	0.447	0.497	0	1
	4 for low-technology	0.247	0.431	0	1
Sunk costs	Total maintenance fee of patent until abandonment/expiry or cut-off date	24673	42442	0	459561
Patent age	No. of days between entry and abandonment/expiry or cut-off date	3266	2131	3	9337

Table 7: Correlations between variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Direct outsourcing	1												
2 Permanent order	0.15	1											
3 Portfolio size	0.21	0.25	1										
4 No. inventors	0.07	0.04	0.02	1									
5 Backward citations	-0.03	0	-0.01	0.005	1								
6 Forward citations	0.02	0.07	0.06	0.07	0.15	1							
7 No. owners	-0.01	0	0.01	0.06	0	0.003	1						
8 Family size	-0.15	-0.09	-0.11	0.06	-0.05	0.02	0	1					
9 Application date	0.01	0.18	0.03	0.03	0.02	-0.11	0	-0.03	1				
10 Firm Origin	0.05	-0.01	0.02	0.008	0.04	0.01	-0.01	-0.04	-0.03	1			
11 Technology class	0.16	0.13	0.23	0.01	-0.08	0.06	0.003	-0.08	0.01	0.08	1		
12 Sunk cost	0.03	0.07	0.05	0	0	0.01	0	0.06	-0.07	0	0	1	
13 Patent age	-0.03	-0.08	-0.07	0.002	0.02	-0.03	0.03	0.04	-0.3	-0.04	-0.09	0.09	1

N=67,701

Table 8: Logit models for outsourcing of patent renewal work

Dependent variable: Probability of direct outsourcing to IP service providers					
	Model 1	Model 2	Model 3	Model 4	Model 5
Variables	Coef. (SE)	Coef. (SE)	Coef. (SE)	Coef. (SE)	Coef. (SE)
Permanent order		2.577*** (0.175)			2.493*** (0.171)
Portfolio size		1.442*** (0.025)			1.408*** (0.025)
Number of inventors			1.124*** (0.14)		1.147*** (0.014)
Backward citations			0.920*** (0.020)		0.895*** (0.020)
Forward citations			0.997* (0.002)		1.0005 (0.03)
No. owners				0.584*** (0.084)	0.584*** (0.084)
IP complexity				0.924*** (0.03)	0.924*** (0.03)
Application date	1.000* (0,0001)	0.999* (0. 00001)	0.999* (0.00001)	0.999* (0. 00001)	0.999* (0. 00001)
Firm Origin	1.000*** (0.00008)	1.006*** (0.0008)	1.006*** (0.0009)	1.005*** (0.0009)	1.005*** (0.0009)
Medium-high technology	0.547*** (0.037)	0.573*** (0.039)	0.601*** (0.042)	0.583*** (0.41)	0.583*** (0.41)
Medium-low technology	0.978 (0.064)	0.994 (0.665)	1.041 (0.71)	0.972 (0.67)	0.972 (0.67)
Low technology	2.132*** (0.156)	1.680*** (0.125)	1.612*** (0.122)	1.565*** (0.120)	1.565*** (0.120)
Sunk cost	1.000*** (0.0003)	1.000*** (0.0003)	1.000*** (0.000002)	1.000*** (0.000002)	1.000*** (0.000002)
Patent age	0.999 (0.0008)	0.999 (0.0008)	1.000 (0.0000008)	1.000 (0.0000008)	1.000 (0.0000008)
number of observations	19,835	19,830	18,995	18,995	18,995
LR chi square	960.78	1754.72	1739.66	2093.83	2093.83
Prob > chi square	0.000	0.000	0.000	0.000	0.000
Pseudo R ²	0.040	0.074	0.076	0.0916	0.0916
Log likelihood	-11382.487	-10982.006	-10556.782	-10379.699	-10379.699

Notes: Robust standard errors are in parentheses.

* Significant at the 5% level; ** significant at the 1% level; ***significant at the 0.1% level.

3.6 Discussion and implications

In this paper, I have investigated factors that may determine a firm's choice of IP suppliers for outsourced IP work. The empirical analysis, which was based on a rich dataset in context of annual patent renewals, suggested that firm characteristics such as IP management capabilities, knowledge base, and IP complexity are significantly related to the selection of the IP supplier. The study helps to answer questions concerning how IP is managed via external parties, and how firms may differentiate between types of IP suppliers. More specifically, the study helps to identify factors that guide a firm's decision to select an IP service provider versus an IP law firm.

3.6.1 A better understanding of managing IP with outsourcing suppliers

In this study, I have extended research on IP outsourcing in several important ways. First, I have introduced the notion of the IP service provider as an important type of IP supplier distinct from the classic IP law firm. Previous studies in the IP and innovation literature have focused mainly on patent attorneys or law firms. Since the assignment of outsourced work to suppliers takes into account the supplier's capabilities, firms are likely to utilize different types of suppliers (Moeen et al., 2013). Hence, it was important to investigate firm choices concerning this other important, highly specialized type of IP supplier, which has been underrepresented in the literature. Second, in this study I have examined the outsourcing of patent renewal work: this represents an important augmentation of existing research, which has centered mainly on the outsourcing of prosecution work (Somaya & Williamson, 2008; Mayer et al.; 2012, Cotropia et al.; 2013, Ayerbe et al.; 2014) or has examined patent renewal data to explain investment decisions based on option theory (Nerkar et al., 2007; Dalziel, 2009; Sereno, 2010; Hikkerova et al., 2015). To my knowledge, patent renewal work with a focus on IP management, particularly IP outsourcing, has not previously been a subject of study. Third, I have added to prior research findings by assessing firm characteristics and capabilities in the field of IP (Ayerbe et al., 2014; Mayer et al., 2013). In line with both the Resource Based View of the firm and Transaction Cost Economics, the results of our study suggest that firms that possess IP management capabilities may be less reliant than others on the advice of external patent attorneys. Thus, the study highlights the choice between access to superior occupational capital – particularly legal knowledge (Moeen et al, 2014; McIvor, 2009) – and access to efficiencies and economies of scale (Roodhooft & Warlop, 1999). Additionally, the study highlights that a firm's IP complexity create the need for an IP supplier with mediation capabilities. By identifying firm characteristics that affect IP supplier

selection, I have gone beyond the simple framework of outsourcing which mainly focuses cost reduction through economies of scale.

3.6.2 Managerial implications

Our empirical findings have implications for both management practice and empirical research using patent data. Prior research has suggested that firms can improve their innovative and financial performance by interacting with different suppliers (Garcia Martinez et al., 2014). Firms externalize a wide range of activities, ranging from product design to assembly and from research and development to marketing, distribution, and after-sales services (Ho, 2009). The main motivation for outsourcing remains cost reduction, which is achieved by using outsourcing to access the economies of scale and unique expertise that a large outsourcing supplier can deliver (Anderson & Weitz, 1986; Roodhooft & Warlop, 1999). More precisely, most outsourcing studies refer to the outsourcing impact as a conceptual combination of cost reduction, productivity growth, and profitability improvement approaches (Jiang, 2006). In this study, I have extended the logic of IP outsourcing by focusing on capabilities, which is most relevant in the domain of IP management rather than costs. Thus, firms face the challenge of identifying the most capable supplier, while simultaneously considering all relevant costs. On the one hand, firms have to expend effort in order to identify which external knowledge and capabilities are valuable to them and need to be acquired (Peeters & Martin, 2015; Cohen & Levinthal, 1990). On the other hand, firms might benefit from open innovation when selecting the most capable supplier. Involving both inbound and outbound activities, for example, where IP know-how is mutually shared (Gassmann & Bader, 2006), can enhance the firm's own IP knowledge base. Following an open culture allows the firm to be exposed to a diversity of external knowledge sources, such as a novel ideas from suppliers, which may help to be proactive, and to avoid overlooking important opportunities in the business environment (Ketata et al., 2015).

The current paper draws attention to suppliers of knowledge work, specifically in the field of IP. Additionally, this study helps to open the "black box" of IP management to understand why firms engage a given type of IP supplier. Little is known so far about the supplier side of IP management, particularly law firms, service providers and local representatives which might be required in some jurisdictions in order to achieve patent protection. Firms need to be aware of the complete IP supply chain and should aim to define an IP sourcing strategy which identifies and manages the most competent IP suppliers in each technological area and jurisdiction satisfying firms needs and the overall challenge concerning the complexity of IP. Additionally, in order to manage IP intermediaries firms are challenged to implement structures, communication and coordination ways which enable an efficient management of

IPR with IP suppliers. Finally, as mentioned missing the payment of a maintenance fee results in the lapse of the patent, which cannot be reactivated. Thus, quality management is a critical factor. Firms are advised to conduct regular audits to assess IP supplier's performance and to ensure and implement quality standards to avoid the potential risk of losing valuable IP rights.

3.6.3 Conclusion and future research

This paper contributes to the IP literature by studying firms' choices regarding IP intermediaries, and also opens up areas for future research. Following key findings can be identified concerning the firm's choice for IP suppliers:

- IP service providers are more likely to be selected if the firm's own IP management capabilities are well established
- IP law firms are more likely to be selected if the firm's complexity is high
- However, there is no significant indication that firm's knowledge base is related to the preference for the IP supplier

Thus, the study has provided new insights into the supply side of IP management, which has to date received little research attention.

Based on the findings of this paper, several areas for future research emerge. Little is known, about firms' outsourcing strategies in context of IP which would represent a welcome complement to this work. Answers to the questions how outsourcing of IP activities should be organized with external IP intermediaries, and how an efficient management of a set of IP intermediaries could be achieved could be further useful insights into the effective management of IP. Also the impact of IP suppliers on IP performance is a ripe area for future research. On the other hand, dealing with external IP intermediaries, such as patent attorneys, law firms or other IP vendors firms creates the need for firms to control, coordinate activities between firms' and IP intermediaries. More research is needed into the triggers, processes, and mechanisms through which firms develop sophisticated patent management capabilities with external IP suppliers (Somaya, 2012).

4 Role of external patent attorneys on patent strategy and its effectiveness

Co-authored by Oliver Gassmann

In the intellectual property rights (IPR) literature, the question of how external patent attorneys impact patent filings has been understudied. We seek to advance this area of research by examining how external patent attorneys and their experiences influence patent filing strategies. We provide insights into filing dimensions which are affected by patent attorneys' work and decision making. Using data on the outsourcing of patent application services, we find empirical evidence that external patent attorneys' work has an effect on: (1) patent scope; (2) international scope, and (3) patenting speed. Moreover, we show that external patent attorneys have a positive impact on the area of protection, and more experienced patent attorneys are using a differentiated filing strategy for instance, drafting narrower and more focused patent applications. Our study suggests that effective filing strategies require an integrated approach between diverse Intellectual Property (IP) stakeholders, and particularly have to be communicated and aligned between all IP stakeholders, including external patent attorneys. We develop a patent filing typology accounting for patent attorneys' decision options. In providing insights into patent attorneys' work and their impacts on IPR management, our study is a useful complement to prior research, which has predominantly focused on applicants or examiners.

4.1 Introduction

During the last decades there has been a continuous growth in patent applications in all major patent offices (van Zeebroeck, 2009). Patents are especially important in the knowledge-based economy, where they represent a strategically important subject, and the basis for rivalry and disputes between industry players. Moreover, the role of patent management has changed from creating a purely legal barrier for competitors to a sophisticated utilization of patents to achieve maximum rents from innovation (Arora, 1997). In a comprehensive intellectual property (IP) strategy, reasons for patenting have been shown to extend beyond direct profit from the invention to supplementary goals such as blocking, licensing, building fences and thickets, and preventing lawsuits (Cohen et al., 2000; Sternitzke, 2013; Cohen et al., 2002; Blind et al., 2009). These alternative uses of patents, often referred to as *strategic patenting*, are clearly responsible for the increase in patent applications and the non-legal literature's interests in patents (Ayerbe et al., 2014, Granstrand, 2000, Hanel, 2006). Previous studies on this topic have discussed various forms of strategic patenting (Bader & Enkel, 2014; Blind et al., 2009; Thumm, 2003), the positive impact of patent strategy on firm performance (Ernst, 1998; Ernst, 2001; Lerner, 1994), and the influence of strategic patenting on companies' patent portfolios (Blind et al., 2009). Additionally, there is a growing interest in filing strategies within the strategic patenting framework. Research on filing strategies analyzes the impact of filing strategies on patent value (van Zeebroeck & van Pottelsberghe de Potterie, 2011), or analyze firms' filing behaviors (Berger et al., 2012; Harhoff et al., 2007). Other studies have defined filing dimensions and classified filing strategies, such as Harhoff (2006a) and Stevnsborg and van Potterie (2007). Experiences with patent systems, the drafting practices of patentees, and the impact of such practices on diverse patent indicators have also been the subject of analysis (van Zeebroeck, 2009). While most studies focus on the behaviors of applicants and examiners, and their influences on filing strategies, only few articles focus on patent attorneys. Several authors (Cohen et al., 2000; Hall & Ziedonis, 2001) highlight that the translation of technological inventions into patents is an imperfect process that is impacted by various factors: attorneys have an especially important role in the patent application process. For instance, patent attorneys tend to change the scope or breadth (number of claims contained in the patent) of the patent, which may eventually lead to different possibilities of being cited in later patents (Bessen & Meurer, 2008). Moreover, Somaya et al. (2007) show that patent attorneys have been demonstrated to have the same proportional impact on a firm's patenting output as R&D spending. They suggest that innovation research may be enhanced by considering the role of in-house patent law expertise in generating patents, and conclude that patent law expertise affects the firm's patenting performance positively. The work done by Reitzig (2004) is one of the few studies in the innovation literature that identifies patent

attorneys' filing rationales. His article expands current theory by describing the work of patent attorneys during the patent granting procedure and the effects of such work on patent value, value determinants, and indicators. However the author provides a rather succinct depiction of patent attorneys' work. Many questions relating to the patent attorney's role, behavior, and impact during the patent filing process remain unanswered, such as: what are the differences in filing strategies between firms which engage external patent attorneys and firms which use in-house IP expertise, and how dependent is the filing strategy and the outcome of the patent process on the skills and experience of the patent attorney? To answer these questions, our present research contributes to intellectual property rights (IPR) literature in three ways. First, regarding content, very few studies have specifically focused on the question of how external patent attorneys impact the effective management of IP, for instance filing strategies, although the patent attorney's primary role during the application process is to provide advice regarding which patenting route to take and what scope of protection to select, and to draft the patent application. Therefore, we expect that external patent attorneys have an influence on the filing strategy and the outcome of the patenting process. Second, the article contributes to theory by extending the understanding of external patent attorneys' work in the context of application procedures, and describing the major dimensions of their filing strategies and decision options. Lastly, based on our empirical results we develop a typology of filing strategies, which takes into account the filing rationales of the patent attorney as an IP intermediary between the IP stakeholders (applicants and examiners), and provides insights for applied IPR management. We evaluate empirically a data set of European patents from the European Patent Office (EPO) database, PATSTAT, matched with a unique patent database of an IP service provider. We complement our large sample analysis with 8 exploratory semi-structured interviews with patent attorneys and patent examiners, which enable us to further corroborate our findings and discuss their theoretical and managerial implications. The paper is structured as follows: First we describe the theoretical framework and derive hypotheses concerning patent attorneys' decision dimensions and impacts on filing strategy. In the next section the research methodology and data set are described. Empirical results and a patent filing typology based on our empirical results is presented. We conclude our paper with the discussion of managerial implications and a brief overview of further research possibilities.

4.2 Theoretical Framework and Hypotheses

In this section, we present an overview of the current patent filing strategy literature. We then describe the work of patent attorneys in the context of patent applications, with a focus on

external patent attorneys. Finally, we develop hypotheses concerning patent attorneys' work and their influences on patent filing dimensions

4.2.1 Literature Review

There is an emerging interest in the worldwide surge in patent applications. A recent study of Danguy et al. (2014) found that the patent explosion observed in several patent offices can be attributed to greater globalization of IPR rather than an increase in research productivity. The authors find empirical evidence that one determinant for the growth in patent applications, are firms' patent filing strategies. Also, previous literature has analyzed filing strategies and their impacts on patent value. For instance, Guellec and van Pottelsberghe de Potterie (2002) assess the extent to which adopted patenting strategies, amongst other patent attributes, are related to patent value. A study by van Zeebroeck and van Pottelsberghe de Potterie (2011) introduces value determinants in the form of applicants' filing strategies (filing routes, drafting styles, and divisional filings), and concludes that filing strategies are positively associated with patent value, although this fact remains widely ignored in literature. The filing behavior of firms has also been studied: for instance, Berger et al. (2012) were able to show that patent applications that are declared as being essential to a technology standard contain significantly more claims and are amended more often than patent applications that are not related to standardization. Thus, they concluded that patent applicants who participate in standard-setting organizations strategically shape the application process to suit their interests. A recent study of Gerken et al. (2015) find empirical evidence that companies focusing on enforceability of their patents file at a very early stage, while companies interested in a broad patent scope, file at later stages and conclude that patent scope is impacted by firms' strategic patenting behavior. Schneider (2007) empirically analyzed patent data applied for by Danish firms at the EPO from 1978 to 1998. He found behavioral differences between experienced and inexperienced applicants; for example, applicants with large patent portfolios applied for more patents and did not withdraw their applications when the expected probability of granting was high. There are several contributions which describe and typify dimensions of filing strategies. Harhoff (2006a) has developed the notion of patent constructionism. He illustrates how firms build patent portfolios by combining multiple priority filings, or by using divisional applications. Stevnsborg and van Potterie (2007) have developed a typology of four filing strategies based on drafting styles, patenting routes, and the behavior adopted for interacting with EPO examiners. Their identified strategies include good will and fast track, good will and slow track, bad will and slow track, and deliberate abuse of the system. They conclude that the choice of a filing route to the EPO is dependent on the character and nature of the firm, and its broad intellectual property objectives.

Empirical literature on specific filing dimensions, such as patenting speed in context with delaying strategies, also exists. Scholars have analyzed motivations for delaying the outcome of the patent process, and how the decision to delay may be related to the value of the innovation, the time lag between application and patent process outcome, and the determinants of the delay. Harhoff and Wagner (2009) found that applicants accelerate grant processes for their most valuable patents, but prolong the applications for which withdrawal or refusal is imminent. Régibeau and Rockett (2010) considered the delay as a function of applicant effort, and van Zeebroeck (2009) concluded that deferral or delaying strategies are more often used in high-tech industries like electronics and chemistry. A major criticism of these studies is that delay in the patent process can be caused by both applicants and examiners (Eckert & Langinier, 2014).

Limited attention has been given to drafting strategies as a filing dimension. Van Zeebroeck (2009) studied determinants of the size of an application (in terms of pages and number of claims) using EPO data for applications from 1982 to 2004. He found that the most important determinants of application size were the geographic origin of the application and the procedural route chosen by applicants. Archontopoulos et al. (2007) found that patent drafting styles may be strongly influenced by national or regional systems, cultures and modes. They report that the practice of using dependent claims as fallback positions is not evenly spread throughout the world, and the level of detail in the specification may depend on the inventor's expectations about the potential behavior of a court in case of litigation. They also make note of important country to country differences in patent drafting practices.

While scholars have suggested that both applicants and examiners influence filing strategy, procedure, and patenting outcome, and have presented empirical evidence in support of this position, there has been little exploration of the roles of other IP stakeholders, such as patent attorneys (in-house vs. external), and their effects on these variables. Two major contributions should be mentioned here. Reitzig (2004) examines patent attorneys' impacts on patent value. His article expands current theory in opening the 'black box' of patent attorneys' work during the patent granting procedure and its effect on patent value, value determinants and patent indicators. His analysis focuses particularly on latent determinants of patent value such as novelty, inventive step, breadth, and difficulty of inventing around. He proposes various new value indicators which arise from the description of patenting rationales, and operationalizes key variables in the filing process as suitable value indicators. Another valuable contribution in this matter is provided by Somaya et al. (2007). These authors combine patent law experience with R&D and draw conclusions concerning the firm's patenting performance. They suggest that

“to file patents, firms need to access specialized legal resources for conducting prior art searches, drafting patent applications, and prosecuting these applications at the patent office” (Somaya et al., 2007, p.923).

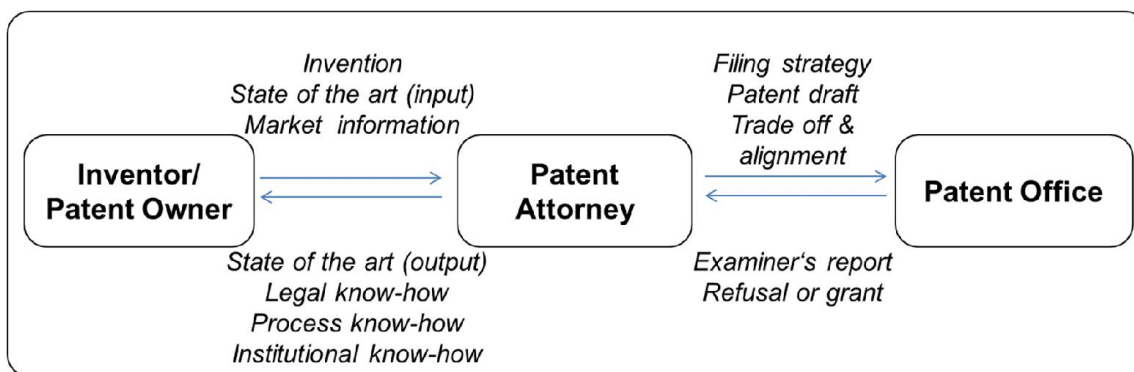
They raise the question of what value is derived from combining patent law expertise with R&D resources internally within the firm, despite the widespread availability of the utilization of external patent law firms. Their results show that in-house patent law expertise is a significant predictor of firm-patenting performance; furthermore, this effect is moderated by the firm's level of top management team (TMT) patent law background and industry-patenting pressures. However, the hypothesis of a complementary relationship between in-house patent law expertise and R&D was not supported; instead, the authors found evidence of a counterintuitive (weak) negative interaction between these two variables. Reitzig and Wagner (2009) have also provided insights regarding these questions. They authors empirically proved that a firm's performance in turning patent applications into patent grants increases linearly with the rate of outsourcing of patent applications to external law firms. Major specialization advantages of the external lawyers are likely to account for the finding. There is an emerging interest in the utilization and effects of external IP firms such as patent law firms. In line with Ketata et al. (2015) we expect that companies following an open culture that allows exposure to a diversity of external knowledge sources, such as a company's suppliers may feed it with new ideas and suggestions, which could help companies to be proactive and to prevent them from missing important opportunities in their business environment. However, many questions remain unanswered; for instance, how do a firm's choice to use external vs. in-house patent lawyers and its internal or external patent law expertise affect strategic patenting and, in particular, filing strategies? The latter is precisely the object of our research.

4.2.2 Patent attorneys' work during application

In this section we describe patent attorneys' work, to understand their decision choices and identify factors that influence filing strategies. More precisely, we focus on patent attorneys' work during the European patent application at the European Patent Office. We conducted unstructured interviews with 8 senior patent lawyers from patent law firms and the European Patent Office. All of the experts have many years of experience in the filing, examination and enforcement of patents in the fields such as chemistry and chemical engineering, information systems, and construction engineering. Their clients range in size from single inventors to large corporations. Our exploratory interviews with external patent attorneys and industrial IP managers show that the patent attorney's role as an interface and IP intermediary between the inventor/applicant and the patent office is very important. This is in line with the position

of Ayerbe et al. (2014) who posited that IP intermediaries, such as law firms and service organizations specialized in managing IPR, play an increasingly active role in the new knowledge market. They state that, besides technological capabilities, patent attorneys possess complementary capabilities based on a specific legal profession. One of the interviewees highlighted that “*the patent attorney has to align, argue and make compromises to achieve protection*”. Figure 9 shows a simplified depiction of the relationships between the inventor, the patent attorney and the patent office.

Figure 9: Participants and interaction during patent application



In general, an inventor or a firm’s IP or R&D department contacts the patent attorney with the instruction to file a patent. Most firms, especially corporations, are engaging external patent attorneys due to the latter’s high flexibility and degree of specialization (Gassmann & Bader, 2007). Small inventors come up with an idea and seek advice, while large corporations often pre-draft the patent application. We will discuss in the following section the work patent attorneys engage in during the application process, and their decision choices. As Harhoff and Reitzig (2004) point out a patent attorney’s work comes closest to a decision making-problem under high uncertainty. According to our interviews this decision during the application process has to address four criteria: *patentability*, *international scope*, *patent scope*, and *patenting speed*.

(1) First, the patent attorney evaluates the state of the art and market information based on inventors’ information, and his or her own search results and expertise in order to assess the *patentability* of the invention. Patentability is established if there is a clear inventive step, and this inventive step is novel and amenable to industrial application (Rich, 1959). In addition the patent attorney can use search engines, which are provided by patent office’s such as Espacenet (European Patent Office) and DEPATISnet (German Patent Office) to conduct a prior art search. The German or European patent attorney is usually highly specialized with a background in science or engineering. This enables him or her to make a first assessment of patentability and provide an indication of whether or not it is worthwhile to continue with the

patent application (Gassmann & Bader, 2007). An in-depth search of the state of the art, assessment of novelty, and citation of prior art documents is done at the EPO, later by the patent examiner (Cotropia et al., 2013). For European patents the disclosure of prior literature is not obligatory and examiners are the main source of references (Criscuolo & Verspagen, 2008).

(2) There are three possible mechanisms of patent protection in Europe: national patent filing in single countries, European patent (EP) filings, and filings according to the Patent Corporation Treaty (PCT) for global protection for a maximum of 30 months (which need to subsequently be validated into national filings or EP filings) (van Zeebroeck & van Pottelsberghe de Potterie, 2011). According to our expert interviewees, the decision about the *international scope*, which concerns in which jurisdictions the patent should be protected, is made based on two considerations: 1) the purpose of the patent application, and 2) the geographic area of protection.

There are numerous reasons for patenting other than direct profit from the invention. The trend of increasing numbers of patent application is ongoing. While large firms patent more, small firms patent more carefully (Parchomovsky & Wagner, 2005). Multinational firms in particular prefer to license their technologies if they would otherwise receive lower returns (Bidault, 2004). Cross-licensing strategies are aimed at complementing firm's internal know-how and avoiding financial compensation (Bader et al., 2012). Further reasons for patenting include the prevention of lawsuits (Cohen et al., 2000) and the possibility of exploitation of the patent; for example, via selling (Ruston, 1996), financing (Spector & Zuckerman, 1997), spin-offs, or joint ventures (Ziegler et al., 2013). Aside from these purposes, the strategic decision to employ a wide or narrow international scope is made based on the geographic area of protection. The following questions need to be answered to identify the minimum geographic area of protection: What are the main markets? Where is the competition? and Where are the production facilities? If the patent is valuable, a broad application can be achieved via PCT application. In fact, PCT applications allow for worldwide protection, and the inventor thus "buys time", which can be strategically important (Reitzig, 2004; Ernst, 2001). If the patent should instead be protected in specific geographic markets, protection is achieved via national applications. All interviewees confirmed that the patent attorney seeks a wide international scope in order to achieve maximum profits from innovations. The main trade off are costs. Fixed costs increase from national, through EP, to global application. The main fixed costs are the official fees of patent offices. At the same time, variable costs decrease from national, through EP, to global application. The main variable costs are patent attorneys' service costs, translation costs, and coordination costs. For a global PCT application only one patent attorney is needed, while for national applications registered

attorneys might be required in several jurisdictions (European Patent Office, 2014), which increases variable costs.

(3) One of the patent attorney's main tasks during filing is claim construction: drafting the patent in which the state of the art is described, the inventive step is reflected, and the solution to the technical problem is summarized. Patent *claims*, also referred to as *patent scope* or *patent breadth*, form a boundary line around the patent, and thereby define the area of patent protection (Merges & Nelson, 1990). This area of protection is the basis for inventing around, or for the identification of infringements (Lemley, 2005). The primary goal of the patent lawyer is to create an effective protection of the invention in order to maximize potential rents from innovations, block competitors, and create uncertainty, especially during the application phase. With a rising number of claims, the risk of a legal attack increases (Bender, 2000). Therefore, claim construction requires strategic and tactical decision making, and a certain amount of experience regarding diverse drafting styles. There are two types of claims: independent claims and dependent claims, which refer to another claim or several claims (Fromer, 2009). Each claim defines a scope. Independent claims stand on their own, and therefore provide a complete protection area. Infringing on an independent claim implies infringement of an entire patent (Fromer, 2009). Dependent claims mainly exist to provide fallback protection in case the independent claim is invalid (Menell et al., 2010). In recent years there is a growing trend towards increasing numbers of claims and increasing complexity of claim structure and the abuse of the patent system (Berger et al., 2012). Applications of over a thousand pages in length are now frequently filed at the European Patent Office and other patent offices around the world, and several applications have even reached 100,000 pages, or up to 20,000 claims, in recent years (van Zeebroeck, 2009; van Zeebroeck et al., 2009).

(4) *Patenting speed* is another important dimension of the filing strategy, given that there has been an unbroken trend toward shorter product and technology life cycles (Bianchi et al., 2011). For some technologies with short life cycles (e.g. information technology, consumer electronic), patenting speed is very critical. Patent attorneys have two tactics to speed up the filing procedure and thereby increase patenting speed: narrowing the area of protection in order to achieve a fast grant, or starting with a wide scope but subsequently compromising, accepting limitations set by the examiner (Harhoff & Wagner, 2009). Scholars have also found that applicants accelerate grant proceedings for their most valuable patents: for instance, by filing a request for accelerated search and examination (Stevnsborg & van Potterie, 2007). Another tactical choice is the strategy to delay, for example, by choosing to file a Euro-PCT application. According to Frietsch et al. (2013), a pending application can have several advantages: for example, claims can be amended, and the market can continue

to be scanned. Trading off between these different strategic considerations is a crucial part of the attorneys' work.

To develop our hypotheses linking patent attorneys' work to patent filing strategy, we neglect patentability since this is often driven by technological constraints for height of inventiveness. Instead we focus on the other three patent filing dimensions: patent scope, international scope, and patenting speed.

4.3 Hypotheses

Based on our expert interviews, patent attorneys' contributions during the application procedure are highest for the development of the patent filing strategy and the patent draft itself. Patent attorneys' work and experiences play an important role in drafting the patent application and deciding which steps to take in order to achieve the patenting output. We tested the impact of patent attorneys' work on the filing strategy by operationalizing patent indicators such as claims, PCT, family size, EP equivalents, and lag. Literature on strategic patenting indicates that firms have been turning more marginal innovations into patents than previously. Moreover a "patenting explosion", has been observed at the European Patent Office, as well as at the patent office for the United States of America and other patent offices worldwide (Harhoff et al., 2007). As mentioned, the firm's motivation is to increase the size of its patent portfolio. The patents themselves are frequently used as bargaining chips in licensing negotiations between firms over access to patents (Gassmann & Bader, 2006). Thus, there is an ongoing trend in growing patent applications with a strong strategic intention other than enforcement. We are interested in the question of how patent attorneys affect this trend by influencing the filing strategy.

4.3.1 Influence of patent attorneys' work on patent scope

A standard patent variable in literature is patent scope or breadth. In the relevant literature, the number of claims has frequently been used as a proxy for patent complexity (Tong & Frame, 1994). Broad patents read on many products or processes and increase the attractiveness of the right of exclusion (Merges & Nelson, 1990; van Zeebroeck, 2009). Dependent claims, and product claims add further breadth to the patent, and are a fall-back option in case of legal disputes (Reitzig, 2004). The patent attorney's aim is to extend the patent scope to its maximum for patents showing a substantial inventive step and the possibility of high profits. As mentioned, a large number of claims increase the complexity of the application. Inventors and patent attorneys use complex applications in order to mask

the content from competitors, or to create uncertainty about that content (Harhoff, 2006b). Furthermore, competitors will find it more difficult to “invent around” a broader patent, which adds value to the exclusion right (Graevenitz et al., 2013). On the other hand, a narrow patent scope enhances enforceability of the patent (Gerken et al., 2015). Additional claims might raise the probability of an infringement, and also make the description of the claimed invention more specific, possibly narrowing the scope of the protected area (Lanjouw & Schankerman, 2004). There is a thin line between the strategic approach of claiming “as much as possible” and the alternative approach of claiming “as much as needed” in order to increase the probability of achieving the grant and avoiding infringements. Van Zeebroeck et al. (2009) found that larger applicants generally tend to file patents with fewer claims, whereas occasional applicants include slightly more claims in their applications. Similarly, Lemley and Sampat (2012) found that experienced examiners cite less prior art and have a significantly higher grant rate. In line with this logic, we suggest that patent attorneys seek to maximize the scope of a patent; however, more experienced attorneys have a capacity to draft their applications in a more focused way, knowing some rules of the disclosure game. Thus, we hypothesize:

Hypothesis 1a: The use of patent attorneys has a positive impact on patent scope

Hypothesis 1b: A patent attorney's level of experience is negatively related to patent scope.

4.3.2 Influence of patent attorneys' work on international scope

An important element of the filing strategy is the international scope. As mentioned, there are different routes for filing an application at the EPO. The patent attorney's role is to advise applicants and help them decide which route to take. According to the Paris Convention of 1883, applicants have one year from the date of their first (priority) filing to extend their patent application to any other patent office in the world (Bodenhause, 1968). The expert interviews also confirmed that a common patenting route is to file an application at the domestic patent office to reach priority and transfer it to other countries within 12 months. Additionally, based on information such as the underlying state of the art and market size, the attorney assesses the economic value of the patent. A large international patent family indicates that the applicant is incurring significant costs to have the invention protected in a large number of countries, and valuable patents obtain the broadest possible international scope (Harhoff & Wagner, 2009). However if the firm's strategic intention is to build a patent portfolio, or thickets of relatively similar patents related to one innovation, the EP application from a priority filing is extended into numerous EP applications, also referred to as EP

equivalents (Graevenitz et al., 2013). In this case, the applicant may not be interested in enforcing the patent, but rather in deterring rivals from filing closely related applications. In fact, filing strategies are faced with trade-offs such as costs, and numerous assumptions are made about competitor reactions. Making the use of the same argumentation as for the first hypothesis, we predict that more experienced attorneys, are more capable of making the right assumptions and to differentiate between these filing strategies. Thus,

Hypothesis 2a: The use of patent attorneys has a positive impact on international scope

Hypothesis 2b: A patent attorney's level of experience is negatively related to international scope.

4.3.3 Influence of patent attorneys' work on patenting speed

One means of obtaining worldwide patent protection is the PCT application. If the strategic intention is to create uncertainty in the market, or if the innovation's market potential is unclear at the time of application, a PCT filing is an option. Using this option the patenting process can be delayed by 18 months and the decision of the extension of the priority patent to other countries can be postponed (Ernst, 2001). According to van Zeebroeck and van Pottelsberghe de Potterie (2011), the ease of this procedure and the longer time it offers to assess the market value of the technology being patented have convinced many applicants to opt for the PCT process: as a result, about 53% of applications filed at the EPO in 2005 initially went through the PCT route, versus 30% of the patents filed between 1990 and 1995. A way to gather information more quickly is to accelerate the patenting process by request for accelerated examination (Harhoff & Wagner, 2009; Reitzig, 2004). Accelerated searches and examinations may also be used by attorneys who are very confident about the patentability of the invention and just want the patent to be granted as quickly as possible (van Zeebroeck & van Pottelsberghe de Potterie, 2011). This argument is supported by recent studies which find empirical evidence that firms want the pendency period or lag to be as short as possible because otherwise the potential value of the IP is reduced if an invention cannot be patented or if certain claims in the patent draft are denied (Laplume et al., 2015). Giving a higher weighting to arguments of more recent studies, we hypothesize:

Hypothesis 3: The use of patent attorneys has a positive impact on patenting speed

4.4 Data and Methodology

4.4.1 Sample and data collection

To measure the potential association between patent attorneys' work and filing strategies a specific dataset has been assembled from two sources: PATSTAT (EPO, 2010³), and an internal patent database from an IP service provider called TOPSIE. This service provider offers IP related services along the life cycle of a patent (e.g. filing, renewal and other legal and administrative services). The TOPSIE database contains patent data from 5,319 firms. The dataset is composed of European patent applications that were granted by the EPO between 1980 and 2010, which represents a total of 922,553 patents. The overall dataset includes three main sets of variables, those that came from PATSTAT (shown in capital letters), and those that came from TOPSIE, and additional constructed variables that we created from them. The PATSTAT database contains data on patents such as filing, granting and renewal information, while the TOPSIE database extends patent data by including detailed information on applicants, and data on third parties such as IP service providers and IP law firms. First, in order to enrich and to achieve maximum data information, we extracted the TOPSIE database and matched it with patent data from PATSTAT, which is available under license from the EPO (PATSTAT 2010). More precisely, data on the filing strategy, such as number of claims, family size, and PCT were obtained from PATSTAT, and data on patent attorneys, such as the names of patent attorneys' or the law firms used for patent filings and the patent size handled by specific patent attorneys' or law firms' were obtained from TOPSIE. The database was subsequently validated to ensure the reliability and accuracy of all data. The final database contains 144,308 patent families, totaling 838,345 patents. To construct our sample we started with a random selection of 100,000 patents from the total population. We defined July 29th, 2010 as the cutoff date and dropped observations with missing values and those with a patent renewal due date later than the cutoff date. This reduced our sample to 67,111 observations, which included data from 815 firms.

4.4.2 Measurement

Dependent variables for filing strategy

We used patent indicators to reflect the three dimensions of the filing strategy: *patent scope* proxied by *CLAIMS*, *international scope* proxied by *FAMILY SIZE* and *EP equivalents*, and

³ We use the October, 2010 version of PATSTAT

patenting speed proxied by *PCT* and *lag*. We tested different dependent patent variables in our model, but used the same explanatory variables and control variables throughout.

We measured patent scope using number of *CLAIMS*. Claims in the patent specification define the property rights protected by the patent. The principal claim describes the essential novel features of the invention and subordinate claims describe detailed features of the innovation (Lanjouw & Schankerman, 2004). In our sample, the number of claims ranged from 1 to 411, and is averaged 10.8. We measured international scope using *FAMILY SIZE* and *EP equivalents*. In order to protect an innovation in multiple countries, a patentee must secure a patent in each country. A patent family consists of all applications related to the granted patent that have been filed in other jurisdictions. In our sample of European patents this value ranged from 0 (a narrowly protected patent) to 35 (a widely protected patent). EP equivalents are defined by the EPOs equivalence rule, which specifies that for two documents to be described as equivalent, all their priorities must be the same (EPO, 2014). EP equivalents in our sample ranged from 0 to 38, with an average of 5.0. We measured patenting speed using the *lag* between the application date and the grant date, and whether or not the patent is filed under *PCT*. The date upon which a patent application is received by the EPO is recorded as the application date: depending on the examination duration, the granting date may be many months or years later. We measured the lag as the number of consecutive days between the application and grant dates. Patent lags in our sample averaged about 1,645 days (approximately 54 months). As mentioned, PCT filings reduce the patenting speed, therefore we used PCT as a dichotomous indicator to further assess patenting speed. This indicator was coded “1” if an international application was filed under PCT, and “0” otherwise. The share of PCT filings in our sample was 30.1%.

Independent variables

We assessed the impacts of the work of patent attorneys using two response variables: the first was a dummy variable that identified whether or not a patent attorney had been used. In our database we defined this variable as the utilization of external patent law firms. 37.4% of the observations in the sample used external patent law firms. The variable was coded “1” if the patent was filed by an external patent law firm and “0” otherwise.

The second variable we used to measure the patent attorney’s impact was their experience. In line with previous research (Schneider et al., 2008; Alcácer et al., 2009), we operationalized experience as the number of patents handled. More precisely, we defined a patent attorney’s experience as the total number of patents handled by the attorney or law firm *i* in the database at the cut-off date (July 29, 2010). We obtained this information from TOPSIE, which contains a unique identifier for each patent law firm. We assumed the quality of work should

increase with increasing experience, due to learning curve effects (Levitt & March, 1988). In our sample this variable ranged from 1 to 3,085 and averaged 377.5 patents handled per law firm.

Control variables

We controlled for firm size, technological diversification, firm nationality, cooperation complexity, application date, and cost of filing. Consistent with past research on patent indicators, we controlled for firm size (Hall & Ziedonis, 2001; Somaya et al., 2007). We used client firm's patent portfolio size as a measure of firm size. We postulate that firms with a relatively large patent portfolio are more likely to use patent law firms in order to maximize efficiencies; for example, by outsourcing administrative or specialized legal tasks to patent law firms (Cha et al., 2009; Jiang, 2006). Moreover, firms with a large number of patents often engage a network of attorneys to manage their IP portfolios (Gassmann & Bader, 2006). Thus, we controlled for client firms' patent portfolio size. We measured portfolio size using the client firm's total number of patents to which the focal patent (unit of analysis) belongs at the time of cutoff. In our sample, patent portfolio size ranged from 1 to 83,136, and averaged about 11,066. We controlled for technological diversification, which is defined as the spread of the patent portfolio over technology classes (Leten et al., 2007), by including a measure of the number of IPC classifications assigned to the patent application by the EPO (Harhoff & Wagner, 2009). We argue that firms with a wider technological spread are lacking in specialization, and are more likely to use external patent attorneys to cope with the technological and legal aspects of patent protection.

Most European patent applications are filed by firms originating in the triadic jurisdictions: the EU, the US, and Japan. In 2014, patents granted to European companies accounted for 51% of patent applications at the EPO, while US companies accounted for 22%, and Japanese companies for 17% (European Patent Office, 2014). In our sample, 98% of observations were associated with companies in the triadic regions. A firm's nationality might impact the patent attorney's filing strategy. Therefore, we controlled for nationality of the patent applicant firm using dummy variables. We also expected that cooperation complexity would have a negative impact on the filing dimensions of the patent attorneys' work, because in a complex context higher coordination and communication effort is needed to involve all patentees. Hence, further we also included a dummy variable to control for cooperation complexity. This variable is coded "1" if the patent is owned by more than one owner, and "0" otherwise. Our database contains data covering three decades. During this period patent management in general has received growing interest, and filing strategies have changed from a defensive to

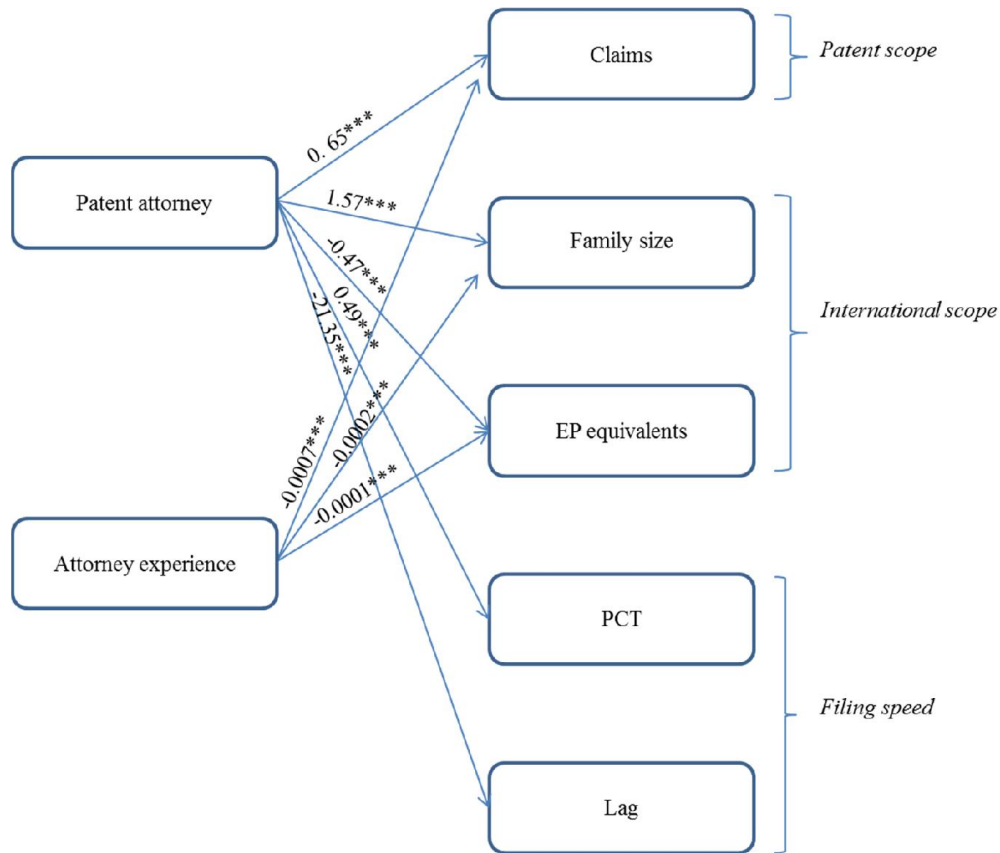
an active part of firms' strategy (van Zeebroeck & van Pottelsberghe de Potterie, 2011). For this reason, we also controlled for the patents' application date. Finally, because cost trade-offs influence strategic filing decisions, we controlled for firms' overall filing costs, including official fees and attorney fees.

4.5 Results

4.5.1 Descriptive Statistics and Results of Hypothesis Testing

Table 9 provides descriptive statistics for all variables, and Table 10 presents the estimation results for different models used to test the hypotheses concerning patent attorneys' influences on filing strategy. We used OLS regression, except for tests involving the dichotomous dependent variable, PCT, for which Logit regression was used. The regression analysis results indicate that both patent attorneys and their levels of experience do have a significant impact on filing dimensions. Models 1, 3, 5, and 7 show estimation results of patent attorneys' impacts on filing dimensions, whereas models 2, 4, 6, and 8, show estimation results of the effects of the patent attorney's level of experience on filing strategy. Our significant results and F-tests for all models enabled the variables to be interpreted further. Figure 10 summarizes the estimation results for the relationships between the attorney variables and filing dimensions.

Figure 10: Relationships between utilization of external patent attorney, patent attorney experience level, and strategic filing dimensions



Interpreting Models 1 and 2, we find that, as hypothesized, the utilization of external patent attorneys is significantly and positively related to patent scope, and attorney experience is significantly and negatively related to patent scope (Hypothesis 1a and Hypothesis 1b). This finding confirms that, in general, the patent attorney has an incentive to claim as broad a technological space as possible (Lanjouw & Schankerman, 1999), and is consistent with van Zeebroeck’s (2009) assertion that more experienced attorneys have a capacity to draft their applications more narrowly, and in a more highly specified manner.

Hypothesis 2a predicted that utilizing external patent attorneys would have a significant positive effect on international scope, and Hypothesis 2b predicted that patent attorney experience level would have a significant negative effect on international scope. Estimation results from Model 3 support Hypothesis 2a, which predicted a positive relationship between the use of external patent attorneys and family size, whereas estimation results of Model 5, which predicted a positive relationship between the use of an external patent attorneys’ and EP equivalents, were significant, but in the opposite direction to that predicted in Hypothesis 2a. These findings suggest that patent attorneys impact to file on a broad basis; however it seems that, in our sample, external attorneys tend to have a negative effect on the development of a patent portfolio and/or thickets of relatively similar patents related to one innovation. One

explanation for the latter result might be that we focused on the influences of external patent attorneys, whereas strategies such as portfolio development require a deep understanding of the firm's R&D program and patenting needs, which is more likely to be characteristic of in-house patent attorneys (van Zeebroeck & van Pottelsberghe de Potterie, 2011). On the other hand, this argument supports Hypothesis 2b, the idea that more experienced attorneys focus their applications to specific legislations, and more experienced patent attorneys are capable of assessing the firm's overall patent strategy and using EP equivalents to create a sophisticated filing strategy. Estimation results of Model 4 and Model 6 support Hypothesis 2b, which predicted a negative impact of patent attorney experience level on family size and EP equivalents. Regarding Hypothesis 3, which concerned the impact of the use of patent attorneys on patenting speed, the results of Model 7 do not support the hypothesis. Specifically, Model 7 shows a significant, positive relationship between utilization of external patent attorneys and PCT. The finding support the motivation to delay the application procedure which can be used as a mean to create uncertainty (Harhoff & Wagner, 2009). This is consistent with the prior research which state that more and more firms opt for the PCT process (van Zeebroeck & van Pottelsberghe de Potterie, 2011). Models 8 exhibit a significant, negative relationship between utilization of external patent attorneys and lag. The negative correlation indicate that patent attorneys follow a strategy to reduce lag and therefore accelerate patenting speed. All of these things taken together build a compelling case that, in general, attorneys should prefer to minimize the lag however the benefits of the PCT option seem to outweigh the motivation to patent quickly.

4.5.2 Robustness

We performed additional analyses to ensure the validity of our results. We assessed whether multicollinearity of measures was a problem. Table 11 gives the correlation matrix for all variables. The highest correlation, $r = -0.780$, is between the two control variables: EU_dummy and US_dummy. The second highest correlation, $r = 0.677$, is between an independent variable, attorney experience level, and a control variable, firm portfolio size. All other correlations are below $r = 0.5$. This level of correlation indicates that problems of multicollinearity are unlikely. To further check whether there was a multicollinearity issue with the variables, we calculated Variance Inflation Factors (VIFs) (see Table 12). The results show that the data are consistent with the assumption of no multicollinearity. The highest VIF is 7.970, and the mean VIF is 2.20: both are below the suggested threshold of 10 (Chatterjee et al., 2015). Overall, these robustness checks provide greater confidence in our reported empirical results.

4.6 Extending theory on patent filing typologies

In this section we use our empirical results and insights from our expert interviews to extend current theory by defining a patent filing typology which accounts for the relationship between the use of patent attorneys and their experience level and filing tactics. As mentioned, patent attorneys' work and the influences of their level of experience on drafting claims, taking certain filing routes and taking measures to slow down or speed up the application procedure can vary according to the filing strategy pursued. In this context, based on patent attorneys' decision options, we identify four types of filing strategies which reflect applicants' strategic use: *secure*, *enforce*, *exploit* or *block* (see Figure 11). We use number of claims, patenting speed, and international scope as patent filing dimensions, which have an impact on the examination procedure, competitive reactions, and potential for disputes. The vertical axis of the matrix represents international scope, operationalized as the number of countries in which the patent is filed. The horizontal axis represents lag, as measured by the time differential between the date an application is received at the patent office and the date the patent is granted. The resulting four quadrants describe the claim construction (number of claims) visualized by circles.

The strategy of *enforcing* a patent can be seen as the "typical" approach to patenting. Patent attorneys aim to maximize the area of protection, especially in the early patenting of yet unfocused inventions. The positive relationship between the use of external patent attorneys and the area of protection and international scope of the patent confirms that the patent attorney starts with a broad claim basis and reduces the area of protection during the examination process (figure 3). An example is provided by van Zeebroeck (2009), who describes a specific enforcement strategy for early inventions wherein the attorney first files a broad application including many claims, but then subsequently files divisional applications – possibly over several generations – so as to progressively restrict the scope of protection while research is advancing, and still benefit from the earliest priority. For European patents, a divisional application represents a „piece“ of a regular filing that is „extracted“ during the examination process. Such applications are usually filed when the uniqueness of the invention was lacking.

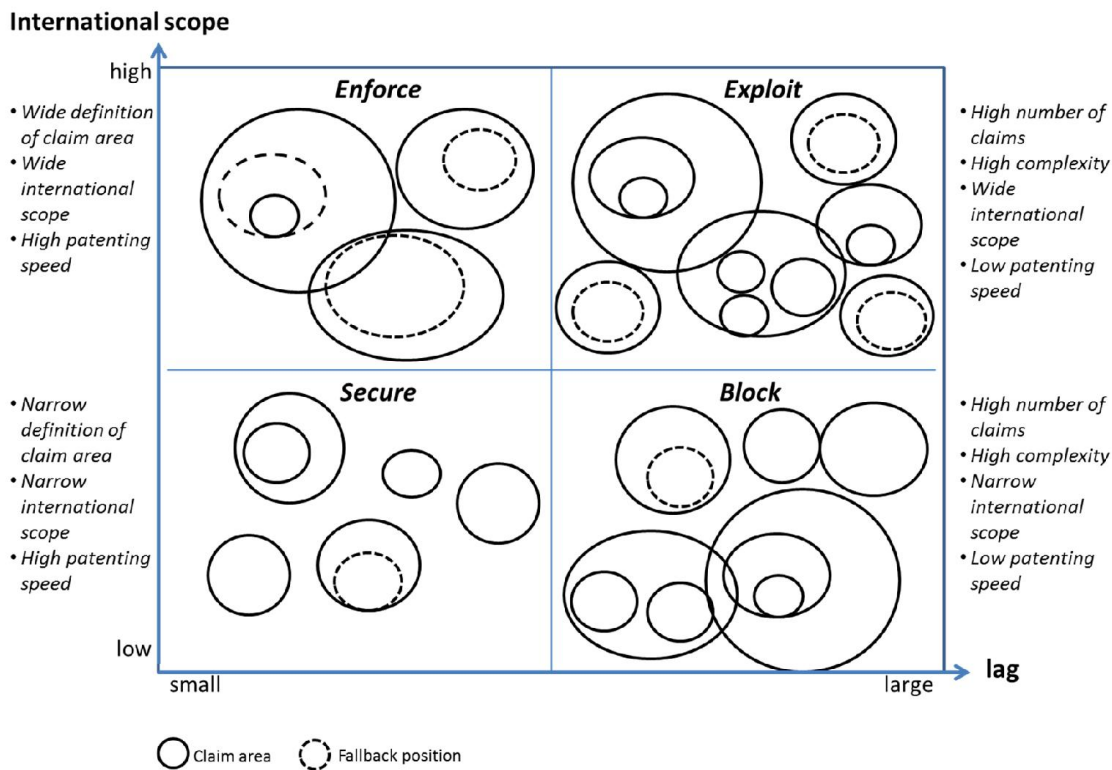
The strategy of *securing* the invention is important for valuable, key technology patents, and for core patents. In such cases the patent attorney identifies a specific area of protection, and claims are drafted in a clear and narrow way. As mentioned, claim construction, the process of defining the words of the claim in other, theoretically clearer words is one of the most significant aspects of patent litigation (Lemley, 2005). Consequently, the claim section focuses on more detailed and specific embodiments, often with the intent of building patent fences around the core invention (Cohen et al., 2000). A focused claim section accelerates the application process, reduces lag and limits the risk of litigation and legal disputes. The

attorney can reduce lag further by applying for an accelerated examination (Reitzig, 2004) in order to obtain protection quickly. Applicants often accelerate grant proceedings for their most valuable patents (Harhoff & Wagner, 2009).

The main motivation to use *exploitation* as a filing strategy is to maximize return on investment by selling or licensing the patent, or by using it as a bargaining chip (Sneed & Johnson, 2009; Gassmann & Bader, 2007; Bader et al., 2012). As Bianchi et al., (2010) state, exploitation strategies may allow for the generation of additional revenues, thus covering the high costs of R&D, and for access to markets – especially foreign markets – that the firm cannot serve directly. This strategy requires that the patent attorney files a broad, international application, or applies via PCT in order to generate high returns. The claim architecture in such cases can be described as wide, and is aimed at protecting as large an area as possible in order to achieve high returns. Typically this filing strategy imposes a high coordination and alignment between the applicant and the examiner (Criscuolo & Verspagen, 2008).

The final filing strategy we identify is *blocking*. As mentioned, an assessment of the evolution of patent filings indicates that, with increasing frequency, applicants and attorneys attempt to file patents that include high numbers of claims (van Zeebroeck et al., 2009). This makes it very difficult for competitors to invent around the resulting patents. Highly complex claims are drafted, which increases lag and creates uncertainty (van Zeebroeck & van Pottelsberghe de Potterie, 2011). In addition, claims are filed in numerous countries, or via PCT, in order to achieve maximum blocking power and extend examination time (Harhoff & Wagner, 2009). One example of a blocking strategy is the “block the fence” approach wherein, in an attempt to drive up the costs associated with “inventing around”, the firm files a large number of patents, only some of which are associated with its core innovation: the rest are instead concerned with related processes and substitute products (Fisher & Oberholzer-Gee, 2013). Another blocking approach is to create prior art when filing patent applications in order to block the patentability of other applications. Once prior art is achieved the applications are abandoned shortly after their publication (Lazaridis & van Potterie, 2007). In this case, patents are intrinsically narrower, possibly because they target very specific domains (Guellec et al., 2012).

Figure 11: Filing strategies and patent attorneys’ decision options



4.7 Conclusion and Managerial Implications

Our study relies on the assumption that patent attorneys influence patent strategies, which has been recognized but not sufficiently analyzed in the existing literature. Previous studies have accounted for patent attorneys’ impacts in a more qualitative way, and only a few have assessed how the characteristics of patent attorneys’ work relates to filing strategies, and to the structure and quality of patent drafts. The objective of this paper was to empirically test whether the use of external patent attorneys, and the patent attorney’s level of experience, have an effect on filing strategies measured by patent indicators. Our implementation employed a unique dataset that included attorney variables, and used five different indicators of filing strategies as dependent variables. The results show that the use of patent attorneys is positively associated with most filing dimensions, particularly with the number of claims, family size, and the PCT route option. One novel and consistent finding is that the patent attorney’s experience level has a negative impact on all dimensions of filing strategy. This suggests that, overall, there is a “maximization approach” at play, which results in more claims, filings in more countries, and more PCT applications; but more experienced patent attorneys are capable of applying a more focused filing approach. The drafting style of the experienced patent attorney is narrower in order to, for example, secure the invention and obtain a granted patent quickly. Based on previous research and our empirical results, we

conclude that filing strategies can be categorized into four types – secure, enforce, exploit, and block – which can be explained by combining filing dimensions used in our models, such as the definition claim basis (wide vs. narrow), the international scope of the filing (wide vs. narrow), and the patenting speed (high vs. low). However, our empirical results do not support the strategy of blocking or exploiting by means of delay tactics, which may induce complexity and uncertainty. We believe these strategies might require specific internal know-how and a deep understanding of the firm's IP situation, which are more likely to be provided by an in-house patent attorney than by an external one (van Zeebroeck & van Pottelsberghe de Potterie, 2011).

Our empirical findings have implications for both management practice and empirical research using patent data. The main conclusion concerning the firm's strategic patenting approach is that strong involvement of the firm's IP managers with external patent attorneys must be ensured. The patent attorney's work has important influences on filing dimensions, and therefore on the patenting output. We suggest an integrated approach, which involves all IP stakeholders, particularly external patent attorneys. As firms can improve their innovative and financial performance by interacting with different suppliers (Garcia et al., 2014), we argue that firms can improve the IP performance by interacting with external patent attorneys. Thus, filing of patents should be coordinated and aligned with all IP actors in order to achieve strategic goals, leverage the best combination of external and internal capabilities and avoid undesirable effects or counter effects. Besides, patent data is increasing in significance as an objective output indicator for R&D activities (Ernst, 2001); therefore, it is advisable to correct for effects associated with the influence of patent attorneys, which might add "noise" to some patent indicators. Our work has identified some of the effects of the use of patent attorneys on patent indicators that need to be corrected for. The present study is subject to certain limitations that could be addressed in future research. For example, we have limited our examination to the impacts of external patent attorneys: future investigations should be extended to include internal patent attorneys as well. With a few exceptions (Reitzig, 2004; Somaya et al., 2007; Moeen et al., 2013; Ayerbe et al., 2014), the literature on vertical integration in the context of IPR is rare. Scholars have recognized that IP management requires a high level of interdependence across functional areas in the IP value chain (Gassmann & Bader, 2007; Somaya et al., 2007), whereas legal patent protection is administered by highly specialized patent attorneys (Reitzig & Puranam, 2009). Fisher and Oberholzer-Gee (2013) point out that the R&D strategy and legal functions are often poorly integrated, and, as a result, firms miss opportunities to create and exploit IPR.

On the other hand, dealing with external IP intermediaries, such as patent attorneys, law firms or other IP vendor firms creates the need for firms to access the most competent suppliers in

each technology area (Moeen et al., 2013), and legal work needs to be coordinated amongst them. As Somaya (2012) states in his review article, more insight is needed into the triggers, processes, and mechanisms through which firms develop sophisticated patent management capabilities with external IP suppliers. Also, in line with the study of Cai et al. (2014) we suggest that different streams of capabilities are required to manage supplier relationships, which facilitates capabilities to exploit and explore, for instance strong ties facilitate capabilities to identify new opportunities, to form a collective to pool resources and to work across organizational boundaries while weak ties are conducive to the search for new ideas but impede firms' capability to realize potential innovations. In this context, an interesting question remains how supplier relationship ties with law firms or other IP suppliers affect firms' patenting output. Finally, the interplay, controlling and coordinating activities between firms' and IP intermediaries is another area for research. Competitive advantage of firms by means of innovation is often driven by the ability of these firms to protect their intellectual property effectively. Overall, the role of patenting strategy and its impact on creating and capturing value out of investments in innovation is a huge field for future research.

Table 9: Descriptive statistics for all variables

Variable	Mean	Std.Dev.	Min	Max
CLAIMS	10.820	8.744	0	355
FAMILY SIZE	8.432	4.161	1	19
EP EQUIVALENTS	5.079	3.335	0	23
PCT	0.138	0.345	0	1
LAG	1478	478.9	376	5140
Attorney dummy	0.375	0.484	0	1
Attorney experience	377.500	620.5	1	3085
Portfolio size	2.939	1.014	1	5
Technological				
Diversification	7.049	5.642	0	121
Cooperation complexity	0.010	0.103	0	1
Filing cost	14.020	133.4	0	6865
Application date ⁴	11830.030	1133.561	6860	14648
EU dummy	0.833	0.373	0	1
US dummy	0.111	0.314	0	1
JP dummy	0.037	0.190	0	1

⁴ The date on which a patent application is received by the EPO is recorded as application date (DDMMYY)

Table 10: Regression results for patent attorneys' impacts on *filing strategy*

Dependent variable	(M1) CLAIMS	(M2) CLAIMS	(M3) FAMILY SIZE	(M4) FAMILY SIZE
Variable	Coef. (SE)	Coef. (SE)	Coef. (SE)	Coef. (SE)
Attorney dummy	0.653*** (0.113)		1.578*** (0.053)	
Attorney experience		-0.0007*** (0.0001)		-0.0002*** (0.00005)
Portfolio size	-0.578*** (0.053)	-0.337*** (0.708)	-0.297*** (0.025)	-0.367*** (0.034)
Technological diversification	0.262*** (0.009)	0.255*** (0.009)	0.124*** (0.04)	0.113*** (0.004)
Cooperation complexity	-0.728* (0.512)	-0.727* (0.512)	0.234* (0.242)	0.343* (0.246)
Filing cost	0.001*** (0.0003)	0.001*** (0.0003)	0.001*** (0.0001)	0.002*** (0.0001)
Application date	0.0005*** (0.00004)	0.0005*** (0.00004)	-0.000002 (0.00002)	0.00001 (0.00002)
EU dummy	-3.966*** (0.395)	-4.203*** (0.393)	-1.461*** (0.187)	-1.931*** (0.189)
US dummy	1.848*** (0.422)	1.665*** (0.420)	-3.036*** (0.200)	-3.592*** (0.202)
JP dummy	-3.184*** (0.476)	-3.146*** (0.476)	-4.446*** (0.225)	-4.451*** (0.229)
Constants	7.045*** (0.691)	6.977*** (0.691)	9.560*** (0.337)	10.808*** (0.333)
number of observations	67,111	67,111	67,111	67,111
<i>Model statistics OLS regression</i>				
R ² (adjusted R ²)	0.093 (0.093)	0.093 (0.093)	0.103 (0.103)	0.072 (0.072)
F statistic (d.f.)	285.61*** (9;67071)	286.61*** (9;67071)	319.31*** (9;67071)	217.48*** (9;67071)
<i>Model statistics Logit regression</i>				
LR chi square (6)				
Prob > chi square				
Pseudo R ²				
Log likelihood				

*p<0.5, **p<0.01, ***p<.001

Table 10: (continued)

Dependent variable	(M5) EP equivalents	(M6) EP equivalents	(M7) PCT	(M8) LAG
Variable	Coef. (SE)	Coef. (SE)	Coef. (SE)	Coef. (SE)
Attorney dummy	-0.474*** (0.043)		0.490*** (0.040)	-21.359*** (6.099)
Attorney experience		-0.0001***(0.0004)		
Portfolio size	-0.015* (0.20)	0.105*** (0.27)	-0.202*** (0.19)	25.591*** (2.887)
Technological diversification	0.066*** (0.03)	0.068*** (0.003)	0.036*** (0.003)	7.791*** (0.509)
Cooperation complexity	0.500** (0.198)	0.451* (0.199)	0.232*(0.169)	-12.604 (27.615)
Filing cost	0.002*** (0.0001)	0.002*** (0.0001)	0.0006*** (0.0001)	0.060** (0.021)
Application date	0.0002***(0.00001)	0.0002*** (0.00001)	0.0007*** (0.00002)	-0.088*** (0.002)
EU dummy	0.484** (0.153)	0.610*** (0.153)	-1.072*** (0.110)	-326.243*** (21.306)
US dummy	-0.663*** (0.163)	-0.478** (0.163)	-0.761*** (0.021)	-14.525 (22.769)
JP dummy	-2.094*** (0.185)	-2.078*** (0.185)	-1.523*** (0.157)	-2.601 (25.704)
Constants	1.6302*** (0.268)	1.039*** (0.268)	--10.111*** (0.280)	2673.414*** (37.282)
number of observations	67,111	67,111	67,111	67,111
<i>Model statistics OLS regression</i>				
R ² (adjusted R ²)	0.063 (0.062)	0.059 (0.059)		0.123 (0.123)
F statistic (d.f.)	187.09*** (9;67071)	175.03*** (9;67071)		391.11*** (9;67071)
<i>Model statistics Logit regression</i>				
LR chi square (9)			2258.41	
Prob > chi square			0.000	
Pseudo R ²			0.112	
Log likelihood			-8890.9722	

*p<0.5, **p<0.01, ***p<.001

Table 11: Correlations

	Claims	FAMILY SIZE	EP equiv.	PCT	LAG	Attorney dummy	Attorney experience	Portfolio size	Tech. Diversification	Coop. compl.	Filing cost	Appli-cation date	EU dummy	US dummy	Japan dummy
Claims	1														
FAMILY SIZE	0.091	1													
EP equiv.	0.022	0.468	1												
PCT	0.198	0.174	0.061	1											
LAG	0.172	0.023	-0.020	0.056	1										
Attorney dummy	0.032	0.190	-0.078	0.095	-0.036	1									
Attorney experience	-0.062	-0.117	-0.029	-0.086	0.093	-0.212	1								
Portfolio size	-0.068	-0.126	0.0005	-0.078	0.059	-0.219	0.677	1							
Tech. diversification	0.189	0.134	0.097	0.065	0.127	-0.075	0.001	0.030	1						
Coop. complexity	-0.009	0.011	0.014	0.014	-0.004	0.023	-0.015	-0.005	0.007	1					
Filing cost	0.037	0.077	0.102	0.061	0.007	0.038	-0.033	-0.052	0.001	0.008	1				
Application date	0.067	0.0004	0.086	0.240	-0.209	0.011	0.042	0.036	-0.0008	0.009	0.034	1			
EU dummy	-0.211	0.116	0.143	-0.034	-0.261	-0.019	-0.090	-0.026	-0.129	0.001	-0.004	0.009	1		
US dummy	0.218	-0.108	-0.082	0.021	0.207	-0.071	0.073	0.014	0.106	-0.025	-0.002	-0.017	-0.790	1	
Japan dummy	0.008	-0.110	-0.139	-0.024	0.115	0.089	0.081	0.073	0.053	0.032	-0.018	0.015	-0.440	-0.069	1

Table 12: Variance Inflation Factors

Variable	VIF	SQRT-VIF	Tolerance	R-Squared
CLAIMS	1.160	1.080	0.865	0.135
FAMILY SIZE	1.470	1.210	0.680	0.320
EP EQUIVALENTS	1.370	1.170	0.728	0.272
PCT	1.150	1.070	0.866	0.134
LAG	1.180	1.090	0.849	0.151
Attorney dummy	1.170	1.080	0.857	0.143
Attorney experience	1.910	1.380	0.525	0.475
Portfolio size	1.900	1.380	0.527	0.472
Technological diversification	1.090	1.040	0.918	0.082
Firm Complexity	1.000	1.000	0.997	0.002
Filing cost	1.020	1.010	0.981	0.019
Application date	1.150	1.070	0.869	0.132
EU dummy	7.970	2.820	0.125	0.875
US dummy	6.430	2.540	0.156	0.845
JP dummy	3.010	1.730	0.332	0.668
Mean VIF	2.200			

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