Three Essays on the Organizational Dimensions of the Strategic Management of Patents

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Declaration

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Abstract

This dissertation is rooted in market for technologies theory and organizational economics to answer to a call for additional research on the processes and organizational mechanisms through which firms implement their patent strategies.

The first chapter investigates the organizational configurations that lead to success in granting a patent and capture value from innovation. Using a fuzzy-set Qualitative Comparative Analysis (fs/QCA) of 20 firms, the chapter explores the role of different combinations of centralization of decision-making, cross-functional involvement, and codification of information on the timely ability to secure protection to an invention through patent grant.

The second chapter provides a micro analysis of the overall management of the technology licensing process. Using multiple case studies, the research found two configurations to organise the capabilities and governance of decision making in technology licensing. In the first configuration, the management of licensing is based on a combination of internal flow of information, stand-alone coordination mechanisms and inside-out negotiating capabilities, which are the capabilities to convince external partners of the validity of the technology. In the second configuration, licensing is orchestrated through an external flow of information, shared coordination mechanisms and outside-in negotiating capabilities, which are the capabilities to convince members of the same organization of the validity of the license agreement and to moderate the various internal debates related to the agreement.

The last chapter examines the role of indemnification clauses on intellectual property (IP) rights in the case of licensing deals and discusses the implications for the optimal design of licensing contracts. The study proposes that indemnification clauses on intellectual property rights operate as signals to share the risk and reduce moral hazard in licensing contracts. Building on market for technology literature and contract theory, the research found that the inclusion of IP indemnification clauses in technology licensing is correlated with a higher likelihood of selecting a payment schemes based on a combination of lump sum and royalty rate. Furthermore, the effect is amplified when the licensee and licensor operate in distant technological domains.

Chapter 1 Introduction

Over the last decades, intellectual capitalism emerged as a combination of a capitalist economy and knowledge economy (Granstrand, 2000). Since intellectual capital assumed a dominant role in companies' strategies (Andriopoulos & Lewis, 2008; Blind et al., 2009; Grindley & Teece, 1997), companies started facing increasing competition and challenges in protecting their knowledge from leakages, imitation, spillover, espionage and counterfeit (Andrea Fosfuri, 2000; Pacheco-de-Almeida & Zemsky, 2012; Reitzig et al., 2007). The rise of intellectual capitalism required the creation of intellectual property (IP) rights, of which patents are a prime exemplar, to protect proprietary knowledge and innovation in order to secure competitive advantages (Markman et al., 2004).

Given the increasing relevance of the strategic management of patents, scholars from various disciplines have broadly inquired how firms should organize strategic patent-related activities –i.e. the acquisition and maintenance of patent rights, licensing, enforcement and litigation. Strategic patent-related activities have been viewed and explained through the theoretical lenses of signalling and information disclosure (Harhoff & Wagner, 2009; Harhoff, Scherer, & Vopel, 2003), real options (Bloom & Van Reenen, 2002; Nerkar, Paruchuri, & Khaire, 2007; Ziedonis, 2007) and non-market strategies (Somaya & McDaniel, 2012b). Within the strategic management of patents, the study of the organization of patent-related activities and of patent-related capabilities remain an overlooked area.

Contributions in this area draw mainly from Resource Based View (RBV) theory and explained how the combination of legal and technical capabilities and cross-functionality across organizational units during the patenting process increase the ability to appropriate value from innovation and secure rents to sustain the competitive advantage (Reitzig & Puranam, 2009; Reitzig & Wagner, 2010; Somaya, Williamson, & Zhang, 2007). Recent studies analysed the role of external law firms as external suppliers of knowledge to facilitate patent-related activities (Wagner, Hoisl, & Thoma, 2014). Despite some progresses, *"more insight is needed into the triggers, processes and mechanisms by which firms develop sophisticated patent management capabilities"* (D. Somaya, 2012, p. 1102).

The three papers in this dissertation answer to the call for additional research on the strategic management of patents and focus on the processes and organizational mechanisms through which firms implement their patent strategies. Rooted in market for technologies theory and organizational economics, my dissertation aims at looking at organizational practices that constitute optimal coordination strategies for the patenting process and the licensing mechanism. Drawing on organizational design literature, I completed a cross-sectional study of large organizations that are highly active in patenting (European Patent Office, 2012) to tease out how the patenting effort is influenced by the configuration of the R&D organizational structure, by formal coordination mechanisms and by interdependent distributed work. Turning to the technology licensing practices, I embraced an organizational contractual framework to look at (1) the micro-practices and micro-foundations of technology licensing within the IP departments and (2) the influence of IP indemnification clauses on technology licensing price.

The dissertation contributes to research on the strategic management of patents by embracing an organizational perspective and by providing a micro-analysis of the practices and capabilities associated with patent-related activities. Through an organizational framework, I examine the conceptual interdependence between patent-related capabilities and the organizational design of patent-related practices to provide a complementary explanation to the current understanding of patent-related capabilities based on RBV theory. The dissertation also provides an empirical contribution in the field of the strategic management of patents, because it triangulates qualitative and quantitative evidence on the practices and mechanisms through which firms organize their patenting and licensing activities. Based on this comprehensive empirical approach, I integrate rich and fine-grained evidence on patent-related practices and capabilities from case studies with a systematic test of secondary data obtained from a large dataset.

The next paragraphs briefly examine existing contributions on patent strategies and the strategic management of patents. I then summarize the three papers and explain how the dissertation connects to and expands previous research on the strategic management of patents and particularly patent management capabilities.

1.1. Patent Strategies and the Strategic Management of Patents

Among IP rights, patents cover an important role in protecting proprietary knowledge. Patents are legal instruments that protect inventions. In order to be granted such legal protection, inventions must be novel, inventive and possess industrial applicability. Patents are exclusive rights that prevent third parties to use, sell, or reproduce the invention without the permission of the patents' owner. The legal protection lasts 20 years after the application and the patentee has the possibility of either exclusively using the patented invention or concluding licensing contracts. In management research, patents have been acknowledged as intangible resources crucial for developing firm strategy and for scaling up the competitive advantage through the acquisition of economic rents (Ceccagnoli, 2009; Hsu & Ziedonis, 2013; Nerkar & Shane, 2007). To protect or improve their competitive positioning, firms can make strategic actions on their patent portfolio. This set of actions can be defined as a proprietary, defensive, or a leveraging patent strategy (Blind, Edler, Frietsch, & Schmoch, 2006; Somaya, 2012). Firms adopt a proprietary strategy when they use patents as offensive blocking instruments to prevent competitors from using or copying the invention and related technology (Arora & Nandkumar, 2012; Ceccagnoli, 2009; Hsu & Ziedonis, 2013). This strategy is aimed at obtaining direct economic rents from the commercial exploitation of the innovation protected by IP rights. Alternatively, firms may decide to develop a defensive strategy. With a defensive strategy, firms make sure not to infringe or violate third parties' patents to avoid being exposed to the risk of being held up for rents. The main goal of a defensive patent strategy is maintaining freedom to operate, for instance by creating patent thickets (Cockburn & MacGarvie, 2009; Ziedonis, 2004). Finally, firms may adopt a leveraging strategy to use patents as a resource to generate additional rents by giving the permission to third parties with a license agreement to use the proprietary knowledge protected through intellectual property rights (Kim, Vonortas, & Wiley, 2006; Somaya, Kim, & Vonortas, 2010). Through a leveraging strategy, firms exercise the bargaining power arising from their patent rights to gain licensing fees. When doing so, they need to balance the trade-off between rent-appropriation and the reduced market-share implied by an increasing competition due to the number of licensees (Andrea Fosfuri, 2006). In addition, patent licensing as leveraging strategy can be used to settle the preliminary phases of litigations (Shane & Somaya, 2007; Somaya, 2003): this type of strategy has been extensively used by “patent trolls” in the attempt to threaten patent holders with the request of large damage awards for patents infringement (Galasso, Schankerman, & Serrano, 2013; Reitzig et al., 2007). Given the strategic relevance of patents and IP rights, research has largely inquired into how firms manage their patent-related choices and actions through the lenses of signalling and information disclosure theory, real options, non-market strategies and institutional targeting frameworks. Signalling and information disclosure theory helped in understanding how the certification of an invention through a patent application provides strategic advantages for a firm. The information contained in patents signals the quality of innovation and is of particular importance for investors and licensees to decrease information asymmetry (A. Agrawal, 2006; Bessen, 2005; J. S. Gans, Hsu, & Stern, 2008; Guellec & van Pottelsberghe de la Potterie, 2000). According to real option theory, obtaining and maintaining patent protection, licensing and enforcing can be seen as a chain of options that firms decide either to exercise or to abandon depending on the value of the patents, inventive characteristics, and uncertainty on the future exploitation of the rights (Bloom & Van Reenen, 2002; Clarkson & Toh, 2010; Nerkar et al., 2007; Ziedonis, 2007). Finally, a recent stream of literature focuses on how law and institutions shape firms' patent strategies. Despite the negotiation of patent laws in international treaties, the institutional system is heterogeneous and firms have to make discretionary choices on where to file and enforce patents. These choices depend on the requirements and duration of the patent application process (Graham & Harhoff, 2014; Harhoff & Wagner, 2009), and the specialization in patent law for the enforcement of patents (Somaya & McDaniel, 2012b).

Within the strategic management of patents, the study of patent-related capabilities and the organizational traits of patent-related activities remain an overlooked area. Research in that area built on RBV framework and has sought to tease out how firms develop capabilities to manage patent-related activities and how they affect firm performance. Patent attorneys contribute with their legal knowledge and organize cross-functionally with the technical experts to translate patenting into a value appropriation activity (Reitzig & Puranam, 2009; Somaya et al., 2007; Somaya & McDaniel, 2012a). Furthermore, firms can leverage external knowledge and capabilities when implementing their patent strategy by outsourcing parts of their patent-related activities, although outsourcing requires careful consideration, because it can lessen the ability to develop internal capabilities (Mayer, Somaya, & Williamson, 2012; Reitzig & Wagner, 2010; Wagner et al., 2014).

Although those studies explained important dimensions of the strategic management of patents and particularly of patent-related capabilities, several questions on the way firms manage their patent-related activities and on the implications for patent strategy remain unaddressed. Particularly, researchers so far omitted to explore the organizational dimensions through which firms organize, control and coordinate patent-related activities and exploit patent management capabilities.

1.2. Three essays on the Organizational Dimensions of the Strategic Management of Patents

My research contributes in extending existing knowledge on patent-related capabilities and the organizational traits of patent-related activities by looking at the organization of intellectual property departments and how these departments strategically manage both patenting and licensing activities to protect innovation and extract value from inventive effort. Three papers form the pillars of my research and their connecting point lies in the organizational dimensions of the strategic management of patents. In the first essay, I draw from organizational design literature and analyse how the centralization of decision-making on patents strategy, cross-functional involvement and formal codification of information jointly impact the capability to appropriate value from innovation. In the second essay, I focus on the micro-practices and the licensing negotiating capabilities that emerge in the technology licensing process. The paper adopts a micro-organizational approach and explores how firms can manage technology licensing through internal flow of information, and internal coordinating mechanisms. The third essay also analyses technology licensing through an organizational framework, but focuses on the contractual dimensions and how to decrease behavioural opportunisms in licensing through the inclusion of indemnities on IP. Summaries of the three papers follow below.

Configurations of vertical and horizontal coordination mechanisms to achieve value appropriation from innovation

The paper investigates how value appropriation from innovation derives from different constellations of horizontal and vertical coordination mechanisms. The research builds on innovation literature and organizational economics and uses a fuzzy set theoretical methodology on a sample of 20 firms. The paper highlights how different combinations of centralization of decision-making on patents, cross-functional involvement and codification of information lead to configurations associated with fast patent grants. Moreover, the research provides an analysis of the 'chemistry of elements' that induces the occurrence of slow patent grants as incapability to timely appropriate value from innovation. The most insightful finding is that it is possible observing value appropriation from innovation, because of a heterogeneous and equifinal bundle of vertical and horizontal mechanisms. Overall, the paper contributes in connecting the complementary research streams on micro practices to appropriate value from innovation with the fast growing literature on R&D organizational structure.

How can IP Department Manage Technology Licensing? The IP Unit Perspective

The paper adopts a qualitative framework to understand the governance and practices of technology licensing. Through multiple case studies of 15 large organizations operating in different industries, it emerges that the technology licensing process is organized through two alternative models, which underline different systems to transfer internal information and to govern the decision making process. Data show that organizations can arrange licensing through negotiators or ad-hoc teams, depending upon the overarching goal of innovation strategy at the corporate level. On one side, negotiator teams manage the technology licensing process through a centralized system that concentrates both the management of internal information and the governance of the decisional power. On the other side, ad-hoc teams play a brokering role in a hybrid system that partially decentralizes the management of information and leads the decision making through an on-going alignment of competing interests. The paper builds on multiple case studies to develop theoretical knowledge on the micro-foundations of patent-related capabilities in the case of technology licensing.

Licensing price and indemnification clauses on intellectual property rights: An empirical investigation of double side moral hazard

This study examines the role of indemnification clauses on intellectual property (IP) rights in the case of licensing deals. I propose that indemnification clauses on intellectual property rights operate as signals to share the behavioral risk and reduce moral hazard in licensing contracts. Building on market for technology literature and contract theory, I suggest that the inclusion of IP indemnification clauses in technology licensing explains the prevalence of payment schemes that are based on a combination of lump sum and royalty rate. This effect is amplified when the licensee and licensor operate in distant technological domains. Predictions are tested on data from the pharmaceutical industry, controlling for technological characteristics and discussing implications on the optimal design of licensing contracts.

The three essays are based on both qualitative and quantitative evidence. I have conducted an exploratory study using an inductive methodology based on in-depth multiple cases study. I collected data from November 2012 to August 2014 from a total of 23 large-sized companies with an internal IP department. Sampling included four cases in the healthcare industry, five in the ICT, and eight in the manufacturing and six in the pharmaceutical industry. I interviewed 48 key informants who were heads of in-house IP units, executives of R&D departments or senior patent attorneys. Interviews lasted one hour and were fully transcribed (totalling approximately 200 pages) and triangulated with personal notes (100 pages), and archival data (150 documents). For these companies, data on their patent portfolios were retrieved from PATSTAT for a total of 21,119,283 patents, while financial measures were obtained from the Orbis database. The first and the second essay of the dissertation are based on this data collection. The thesis finally analyses the role of indemnification clauses on intellectual property right as tools to manage double side moral hazard in technology licensing. From the Recap dataset, I collected data of indemnification clauses and warranties in technology licensing contracts for firms operating in the pharmaceutical industry between 1980 and 2004. In total 151 licensing contracts were used.

For each contract, patent data were retrieved from the USPTO patent database and financial measures from the Compustat dataset.

1.3. Contributions

The thesis contributes to the current research on the strategic management of patents by providing a comprehensive analysis of the organizational dimensions through which firms organize, control and coordinate patent-related activities. As its main theoretical framework, the dissertation adopts the organizational design literature and organizational economics as complementary lenses to understand how firms strategically manage patent-related activities that are connected with efforts to enhance the firm's performance.

The dissertation provides three main theoretical contributions. First, it disentangles the relationship between organizational structure and patent-related practices that leads to higher value appropriation from innovation. In doing so, the research conceptualizes the organization as whole, where practices and structure need to be jointly analysed and explained (Mohr, 1982). Through an organizational design framework, the research complements previous contributions on the patent-management capabilities that rely on RBV framework (Reitzig & Wagner, 2010; D. Somaya et al., 2007; Wagner et al., 2014). The dissertation also highlights the concomitant importance of multiple organizational mechanisms such as centralization of decision-making and coordination to effectively implement a patent strategy, extending previous studies that focused on the effects of single organizational mechanisms, for example cross-functionality in patent-related activities (Reitzig & Puranam, 2009).

Second, the dissertation expands a growing research stream in the field of market for technology that studies the organization of technology licensing. Building on a pioneering paper by Arora and colleagues (Arora, Fosfuri, & Rønde, 2013), the dissertation provides a conceptual model that connects the organizational design of licensing with the management of internal information flow and coordinating mechanisms. The dissertation aims at providing the micro-foundations of the technology licensing process with an analysis of micro-practices and emerging capabilities and connects research on technology licensing with studies on strategy framing and internal political negotiations (Kaplan, 2008).

Third, the dissertation builds on contractual economics and expands our knowledge on the contractual clauses that could be inserted into a licensing contract to lower behavioural risk and reduce moral hazard (Laursen, Leone, Moreira, & Reichstein, 2013; Leone & Reichstein, 2012; Somaya et al., 2010). The research provides a novel analysis of the effect of indemnification clauses against patent infringements on licensing price and sheds light on the optimal design of licensing contracts.

The thesis also combines different methodologies and integrates both qualitative and quantitative evidence as well as primary and secondary data. From a methodological point of view, research on the strategic management of patents so far relied on quantitative investigations based on secondary data. Case studies that combine both primary and secondary data are instead scarce (Somaya, 2012), but by combining rich and fine-grained qualitative evidence obtained from primary sources with rigorous tests of data retrieved from secondary datasets this dissertation represents an intriguing example of the approach's potential. Furthermore, the thesis adopts three methodologies –i.e. multiple case studies, qualitative comparative analysis and multinomial regressions- to investigate how firms organize the strategic management of patents. The synergies among the different methodologies permit to unbundle the phenomenological complexity and provide an exhaustive and in-depth empirical investigation.

Chapter 2 Configurations of Vertical and Horizontal Coordination Mechanisms to Achieve Value Appropriation from Innovation

Abstract

This paper investigates how value appropriation from innovation is associated with different configurations of horizontal and vertical coordination mechanisms internal to the companies that innovate. Building on the innovation literature and organizational economics, and using a fuzzy-set Qualitative Comparative Analysis (fs/QCA) of 20 firms, we argue that different combinations of centralization of decision-making, cross-functional involvement, and codification of information are associated to high "patent grant success" (Reitzig & Puranam, 2009). We also analyse the configurations of organizational elements associated with low patent grant success, intended as a proxy of a firm's limited capability to timely appropriate value from innovation. Our findings show that value appropriation from innovation can be facilitated by a heterogeneous bundle of vertical and horizontal mechanisms, suggesting structural heterogeneity and equifinality in the causal patterns. Our findings contribute to integrate research on practices of value appropriation with the fast growing literature on R&D organizational structure.

2.1. Introduction

The analysis of the antecedents of value appropriation from innovation has been proven to be a rich source of insights into the causes of interfirm performance difference. A growing research stream focused on R&D organizational structure as macro vertical coordination mechanism that influences how firms appropriate value from their innovation (Aghion et al., 2013; Argyres & Silverman, 2004; Ashish Arora, Belenzon, & Rios, 2014; Leiponen & Helfat, 2011; Lerner & Wulf, 2007). For example, empirical evidence demonstrated that a centralized organizational structure might be helpful in setting the governance of long-term investments in R&D projects (Aghion et al., 2013; Lerner & Wulf, 2007). Furthermore, previous research highlighted the importance of the R&D organizational structure to integrate internal and external knowledge to foster innovation and appropriate value from this latter (Ashish Arora et al., 2014; Leiponen & Helfat, 2011).

Building on organizational economics theory, further studies have focused on the horizontal organizational mechanisms that foster innovation outcomes and value appropriation. Within this research stream, scholars explored the internal communication patterns that develop from and within the R&D department (Engelen & Brettel, 2012; Paruchuri & Eisenman, 2012; Van den Bulte & Moenaert, 1998), the integration of in-house patent law expertise and financial investments in R&D (D. Somaya et al., 2007) and cross-functionality across intellectual property (IP) generation, protection and utilization (Mayer et al., 2012; Moeen, Somaya, & Mahoney, 2013; Reitzig & Puranam, 2009; Reitzig & Wagner, 2010).

However, despite the common focus on value appropriation from innovation, these research streams remain mostly disjoint and separate. Yet, organization is an interdependent system where practices, processes and structures need to be jointly considered (Ménard, 2009; Mohr, 1982). Therefore, if we try to overlay these bodies of studies, it is fair noting that little is known on the mechanisms, by which organizations connect R&D organizational structure to IP practices to achieve value appropriation.

For example, Microsoft has a centralized R&D structure that focuses on four engineering silos: Operating Systems, Apps, Cloud and Devices. In 2015 they invested $12billions equal to 13% of their operating revenues in R&D, focusing mostly on basic research. As Microsoft stated on its website *"This investment serves as the foundation for Microsoft's vast patent portfolio of 60,000 issued patents and 35,000 pending applications"*. However, the management of the patent portfolio is not left to the research units, but to the centralized legal team. Within the centralized legal team, Microsoft has two distinct groups in charge for the patent portfolio management. On one side, a part of the legal team is responsible for patent application and prosecution; on the other side, the Intellectual Property Licensing group is a dedicated team nested in the legal function specialized in inbound and outbound negotiation of technologies. This example shows that the maximization of innovation outcome and value appropriation is not simply due to the effort of the R&D function. Instead both the centralized R&D and legal functions are jointly involved. This joint involvement raises two fundamental questions: how do these functions interact and coordinate in order to appropriate value from innovation? Is the centralized structure the only organizational form that achieves value appropriation from innovation? To the best of our knowledge these questions still remain unresolved. A compelling explanation that integrates structure and practice as vertical and horizontal mechanisms to achieve value appropriation from innovation is still lacking. Similarly, it is yet unclear how vertical and horizontal mechanisms work together to form a coherent system to appropriate value from innovation. Thus, we aim at tackling the research lacuna and answering *which configurations of horizontal and vertical mechanisms are associated with high value appropriation from innovation?*

We are interested in the chemistry of causal ingredients (Fiss, 2007) of both patenting practices and R&D organizational structures that could not be disentangled at any single level of analysis, yet understood through the comparison of configurations of elements (Ragin, 2008; Ragin & Zaret, 1983). In fact, effectively designed systems should be composed of different organizational attributes interconnected through discrete configurations of elements and practices (Grandori & Furnari, 2008, 2009). To explore the research gap, we designed a field study and investigate 20 firms operating in industries with high patenting rate (EPO, 2012). We build the patent portfolio of each firm, retrieving 2,687,331 patents and collecting data on number of patent applications, citations and grant dates. To understand the IP practices and the mechanisms through which organizations connect R&D structure with other functions and patenting practices we collected 41 in-depth interviews with patent counsels, scientists and heads of IP departments. We use set-theoretic methods to study in detail the potential combinations between R&D structures and patenting practices. We find set-theoretic method particularly appropriate to explore the research question, because it permits to analyse the cluster of interconnected structure and practice by combining multiple levels of analysis (Byrne, 2009; Fiss, 2011). Finally, by using a qualitative comparative analysis approach, we provide a representation of multidimensional interactions and internal hybrid configurations through a systematic cross-case comparison to not lose the within-case richness and complexity.

Our contribution is threefold. First, we contribute by expanding the notion of complementarity in innovation literature (Arora et al., 2014; Cassiman & Veugelers, 2006; Moeen et al., 2013; Somaya, 2012) by developing a holistic framework that connects both vertical and horizontal organizational coordination mechanisms. Through an empirical examination we show how it is possible identifying an equifinal ‘gestalt’ of practices and structures that define complementarity in inventive and patenting activities. Firstly, we find that centralization of R&D structure is a sufficient yet non-core condition to appropriate value from innovation. Organizations could better appropriate value from innovation through the patenting process when the centralization of their R&D structure is associated with a high degree of cross-functional involvement among organizational units and a mild level of formalization of communication. Second, our study sheds light on the organizational dimensions that influence the allocation of resources necessary to invest in patent filing and maintain patent prosecution (Guellec & van Pottelsberghe de la Potterie, 2000; Hegde, Mowery, & Graham, 2009; Peeters & Pottelsberghe de la Potterie, 2006). We claim that organizations should carefully plan their investments to increase their ability to appropriate value from innovation and target budgets to sustain R&D capacity without dismissing the relevance of the legal function. A second implication consists in the increasing relevance of communication mechanisms, tools and internal platforms that should be designed in order to maximize value appropriation from innovation. Finally, our configurational approach and qualitative comparative analysis complements the growing research on configurations in organizational design and strategy research (Fiss, 2007, 2011; Greckhamer, Misangyi, Elms, & Lacey, 2008; Miller, 1986, 1987). Qualitative comparative analysis aims at identifying the combination of factors that accounts for a specified outcome instead of isolating single explanatory variables. Thus, fuzzy-set qualitative comparative analysis (hereby fs/QCA) is a powerful tool that overcomes limitations of regression analysis with multiple interaction terms (Fiss, 2008). This methodological advance allows us to inquire deeper into the horizontal and vertical organizational mechanisms that jointly affect value appropriation from innovation.

2.2. A Configurational Approach to Value Appropriation from Innovation through Patent Grant

For many reasons, value appropriation from innovation has held the attention of strategy and innovation scholars frequently (Chatain & Zemsky, 2011; Grimpe & Hussinger, 2013; Jacobides, Knudsen, & Augier, 2006; Pacheco-de-Almeida & Zemsky, 2012). The core idea of value appropriation from innovation resides in the firms' capabilities to capture and protect the returns from inventive efforts at the origin of value creation. An obvious parameter to monitor value appropriation from innovation is the ability to obtain legal protection of invention through patents. Indeed, even though a patent is not a perfect gauge of innovation, it has been acknowledged as a sufficiently reliable indicator of the efforts to translate R&D productivity into commercial products (Jiang, Tan, & Thursby, 2011; Nerkar & Shane, 2007; Shane, 2001; Zahra & Nielsen, 2002). With the grant of a patent, all the inventive steps and innate novelty are assessed and recognized by a patent examiner, who is an official third party that must be convinced of the quality of the patent draft provided by the firm in order to confer the exclusivity IP rights (Guellec & van Pottelsberghe de la Potterie, 2000). Patent applicants negotiate with the examiners the claims to differentiate submitted applications from what is already covered by legal protection and highlight the increasing sophistication of innovation (Cockburn, Kortum, & Stern, 2002). However, emphasis is not only on the breadth and novelty of patent claims, yet also on the duration of the examination to obtain a patent grant and the exclusivity on the technology. In fact, organizations have a strong incentive to craft and submit solid patent applications with compelling claims in order to secure the grant fast. Only a granted patent gives the right to exclude third parties from the use of its protected technology, which can be exclusively used in the business development and secure value appropriation from innovation. Empirical evidence demonstrated that well-documented applications obtain faster patent grant and applicants tend to accelerate grant proceedings for innovations considered highly valuable and strategic, while controversial submissions correlated with a poor drafting tend to be delayed and eventually withdrawn (D. Harhoff & Wagner, 2009).

Furthermore, it is possible considering the grant of the patent as the ultimate outcome of a complex value chain (Reitzig & Puranam, 2009) that integrates formal structure with complementary processes and practices related to both IP generation and IP protection (Phanish Puranam & Srikanth, 2007; Reitzig & Wagner, 2010; D. Somaya et al., 2007). Firstly, the R&D function is involved with the patent attorneys on the backstage of a patent grant process for the disclosure of ideas. In this phase, scientists, doctors, and engineers play an important role in the IP generation, providing initial information such as sketches, innovation briefings and preliminary outlines of a potential patent. Patent attorneys support R&D members through the eliciting of patentable innovations, highlighting business and commercialization opportunities and legal issues. Secondly, patent attorneys are in charge of drafting and filing patents. Albeit patent offices such as the European Patent Office, US Patent and Trademark Office and Japanese Patent Office differ in some specifics of patent filing, it is fair to state that the main stages are common (S. Graham, Marco, & Miller, 2015; OECD, 2009). In the phase of IP protection, IP lawyers provide initial information on the scope and the claims of the application to the patent officer, who will revise the technicalities and reject or approve the application through a grant for exclusive legal protection. During this second step, IP lawyers might still ask inventors for further specifications and tests to make stronger the request to be submitted to the patent officer. Furthermore, research showed that this complex set of practices is more efficient if arranged in-house through vertical architectures that connect R&D with IP lawyers and other layers of the organization involved in IP creation and protection (Reitzig & Wagner, 2010). In fact, the more an organization internalizes the process of patent filing, the better its capability of leveraging internal knowledge and improving its responses towards competitors in the downstream production. In sum, research has independently highlighted that IP generation and IP protection are carried out through either horizontal (e.g. cross-functionality) or vertical coordination mechanisms (e.g. vertical architectures) structured throughout different layers of the organization. In the next paragraphs, we draw upon important streams in innovation literature and organizational economics to better define the vertical and horizontal coordination mechanisms identified as pillars to appropriate value from innovation. We also justify why these core organizational mechanisms should be analysed jointly instead of independent causal antecedents of value appropriation from innovation.

2.2.1. Vertical coordination mechanism

The first pillar focuses on centralization of decision making, as this construct influences the articulation of the organizational structure and resources' allocation for practices involved in innovation and patenting (Mohr, 1982; Williamson, 1991). Centralization of decision making can be either concentrated at an integrated hierarchical level or it can be diluted across lower positions assuming a decentralized structure (Mansfield, 1973; Pugh, Hickson, Hinings, & Turner, 1968). Organizations through authoritative centralized mechanisms provide a means for coordinating the activities of groups of individuals in way that are not easily achieved by free contractual agreements (Ménard, 2009; Simon, 1991; Williamson, 1991).

Concentration of decision making enhances the ability to leverage existing knowledge through the use of common goals and links artifacts embedded in the minds of individuals, leading to the emergence of rich informal communications (Puranam & Srikanth, 2007). Theoretical statements on the positive impact of centralization of decision making on performance found empirical support: there is a positive correlation between centralization of decision making in R&D function and high inventive performance and patenting activity, meanwhile decentralized R&D structures tend to perform poorer (Argyres & Silverman, 2004; Ashish Arora et al., 2014). However, when the articulation of formal structure is centralized in unique hierarchy, the quest for researching in external areas respect to the core is limited and inventive activity mostly relies on internal R&D (Argyres & Silverman, 2004; Ashish Arora et al., 2014; Leiponen & Helfat, 2011). Yet, research on complementarity in innovation demonstrated that inventiveness could be sustained by the combination of internal and external sources (Cassiman & Veugelers, 2006). Furthermore, empirical evidence found that decentralized organizations are more capable than centralized ones at acquiring knowledge to innovate from external sources and exploiting inventions coming from complementary fields, especially for those inventive activities that do not terminate with a new-to-the-market products (Argyres & Silverman, 2004; Ashish Arora, Belenzon, & Rios, 2011; Ashish Arora et al., 2014). Therefore, organizations with decentralized R&D functions could be able to reach high inventive performances in any case, by integrating internal and external sources and activities that sustain innovation. In fact, by being decentralized, organizations cannot generally benefit from intra-organizational knowledge spillover, as research focus is often different across the organization (Belenzon & Berkovitz, 2010; D. J. Miller, Fern, & Cardinal, 2007). However, decentralized organizations are influenced for each subgroup by more diverse external stimuli (Siggelkow & Levinthal, 2003), which help them in selecting among multiple sources in adjunct to those internal to foster inventiveness. Indeed, research reports strong inventive performances measured by high patenting rate for decentralized organizations, whose subgroups highly rely on external funds and more diversified capital sources (Belenzon & Berkovitz, 2010).

2.2.2. Horizontal coordination mechanism

The second pillar to explain value appropriation in the context of obtaining patent protection is cross-functional involvement. Cross-functional involvement can be defined as the mechanism that enables coordination between interdependent specialists nested in different functions within the firm (Puranam & Ravendraam, 2013; Reitzig & Puranam, 2009). Through cross-functional involvement, the organization is pervaded by an underlying structure of interdependencies that are particularly fruitful in the search of complementary solutions, especially when surrounding circumstances are unclear or in dynamic contexts (Levinthal & Warglien, 1999; Siggelkow & Levinthal, 2003). Furthermore, cross-functional involvement helps to avoid capabilities traps and being stuck in peculiar domains, because the interactions among complementary practices and capabilities across divisions enhances experimentation and spawns cross-fertilization (Levinthal & Warglien, 1999). However, in the case of obtaining patent protection, research found a negative correlation between patenting performance and high cross-divisional involvement of R&D and legal functions (D. Somaya et al., 2007). These findings could be explained through the lenses of specialization. Activities related to IP generation let engineers and patent attorneys work together on the same projects, leveraging reciprocal profound knowledge to understand the potential of inventions. However, technologists and lawyers have also divergent specialist expertise due to their divisional roles. Indeed, technologists have a scientific background, while patent attorneys are primarily skilled and trained from a legal perspective in order to absolve the law requirements necessary for the IP registration (Somaya & McDaniel, 2012). Thus, they might incur in coordination difficulties, because those actors belong to two distinct and (partially) incompatible micro-environments with their own mind-sets, languages and priorities. Yet, cross-functional involvement requires strong interactions among highly specialized employees with specific capabilities either in the technical or in the legal fields. Thus, after a certain threshold of specialization, interactions between technologists and attorneys could require too much effort in understanding and sharing information among functions, loosing therefore the benefits of interdependencies. We can therefore argue that high inventive performances are achieved for moderate degrees of cross-functional involvement. Indeed, empirical research found evidence of the positive relationships between intermediate levels of cross-functional specializations and value appropriation in the context of patent protection (Engelen & Brettel, 2012; Paruchuri & Eisenman, 2012; Reitzig & Puranam, 2009).

The third pillar refers to codification of information. Through codification, chunks of information are structured into pre-established formal mechanisms and plans that allow the transmission of notices and instructions (Srikanth & Puranam, 2011; Thompson, 1967). The establishment of codification permits to generate channels of communication that give clear directionality to the workflow and coordinate interdependence through modular interfaces (Puranam, Goetting, & Knudsen, 2010). Coordination strategies that use codification of information are often opposed to those that adopt on-going interactions and unstructured feedbacks (Thompson, 1967). In fact, in certain circumstances individuals may circumvent codification and transmit information through on-going communication, e-mails, informal presentations or phone calls (Srikanth & Puranam, 2011). In this latter case, the effective transmission of information is enhanced by the existence of a common ground through which expectations and discursive communications can converge on a shared framework (Kogut & Zander, 1996). Research demonstrated that engagement with the inventors through informal means and daily sharing of feedback has positive effects on inventiveness (A. Agrawal, 2006) and the effect is enhanced in the case of co-location of members (Giuri et al., 2007; Van den Bulte & Moenaert, 1998). Furthermore, IP lawyers are generally pro-active at bonding with scientists during the disclosure of ideas through personal conversations or internal platforms (D. Somaya et al., 2007). However, on-going communication might be problematic across different divisions and subgroups: members of separate divisions may lack a common background, inconsistent conventions and functional differences, so that communication will be limited (Camerer & Knez, 1996). Therefore, codification of information and communication through plans fosters the sharing of knowledge and data when the organizations present a decentralized structure (Srikanth & Puranam, 2011; Tushman, 1978), since the codified mechanisms and devices instil more reliability and certainty in the process. Furthermore, research provided evidence that high performing R&D projects with a high degree of interdependence make intensive use of technical services and devices to transfer information (Tushman, 1978). In fact, cross-functional involvement boosts interdependence among members belonging to different contexts, therefore the use of interfaces and codified procedures could be considered a more suitable option to coordinate activities and members involved in the inventive process.

2.2.3. Combinatory Laws of Complementarity Practices and Structure to Appropriate Value from Innovation through Patent Grant

The preceding discussion suggests that both vertical and horizontal coordination mechanisms related to IP generation and IP protection are idiosyncratically interconnected and interdependent in the whole organization, creating a complex system of practices and structure to appropriate value from innovation. While previous studies have separately analysed these coordination mechanisms (Argyres & Silverman, 2004; Arora et al., 2014;Puranam & Srikanth, 2007; Reitzig & Puranam, 2009; Reitzig & Wagner, 2010), our assumption is that R&D organizational structure, cross-functionality and coordination by plan interdependently contribute to appropriate value from innovation through patent grant.

To elucidate the gains and implications of the interdependence between vertical and horizontal mechanisms to appropriate value from innovation through patent grant, we adopt a configurational and complementary approach. Organizational economics and strategy research have widely demonstrated the joint importance of configurations (Meyer, Tsui, & Hinings, 1993; Miller, 1987) and complementarities (Milgrom & Roberts, 1990, 1995) to sustain firm's performance. These two approaches are conceptually distinct, yet theoretically synergic. The configurational approach postulates that organizational practices interact with each other and create multiple combinations along the process of the generation of outcomes (Fiss, 2007; Miller, 1987). An important assumption of configurational logic is equifinality: through the intersection of bundles of practices it is possible noting that there is not a "one-fits-all" solution, but multiple combinations can lead to the same outcome (Grandori & Furnari, 2008, 2009). Complementarity integrates and enriches the notion of configurations, since it is grounded on the concept of internal fit of activities performed at different levels in an organizations (Milgrom & Roberts, 1995). The concept of complementarity of processes has been extensively studied in innovation literature (Cassiman, Di Guardo, & Valentini, 2009; Cassiman & Veugelers, 2006; Veugelers & Cassiman, 1999). The core idea revolves around the intuition that giving two activities A and B, adding the activity B while A is already being performed has a higher incremental effect on inventive performance than adding the activity in isolation (Cassiman & Veugelers, 2006; Gatignon, Tushman, Smith, & Anderson, 2002; Reitzig & Puranam, 2009). In similar fashion, complementarity logic assumes that high firm performance does not arise from a unique combination of activities. However, complementarity is set apart from the configurational framework, since it assumes that “high performance arises only when particular combinations of practices with similar or different attributes interact with each other *in a positive way*” (García-Castro, Aguilera, & Ariño, 2013, p. 392). Thus, complementarity permits focusing on the positive interactions among practices and structures and understanding how their configurations might lead to firms’ high performance.

2.3. Empirical Analysis

Drawing on our theoretical development, we designed an investigation to understand how firms interconnect vertical organizational structures with horizontal practices in their IP departments to achieve a high rate of success in obtaining patent grants, which is our ultimate measure of value appropriation through innovation. We focused on the organizational features of IP departments and their intersection with inventive performances, because we believe that this research setting provides a suitable context for understanding the impact of organizational structure on performance (Gulati, Puranam, & Tushman, 2012; Reitzig & Puranam, 2009). Furthermore, we want to expand our general understanding of organizational traits of innovation (Ashish Arora et al., 2011, 2014). On the basis of high patenting activity (EPO, 2012), we selected 20 corporations in four sectors. This mid-sized sample allowed us to combine in-depth knowledge of individual cases and variation across contexts (Crilly, Zollo, & Hansen, 2012).

2.3.1. Data

The research uses a comparative analysis of multiple case studies. We collected data in years 2012-2014 from 20 large and very large sized companies that have an internal IP department. Cases were selected because they operate in industries where patenting activity is intense (EPO, 2012). Furthermore, cases were comparable according to industry and technological domain. Sampling followed the saturation logic and included four cases in the healthcare industry, four in the ICT, six in the manufacturing and six in the pharmaceutical industry. Furthermore, the 20 firms in our sample were responsible for approximately 5% of all patent applications at the US Patent Office in the years 2011 and 2012. Thus, our sample covers cases very active in patenting and for which patent grant is an important outcome. We collected 41 interviews from 26 key informants who covered relevant roles in the IP units and were notably heads of in-house IP unit, executives of R&D departments and senior patent attorneys. Interviews lasted between 50 to 90 minutes and were fully transcribed and triangulated with personal notes, archival data from Nexis database and corporate web pages.

However, our data collection is more exhaustive. In fact, we relied on three data sources: (1) interviews with heads of in-house IP unit, executives of R&D departments and senior patent attorneys of the companies; (2) patent data for each of those firms and (3) archival data.

Interviews with members of IP departments

From September 2012 to August 2014, we conducted 41 semi-structured interviews. At each firm we interviewed heads of in-house IP unit, executives of R&D departments and senior patent attorneys. When possible we also interviewed senior scientists and researchers of the organizations. We conducted interviews on site and over the phone. Interviews were lasted between 50 and 90 minutes and were fully transcribed. Detailed notes were made on a side to integrate and triangulate the analysis. Interviews addressed understanding the organizational structure of both IP departments, their relationship with research and development units, their role in the corporate strategy and in the design of intellectual property portfolio. When it was not possible interviewing more than two members of the same organizations, we collected further primary evidence through emails and confirmatory cases with additional internal members of IP departments.

Patent data

For each company we built the patent portfolio following the procedure implemented by Belenzon and Berkovitz (Belenzon & Berkovitz, 2010). Based on ownership chains, we firstly built the patent portfolio of each company from Orbis database. We retrieved 2,687,331 patents from Orbis and through a unique identifier we linked them to PATSTAT. This process was crucial to complement the dataset with additional information on innovative variables such as the degree of diversification of the patent portfolio, patent citations, families in which the patents has been allocated, application and grant dates, amendments on the submitted patent applications.

Archival data

We collected extensive documentary evidence, including public press retrieved by Nexis database, conference presentations, webinars and webpages. We used this evidence to triangulate the interview data and confirm the representation of the 20 case studies.

2.3.2. Research Method: A Fuzzy Set Qualitative Comparative Analysis

A configurational approach demands a detailed understanding of the causal relationships. Therefore, we opted for a fuzzy set qualitative comparative approach (fs/QCA). The fs/QCA method is ideal to detect combinatory effects and equifinality of different combinations in reaching the same outcome. There is an increasing interest in the application of qualitative comparative analysis in strategic management and organization studies (Bell, Filatotchev, & Aguilera, 2013; Crilly et al., 2012; Grandori & Furnari, 2008) because of its advantages in finding causal patterns (Fiss, 2007) and condensing the complexity of qualitative analysis through Boolean minimization (Ragin, 2008). One of the main features of fs/QCA consists in treating cases as configurations of conditions that jointly produce an outcome, typically distinguishing which conditions are necessary and/or sufficient for an outcome to occur. A condition is associated with a set membership and every case is treated depending upon the degree of inclusion in the set. Every organization is treated as a member of multiple sets (e.g. the set for high patenting performance), so that fs/QCA is employed to identify consistent patterns among set membership.

This type of analysis has a number of advantages for the present study. The method allows for theory elaboration for middle N-samples that would not produce statistically relevant results and would be too large to accommodate the procedure of a purely qualitative research design (Fiss, 2011; T. Greckhamer et al., 2008). By identifying the 'chemistry' of conditions that causally lead to an outcome, fs/QCA is particularly suitable for advancing theories that are nested at different levels (Fiss, 2011). Therefore, its usage is consistent with our aim of understanding the interplay between factors at the structural and process levels. Furthermore, fs/QCA allows for equifinality in the minimal causal solutions that lead into an outcome. This enables to have a parsimonious and nuanced analysis of factors that contribute in generating high patenting performance.

The transformation of variables into sets requires calibration, which consists of the specification of full membership, full non-membership and cross-over points of ambiguity. Indeed, a fuzzy set scales degree of membership (e.g. membership in the set of organizational centralization) in the interval from 0.0 to 1.0, with 1.0 indicating full inclusion and 0.0 full exclusion. In between this spectrum, qualitative anchor points are used as crossover from which deviation scores are calculated respect to full membership. For instance, levels can be 1 (full membership), 0.67 (intermediate membership), 0.33 (partial exclusion) and 0.0 (exclusion). Alternatively, levels of inclusion and exclusion can be based on a more nuanced scale: 1 (fully in), 0.9 (mostly in), 0.6 (more in than out), 0.4 (more out than in), 0.1 (mostly out), 0.0 (fully out). For the construction of the fuzzy sets, we used both the anchor points specified above and we have followed the "direct method" basing on iterations of theoretical wisdom and in-depth knowledge of the cases.

Following our theoretical framework, we consider one outcome –i.e. the success in obtaining fast patent grant achievements- to capture a firm's ability to capture value from innovation. To depict the organizational dimensions, we then consider three causal conditions: (1) the degree of centralization of the IP department respect to the organizational structure; (2) the degree of cross-functionality of IP departments with other units; (3) the adoption of a structured plan in the processes related to patenting. To capture the breadth of innovation produced by each firm and controlling past performances in the patenting process, we rely on two conditions: (1) the average number of patent citations that compose the patent portfolio (2) and lags between the application and granting dates. We discuss here below our conditions and their calibration. Our analysis and results are computed with R using the QCA package recently developed by Thiem and Dusa (Thiem & Dusa, 2013a, 2013b)

Fast grant achievement

A patent represents an advance in technology and it is a useful indicator of value-creation activities by the firm. In a first instance, a patent confers the exclusive right to the owner to use and exploit the technology. Therefore, the grant of a patent represents the ability of an applicant to convince a patent examiner of sufficient novelty, inventive improvements and industrial applicability when judging the application. Therefore, a very crude indicator of success of achieving patent protection is simply whether or not a patent was granted in an application. The duration of the application process is a more refined criterion. In fact, well-documented applications are approved faster and they have lower probabilities of being withdrawn (Harhoff & Wagner, 2009). Applicants have more incentives in accelerating patent application process for those patents that are considered valuable. At least two advantages are associated with a fast patent grant: certainty on the status of the patent portfolio and the possibility of using legal instruments to prosecute infringers. Furthermore, obtaining rapid patent protection through compelling applications could guarantee the applicants an advantage in excluding competitors from the adoption of a certain technology to exploit commercial opportunities. It is particularly important in industries such as pharmaceuticals or biotech, where innovation cycles are short. Thus, we create the condition '*fast grant achievement'* based on the capability of obtaining fast patent grants. Following previous research (Reitzig & Puranam, 2009), for each organization in our sample we firstly create a dummy variable 'grant' equal to one if a patent in the firm's patent portfolio was granted in the study window. In order to control for technology specific effects, we divide the dichotomous variable 'grant' by the average granting ratio of the relevant technology sector. Finally, we multiply the ratio by the average time between the filing and grant in its technological sector. The measure can be formalized as follows.

$$fast\ grant\ achievemenent = \frac{grant * lagtime\ grant_{industry}}{grant\ ratio_{industry}}$$

Through this measure we were able to capture the effectiveness of the IP department in the patenting process. In our analysis we referred to US patent data. The US patent system is one of the strongest and best-acknowledged frameworks to obtain legal rights on a registered innovation. Finally, we limited the effect of institutional factors by referring to patent rights from only one jurisdiction instead of analysing for example both USPTO and EPO data. To build the measure, we decided to refer to applications filed up to year 2011 because on average patents take more than one year to be granted. Thus, when we started our data collection in 2012 interviewees might have referred to the process that involved the grant of patents filed at least in 2011. Therefore, we decided to take year 2011 as starting reference point to construct our measure of fast patent grant. While other contributions in the literature adopted a four-year window to measure patent grant (Reitzig & Puranam, 2009), we decided to opt for an even more conservative time frame from 2011 to 2014 to limit to a minimum potential biases from retrospective analysis. We transformed the measure in a fuzzy set by taking the average and using the first, third and fourth quintile for full membership, crossover point of maximum ambiguity and full non-membership, respectively.

Explanatory conditions

We consider three conditions that might influence patent grant success at organizational level. These conditions were based on qualitative evidence from the interviews and archival data.

Centralization

The first condition, centralization, measured the degree of centralization of decision making. Through iterations of coding, we created a systematic classification of the centralization of decision-making. On one side, decision-making can be totally centralized for both R&D units and IP department. On the other side, decision making for both R&D and IP is decentralized to peripheral units. In between we can find some intermediate situations in which: i. Decision-making is mostly centralized for both the IP and R&D, but this latter has also some minor decentralized entities; ii. IP unit maintains a centralized decision making structure, while the R&D follows an hybrid structure, but overall there is a partial predominance of centralized decision making; iii. Both IP and R&D follows a hybrid decision making structure; iv. Decision-making referable to both R&D and IP is partly decentralized apart a minor form of decisional power coming from a superior unit. We perform a fuzzy set calibration ranging from 1, for high degrees of centralization, to 0 when decision-making is decentralized. We calibrated intermediate levels of decision making as depicted in table 2.1.

Table 2.1 Criteria Used for Calibrating the Condition 'Centralization'

Calibration	Criteria	Cases with codes and explanation of the context
Fully out (0.0)	R&D is decentralized and IP is decentralized. Decision making power is decentralized to the single units.	(11) "Decentralized; separation": The R&D is decentralized. The IP department works as separate stand-alone unit. At the corporate level they have two main IP departments, one for pharmaceutical and the other one for performance materials; (13) "Split; IP mirrors R&D": R&D is built on separate and independent units for each stage of research. Each R&D centre has its own IP department. It is the R&D that has decisional power on technological and patenting directions. The decentralized IP department has control of the IP budget; (16) "Nested structure; separation": The R&D is decentralized in three main units. The IP department is organized in two decentralized units: one that advises the first research unit and the other one for the other two R&D departments
Mostly but not fully out (0.2)	R&D and IP are partly decentralized, but there is a minor form of decisional power coming from a superior unit	(6) "Separation; centralization": The R&D has a matrix structure while the IP department has a centralized organization that supports the entire group. R&D has a central corporate centre and then it is organized on a decentralized structure. IP is a separate group respect to R&D and it is centrally directed with some activities managed centrally and others (for example, patent registration) at decentralized level; (8) "Autonomy; matrix; exclusive control; internal hybrid": Both the R&D and the IP of the Healthcare division are disconnected from the headquarter. In the subunit, the IP mirrors the structure of the R&D: in the sub-unit the main activities are centrally located while implementing and development tasks on local sites with a dedicated IP centre connected to support locally.
More or less out (0.4)	R&D and IP have an hybrid structure Some decisions are taken at decentralized level	(1) "Hybrid; separate control; matrix": The R&D is divided into multiple technological platforms that handle the development while pure research is mostly at corporate level. The IP department has a hybrid structure, in which some functions are either held centrally (almost the majority of the ownership) or into the business units (e.g. decisions concerning the technological directions), which in some cases can be also the owners of technologies and patents. Filing is performed locally, while prosecution is centralized. (3) "Matrix:" The R&D is based on three main corporate platforms that then separate into dedicated research subunits. The IP department is organized in a common shared platform for all the units. (19) "Matrix; hybrid; global for several": R&D has a hybrid structure with 6 main geographical centres. The IP unit has an hybrid structure with two main corporate centres and then decentralized centres closed to main research centres.

More or less in (0.6)	R&D has an hybrid structure and IP is centralized. There is a partial predominance of centralized decisional power	(2)"Centralization; corporate department; authority at divisional level": The R&D is centralized but business divisions have their own research centre with decisional power. IP is nested into the corporate R&D. Key decisions are taken by CTO; (4)"Local and central; centralized structure": The R&D has a matrix structure while the IP department has a centralized organization that supports the entire group. R&D has a central corporate centre and then it is organized on a decentralized structure. IP is a separate group respect to R&D and it is centrally directed with some activities managed centrally and others (for example, patent registration) at decentralized level; (5) "Local and central; centralized structure": R&D has a hybrid organizational structure based on geographical dimensions, while IP is centrally organized; (9)"hybrid; sister organizations; decision making at the headquarter": The R&D has a hybrid structure based on technology platforms with the main research function at the headquarter; The IP department is centralized at the headquarters and serves all the departments; Decisions concerning the IP management are taken centrally; (10)"hybrid; centralization; pyramid": R&D has a hybrid structure based with corporate basic research and thematic decentralized labs in geographic areas. The IP is organized at corporate level; (12) "Global for several; general responsibilities": The R&D has an hybrid structure based on three main platforms, while the IP is centrally organized with global responsibilities; (17)"tension global/local; IP structure in response to R&D structure; hybrid; moving from vertical to horizontal framework": R&D is built on a matrix based global/local dimensions. Research programs are global, but there is global staffs that is decentralized locally. The IP department follows the same logic by patenting locally and cross-sectional.

Mostly but not fully in(0.8)	R&D is mostly centralized with minor decentralized entities. IP is centralized. Decision making is mostly central.	(7)"hybrid; centralization ": R&D is organized mostly centrally with some decentralized units. IP unit is centrally located and it is fully independent from all other unit with autonomy over IP budget; (14) "matrix; centralization of IP; top executives on decisions": The R&D has a hybrid structure based on technology platforms with the main research function at the headquarter and then ; The IP department is centralized at the headquarters and serves all the departments; Decisions concerning the IP management are taken centrally; (15)"Hybrid; individual programs; centralization": The R&D is based on three main corporate platforms with basic research centralized and decentralized units at the business levels. The IP department is centrally organized and totally autonomous; (18) "Separation; matrix; central group": R&D works with both a centralized unit, which provides general research with a mid-long term horizon, and minor research units that are in charge to develop projects locally and to specific needs in the short term. IP is centrally organized with local presence of IP attorneys for patent drafting. Decision making is taken centrally by the head of IP for both the IP and R&D.
Fully in (1)	R&D is centralized and IP is centralized. Decision making power is centrally located.	(20) "Proximity; centralization; stand-alone": The R&D is centralized and is in the same building of IP, which is a centralized and stand-alone unit. The CEO, Head of R&D and Chief IP executive take decisions at central level.

Cross-functionality

The second measure, cross-functionality, was based on evidence that relates to the degree of interactions among different functions in the patenting process. On one side, it emerged that companies segregate the IP and R&D into two separate functions that communicate through the establishment of an internal cross-functional board, where scientists and patent attorneys jointly monitor the patenting process. On the other side, companies organize R&D and IP into the same function and the process is internally managed without any interaction with other functions such as legal or finance. In between, companies might present intermediate degrees of cross-functionality: i. R&D and IP are maintained as two separate but highly interacting functions, without the intervention of a cross-functional board; ii. R&D and IP are two functional silos and interactions with other functions can occur on demand; iii. R&D and IP are two different functions, which interact based on case-to-case necessity, but involvement with other functions such as business or legal is very limited; iv. R&D and IP are in the same functions and involvement with other functions is very limited on necessity when internal information and knowledge is not sufficient. We performed a fuzzy set calibration ranging from 1, for high degrees of cross-functionality, to 0 when R&D and IP are in the same function without any external interaction. We calibrated intermediate levels of decision making as depicted in the table 2.2.

Table 2.2 Criteria Used for Calibrating the Condition 'Cross-functionality'

Calibration	Criteria	Cases with codes and explanation of the context
Fully out (0.0)	R&D and IP are in the same functions. Patenting practices do not include any involvement with members from other functions	(2)"embedded IP; local head of IP is in between": IP is nested in the R&D and works on the objectives designed by the R&D. The process is coordinated by a divisional IP manager that needs to keep the contacts with the central IP group and the business division; (10)"divisional patent committee; there to file": IP is nested in the R&D function. Scientists submit the invention to a patent board internal to his or her research function; (18) "Dedicated group; no interaction; tension corporate/local; personal scope": IP is a unique thing with R&D and they rarely interact across business divisions, while there is a strong interaction within the same division between scientists and patent attorneys.
Mostly but not fully out (0.2)	R&D and IP are in the same functions. Involvement with other functions is very limited and induced by necessity when internal information and knowledge is not sufficient	(3)"co-location; complement each other": IP is a centralized legal platform that serves the three research centres. Interaction is generally between the dedicated attorney and the scientist who are co-located. Interaction with the business unit is limited to the final stages and it is rare; (15)"different functions; autonomy; discretionary request for coordination": Patenting and Research are two different functions. After the submission of the idea to patent attorney, assigned IP attorney is totally in charge of the process and has the discretionary power to ask for additional consultation. Interactions with other functions are generally developed in a strategic phase (with the definition of patent strategy document) instead of application stage. Scientists and attorneys are in two different locations; (16)"nested; dedicated members; 1-to-1; co-location": IP department is nested in the research unit that is supporting. Relationship mainly remains in the same function where attorney and scientist collaborate in a one-to-one basis. Interactions with other functions are limited to spotted cases that require more information;

Calibration	Criteria	Cases with codes and explanation of the context
		(19)"internal coordination; coordination through local presence": IP is nested in the R&D function. Involvement among functions relate members of research with product categories' managers, patent attorneys support this interaction as members of research; (20) "R&D pushes into IP; forced to coordinate": IP is nested in the R&D. The R&D is required to engage with the IP. Coordination is induced. IP department nested in the R&D and there is any integrated interconnection with marketing or business side. The R&D demands to engage with the IP. Coordination is induced;
More or less out (0.4)	R&D and IP are two different functions. Involvement with other functions different from research and IP is very limited.	(14) "R&D asks to IP depending on common sense; R&D pushes into IP": IP and R&D are two separate functions. Both the R&D development and the discovery team are required to engage with IP function. The IP function interacts with business entities for troubles. Both the Head of R&D and the Chief IP Officer report to the CEO. It is the R&D that decides when to interact with IP and then the IP can proceed by itself in the process;
More or less in (0.6)	R&D and IP are two different functions. Involvement of the IP is not rare but on demand from other functions	(1)"supporting; on demand involvement": Patenting function is part of the legal department at it is mostly at the corporate level. R&D function and business development function are focused on innovation pipeline. During the developmental stage, engineers and business managers interact with the patent attorney. IP department is kept informed of all the on-going projects and asked to intervene when needed in case they have the sensation that they would have to solve a patenting issue; (5)"Problem in disclosure; technical language; isolation of IP unit; tricky bridge with scientists and businesses; patent attorney needs to know a little bit of everything": IP department is part of the legal function. IP department is isolated and responsible of patenting filing activities; they serve the patent filing activity through a legal perspective; interaction with the business side through gatekeepers on demand; the interaction is mostly internal in the IP department between the Chief IP Officer -who has both a technical and legal background- and the patent attorneys -who have legal background; (11)"temporary membership; by invitation; driven by": IP department is a separate function that align and follows other divisions of the organization: research, commercial team, marketing, etc.

Calibration	Criteria	Cases with codes and explanation of the context
		Interactions are limited to the extent to which is necessary and it is based on temporary membership. Further interaction might be requested for specific purposes and it is always on demand; (13) "IP mirroring R&D; supporting; we are legal": The IP department is part of the legal unit, but works very close to the R&D as supportive function. Despite the fact that IP is nested into the legal function, they do not have connections with other lawyers (for instance trademark). The senior management of these departments sit on the same Legal Leadership Teams to coordinate what their departments are doing. Scientists start patent process. Within the organization, patent attorney support scientists depending on particular disease area. Business units do not interfere in the patent process but just in the portfolio revision;
Mostly but not fully in (0.8)	R&D and IP are two different functions. Interaction is very intense and continuous but the involved groups never bond in a cross-functional team	(4)"internal negotiation; internal reporting; patent common activity": IP department is a separate division respect the R&D, but the process is highly integrated. In each division they have co-located IP employees that work together with R&D personnel. Every research centre has to report to the corporate head of IP; (12) "Multiple functions in the IP department; forecasting; squeezing ideas; extracting ideas from R&D programs": Patenting function is part of the legal department but works very close to R&D and has a proactive role in harvesting innovation. They make a pre-filter on where to look for ideas through a search function and they do estimate where good ideas come from. Patenting teams are separated by technologies and they do not interact with each other. Members in the patenting functions are lawyers with a technical background; (17) "Supporting R&D; multiple functions in the IP department; look for applications depending upon expertise": The IP department is part of the legal unit, but works very close to the R&D as supportive function. Despite the fact that IP is nested into the legal function, they do not have connections with other lawyers (for instance trademark). Patent filing derives from a back and forth process between the scientist and the local attorney, who is supported by the global team, which supervises the areas. Patent attorney discusses the patent filing with the R&D project leader and product manager;

Calibration	Criteria	Cases with codes and explanation of the context
Fully in (1.0)	R&D and IP are two different functions. Involvement is maintained through the process with the definition of a an internal cross functional board.	(6)"work with one group; jump between groups; input of scientist": IP department is separate from the R&D, but the process in highly integrated with a close interaction between the scientist, the dedicated lawyer and members of the R&D and IP who attend the scope meeting. There is an internal senior IP manager that makes sure there is a proper coordination among groups; (7)"case core responsible; involvement; joint responsibilities": Research and IP are two separate functions. Main patenting trajectories are decided by an executive team formed by R&D, business, IP and CEO. Patenting application is a process inserted in a research project. Patenting project has a project leader and it needs to be discussed in front of committee with attorneys and scientists; (8)"Complementary disclosure; Board; closeness to technology; close to marketing; cross-unit involvement": IP department works with R&D members in the process of patent harvesting and registration through a Board. The IP department interacts with business managers and marketing managers for the development of design patents; (9)"ad-hoc team; technology matrix; mutual objects": Patenting and Research are two different functions. In the patenting process, organizational experts from different fields interact from the disclosure up to the registration.

Coordination by plan

The third measure, coordination by plan, was based on the degree of adoption of formal channels, structured procedures and tools to communicate during the patenting process. On one side, companies can decide to process all the patenting steps through the use of platforms, standardized communication channels, software and tools. Therefore, the sharing of information follows a structured and planned approach. On the other side, coordination and communication on patenting process can develop exclusively through informal and unstructured channels. Alternatively, companies can adopt intermediate degrees of structured coordination: i. the patenting process is mediated by formal communication but occasional and unstructured sharing of personal information might occasionally occur; ii. Coordination develops through formal channels, which are integrated in some occasions with some forms or informal sharing of information and informal mechanisms; iii. Coordination develops mostly through informal channels, but the preliminary phases of patent application are structured through a lean form of formal mechanisms; iv. Coordination develops mostly through informal channels and means, apart for patent dismissal, which make use of formalized procedures and tools. We performed a fuzzy set calibration ranging from 1, for high degrees of coordination by plan, to 0 when coordination is mostly unstructured and unplanned and communication occurs through informal interactions. We calibrated intermediate levels of decision making as depicted in table 2.3

Table 2.3 Criteria Used for Calibrating the Condition 'Coordination by Plan'

Calibration	Criteria	Cases with codes and explanation of the context
Fully out (0.0)	Coordination and communication develops exclusively through informal channels.	(4)"interaction on the board; personal talk; daily conversation": Coordination and communication develop through personal interactions and daily face-to-face meetings; (5)"speaking with clients; pendulum; informal means": Coordination is based on personal interactions, mails, and meetings. There is not a clear formalized plan; (16)"meeting to reach consensus; discussion": Coordination and communication develop through meetings and unstructured conversations. Through meetings they formalize their strategy and future actions; (20)"no tools; speaking with clients; culture of IP": No platform but communication through personal interactions.
Mostly but not fully out (0.2)	Coordination and communication develops mostly through informal channels and means, apart for patent dismissal, which make use of formalized procedures and tools.	(1)"internal conversation; discussion": Once the strategy document is approved, coordination is achieved mostly through internal discussion and local patent attorneys can file patents on the behalf of central IP unit. (6)"talk and discuss; memos of invention; ask to people": Coordination and communication develop through personal channels and informal conversations. People sit and talk. Formal documents are the outcomes of an informal communication that develops through different meetings. (11)"face-to-face": Coordination and communication develop through personal interactions and daily face-to-face meetings. Once per year there is an official report that conveys main strategic directions and plans (13)" informal and interactive communication; no IP plans": Interactions are maintained through personal communication. The Head of IP meets regularly with the executive management either in ad hoc meetings to discuss key issues or in regular meetings. They have an internal platform just to post dismissing patents.
More or less out (0.4)	Coordination and communication develops mostly through informal channels, but the preliminary phases on patent application are structured through a lean form of formal mechanisms.	(2)"seat together; formal and informal; mix of tools": Coordination and communication is based on personal interactions between the scientists and the IP manager, but since the process is highly outsourced they have an internal IP tool to keep track of the process, communicate and coordinate; (3)"multiple layers; support; track KPIs; library": Coordination and communication is mostly through persona interaction at the lowest level, which means between scientist and lawyer. Yet on the corporate level they try to coordinate and make sense through internal formalized reports on research KPIs. (7)"no tools; proximity; personal informal channels": There is a general plan to develop patenting and technological trajectories, but then practical implementation is developed through informal communication channels.

Calibration	Criteria	Cases with codes and explanation of the context
		(8)"coordination through calls; always the same written information": General platform to access to state of art across groups. Sharing of unique formalized documents. Communications through monthly calls and personal meetings. (12)"multiple coordination mechanisms; formal tools; informal and personal interaction; chatting": General platform to access to state of art across groups. Sharing of unique formalized documents. Communications through monthly calls and personal meetings. (14)"informal and interactive communication; no IP plans": Interactions are maintained through personal communication. The Head of IP meets regularly with the executive management either in ad hoc meetings to discuss key issues or in regular meetings. They have an internal platform just to post dismissing patents.
More or less in (0.6)	Coordination and communication develops through formal channels, but those latters are combined in some occasions with some forms or informal sharing of information and informal mechanisms.	(19)"on line tools; automation; meeting and talking": Coordination and communication is firstly transmitted through platforms and structured channels that can be benchmarked with KPIs. On a side, they develop also personal communication and informal coordination.
Mostly but not fully in (0.8)	all the process is mediated by formal communication and personal informal communication is rare	(10)"submission; feedback": Coordination is mostly based on submission mechanisms through internal platforms and formal feedbacks. They use also phone calls when it is not possible organizing personal meetings with decentralized inventors. (15) "Separation; formalization": Patenting process is based on formalized plan. Patenting process is transmitted through separate functions located in different geographical areas. (17)"formal interactions; boundaries; formal rules": All the process is mediated by a formal procedure that patent attorney needs to follow. Face to face interaction with scientists is rare. (18)"on line tools; automation; meeting and talking": Coordination and communication is transferred through platforms and structured channels that can be benchmarked with KPIs. In addition, they develop also personal communication and informal coordination.
Fully in (1.0)	Coordination and communication in the patenting process develops exclusively through formal channels, structured procedures and tools	(9)"tools; highly automated process": Patenting process is transmitted through the use of internal platforms and tools only.

We consider two conditions to control how characteristics of the technology portfolio that might influence the achievement of fast patent grants: forward patent citations and past patent lags (Conti, Gambardella, & Novelli, 2013; Giuri et al., 2007; Hall, Jaffe, & Trajtenberg, 2001; Somaya, 2012). We based these conditions on USPTO patent data.

Patent citations

Citations received from subsequent patents and examination reports are an indicator of the influence of the underling inventions to the state of art in a certain technological industry. Previous literature demonstrated that a larger number of patent citations reflects a valuable patent portfolio (Harhoff, Scherer, & Vopel, 2003). Furthermore, patents with higher citations tend to have a lower duration in the process of patent grant (D. Harhoff & Wagner, 2009), because applicants are more inclined in submitting well-written and complete applications for those inventions that are considered core to protect or penetrate a strategic market. Thus, taking into account the incentives of the applicants, we can infer that companies with higher patent citations have a more valuable patent portfolio and conscious approach towards IP generation and protection, and submit strong applications, which have better chances to have a positive outcome in the patent granting process. For each firm we measured the average number of patent citations from years 1991 to 2014. We selected 1991 as starting point because of data availability. We then transformed the variable into a fuzzy set using the first, third and fourth quintile for full membership, crossover point of maximum ambiguity and full non-membership.

Patent lag

We relied on patent lags to monitor past patenting capabilities. The main idea is that if a patent is the outcome of a well-designed process, integrating technical knowledge with legal capabilities and business awareness, it might be particularly well-drafted, leading to a stronger application that is less likely to be rejected or undergo lengthy revision. Therefore, minimizing the time from filing to grant is generally in the interest of patent applicants (Harhoff & Wagner, 2009; Jaffe, 1986; Reitzig, Henkel, & Heath, 2007). Accordingly, for values of patent lag closer to zero we might expect a more efficient patenting process, which then should be reflected in a positive outcome. For each firm we estimated the average patent lag from years 1991 to 2011. We selected 2011 as the final year to avoid overlapping with the measure *fast grant achievement*. We then transformed the variable into a fuzzy set using the first, third and fourth quintile for full membership, crossover point of maximum ambiguity and full non-membership.

2.3.3. Analysis

After the calibration of fuzzy sets, the second step in performing an fs/QCA involves the construction of the truth table. The truth table lists all the 2^k possible configurations of conditions, where k is the number of causal conditions used in the analysis. Following previous research (Greckhamer, 2011; Ragin, 2006; Ragin, 2008), we specified a consistency threshold equal to 0.9 to select the configurations reliability associated with one of the outcomes. Consistency refers to “the degree to which instances of an outcome agree in displaying the causal condition” (Ragin, 2008: 44).

The next step involves the Boolean minimization of the truth table through the Quine-McClutskey algorithm in order to obtain both the parsimonious and intermediate solutions. This procedure is based on the analysis of counterfactuals and has the advantage of reducing the complexity of resulting configurations by distinguishing between “easy” and “difficult” counterfactuals (Ragin, 2008). Counterfactual analysis is justified in situations of limited diversity and small sample size (Fiss, 2011; Soda & Furnari, 2012), therefore it perfectly suits our study. Indeed, the analysis is grounded on the comparison of “parsimonious” and “intermediate” solutions. Parsimonious solutions include all simplifying assumptions independently from easy or difficult counterfactuals, while intermediate solutions are based only on easy counterfactuals. On one side, easy counterfactuals refer to situations, in which a redundant causal condition is included in a set of causal conditions that already lead to the outcome in question. On the other side, difficult counterfactuals refer to situations in which a condition is removed from a set of causal conditions leading to an outcome on the assumption that this condition is redundant. The selection of simplifying assumptions follows the general recommendation of using both an in-depth comprehension of cases and theoretical knowledge to craft intermediate solution terms (Schneider & Wagemann, 2012, 2013; Soda & Furnari, 2012). The appendix documents how we established easy counterfactuals in the intermediate solutions. Drawing from counterfactual analysis, we were able to identify core and peripheral conditions that lead to high and low membership of fast patent grant achievement. Core conditions are included in both parsimonious and intermediate solutions, while the peripheral conditions are eliminated in the parsimonious solutions. This approach permits to highlight the strength of the evidence relative to the outcome.

2.4. Results

Table 2.4 presents descriptive statistics, while table 2.5 displays the results associated to fast patent grant achievement. We also performed analysis on the negation of outcome –i.e. slow patent grant achievement- and related configurations are displayed on table 2.6.

Table 2.4 Descriptive statistics

Conditions	Cases	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
centralization	20	0.515	0.3232646	0.6	0.525	0.37065	0	1	1	-0.25223386	-1.1930658	0.07228416
cross_functional	20	0.52	0.3577709	0.6	0.525	0.59304	0	1	1	-0.05031153	-1.4965625	0.08
plan	20	0.39	0.3007009	0.4	0.375	0.29652	0	1	1	0.34491008	-1.0132539	0.06723877
past_lag	20	2.3	1.3416408	2	2.375	1.4826	0	4	4	-0.15155572	-1.3000926	0.3
citations	20	2.1	1.4473206	2	2.125	1.4826	0	4	4	-0.16426125	-1.4321282	0.32363072
fast_grant_achievement	20	1.9815	0.5485893	1.975	1.95625	0.704235	1.18	2.94	1.76	0.19446428	-1.3556114	0.12266831

In displaying our results, we follow the approach of Ragin and Fiss (2008) by presenting the intermediate solutions consisting of core and peripheral conditions. The peripheral conditions are represented by smaller symbols than the core conditions. Finally, the presence of condition is indicated with a black circle, while a while circle signals the absence of a condition.

In searching for configurations associated with fast and slow patent grant achievement, we ran two separate analyses. We firstly examined how fast patent grant achievement derives from the combination of organizational configurations and a highly valuable technology portfolio, measured by the citations received by the patent portfolio. This analysis aims at controlling for the joint effect of organizational dimensions and innovative characteristics of the patent portfolio on the outcome. We then inspected how fast grant patent achievement is the outcome of the combinatory effect of organizational configurations and past patent process performance, measured by patent lags. This analysis is aimed at controlling the effect of past performance in the patenting process. We then evaluated how these configurations lead to slow patent grant achievement.

2.4.1. Configurations that achieve fast patent grant as proxy for value appropriation from innovation

The results in table 2.5 show that the overall solution that explains the joint effect of organizational configurations and of the value of patent the portfolio has a consistency of 0.975 and a coverage equal to 0.683. The solution that unfolds the combinatory action of organizational configurations and patent lags has a consistency of 0.88 and coverage equal to 0.678. Both those consistency thresholds are higher than the cut-off point suggested by literature (Fiss, 2011). In addition, coverage thresholds gave us confidence that the obtained solutions can find strong empirical exemplifications. We also report consistency and coverage for each individual configuration.

The impact of organizational configurations and value of patent portfolio on fast grant achievement

We found two configurations, 1 and 2, that explain the combinatory effect of centralization of decision making, cross-functionality, and coordination by plan and highly valuable patent portfolio. Configuration 1 (consistency 0.791) implies that when the portfolio does not have a high number of citations, centralization of decision-making of R&D is a sufficient yet non-core condition to achieve patent grant in a limited amount of time. This configuration holds regardless the presence or absence of cross-functionality of coordination by plan. Interestingly, this configuration partially revises previous studies that defined cross-functionality as an antecedent of fast grant achievement (Reitzig & Puranam, 2009). Companies 15 and 18 belong to this configuration. Configuration 2 (consistency 0.89) demonstrates an alternative pattern that leads to fast patent grant achievement. It includes the presence of both centralization of decision making on R&D and cross-functionality and the absence of coordination by plan. All these conditions are core to the attainment of the outcome. Particularly, configuration 2 highlights how vertical and coordination mechanisms need to be jointly present to be effective in appropriate value from innovation, confirming our theoretical speculation. It is also noteworthy that when cross-functionality is present, coordination by plan must be absent, stressing therefore the antithetic effect of these two horizontal coordination mechanisms to integrate distributed work and optimize interdependencies (Puranam, Raveendran, & Knudsen, 2012; Srikanth & Puranam, 2011). Finally, configuration 2 holds regardless the number of citations received by the patent portfolio. Company 4 represents this configuration.

The impact of organizational configurations and patent lags on fast grant achievement

We found configurations that lead to fast grant achievement through the integration of centralization of decision-making, cross-functionality, coordination by formal plans and past patent lags. These configurations aim at including the effect of past patenting performance in the cross-sectional analysis to understand if there is any systematic effect in the patenting process that should be considered across years.

Configuration 3 (consistency 0.88) resembles on the presence of centralized decision-making and coordination by formal plans and the absence of cross-functionality, regardless of patent lags. While centralization of decision making on R&D is a sufficient yet peripheral condition, the absence of cross-functionality and the presence of coordination by plan are core to the outcome. This configuration holds independently of past performances in protecting inventions through intellectual property rights. As for configuration 2, the fast attainment of patent grant is based on the contribution of both vertical and horizontal coordination mechanisms. However, configuration 3 highlights that if coordination by plan is present, then cross-functionality must be absent. Thus, configuration 3 provides further insights on how coordination by plan and cross-functionality operate as substitutes rather than as complementary horizontal mechanisms. Two companies – notably, company 15 and 18- are represented by this configuration.

We also found configuration 4 (consistency 0.89), which implies that fast grant achievement can be obtained through the presence of centralization of decision making on R&D and cross-functionality and the absence of coordination by plan. All of them are core and sufficient conditions to appropriate value from innovation. It is remarkable that configurations 2 and 4 overlap with identical raw coverage scores (0.439), implying the uniqueness in their causal effect. It suggests that this configuration offers a sort of reliable recipe for reaching the outcome. Surprisingly, this configuration emerges as a causal pattern for fast grant achievement, regardless of every condition referable to innovation. In this sense, our results suggest that the joint presence of centralization of R&D and cross-functionality and the absence of coordination by plan play a core role in explaining the causal conditions that lead to value appropriation from innovation through the protection of intellectual property rights and independently of previous patenting performance and technological characteristics of patent portfolio. Company 4 belongs to configuration 4.

In sum, configurations 1 to 4 strongly emphasize how value appropriation from innovation through fast grant achievement depends on the joint effect of vertical and horizontal mechanisms. These configurations confirm previous studies on the relevance of the organizational structure of R&D as sufficient causal mechanism to appropriate value from inventive effort through fast grant achievement (Argyres & Silverman, 2004; Ashish Arora et al., 2014), yet the overall picture is more complex, as our findings highlight the complementary relevance of horizontal coordination mechanisms such as cross-functionality and coordination by plan. These latter do not operate as complements rather as substitutes to coordinate interdependencies. We found that companies 15, 18 and 4 are representative of the explained configurations. Given the small N-sample, it is worth highlighting that there are configurations that are partially overlapping in terms of cases covered, meaning that there are cases that adopt more than one configurations depending upon the inclusion of either citations or past patent lags as controlling conditions. Finally, we found that configuration 2 and 4 present the same combination of conditions, having both an overlapping raw coverage (0.439) and consistency (0.89) and being both represented by company 4. These findings let us believe that company 4 is a unique yet consistent example on how to obtain fast grant achievement and appropriate value from innovation.

Table 2.5 Fast patent grant achievement

	Analysis with citations	
	1	2
centralization	•	●
cross_functional		●
Plan		⊘
Citations	⊘	
Consistency	0.791	0.89
Raw coverage	0.551	0.439
Unique coverage	0.244	0.133
Overall solution consistency	0.975	
Overall solution coverage	0.683	
Number of cases in the configuration	9	
Cases with positive outcome	15,18	4

	Analysis with past patent lag	
	3	4
centralization	•	●
cross_functional	⊘	●
plan	●	⊘
past_lag		
Consistency	0.88	0.89
Raw coverage	0.401	0.439
Unique coverage	0.239	0.277
Overall solution consistency	0.88	
Overall solution coverage	0.678	
Number of cases in the configuration	9	
Cases with positive outcome	15,18	4

2.4.2. Configurations leading to slow grant achievement as proxy for low value appropriation from innovation

Interestingly, in fuzzy set analysis the set of causal conditions leading to the presence of the outcome might differ from a set of conditions leading to outcome with not-high or low performance. These differences demonstrate the need to shift towards an asymmetric understanding of causality. We conducted fuzzy set analysis by modelling the negation of fast patent grant achievement. Results of the analysis are available in table 2.6.

The impact of organizational configurations and citations on slow grant achievement

We found two opposing configurations that explain the slow achievement of patent grants and thus a potentially low return from inventive activities when citations are included as condition for fuzzy set analysis. On one side, configuration 5 (consistency 0.964) predicts that the concomitant absence of cross-functionality and coordination by plan and the presence of a high number of patent portfolio citations are sufficient conditions of being ineffective in protecting the efforts on innovation, regardless the structure of R&D. Thus, configuration 5 implies that an organization might be ineffective in appropriating value from innovation if it fails at implementing at least one of the horizontal coordination mechanisms. Both the absence of cross-functionality and coordination by plan are core sufficient conditions, while the presence of citations as condition is peripheral. In our sample, companies 16 and 20 are representative cases for this configuration. On the other side, configuration 6 (consistency 0.886) offers an opposite explanation of low value appropriation from innovation. In fact, when both the two horizontal coordination mechanisms are present in conjunction with high number of patent portfolio citations, the organization does not achieve fast patent grant, regardless the structure of the R&D. While cross-functionality and coordination by plan are core conditions, having a high number of citations in the patent portfolio is a peripheral condition for the achievement of the outcome. Company 9 is a representative case for this configuration.

The impact of organizational configurations and patent lag on slow grant achievement

Our analysis revealed two pathways that explain how companies are slow in obtaining patent grant when previous patent lags are taken into account. Configuration 7 (consistency 0.944) highlights that slow patent grant achievement is the outcome of the combination of both lack of cross-functionality and coordination by plan, regardless the structure of the R&D and past patenting performance, measured by past patent lags. As for configuration 5, the lack of both horizontal coordination mechanisms is core for obtaining the outcome in configuration 7. Companies 16 and 20 are included in this configuration. We also found a second configuration – configuration 8 (consistency 0.876) - associated with slow patent grant achievement. In this case, the presence of both cross-functionality and coordination by plan is core and sufficient for the realization of the outcome, while past patent lags are a peripheral condition. In this last configuration, company 17 features all the combination of conditions and achieves slow patent grant ratios.

Summarizing previous findings, our analysis suggests that slow patent grants as a measure for low value appropriation from innovation is generally due to the concomitant presence or lack of both horizontal coordination mechanisms, regardless of the organizational structure of R&D. These conditions hold also when the patent portfolio is considered valuable and after having controlled for past patenting performances. It is interesting noting that vertical horizontal mechanisms don’t need to be considered as antecedents of slow patent grant. Furthermore, we found that companies 9, 16, 17 and 20 are consistently associated to configurations leading to slow patent grant. Particularly, companies 16 and 20 emerge as exemplary cases of how to achieve slow patents grant due to lack of cross-functionality and coordination by plan when we included either the average number of citations or past patent lag in the analysis. It suggests that the absence of horizontal coordination mechanisms is a core antecedent to explain low capabilities to appropriate value from innovation. Moreover, companies 9 and 17 provide complementing configurations where the presence of both cross-functionality and coordination by plan are considered as core forerunner of incapability of appropriating value from innovation through a very slow process to obtain legal protection through intellectual property rights. This findings lead us assuming that cross-functionality and coordination by plan are not effective as complementary processes to appropriate value from innovation, yet they need to be adopted as substitutes as shown in configuration 1 to 4.

Table 2.6 Slow patent grant achievement

	Analysis with citations	
	5	6
centralization		
cross_functional	⦸	●
Plan	⦸	●
Citations	•	•
Consistency	0.964	0.886
Raw coverage	0.37	0.402
Unique coverage	0.198	0.231
Overall solution consistency	0.902	
Overall solution coverage	0.601	
Number of cases in the configuration	9	
Cases with positive outcome	16,20	9

	Analysis with past patent lag	
	7	8
centralization		
cross_functional	⦸	●
plan	⦸	●
past_lag		•
Consistency	0.944	0.876
Raw coverage	0.505	0.411
Unique coverage	0.314	0.22
Overall solution consistency	0.909	
Overall solution coverage	0.725	
Number of cases in the configuration	9	
Cases with positive outcome	16,20	17

2.4.3 Firm-level illustration of the findings

To further substantiate the different paths of causal combinations leading to both fast and slow patent grant achievement, we made a step further in trying to back up our configurational analysis with cases from our data collection. In particular, we describe cases 15 and 18 and then case 4 as examples to obtain fast patent grant to appropriate value from innovation. We contrast those cases with the example of cases 16 and 20 and then 9 and 17. Table 2.7 provides qualitative evidence on the cases.

Cases 15 and 18 in configurations 1 and 3. Case 15 operates in the manufacturing industry in the production of small electronics, white goods, and communication appliances and over the last twenty years has been known as one of the most progressive companies in the organization of their IP departments, which has for example direct reporting lines to the corporate level. Case 18 operates in the information and media communication technology industry. It has been recently going through a major re-organization where the leadership for R&D and IP functions has been merged in one pole with a high patenting background. Both cases work on patent processes through dedicated groups, which do not need any interaction with other functions because information and knowledge are extremely clustered in the IP department. Furthermore, these departments sustain a high degree of automation in the communication have developed formalized coordination channels and tools to create benchmarks. They also opted for a high degree of centralization in the decision-making process of R&D projects. Finally, it is worth noting that cases 15 and 18 operate in two different sectors:

manufacturing and information and communication technology. Thus, it is fair assuming that the configurations underlying the cases might be generalized across industries.

Case 4 in configurations 2 and 4. Case 4 operates in the manufacturing industry with a leading position in the production of cameras and optical appliances and over the last ten years increasingly sustained the role of IP within the main organizational chart and clearly assigned role and responsibilities to IP department, which has a direct reporting line to the corporate level. Even if company 4 has a strong separation between the IP and R&D functions, the patenting process benefits from the co-location of personnel assigned to every single invention. Given such close physical proximity, company 4 decided not to implement any structured communication scheme or to adopt any tool to formalize the sharing of information related to the patenting process within the organization. Yet, a strong informal patenting culture and intense interaction facilitate the process, which remains highly centralized.

Cases 16 and 20 in configurations 5 and 7. Cases 16 and 20 in configurations 5 and 7 have been associated with slow patent grant achievement and low capability to appropriate value from innovation. Case 16 is a leading company in the pharmaceutical industry and divided its production lines into three main silos to develop dedicated research streams. The IP department does not follow the same organizational structure, yet is split according to geographical units. For each R&D unit, the IP department has an ancillary role. In fact, specialized patent attorneys are assigned to projects to assist scientists. Interestingly, cross-functionality and connections with the business units are very limited, particularly for those patents that are still far from the commercialization phase. Given the very strong interaction between patent attorneys and scientists within the same function, company 16 did not develop any structured or formalized communication plan. Yet, the sharing of knowledge and information develops mostly through unstructured conversations and informal meetings. Company 20 operates in the healthcare industry and is leader in the production of hearing aids appliances. Case 20 decided to organize the IP and R&D in the same function and limit the interactions with other functions, such as business or marketing. In addition, company 20 decided not to adopt any tool or platform to foster communication between scientists and patent attorneys or personnel connected to the patenting process.

Case 9 in configuration 6 and case 17 in configuration 8. Case 9 and case 17 are very similar and have been associated with slow patent grant achievement. While case 9 is one of the principal competitors in the ICT industry, with a specialization in software, case 17 is one of the leading companies in the pharmaceutical industry. Despite the huge importance given to the IP department and patenting process in general, both case 9 and 17 suffer from an automated and formalized coordination mechanism and a strong use of cross-functionality in the patenting process. For instance, in company 9 the patenting process is managed through a strong interaction among IP attorney, scientists and the business manager. Cross-functionality relies highly on face-to-face interactions and personal feedback. However, attorneys and scientists are also asked to formalize all the information that they generate into an internal platform that transmits and organizes the network of various projects.

Precise standards enforce the criteria through which attorneys and scientists should coordinate through the use of formal platforms. Standards are set at a corporate level and are based on general planning. The simultaneous use of both cross-functionality and coordination by plan might have a detrimental effect as some spontaneous conversations might be lost once the parties are required to coordinate through standardized tools designed according to hierarchical planning. In case 17, the organization of the IP department is tailored according to geographical reach and scope of the R&D units. Scientists and patent attorneys tend to be co-located depending on research needs to foster personal communication and interactions, the patenting process is executed according to a 'patent strategy document', where junior attorneys are asked to execute the strategy, and the agreement of the global IP team, that supervises the different areas of research that need to be covered by legal protection. Also in case 17 we spot the tension between two conflicting coordinating mechanisms: cross-functionality at the decentralized research unit level and coordination by plan in the IP department. All in all, the concomitant existence of conflicting processes might slow down the patent application process and as a result decrease the capability of appropriating value from innovation in a timely manner.

Table 2.7 Qualitative evidence from cases

ID case	Centralization	Cross-functionality	Coordination by plan
4	"The TC centre has 280 people that are divided into each R&D group or business units. Business units also have R&D functionalities, plus centralized R&D group is also like this, we are assigned to one central division to treat IP activity on each R&D group, so for example, basic or fundamental research is done in the centralized R&D unit and we assign something to the local IP head, for example the head of Malaysia, to discuss with the head of R&D to track down IP and R&D services, then simply in couples of business units we create the counterpart of the IP group in each business unit". (Head of IP Corporate Department)	"A particularly unique initiative is the Patent Grade-Up Activity (PGA). Inventors, as well as other engineers, work together with intellectual property division personnel to thoroughly discuss a single invention; This not only improves the quality of patents but also can lead to the creating of new inventions. Thanks to collaboration between the technology division and the intellectual property division, the company consistently ranks among the top U.S. patent recipients" (Company web site). "In each research centre they are all IP people and they have some rules to discuss with research engineers how to make patent strategy and then the centre needs to report to me" (Head of corporate IP department)	"Mainly I try to talk with the responsible of patents in each business unit; fortunately the head of IP in the company is a board member, then other business units people are also board members, so therefore we have almost daily meetings with them in the morning and I would talk with them and confirm my strategy and my problems with them or not" (VP corporate IP department)
15	"We are probably closer to the hybrid structure. We have central research and the product develop is with business division...For that (i.e. patenting activity) we have the organization I am part of, the IP&S, which is a stand-alone organization." (Senior IP attorney)	"Each group, each R&D group would normally have one or more people responsible for it within the IP organization. It is part of the job of the IP to work out what is coming out, what level of protection is needed and make sure that the research is aware of what can be patent and how to go about it. They do not actually work in the research group but they have their own responsible for IP. They would meet with inventors and have discussion with management and so on, but it is physically a separate organization. The offices of the IP people are in the IP building and not mixed." (Senior IP attorney)	"Decision to patent a particular invention rests with IP counsel assigned to handle that invention. In taking the decision, IP counsel consults relevant people within the company taking into account the overall filing plan of the field to which the invention pertains. The relevant IP manager makes the filing plan every year. The filing plan is based on the IP strategy which in turn is based on the business strategy." (Senior in-house IP attorney)

ID case	Centralization	Cross-functionality	Coordination by plan
18	"We have a global R&D that scans the global R&D opportunities and then we have a decentralized R&D structure based upon regional expertise and subject matters expertise within the overarching umbrella…In response to hybrid (R&D) organization, we have hybrid (IP) system" (Chief IP Officer for America.) "We have a matrix design: one access is geographical location and another array on the matrix is functional responsibility of the particular group". (VP patent department for emerging markets)	"The are separate, they are not silos, but you know, the very business groups are very different and there is not so much interaction between the dedicated R&D group in each business division, apart some very specific cases. […] Patent attorneys you know have a kind of personal scope, that is that each patent attorney is dedicated to work with one R&D team mainly, this is how it works, so it is an R&D community that knows who is the patent controller in charge for the area" (Senior IP manager)	"We have set up an online tool for meetings and inventions, so it is totally automated, so there is the portal, the inventor portal, the inventor goes to that portal, there is a form to be completed, a document to be attached and then later you have a workflow, so it is automatically addressed to a patent manager. [...] so, there is a process automated, we have KPIs on each quarter and during the disclosure we look at where they are, where they do come fro, what they are related to so we can transform this into the patent project...[...] there other initiatives that I would say, have been launched, because it is difficult to stay on top of everything, that it why it is important to meet with people and to talk and always having the idea that you want to know more about projects" (Senior IP manager)
16	"Even if the company is worldwide, there are two major quarters: one in diagnosis and one is pharmaceutical. I work for the pharma group and I have really nothing to do with the diagnostic, which is an organization on its own, so we are like two groups" (Head of IP department in pharma division)	"For example, you have 8 patent people in charge for a certain area or research and they are doing a patent in a specific area, then the other patent people might work on sub-projects in that area [...] because you have separate patent attorneys in that particular area of research. [...] We have pretty much one to one relationship, so if the scientists come up with some inventions or if the scientist on the other side is worried about freedom to operate, and we want to know if I want to patent something, can I do that?...so, you need a person from the patent group that needs to go through what they ask and work together to generate patent application, look for prior art" (Head of IP department in Pharma division)	"We actually have maybe a meeting to get approval every months and so the patent attorney would come and say 'ok, I have 2 applications that I want to write' and they would discuss what the applications would deal and the general technology. And then they would discuss 'ok, we are fine with that' or 'we can use it for something else?' sometimes you have multiple inventions at the same time and you need to shift resources to cover everything or you need to give priority to the others and it would be decided by this group meeting that they have every month" (Head of IP department in Pharma division)

ID case	Centralization	Cross-functionality	Coordination by plan
20	"Basically we are stand alone...We handle all the R&D at the headquarter, where the patent department is based too and we are not too far." Chief IP Officer	"The IP department is embedded in the R&D department so we have the head of R&D managing the patent activity. Of course, sitting next door does not mean that you speak easily, but you have the opportunity. We are acting on R&D people innovation, we are not setting targets to them, they are coming to us and we are dealing from there. We are not really communicating (with other departments) and the reason is: it regards something that is just involved in the way we are dealing with inventions and patent prosecutions, so it is not really necessary involving externals" Chief IP Officer	"Connections are more or less informal. We do not have any tool for doing the innovation harvesting. We had one Head that was honoured by EPO because they are very sensible to patents" Chief IP Officer.

ID case	Centralization	Cross-functionality	Coordination by plan
9	"We have centralized research and distributed development. Then we have a corporate team for patenting and licensing, then there is a legal team and a business team. We are separate but I call them "sister organizations" within corporate headquarter, they work very closely in particular with the centralized research, but we also work very close very closely with all the business units that generate patents and are responsible for business strategy. We have this ability to bring the appropriate decision makers from the business units together to talk to us when we have to make a decision" Chief IP Officer	"We work rather close with the R&D team... we work out mutual objects...when we get an invention, we have teams within the company that are assigned to evaluate the invention that is submitted people are assigned to teams based upon on where in the business they work and by technology breakout for this is a kind of matrix. So a typical team would have a small digit number of people, usually they are not fixed but they would represent different parts of the business with expertise in the particular field of technology and on side with patent attorneys, and they will typically meet with the invents make sure that they understand what the invention is and they do some prior art search before or during that discussion" Chief IP Officer	"We have our own set of tools that we developed in-house for managing our inventions' pipeline and so our inventors are able to submit their inventions to us using our tools, and our tools automatically rout the description of the invention to the appropriate attorney and to an evaluation team, which includes tech and business evaluators, collect the feedbacks from that team and facilitates prior arts' searching and for those which we automatically define to file patent application then facilitates drafting the description for patent application and monitor and the exchanges back and forth with the USPTO or with the other patents offices depending upon what feedback we obtained, and to keep track of our pipeline and to manage the maintenance fees. So, we have a highly automated process to go back and forth with our technical team to value their inventions, to file patents applications, to manage the portfolio after the patenting issues and so on." Chief IP Officer

ID case	Centralization	Cross-functionality	Coordination by plan
17	"We have a global R&D that scans the global R&D opportunities and then we have a decentralized R&D structure based upon regional expertise and subject matters expertise within the overarching umbrella…In response to hybrid (R&D) organization, we have hybrid (IP) system" Chief IP Officer for America. "We have a matrix design: one access is geographical location and another array on the matrix is functional responsibility of the particular group". VP patent department for emerging markets.	"We organize ourselves by function and by there I mean that we have patent attorneys who are dedicated to the basic components of getting patents, so handling invention disclosure, working with scientists that come up with invention but we may see the patents, we have litigators and we have few people involved in licensing...There is a constant interaction. We have a document based on a form that we developed that guide the attorney though a discussion with a project leader for a particular project or the product managers for a product that is already on the market and for which there is continuing research" VP IP Officer, emerging market.	"If you make a spectrum where you have completely informal and formal interactions, our case would probably falls 2/3 formal and 1/3 informal. That is the basic relationship that patent attorneys have with scientists they serve...We have a relatively formalized process based on our overall patent strategy design, which we execute for each individual project." VP IP Officer, emerging markets.

2.5. Discussion and Conclusions

This article seeks to build a bridge between the research on internal capabilities and practices to achieve value appropriation from innovation (Moeen et al., 2013; Reitzig & Puranam, 2009; D. Somaya et al., 2007) with the fast growing literature on R&D organizational structure and its impact on innovation output (Argyres & Silverman, 2004; Ashish Arora et al., 2011, 2014). Previous literature explored horizontal coordination mechanisms such as cross-functionality and internal practices in the patenting value chain as antecedents of value appropriation from innovation (Mayer et al., 2012; Reitzig & Puranam, 2009; Reitzig & Wagner, 2010; Somaya, 2012). An emerging stream of studies focused on the organization of the R&D and how this latter is a vertical coordination mechanism that influences the capability to appropriate returns from inventive efforts (Ashish Arora et al., 2014; Leiponen & Helfat, 2011). However, the organization is an interdependent system, where practices and structures need to be jointly considered as they are part of a coherent arrangement (Ménard, 2009). This study contributes to the extending body of literature by focusing on the complementarities of internal organizational practices as horizontal coordination mechanisms and the organizational structure as vertical coordination mechanisms as antecedents of value appropriation from innovation.

We relied on comparative qualitative analysis of 20 cases operating in industries where obtaining patent protection is crucial to appropriate value from innovation, and focused on the organizational capabilities and architectures that allow to secure timely legal protection of the inventive efforts. Following a complementary logic, we found that organizations adopt three different patterns to secure value from innovation by achieving a fast patent grant. Therefore, the first important finding consists in observing equifinality in the causal patterns that lead to fast patent grants achievement as proxy for value appropriation from innovation. This conclusion represents the pitfalls of reality, illustrates the complexity that arises from the intersection of organizational structures and practices, and it allows to perceive clearly that there is not a single recipe according to which companies should organize to be effective in value appropriation. In the three successful configurations of causal elements, centralization of R&D is a sufficient yet peripheral condition for obtaining fast patent grants. This finding is in line with previous evidence (Argyres & Silverman, 2004), yet challenges the importance of centralization of R&D, as it is not a core element for the achievement of fast patent grants. What is more, centralization of R&D could be complemented either by cross-functionality of different units or by coordination by plan, which are both core but disjoint conditions to achieve fast patent grants. Thus, horizontal and vertical mechanisms jointly intersect to appropriate value from innovation. Furthermore, our analysis depicts the antagonisms between cross-functionality and formal planning as coordination mechanisms. Thus, our study offers contribution to the literature on organizational design and innovation management (Puranam & Srikanth, 2007; Reitzig & Wagner, 2010; Srikanth & Puranam, 2011) by demonstrating another tension between cross-functionality and coordinating mechanisms in the design of interdependent tasks. What we observed is that companies that successfully obtain timely patent grant adopted cross-functionality and coordination by plan as (perfect) substitutes instead of complementing coordinating mechanisms.

Furthermore, we explored the causal conditions that are the origin of slow patent grants as proxy of incapability to appropriate value from innovation in a timely manner. This is a new perspective to tackle the problem of how to appropriate the value of innovation. Indeed, literature focused mostly on the attainment of positive performance in patenting and inventing, but researchers and practitioners can learn also from failures and errors of non-performing cases. We derived two theoretical configurations that explain low patent grant. In fact, we provided a minimized model and empirical evidence of at least one case, which demonstrated that the centralization of decision making is not a relevant condition and that the configuration failed to generate a positive outcome, despite a high degree of cross-functionality and coordination by use of platform and structured practices. We suggest that further studies can pursue this direction and explore more what are the causes of failure of value capture from innovation.

Beyond theoretical implications, the research offers useful insights from a managerial perspective. Understanding the organizational implications of the patent processes is important for the world of practice, because of the high costs involved in patent granting (J. S. Gans et al., 2008; Guellec & van Pottelsberghe de la Potterie, 2000) and the threat of competitors benefiting from the disclosure of innovation in the time gap between the application and the grant (Graham & Hegde, 2015; Graham et al., 2015; Harhoff & Wagner, 2009). Interestingly, IP advisors highlight how critical is uncertainty in patent grant and how companies must plan a strategic timeline in the patent applications process:

"I explain it as an "IP calendar", where you sign what vegetables and other stuffs are missing from the kitchen. Companies need to understand that if their IP calendar were full of holes, it would drill down their time. So, for example, if you file an application, and you need to publish it but you do not obtain a patent, then you have published information that now is public and get nothing from it. You are basically disclosing your intellectual property; you are sharing information with suppliers, other companies, and manufacturers. So, a lot of companies do not fully understand and appreciate how devastating having a meeting with someone during the time when your invention is still pending". Interview with Dr Sant, founder and managing director of White Light Consulting (IP consulting firm listed in IAMStrategy300), 11 July 2013

While scholars highlighted some coordination mechanisms that link research units with business and legal experts in the process of IP generation, practitioners so far acknowledged that there is a number of models that organizations can adopt in order to appropriate value from innovation.

"There is no one-size fits-all. They vary greatly in terms of how they organize their IP, how do they structure, how do they report, whether they are centralized or decentralized. I've seen a lot of different examples and there are lots of facts that you have to take into account when to organize your IP

department." Interview with Mr O'Connell, founder and managing director of Chawton Innovation Services Limited (IP consulting firm listed in IAMStrategy300), 19 July 2013)

We believe that our research can potentially shed light in this direction. On one side, it fair stating that there is a natural gap between normative explanation for managerial audience and empirical evidence on the vertical and horizontal coordination mechanisms to fast achieve patent grant. On the other side, the paper presents a methodological inquiry on the organizational dimensions that enforce patent generation process at the organizational level. Managers can benefit from a simplified yet exhaustive depiction of IP generation and protection and by the disclosure of three important dimensions –centralization of R&D, cross-functionality and coordination by plan- as cardinal mechanisms through which orient the actual practices related to patent granting. Forcing companies in making a conscious effort on their organizational design in terms of architectures and practices that are effective for IP strategic management should be encouraged, particularly in those industries such as pharmaceutical and ICT, where freedom to operate and prevention from infringement are guaranteed by the exclusive ownership of intellectual property rights. Furthermore, organizations should be aware that not all the configurations of mechanisms are effective in achieving a timely legal protection. Particularly, companies must be sensitive in fostering cross-functional interactions among different units and the application of formal tools and procedures to coordinate scientists, legal experts, business management and other parts of the organization such as finance or corporate levels. In fact, these two horizontal coordination mechanisms work through antithetic logics and redundancies or delays might arise.

A final contribution of our study consists in highlighting how a qualitative comparative analysis can be useful to understand complementarities between practices and structure. In particular, we explore and map complementarities from a configurational perspective using a fuzzy set method. Research on organizational design and innovation management to date focused on econometric techniques and linear or curvilinear relationships between variables and the outcome. However, those techniques proved to be limited in the exploration of the interaction among multiple parameters (Fiss, 2007; Fiss, Sharapov, & Cronqvist, 2013). Instead, with fs/QCA it is possible analysing relationships and combination of causal mechanisms that go beyond for instance three-way interactions. Furthermore, for our research we relied on both quantitative features retrieved from a large sample of patents and rich qualitative evidence on the cases, which enabled a full speculation on the processes behind the coordination between R&D and IP units. Together with Somaya and colleagues (2007), our research is one of the few examples that triangulate quantitative and qualitative evidence despite this being quite powerful to tease out the mechanisms and associate these to performances. In fact, to the best of our knowledge previous studies on the organizational design and innovation management of intellectual property rights have mainly relied on single case studies (Reitzig, 2004), survey data (Pitkethly, 2001) or large datasets. In light of intriguing results obtained with fs/QCA, we would encourage future research on micro interdependencies in the structure and practices related value appropriation to complement more systematically qualitative evidence with large quantitative studies.

Finally our study is bounded by some limitations. First, we do not claim that the observed configurations are exhaustive or cover all contingencies. We ran sensitivity analyses with alternative specifications of causal conditions -for instance, the average number of patent families or standard deviations from the average number of families to measure the value of the patent portfolio. Indeed, patents included in the patent families are usually of greater value, because the patentee only takes the additional costs and delays of extending patent protection to other countries if it is prospectively worthwhile. Previous literature found a positive correlation between family size and the likelihood of a patent being granted (Guellec & van Pottelsberghe de la Potterie, 2000). Fs/QCA analysis indicates an absence of a clear set-theoretical relationship when organizational configurations and patent families are used to explain fast patent grant achievement. In other words, there are many ways of positively performing depending on those conditions, but no consistent pattern. Thus, despite the effort of covering exhaustively the main causal mechanisms at the basis of value appropriation from innovation in the context of IP generation, we believe that a more comprehensive and extensive classification of practices and structures should be developed in future research and we hope to stimulate further studies in this direction. The second limitation of our study also relates to the configurations. In fact, we rely on the empirical analysis of a sample of 20 cases. Given this number of cases, general theory on configurational analysis suggests analysing between three to four conditions (Greckhamer, Misangyi,

& Fiss, 2013; Ragin, 2008). In our study, we consider four conditions for a total of 2^4 configurations. If we were adding more conditions, the degree of complexity in the analysis and in the representation of results would increase, meaning that the number of counterfactuals –i.e. configurations not observed in reality yet still theoretically possible- would also increase, creating difficulties in the resolution of simplifying assumptions. A straightforward solution would be to increase the number of cases under investigation and to explore the role of additional categories. As for previous research (Reitzig & Puranam, 2009), we faced the difficulties of collecting rich and exhaustive data on the internal organization of IP generation and IP protection, so we limited our analysis once reached the sample saturation. In that regard, it is important to acknowledge our sample as representative both in terms of industry coverage as well as in terms of number of patent applications (on average 5%) filed at the US Patent Office in the study period. However, we hope that future research will take up this challenge. For instance, an interesting line of investigation would be the understanding the intersection between architectural structure and processes and practices after changes in the organizational structures and mergers, as this phenomenon is common especially in the pharmaceutical industry. This area of research would contribute to expand our understanding of interdependencies among different layers and how organizational changes trigger value appropriation from innovation in the case of IP generation and protection.

In conclusion, despite some limitations, we believe that our study presents an interesting and innovative understanding of the configurations of horizontal and vertical coordination mechanisms at the ground of value appropriation in the case of IP generation and IP protection. Furthermore, the research offers a novel and unique combination of qualitative and quantitative evidence and well as methodological contribution.

Chapter 3 Managing Technology Licensing: The IP Unit Perspective

Abstract

This paper examines the management of the technology licensing process. Using multiple case studies, I found that capabilities and governance of decision making in technology licensing can be organized through two alternative configurations. In the first configuration, the management of licensing is based on a combination of internal flow of information, stand-alone coordination mechanisms and inside-out negotiating capabilities, which are the capabilities to convince external partners of the validity of the technology. In the second configuration, licensing is orchestrated through an external flow of information, shared coordination mechanisms and outside-in negotiating capabilities, which are the capabilities to convince members of the same organization of the validity of the license agreement and to moderate the various internal debates related to the agreement. The difference in the two configurations can be traced back to the establishment of a nested licensing unit in the organizational structure, which highlights an overarching strategic intent of capturing value from innovation. This paper provides a micro analysis of the overall management of the technology licensing process and complements previous models for the organizational design of technology licensing decision making.

3.1. Introduction

Activities in and attention to technology licensing are increasing. Recent statistics demonstrate that since the mid-1990s (Zuniga & Guellec, 2009) the number of licensing agreements struck and the amount of revenues generated have risen across industries and countries: the annual value of transactions ranges from $25 to $35 billion in the United States and from $35 to $50 billion globally (Ashish Arora, Fosfuri, & Gambardella, 2001). In parallel, researchers examined the motivations that prompt decisions to license with a particular focus on patent characteristics (Gambardella, Giuri, & Luzzi, 2007; Kim et al., 2006), expectations from commercialization (Nerkar & Shane, 2007), contractual characteristics (Anand & Khanna, 2000; Oxley, 1997), knowledge flow among parties (A. Agrawal, 2006; J. Oxley & Wada, 2009) and the creation of technological standards (Joshi & Nerkar, 2011).

Recently, scholars shifted their attention to organizational traits that might influence the decision to license technology. A first dimension that has been investigated is firm size. Researchers found that compared to large organizations, small firms with limited production capabilities are more likely to license out technology because they benefit from royalties while having inadequate possibilities for commercial exploitation (Gambardella et al., 2007; Kollmer & Dowling, 2004). However, in a recent OECD survey, Zuniga and Guellec (Zuniga & Guellec, 2009) showed that the distribution of firms that license their patents is bimodal: both small and very large companies are willing to license their patents, while medium-sized enterprises are reluctant. Therefore, organizational size does not provide a clear-cut explanation for the decision of large organizations to license, as empirical evidence presents unsystematic and complex patterns. One way to disentangle ambiguity would be to adopt a more fine-grained approach in order to understand whether these differences in the willingness to license can be explained by the management of technology licensing. On this count, Pitkethly's seminal paper provided evidence that a greater involvement of top management in the licensing process increases the odds of establishing an agreement (Pitkethly, 2001). Recently, Arora, Fosfuri and Rønde (Arora, Fosfuri, & Rønde, 2013) enquired into the organizational structure behind the decision to license technology. They developed a theoretical argument that explains how differences in incentives and difference in information impact the decision to license a technology either at central corporate level or within the business divisions.

Previous contributions devoted scant attention to how members of in-house Intellectual Property (IP) units engage in the management of technology licensing and mobilize information and power in the attempt to reach a final consensus. This is surprising since research had analysed how in-house IP units manage the decision to patent an invention through cross-functional practices with the R&D and the integration of technical and legal capabilities (Reitzig & Puranam, 2009; Reitzig & Wagner, 2010; D. Somaya et al., 2007). Nonetheless, there is still limited knowledge of the contributions of members of the IP-units to manage the decision to license technology. To tackle the lacuna this research adopts a processual perspective and examines the following research question: *how do IP units manage the licensing process?* Gaining insights into the process by which in-house IP units manage and organize technology licensing can provide a deeper understanding of the practices and characteristics of the decision to license technology, particularly for large organizations.

In approaching the research question, I conduct an exploratory study using an inductive methodology based on an in-depth multiple cases study. Case studies are well-suited for this type of research, because they can address questions about processes and organizational contexts that lead to frame decisions (Bidwell, 2009; Kaplan, 2008). My research focus is on large and very large organizations and data are collected in 15 cases that have an internal IP department. Within each case, I examine the micro-practices of individuals engaged in technology licensing. From the comparison of these cases, a detailed picture of the key influences at the process level that affect the decision to license technology emerges.

The results of this study suggest that decentralization and delegation of authority versus centralization are not the only organizational traits that impact the management of technology licensing and shape decision making. Two factors appear to be particularly important: the management of information and the internal coordinating mechanisms. Furthermore, internal coordinating mechanisms can be reinforced by both the existence of an internal supportive parallel structure and the enforcement of the decision by other layers of the organization. The resulting combination of the management of information and internal coordinating mechanisms manifests in different negotiating capabilities to manage the technology licensing process.

This study contributes to an emerging stream of market for technology literature that aims at exploring the role of organizational traits in technology licensing (A. Arora et al., 2013; Ceccagnoli & Jiang, 2013; Pitkethly, 2001). By adopting the IP unit perspective this paper elucidates the practices and organizational dynamics through which actors frame the decision to license technology. This approach aims at grounding the micro-foundations of technology licensing and at explaining the role of internal management of information and internal coordinating mechanisms. Explicit emphasis is put on the process through which members of IP units develop negotiating capabilities to mobilize knowledge, information and decisional power. In that respect, the role of individual cognition as well as internal frictions in licensing practices are highlighted. Finally, the paper provides fine-grained qualitative evidence of the organizational capabilities that in-house IP departments develop to interact with other units in the organization for the strategic management of intellectual property rights (Reitzig & Puranam, 2009; Reitzig & Wagner, 2010; D. Somaya et al., 2007).

The paper is organized into four sections. In the beginning, I review existent literature on the organizational dimensions of technology licensing. Then, I describe the research method and present the data, which is followed by the analysis and interpretation of the multiple case study. Finally, I discuss the results and the implications of the research.

3.2. Conceptual Background

The paper is an inductive, explorative study that started as an investigation of in-house licensing practices and mechanisms. Its theoretical framework emerged through a cycling process that knits together data and literature. To orient readers, I start off with a brief overview of concepts and literature that informed the research (Pratt, 2009; Suddaby, 2006).

Licensing is an essential strategic activity that corporations carry out in order to commercialize their technologies, to pre-empt their technological domain and to block competitors' (illegal) use of innovation (Arora & Fosfuri, 2003; Ceccagnoli, 2009; Gans, Hsu, & Stern, 2008). Important clues as to what drives the decision to license technology may be encountered at the patent level. Research found that the size of a patent portfolio (Kim et al., 2006), its innovative characteristics (Nerkar & Shane, 2007) and its efficient legal enforcement through timely patent grants (J. S. Gans et al., 2008) increase the probability to license proprietary technology.

The expected appropriation of the economic rents (A Arora & Fosfuri, 2003) is another important objective that stimulates the decision of licensing an IP. Bargaining power of the licensor over the licensee fosters the probability of establishing arm’s length relationships with direct rivals and of leveraging the technological leadership in order to gain from royalties and fees, despite the possibilities of using exclusively the technology in the downstream market (Gallini & Winter, 1985). However, in this case the licensor needs to find an optimal number of licensees without eroding business profits and allowing competitors to enter into the competitive space (Andrea Fosfuri, 2006). Given these economic motivations, contingencies may moderate the attitude towards licensing. For instance, literature showed that market volatility (Andrea Fosfuri, 2006; Gallini & Winter, 1985) and information asymmetry between licensor and licensee have a negative impact on the propensity to license (Anton & Yao, 2002; Kale & Singh, 2009; Zuniga & Guellec, 2009).

Finally, organizational characteristics are important pre-conditions of the decision to license. Earlier literature focused on firm size and found that small firms are more likely to license than large organizations because they benefit from royalties and fees, given the limited production capabilities for commercial exploitation (Gambardella et al., 2007; Kollmer & Dowling, 2004). Subsequent research found mixed results for large corporations. Zuniga and Guellec (2009) more recently analysed 600 European and 1600 Japanese firms and showed that both small and large organizations are willing to license while medium-sized firms are more conservative. Thus, empirical evidence appears to depict complex patterns, which suggests that beyond firm size further organizational dimensions might influence the decision license.

A recent research stream (Ceccagnoli & Jiang, 2013; K. Laursen, Leone, & Torrisi, 2010) drew from absorptive capacity literature and showed that the decision to license is enhanced by licensee's stock of knowledge and its capability of exploring and monitoring complimentary technological domains. Consequently, a licensee's high absorptive capacity fosters the decision to license (K. Laursen et al., 2010). Ceccagnoli and Jian (Ceccagnoli & Jiang, 2013) complemented these findings and claimed that the licensor develops knowledge transfer capabilities when the licensee has weak absorptive capacities. Indeed, when the licensee has weak absorptive capacity it might not be able to recognize the full potential (disclosed) in licensed technology, and in turn likelihood to license technology might decrease. To avoid this situation, a licensor leverages its knowledge transfer capabilities, which are competences in establishing licensing transactions, gathered through past experience in the industry.

In an emergent research stream on organizational structure of innovation and R&D (Argyres & Silverman, 2004; Arora, Belenzon, & Rios, 2011; Miller, Fern, & Cardinal, 2007), Arora and colleagues (A. Arora et al., 2013) lately developed an argument on the benefits and drawbacks of either a centralized or decentralized structure to manage technology licensing. They mathematically formalized that centralized headquarters are more prone to establish outbound licensing agreements, because monetary incentives from licensing fees generally counterpoise searching costs for potential licensees. On one side, even if centralized headquarters have less information concerning the competitive outcomes in the downstream market, they tend to license aggressively and for revenue-oriented deals to counterbalance the risk of accepting value-destroying agreements or rejecting favourable ones. On the other side, business units (usually) have more complete and extensive information on profitable opportunities. In spite of that, decentralized subsidiaries chronically under-license, because they fear losing their market share (rent dissipation) and they slant towards total production benefits and long-term rewards from business profits rather than licensing fees.

Although these contributions identify the licensor's knowledge transfer capabilities and the organizational structure of decision-making as organizational traits that explain the decision to license technology, still missing is an adequate recognition of the contribution of the members of the internal IP department. Scholars have already acknowledged the role and competences of in-house IP members in the process of patent generation

(Grindley & Teece, 1997; Reitzig & Puranam, 2009; D. Somaya et al., 2007) and the enforcement of intellectual property rights (Reitzig & Wagner, 2010). Concerning technology licensing, Pitkethly (Pitkethly, 2001) found that on average IP staff are mostly dedicated to activities around patent filing and just a minority of IP members are acquainted with either litigation, patent information management or licensing contracts. Furthermore, a propensity to license out technology appears to be higher in UK, where top management is more frequently involved in the deals. Despite the importance of internal IP members for a broad range of activities that concern the strategic management of intellectual property rights and Pitkethly's (2001) evidence for a potential correspondence between technology licensing behaviour and the composition of in-house IP units, we are still missing holistic empirical insights and the perspective of in-house IP units in the licensing process remains poorly understood. In fact, there is strong reason to believe that a better understanding of the tasks and roles of in-house IP members in the process of technology licensing would provide us a better grasp of the overall management and complement previous research on the organizational dimensions of technology licensing.

The study expands on these insights by examining how in-house IP units manage technology licensing through micro-practices and internal organizational dynamics among their members. A key to understanding the impact of micro-patterns of IP unit on licensing process is found in the cognitive frames as a means through which agents shape their own agendas and control information flow to steer decision making processes towards a certain, preferred outcome (Bower, 1970; Kaplan, 2008). In fact, research in the organizational domain suggests that actors make use of cognitive frames to make sense of uncertainty and ambiguous signals from the environment (Bower, 1970). During strategic decision making, actors adjust their attention and integrate cognition and political actions to establish the legitimacy and authority of their claims and reach an agreement (Burgelman, 1994; Kaplan, 2008; Snow, Rochford, Worden, & Benford, 1986). However, actors involved in strategic decision making generally depend on each other in their interactions and might experience interpersonal conflict and contrasting motivations. Therefore, actors should establish empirical credibility of their frame by building coalitions and interrelating disconnected practices (Snow et al., 1986). Through the integration of cognition and politics, agents can re-align the scope of the decision and converge self-interests towards a common a shared goal that maximizes the overall outcome (Bower & Doz, 1979; Burgelman, 1994).

Applying this view to an analysis of in-house IP units shifts the analytical focus from the organizational structure to the practices necessary to manage technology licensing as a decision-making process. In fact, if we transpose previous arguments into in-house IP department, such a department might be seen as a unit that interfaces with other organizational units – e.g. scientists or business managers to discuss and seek for information. Furthermore, it might be possible to identify multiple actors even in the same IP unit that need to interact and reach consensus. Therefore, technology licensing might be described as an organizational process in which multiple members of the organization participate at different organizational levels and intervene through complex intersections of cognitive frames and of powerful coalitions to shape the final decision.

As little is known about how IP departments manage the licensing process through their micro-practices, when I began this study, I choose to pursue my investigation inductively, relying on a qualitative interpretative approach. Interpretative research focuses on building an emergent theory from a perspective that gives voice to the explanations and storytelling of those who are embedded in the process (Siggelkow, 2007), which in this case is the licensing process. Thus, I developed my study through a multiple case study that relies on qualitative data drawn from members of internal IP departments of very large and large sized organizations. In doing so, I aim at providing the ground for the organizational micro-foundations of technology licensing.

3.3. Method

In order to formulate an inductive model (Eisenhardt, 1989; Yin, 2009) of how organizations make decisions about licensing, this study utilizes 15 companies as cases to zoom in on the micro mechanisms of the licensing process. The cases are treated as multiple experiments, each helping to confirm or disconfirm the findings drawn from the others (Yin, 2009). A preliminary pilot study was performed to acquire informative hints on the empirical problem. It was followed by a complete and intensive analysis.

Stage 1: Pilot Study

In order to grasp a more practical view on the research question and to familiarize with the language and mentality of people involved in IP management and licensing, I performed a series of preliminary pilot interviews with IP managers of large corporations and with IP experts. These cases were chosen according to three criteria. Firstly, the corporations must be highly active in patenting, so the management of intellectual property is a relevant issue within the corporate and business governance. Secondly, patenting strategies and IP management logics might differ from industry to industry. Therefore, to understand the emergence of different behaviours and strategic approaches towards patenting I selected firms that registered their innovation in the following fields: medical technology, electrical machinery, digital communication, measurement, organic chemistry, pharmaceutical, biotechnology, and engines. I chose those technological domains because patent filing and granting happen with high intensity (EPO, 2012). The heterogeneity among technological fields for patenting allows interrogating the data for possible industry patterns and facilitates generalizability. I counted the number of patent applications per applicant and the number of applications of each applicant with respect to each field: this double check captured the relative importance of patenting within the industry. Finally, and most importantly, corporations present a complex organizational structure in terms of R&D and units responsible for patenting, geographical locations and business lines. The complexity of the organizational structure allows querying organizational differences in the way IP strategy and licensing are developed within the firms in the sample. Seven companies took part in the preliminary study. Data were gathered through semi-structured interviews with individual respondents between November 2012 and April 2013. I selected and contacted participants that have direct experience within IP management and licensing: interviewees were either Chief Technology Officers, heads of patent department or chief IP counsels. Moreover, personal interviews with three external IP consultants complemented the first pilot round of the project. External experts are generally patent attorneys that operate in law firms specialized either in patent filing, litigation, licensing and IP strategic advisory. It is important to notice that the roles covered by interviewees allow them to have a clear view of the scope and processes of IP management, the organizational structure of IP units and of the antecedents and outcomes of technology licensing. Interviews were conducted either personally or over the phone always using an interviews' guideline, they were recorded and then transcribed. Detailed notes complemented the transcripts. During the pilot study I adopted an in-vivo coding scheme: this approach is helpful to extract main themes and concepts, which could then applied in the main study (Saldaña, 2009). Therefore, I developed analytical tables to navigate into the emerging themes (Eisenhardt, 1991; Eisenhardt & Graebner, 2007). Table 3.1 here below summarizes the pilot interviews sample.

Table 3.1: Summary of interviews conducted for the pilot case study

ID Interviewee	Industry	Role in the Company	Experience in the Industry
1	Law and IP consultancy	vice president	more than 20 years
2	IP brokerage	vice president for Europe	more than 20 years
3	IP consultancy	director	more than 20 years
4	Electronics	global chief patent counsel	more than 20 years
5	Electronics	chief patent officer	more than 20 years
6	Medical	chief patent officer for the medical division	between 15 and 20 years.
7	Electronics	patent attorney in the global IP division	between 15 and 20 years.
8	Pharmaceutical	global chief patent officer	between 15 and 20 years.
9	Food and healthcare	chief patent officer	more than 20 years
10	IT services	chief executive officer	more than 20 years

Stage 2: Multiple cases study

Once the pilot cases had determined the general outline of the phenomenon, a multiple case study design was chosen to deepen the understanding on the relationship between organizational structures of IP departments and the licensing process. Multiple case study design is a suitable method to compare how different types of organizations organize the licensing of their technologies. Indeed, each case enables replication logic to confirm or disconfirm the patterns of evidence depicted in the other instances, providing compelling results and associations of facts at multiple levels (Yin, 2009). The successive replication and comparison of the phenomenon through multiple cases allows establishing a more stable theoretical framework (Eisenhardt, 1989; Siggelkow, 2007).

In the multi case study, I employed 15 cases to demonstrate the emergence of organizational aspects of IP management influencing the licensing process.

After the pilot study with the initial sample of 7 organizations, I contacted additional cases, following a saturation logic (Yin, 2009). A first dimension that drives the sampling construction is the technological domain of IP portfolio. The pilot study analysed organizations from heterogeneous technological fields to provide general patterns and findings. Since each industry may be affected by its own peculiar logic, the comparison of cases that operate in heterogeneous technological fields might be weak in providing stable patterns. In order to overcome this potential impediment and strengthen the analysis, I enlarged the preliminary pilot sample to have at least pair-wise comparisons among the IP portfolios of organizations in the following patenting areas: medical technology, electrical machinery, digital communication, measurement, organic chemistry, pharmaceutical, biotechnology and engines. From an industrial classification, those organizations are active in the pharmaceutical, manufacturing, healthcare and ICT sectors. Through this first dimension I sought to include theoretical sample cases with similarities that would aid comparison and replication, yet with sufficient heterogeneity to help assess potential generalizability (Eisenhardt & Graebner, 2007). A second dimension through which I developed the theoretical sampling is the organizational structure of IP departments. Indeed, the pilot study showed that the IP departments could either work at centralized level or operate through decentralized units. I used this specification for comparing and combining polar cases within the technological domains. As a result, companies included in the theoretical sample are multinational, multi-business organizations, with comparable IP portfolios and active players in technology licensing. To increase generalizability, I adopted a purposive sampling technique for the mentioned parameters (Silverman, 2006). To access insider knowledge about how IP departments manage the licensing process, I secured an independent expert (a former Head of the IP unit of one of the biggest patenting organizations). On the basis of discussions with him, I selected cases that varied in the dimensions mentioned before.

Case Description

I first selected 120 companies that met the criteria above and that could be contacted through institutional[1] or personal relationships. Of these companies, 30 agreed to participate, including three that participated in the pilot study. However, at an early stage of the interview process, 15 decided to drop out because they believed that the issue discussed was too sensitive and strictly confidential. This caution was not surprising, as companies refrain to divulge data on patenting and particularly licensing, which reflects strategic choices with very limited public disclosure (Reitzig & Puranam, 2009). The final sample consisted of 15 companies. Three companies work in the pharmaceutical industry. They are globally active in a vast range of research areas such as oncology, diabetes, vaccines, animal health, and generic consumer health. Three companies belong to the healthcare sector. Those organizations are worldwide players in producing biopharmaceutical manufacturing technologies and patient systems, which are areas where there is urgency for innovation protection. Five companies operate in the ICT

[1] Companies selected for initial contact were members of the Licensing Executive Society. This fact further re-assured the researcher that licensing was a relevant phenomenon to engage with for the company.

industry. This industry plays an important role in fostering technological evolution and firms are widely active in patenting their innovations. Companies in this industry are software and information systems producers, hardware manufacturers, and communication and media providers. Four companies operate in the manufacturing industry. Companies included in this cluster are active players in the production of electric machinery, power systems and robotics. Table 3.2 summarizes the final sample. It is worth stressing that such a heterogeneous sample in terms of industry classification permits the finding of patterns that do not depend on a singular industry and therefore this study might provide a wider generalizability of results.

Table 3.2: Summary of Characteristics of Firms in the Final Sample

ID Company	Company Core Business	Industry	Employee number (2013)	Geographic location	structure of R&D unit	structure of IP unit
1	Robotics and Oil conducts	Manufacturing	146100	Europe	centralized	hybrid
2	Information systems	ICT	76417	Europe	hybrid	centralized
3	Chemicals and Pharma	Pharmaceutical	113200	Europe	centralized	centralized
4	Telecom, manufacturing	ICT	110255	Europe	Decentralized	centralized
5	Computer HW	ICT	434246	USA	centralized	centralized
6	Robotics	Manufacturing	39312	Europe	centralized	centralized
7	Beauty and personal health	Healthcare	72637	Europe	centralized	centralized
8	Communication	ICT	97798	Europe	Decentralized	decentralized
9	Pharmaceuticals	Pharmaceutical	135696	Europe	Decentralized	decentralized
10	Hearing devices	Healthcare	9063	Europe	centralized	centralized
11	Electronics, manufacturing	Manufacturing	118087	Europe	Decentralized	centralized
12	Pharmaceuticals	Pharmaceutical	111974	Europe	hybrid	hybrid
13	Media, communication	ICT	14000	USA	hybrid	centralized
14	Manufacturing	Manufacturing	172000	USA	hybrid	hybrid
15	Hearing devices	Healthcare	3080	Europe	centralized	centralized

3.3.1. Data Collection

My data collection was intensive, extending over the years 2013-2014 in which I proceeded through the collection and analysis of records (Locke, 2001). I adopted multiple sources of evidence, primarily interviews supplemented with archival data and expert validations to encourage convergent lines of inquiry. The first data access started in the mid of June 2013 and it lasted until the mid of August 2013. A second round of interviews and field research took place between May 2014 and early September 2014.

Interviews

Interviews were the major source of data for the project. My principal informants were Chief Technology Officers and Heads of intellectual property divisions. Indeed, persons in charge for the mentioned roles have senior positions, which allows them to have a broad view of the overall initiatives that concern intellectual property rights (IPR) –i.e. the filing, prosecution, protection and monetization of IPRs. Moreover, Chief Technology Officers and IP executive managers have crucial roles in matching and harmonizing the corporate strategy with the needs of their divisions and coordinate with the R&D laboratories and the business unites. For each selected organization, interviews were conducted in person or, when that was not possible, over the phone, always using an interview guideline. Interviews lasted between 50 and 90 minutes, were tape-recorded and then fully transcribed except for one case. Notes taken during the interviews were transcribed within the following 24 hours. An interview protocol was designed and interviewees were asked to describe their involvement in the IP management of the organization, their relative competences, the frequency and topics of their meetings; therefore, I asked them to describe a typical process of licensing-out and its time line, how they collaborate within the IP department and with other organizational units, what are their incentives in licensing-out and whether they might have experienced any problems in dealing and designing a license agreement. Finally, some respondents were contacted a second time for a follow-up. Second-order interviews are useful not just to deepen some aspects, but they strengthen research by mitigating cognitive biases and impressions in retrospective data collection (Huber & Power, 1985).

To ensure that the theoretical sample includes the most knowledgeable informants, I used a “snowballing technique” (Eisenhardt & Graebner, 2007). I usually asked the focal interviewees to introduce me to another crucial colleague who usually takes part in the licensing process. Persons that cover these roles are often senior patent attorneys with a mandate to operate in crucial jurisdictions -either the USA or Europe- and they have both a technical and a legal background, which are essential for designing licensing contracts. Indeed, the pilot study highlighted that IP management and technology licensing are areas where law, scientific and business logics co-exist. Having multiple interviewees from the IP department allowed me to juxtapose and compare stories and impressions on licensing process and IP management, controlling for the emergence of different or complementary versions and minimizing biases in respondents’ perception.

During the data collection it became clear that the participating organizations would not allow me to interview everybody at will, as people’s time was considered a scarce resource. Furthermore, the pilot study indicated that licensing decisions usually are made by a very small set of people, typically the senior members of the IP departments and eventually other key executives or board members. Other individuals in the organization have limited if any awareness of the whole chain of events taking place during licensing process. This pattern reflects the sensitive nature of licensing and is consistent with other prior evidence that awareness of an organization’s strategy declines rapidly below the core management teams in similar strategic settings such as acquisitions or spin-offs (Graebner & Eisenhardt, 2004; Souitaris, Zerbinati, & Liu, 2012). Thus, when I was refused to interview two principal informants per IP department, I agreed to access a second member via e-mail to confirm my findings and to minimize single informant's bias (Locke & Ramakrishna Velamuri, 2008; Yin, 2009).

Public speeches

Informal, nonparticipant observations were made in the research during practitioners' conferences. During these conferences, I attended and recorded the speeches of representatives of the organizations included in my sample. I attended four major world-wide conferences in the field of intellectual property management held in Europe between November 2012 and May 2014. Conferences were organized by leading chartered institutions and organizations; they covered presentations and round tables on managerial and financial aspects of intellectual property rights. During the conferences, I also shadowed practitioners discussing on the most relevant topics that concern the management and the monetization of IPs and the challenges that they face in different countries and legal jurisdictions.

Overall, this study relies on 38 interviews and 10 public speeches from 27 individual respondents. Table 3.3 provides a summary of the semi-structured interviews with the principal informants.

Table 3.3: Data source: Interviews, presentations and evidence via email

ID Company	Industry	Interviewees and number of relative interviews	Public presentations	Emails (Validating Evidence)
1	Manufacturing	Business development manager (2): senior IP attorney (1)		2
2	ICT	Head of IP department (2); senior IP attorney (1)	1	1
3	Pharmaceutical	Senior IP attorney (2); VP of IP department (1)	1	
4	ICT	Head of IP department (2); VP of IP department (1)		
5	ICT	General Counsel of IP (2); Director of IP Strategy (1)		1
6	Manufacturing	Head of IP department (1)		1
7	Healthcare	VP of R&D unit (2)	1	1
8	ICT	Director of Legal & Intellectual Property for Device Concepts & Technology (1); Director of Licensing (1)	1	
9	Pharmaceutical	Senior licensing manager (1); Senior patent attorney (1)	1	
10	Healthcare	Head of IP department (2); senior scientist (1)		
11	Manufacturing	Head of IP department (1); senior licensing attorney (2)	2	1
12	Pharmaceutical	Head of IP (1); VP of IP department (1)	1	
13	ICT	Head of IP department (2); VP of IP department (1)		
14	Manufacturing	Head of IP department (2); VP of IP department (1)	2	1
15	Healthcare	Head of IP department (2)		1
Total		Number of Interviewees: 27; Number of Interviews: 38	10	8

Notes: Numbers in parenthesis refer to the number of interviews for each interviewee

External and Internal Documents

External and internal documents are another important source of information and data triangulation. For this purpose, I collected contents from corporate web pages of the 15 cases. Moreover, I searched on the database *Nexis* for business press related to both IP management and license agreements of companies included in the theoretical sample. External documents may contain descriptions of licenses established by the selected organizations and of positive or negative results achieved through licensing. After the interviews, I used the retrieved documents to "triangulate" the interview data and to identify confirmatory or dissenting evidence.

3.3.2. Analysis

My analytical approach was open ended (Corbin & Strauss, 2008) and driven by a broad interest in how in-house IP members frame and then make decisions on technology outbound licensing. As is typical of inductive research, I iteratively explored my data going back and forth between the described phenomena and the emerging theoretical arguments (Locke, 2001; Miles & Huberman, 1994). I analysed data by firstly building individual cases that synthesized interviews and archival materials (Eisenhardt, 1989). As a check, an independent researcher[2] was asked to compare the original interviews and the summary and to comment on these to provide an unbiased view on each case.

[2] It is worth to mention that for all the interviews it was agreed that the study included a third external researcher with an advisory role on the analysis of the cases. To motivate informants to provide accurate data, confidentiality was promised (Huber and Power, 1985).

Following exemplar inductive studies (Andriopoulos & Lewis, 2008; Graebner & Eisenhardt, 2004; Souitaris et al., 2012) and analytical techniques to move from raw data to theoretical framework (Gioia, Corley, & Hamilton, 2012; Pratt, 2007; Pratt, 2009), I progressed through a three-step process, which is depicted in Figure 1.

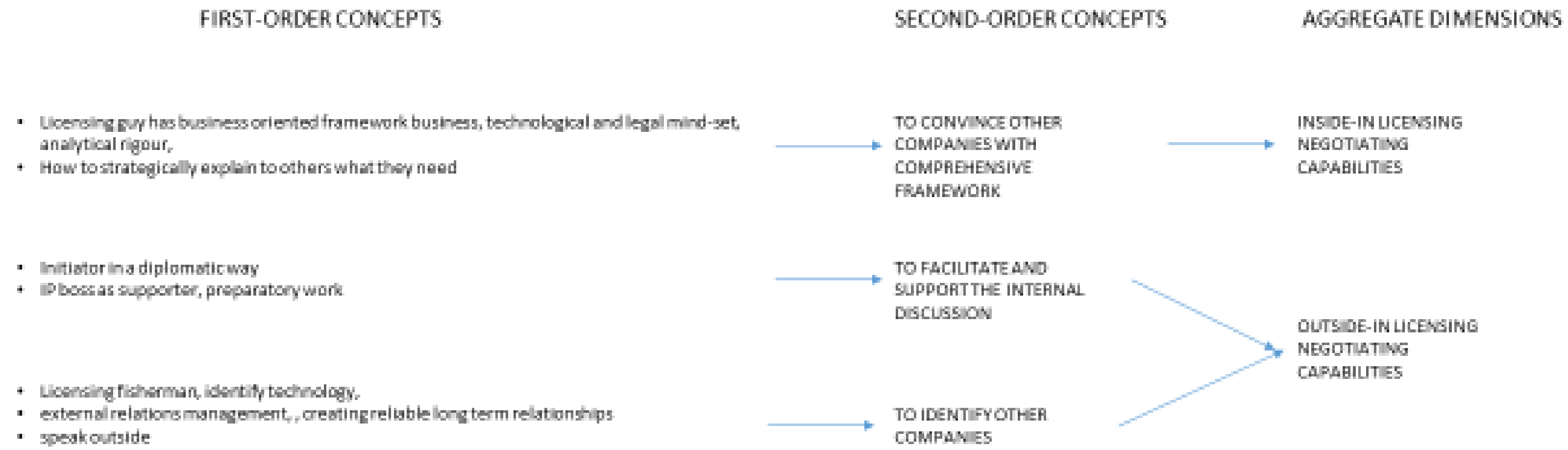
In the first step of data analysis, I compiled separate cases for each IP department embedded in the observed organization. The within-case histories were the basis to develop constructs and relationships to describe the licensing process experienced by each single IP department. Thus, by examining all interview transcripts I identified patterns and differences in the descriptions of the IP management and licensing processes using open and in-vivo coding to better understand how IP actors describe their world (Locke, 2001). For example, I identified several data segments related to "communication", "advice", "negotiation", and "framework". I then reviewed the data to countercheck whether assigned codes fit with chunks of texts: when the match was poor or weak, I revised or abandoned the first-order concepts (Silverman, 2006). Examples of preliminarily abandoned codes are "propensity to license" or "relation between R&D and Business".

I proceeded in the analysis by consolidating categories, which became more theoretical and abstract. Particularly, I looked for links among first order concepts, so that categories could be grouped into second order themes. Thus, I moved from open to axial coding (Gioia et al., 2012; Locke, 2001). For instance, I noticed that the theme "seeking for information" consolidates issues concerning the means and tools, roles and timing of activities accomplished to gather information for the licensing process. Particularly, the second-order themes encompassed constructs that exist in the literature.

In the third step, I moved from a within-case analysis to a cross-case comparison (Eisenhardt, 1989) and I looked for relationships and similarities in second-order constructs among cases (see Figure 3.1). Similar second-order themes were grouped into aggregate dimensions, which either refer to established constructs in the literature (e.g. “information flow”) or to abstracted concepts (e.g. “inside-out negotiating capabilities”). Aggregate dimensions that emerged formed the ground for the theoretical framework. For instance, I noticed that when cases were ordered according to the degree to which each second order theme was present (e.g. “inside-in information flow” and “stand-alone coordinating mechanisms”), they clustered into two groups that were comparable and fitted into a coherent picture, which could be described through unique theoretical lenses.

Figure 3.1 Data structure: from first-order concepts to aggregate dimensions

FIGURE 3.1 CONTINUED



3.4. Results

3.4.1. The design of licensing units and the strategic framing of technology licensing

During cross-case analysis, I observed that IP units tend to cluster into two main groups, depending on the organizational functions they are supposed to cover. With *functions* I mean the systems of homogeneous activities and relationships, in which members of organization are embedded at a certain time (Fischer, 1974). As we may see from Table 3.4, all cases highlighted that IP departments cover the *patenting*[3] function, which consists in the systems of activities that are necessary to harvest innovation and that guarantee the right level of legal protection. Consistently with previous studies (D. Somaya et al., 2007), I found that members involved in the patenting function are grouped into patenting teams according to their technological background and generally assist scientists from the disclosure of ideas to patent application and prosecution in the various jurisdictions. Typically, the head of IP department supervises patenting teams in the execution of patenting strategy, which derives from a joint discussion with the executive members of both research and development and business strategy divisions. However, evidence highlights that in seven cases IP departments introduced licensing as a complimentary function with respect to patenting and created dedicated units for the exploitation of licensing as a strategic activity. For instance, Company 12 mentioned that the IP department

[3] In the appendix I provide additional comparative cross-case evidence (proof quotes) to bolster points mentioned in the paper. Indeed, empirical evidence in the paper is presented through vivid “power quotes” that might be integrated by the reader through “proof quotes” in the comparative table (Pratt, 2008).

is formed by three main groups: a patenting team, litigators and a licensing team. In the same industry –i.e. pharmaceutical- also Company 3 maintains separate the patenting and the licensing teams. The same evidence is observable in both the ICT industry for companies 4, 5, 8 and 13 and in the manufacturing industry for company 11. For example, an IP representative of Company 4 explained that: *"In that IP organization, which consists of 200 people, we have these 10 patent units and we call them patent development parts. Then, there is one group working with licensing (...), they are about 10 people." (Company 4).* Also the representative of Company 5 commented that *"We have a corporate team for patenting and licensing (...), we are separate, but I call them "sister organizations" within corporate headquarter. We work very closely." (Company 5)*. Therefore, in all those cases licensing emerges as a relevant function that organizations decide to create in conjunction with patenting activity and to enforce with a dedicated nested unit. It is also worth noting that IP and licensing units exist both at centralized and decentralized organizational level. This finding is noteworthy, because it partially revises the theoretical assumptions of Arora and colleagues (A. Arora et al., 2013) according to which licensing units tend to be centralized at the corporate level, while if licensing is decentralized then business units take the governance.

Table 3.4 Organizational dimensions of R&D and IP unit and functions of IP unit

ID Company	Industry	structure of R&D unit	structure of IP unit	Functions of IP Unit	
				patenting	licensing
3	Pharmaceutical	centralized	centralized	X	X
12	Pharmaceutical	hybrid	hybrid	X	X
4	ICT	decentralized	centralized	X	X
5	ICT	centralized	centralized	X	X
8	ICT	decentralized	decentralized	X	X
13	ICT	hybrid	centralized	X	X
11	Manufacturing	decentralized	centralized	X	X
9	Pharmaceutical	decentralized	decentralized	X	
2	ICT	hybrid	centralized	X	
1	Manufacturing	centralized	hybrid	X	
6	Manufacturing	centralized	centralized	X	
14	Manufacturing	hybrid	hybrid	X	
7	Healthcare	centralized	centralized	X	
10	Healthcare	centralized	centralized	X	
15	Healthcare	centralized	centralized	X	

In correspondence with cases where licensing units are nested into IP units, we can observe the emergence of a specific framework assigned to technology licensing. In fact, technology licensing is part of the corporate culture and the IP unit identifies itself with the specific task of licensing: one representative of Company 4 reported *"We are called 'IPR and Licensing', so, it is quite obvious to have such a unit. It is a very specific task. We have started our licensing program 20 years ago at a high level"*. Licensing is part of the unit's identity and members acknowledge the duality of their role. Furthermore, technology licensing is a "*tradition*", as reported by Company 8, and current deals are based on successful heritage as stated for instance by a representative of Company 13*: "There is a long story of very successful patenting licensing business in our company"*. Furthermore, technology licensing is framed as a business activity that contributes to income generation. For example, one representative of Company 13 stated *“we are not an IP company but we have an IP business, which is well-known and which is organized like any other business in the group"*. Therefore, when technology licensing becomes prominent in the organizational culture and serves as one of the overarching strategic goals, then the organizational structure is arranged accordingly with the creation of a nested licensing unit.

In contrast, when technology licensing does not have a strategic connotation within an organization, they avoid designing dedicated licensing units within their IP department. For example, the head of IP unit of Company 15 reported *“We do not have any specific licensing competence in the patent department. But if we have to negotiate a license with the competitor, the team set up and the role of the top manager is typically of the CEO or the R&D head, the head of the legal department and one of the people in the patent department. So, it is an ad-hoc set-up”.*

The emergent dichotomy between IP departments with and without a licensing function organized in a nested unit is intriguing and adds more complexity to the existing models of the organizational design of technology licensing (Ashish Arora et al., 2013). Indeed, it appears that allocating the authority to license to either a centralized licensing unit or to de-centralized business divisions is not the only relevant dimension to disentangle differences in the management of technology licensing. In fact, technology licensing can be organized as a complementary function thanks to dedicated nested unit in the IP unit that could operate either at centralized or decentralized level and that mirrors a strategic frame. Furthermore, during the data analysis additional conditions emerged as core for the management of technology licensing. These conditions are i) the management of information flow, ii) the governance of decision making through coordinating mechanisms, hierarchical enforcement and the existence of a supportive parallel structure, and iii) licensing negotiating capabilities. Interestingly, these dimensions are different depending on the existence of the nested licensing function as represented in table 3.5. Below, I report the empirical evidence to illustrate each of these conditions.

Table 3.5 Organizational Configurations Emerging from the Analysis

	ID Company	Industry	Information Flow		Coordinating Mechanisms		Enforcement		Supportive Parallel Structure	Licensing Negotiating Capabilities	
			internalized	externalized	stand-alone	shared	ex-ante	on-going		inside-out	outside-in
IP units with nested licensing units	3	Pharmaceutical	X		X		X		X	X	
	12	Pharmaceutical	X		X		X		X	X	
	4	ICT	X		X		X		X	X	
	5	ICT	X		X		X		X	X	
	8	ICT	X		X		X		X	X	
	13	ICT	X		X		X		X	X	
	11	Manufacturing	X		X		X		X	X	
IP units without nested licensing units	9	Pharmaceutical		X		X		X	X		X
	2	ICT		X		X		X	X		X
	1	Manufacturing		X		X		X	X		X
	6	Manufacturing		X		X		X	X		X
	14	Manufacturing		X		X		X	X		X
	7	Healthcare		X		X		X	X		X
	10	Healthcare		X		X		X	X		X
	15	Healthcare		X		X		X	X		X

3.4.2. The management of information flow

Depending on the existence of a nested licensing unit, we might observe different patterns of information flow during the licensing process. With information flow I mean the sharing of data and knowledge relative to the environment, competitors, potential licensees, products and technologies available in the portfolio and on the market.

On one side, when technology licensing is organized through a dedicated function and a nested licensing unit, information is shared through channels that are internal to the IP unit. Members of the licensing unit receive information directly from a competitive intelligence nested in the IP unit. For example, a representative of Company 8 reported *“We have had a large group in Company 8 which has been following our competition, so lot of the information has been created in house by that group; we have also one person in the licensing team who is specialized in the data collection for licensing purposes and working on creating data for our licensing purposes. I would say, yes, we do lot of it in house”*. Moreover, members of the nested licensing unit perform their own personal search on competitors and technologies in addition to the relevant internal information that they receive. A representative of Company 3 described this process as follows *“You need to do one big exercise, you need to look at the whole universe of opportunities and licensing. And if you do the filter process correctly is not that you see so many opportunities, you would narrow down to 5-10 potential options. [...] It is really fast and you need brain power...the main intellectual work is setting the filter right, ok, and then go back and forth and do that to see if it makes sense”*. The shared information resides within the licensing unit and remains concentrated among the members. In fact, licensing members do not need to disclose information to the other members of the IP department, for example to the patent attorneys involved in patenting. Therefore, it is possible describing the flow of information through an internalized pattern that concentrates data and relevant hints in the licensing unit.

On the other side, when the nested licensing unit is not present, members in charge of licensing tend to rely on sources of information external to the IP unit. For instance, a representative of Company 9 said *"For example if we see a license opportunity -and they come us quite regularly- we would do full due diligence investigation on the products from...all the scientists from R&D organization would be looking at the scientific perspective but it would be also looked at the patent perspective, so a patent attorney would be assigned to that license opportunity to do the due diligence evaluation."* Members of the IP unit involved in licensing decision-making have to go through a collage of information available from other departments, for instance production or R&D. In this process, representatives from interviewed cases highlighted that creating a personal network in the organization with the other departments in order to access the relevant information timely is very important. A representative of Company 6 commented on this point: *"I mean, what you do need to make a successful patent licensing is having enough information about competitors' products and you have it through sales; then we need to have a proper technical analysis, so we need R&D from the laboratory, and finally we need financial data such as margins for that kind of products and we get them in our case* *from sales, because when they do products they do price calculations for products."*

Therefore, through the comparison of cases it is possible to show that the management of information is a crucial aspect of the management of technology licensing. Through the management of the flows of information the licensor acquires relevant data to decrease information asymmetry on the licensee and competitors (Beggs, 1992; Danneels, 2007; Katz & Shapiro, 1985). Previous research assumed that access to better information for the licensor depends on the decentralization of decision making to business units (A. Arora et al., 2013). Yet, data suggest the internalization versus externalization of information flow with respect to the IP unit as another dimension that decreases information asymmetry. Depending upon the design of a nested licensing unit, the management of information flow can either be internalized within an IP unit or externalized to other units within the organization. When technology licensing is managed through a nested licensing unit, an internalized information flow is set up to transfer directly relevant information to licensing decision-makers.

3.4.3. Coordinating mechanisms

Through empirical evidence it emerged that different internal coordinating mechanisms are associated with cases where technology management is orchestrated through a separated nested unit.

When licensing is managed through a nested licensing unit, members involved harmonise their tasks and practices through internal and stand-alone coordinating mechanisms. Since licensing is independently organized with respect to the other functions of the IP unit, members involved in the nested licensing unit meet separately and seek advice among themselves. A representative of Company 8 commented that *"We have in-house licensing teams, so we know our licensing contracts and questions on our licensing contracts are direct we internally advice our businesses when they have questions concerning licensees and otherwise we focus on making deals."* Internal meetings within the nested licensing unit serve to check that there is no conflict among the various licensing deals negotiated at that moment. For instance, a representative of Company 13 reported that *"so every month we have the business review in which we review all the important negotiation ongoing"*. Members of the nested licensing unit tend to develop a sense of belonging and do not see the need to further coordinate with other groups within the organization. A representative of Company 11 claimed that *"For licensing out it is entirely controlled by us. so, we are looking through the portfolio, finding what we think are good opportunities for licensing or indeed any other way for getting value from the portfolio so we might consider selling patents in some cases. We decide what we would like to focus on for licensing, get the right people to be involved, investigate the products we think could need the license, investigate the patents we think cover those products and then approach the companies and have a negotiation"*.

On the contrary, when licensing is not managed through a nested licensing unit but rather through ad-hoc teams, cases demonstrate that coordination with other groups within the organization is widely adopted. Members of the ad-hoc licensing team need to frame the decision to license technology by integrating their opinion with the heads of the other groups.

For example, the VP of the IP unit of Company 2 reported *"If we are talking about licensing out activity we are talking about the Head of IP department and myself, we are really responsible people. […] and so together with the business owners we create a big picture"*. This step is necessary to coordinate different interests in the organization. Shared coordination is also achieved by the selection of the spokesman from the business units or the board. This measure guarantees that interests of licensing are aligned with those of the other units and that the technology licensing framework is shared across the organization. The Head of IP unit of Company 10 commented *"The governance in this situation is as for the strategy, with the president of Company 10 and the CEO and president of the Holding. […] they could also see whether the negotiation makes...it is their decision whether in this context is the right thing to do with that particular company we want to out license to. So, we are consolidating all the interests in the group."*

Collectively these data suggest that internal coordinating mechanisms are important to align interests and to develop a cohesive framework to license technology. Existing literature focused on the presence of economic incentives to align different motivations within the organization to manage technology licensing (A. Arora et al., 2013). The data analysis reveals that internal coordination is a complementary mechanism to align different organizational interests. However, cases reveal a dichotomy between stand-alone and shared coordinating mechanisms depending upon the design of a nested licensing unit. When a nested licensing unit is in charge of technology licensing, stand-alone internal coordinating mechanisms are in place to align the interests of the licensing unit. With the design of a nested licensing unit, the organization assigns specific priorities to technology licensing. Given the dominance of licensing in the organization’s objectives, the main purpose of the members involved is making sure that there is no conflict of interest in licensing as a separate function. Thus, stand-alone coordinating mechanisms are applied in the nested licensing unit to guarantee internal consistency. When technology licensing does not assume core strategic relevance through the establishment of a nested unit in the IP department, the scope of licensing must be weighted with a plethora of other stakes embedded in the organization. Therefore, coordinating mechanisms to license technology are shared with other units to guarantee consistency of actions in a broader sense.

3.4.4. Supportive Parallel Structure

The data analysis revealed that coordinating mechanisms benefit from a supportive parallel structure. A supportive parallel structure is a system of ancillary processes organized to facilitate the management of technology licensing. Business units, scientists, technical engineers and members of the legal department are involved in a series of complimentary and supportive tasks during the licensing process. Support usually refers to technicalities outside the main competence of members involved in the licensing process. For instance, members of the finance department could provide accurate figures of revenues, scientists could contribute in understanding the underlying technology and the legal department could provide assistance in drafting a licensing contract. Interestingly, the existence of a supportive parallel structure emerged across all cases independently of the design of a nested licensing function. For instance, a representative of Company1 reported *"when you prepare an agreement, you prepare something you try to insert the conditions and so on, you are helped by you lawyer here and then"*, while a licensing manager of Company 11 commented *"Then you have a range of support functions. I mentioned the testing and measuring ones: an example on some patents covering mobile phone: if you make a phone call they must be using these patents because to make a phone call it has to do this this this, it is written in a standard and we have a patent covering that. So, sometime you can do without measuring but some other times patents have some specific requirements and so for example something we are doing now has to do with touch screens for iPhone or smartphone and patents have certain requirements for the speed and lag between the time when you touch and they react, and so on, so you need to have people set up and testing schemes"*. Help is generally provided through internal meetings and is finalized to generate a better understanding of possibilities, drawbacks and convenience of the deal. Hence, the supportive architecture works in parallel to internal coordinating mechanisms and provides useful hints on items that need to be discussed in meetings to coordinate actions and conflicting interests. This finding is coherent with previous research on the architecture of coordination between R&D and productive subunits (Engelen & Brettel, 2012) and on the use of integrated distributed work through modularized processes (Phanish Puranam, Singh, & Zollo, 2006; Srikanth & Puranam, 2011). Therefore, a supportive parallel structure is a general facilitating mechanism that allows coordination with the other members of the organization involved in the licensing process.

3.4.5. Hierarchical enforcement

During the interviews, hierarchical enforcement emerged as a salient and recurrent trait of the governance of licensing decision-making. Hierarchical enforcement is the endorsement of the decision-making process and associated outcome by a higher organizational layer. Through hierarchical enforcement, members of the organization with a higher decisional power validate the directions and decisional framework created by members directly involved in the licensing deal. Cases clustered around two types of hierarchical enforcement.

On one side, hierarchical enforcement is taken as preliminary at the start of every licensing negotiation. Ex-ante hierarchical enforcement is associated with the existence of a nested licensing unit. Members of the nested licensing unit negotiate the technology agreement within a general template established ex-ante by an internal steering committee, where members of the executive management, the head of the IP department and the head of licensing discuss the objectives and main expectations. For instance, a representative of Company 3 reported that *"we got the template"*, while a representative of Company 4 claimed *"As part of the whole business process and preparation we look at those companies and we think at what we should strive for and what should this agreement cover. So, they do have those frameworks into which they negotiate*". Potential conflicts of interest among foreseeable licensing programs are discussed upfront and conciliated with the main interests of the organization. This would guarantee that the member of the licensing unit in charge to negotiate the licensing deal can proceed and establish the agreement. A representative of Company 11 reported that *"Is in* *the management role to handle that because obviously you can end up with a conflict of interest, because in going after another company to get money for a patent there is a risk that other companies decide that actually they quite like money from Company 11 for their patents and so that does need to be handled; the high level of the businesses are aware of the activities that are going on and we do and we try to have at least some liaison to make sure that nothing too unfortunate happens."*

On the other side, hierarchical enforcement is present all along the licensing process through the creation of a progressive understanding of the benefits of the agreement. Both managers at the business and corporate level are involved in the discussion. Members of the IP unit involved in the licensing deal need to provide a general framework for the negotiation and a set of recommendations to facilitate a progressive cognition on the licensing. For instance, the Head of IP of Company 6 commented *"It is a joint decision within the business and the IP. I would come out with recommendation for the R&D and the sales on what we can get out of that and they need to agree on that proposal, otherwise we cannot settle it."* During the progressive sense-making of licensing, members of the IP unit need to consult with the various heads of other units that might be affected by the agreement, for example the R&D or the business units, to understand the degree of acceptance of the deal. For instance, the VP of the IP unit of Company 7 reported *"All the decisions have to be approved at their early stage because we are not able to contact any party prior to be sure that all the top management is aware of what will happen; and especially we have to inform them about the potential consequences of the licensing program."* Once gone through the various phases of the negotiation, the executive board or the reporting executive of the IP department should provide the final endorsement. For instance, representative of Company 15 claimed *"So in the first meeting we exchange expectations and then we can start negotiating and, at the end of the day, it is of course a legal department that signs the license agreement."*

The dichotomy between the types of hierarchical enforcement is interconnected with the evidence of two distinct forms of coordinating mechanisms. In fact, cases that present stand-alone coordinating mechanisms have their decisions enforced ex-ante by a steering committee located on a higher level with respect to the nested licensing unit. Vice versa, shared coordinating mechanisms occur when on-going hierarchical enforcement takes place in the decision making. It is possible finding a rationale to this distinction among cases. When ex-ante hierarchical enforcement is adopted to justify technology licensing, members of the organization at corporate level discuss main conflicts and share opinions before the start of the licensing program. Once members of the nested licensing unit start the negotiation, they do not need to seek additional understanding or confirmation from other parts of the organization, because potential disagreements have been already discussed at a higher organizational level. Therefore, members of the nested licensing unit can coordinate among themselves through stand-alone mechanisms. When the consensus on the license agreement is created progressively, different parts of the organization need to understand to what extend they might benefit and opinions must be shared with a wider audience than simply the internal members of the IP unit. Because of a need of wider participation in the progressive sense-making, shared coordinating mechanisms are convenient instruments to align interests.

3.4.6. Licensing Negotiating Capabilities

During the analysis it emerged that cases can be grouped according to the intersection of the management of information flow and internal coordinating mechanisms. Cases where information flow is managed through an internalized channel govern the decision making through stand-alone coordinating mechanisms. In those cases, members of the licensing unit qualify themselves as *'negotiators'* with a specific set of capabilities. First of all, negotiators need to be able to make sense of the underlying technology and have a solid technical knowledge. Then negotiators need to be able to draft a licensing contract and understand the technicalities of the law under different jurisdictions. Finally, negotiators need to be able to make sense of the economic convenience of the agreement and have a business oriented mind-set. To accomplish all these heterogeneous tasks, negotiators are very often patent attorneys with a scientific and legal background as well as specific training in finance and accounting. Thanks to their comprehensive know-how, negotiators absorb relevant information transferred through internalized channels and stand-alone coordinating mechanisms nested in the licensing unit. In this way, negotiators demonstrate a capability to make sense of technology licensing from an internal perspective. The Head of the licensing unit of Company 13 reported that *"I am a licensing negotiator, so my job is to be charge of the negotiation, this is a lot of skills, soft business skills, because it is business to business sales, you know, then technical skills* *because you have to understand the technology, legal because you need to know the legal side of patents and also you have to think about the agreement at the end, cultural skills, because most of the time we discussed in Asia, Japan, Korea Honk Kong and Taiwan and you really get in touch with different cultures, so we need also this kind of skills and also more and more economics skills, because when you negotiate first you have to recognize that you have valuable patents and then the negotiation is about the price, so you need to build up some economic models with NPV and it leverages the skills that you need to have ".* Having acquired and integrated the relevant knowledge, the main scope of negotiators is to actively scan for potential licensees and convince them of the relevance of the technology. Negotiators need to be able to explain how the licensed technology matches with the licensee's technological portfolio and to guide the licensee in the financial evaluation. In order to successfully perform their role, negotiators need to understand the market, communicate relevant information externally and interact with third parties involved in the negotiation. For instance, the VP of the licensing unit of Company 8 commented *"you need to be a convincing person in order to do out-licensing."* In line with this statement, the analysis reveals that negotiators need to have also the capability to make sense of technology licensing from an external perspective and to be convincing. In summary, negotiators highlight inside-out licensing negotiating capabilities, which are the capabilities to absorb relevant internal information and convey such information to the licensee in order to convince it about the validity of the technology and to create a customer link.

Evidence from the cases further revealed another configuration of the management of information flow, governance of decision making and licensing negotiating capabilities. When information flow is managed through an externalized network with respect to the IP unit, coordinating mechanisms are shared with other units and members of IP unit are selected ad-hoc to be part of the licensing team. In this configuration, members involved in the licensing process are active brokers with third parties but they are not part of the final decision. Furthermore, the head of IP unit fulfils two main roles. First, he or she is in in charge of managing the external relations and of creating reliable long-term relationships. The head of IP department serves as the first point of contact for external third parties during the licensing process. In this role, the head of IP department highlights valuable externally-oriented capabilities to connect the licensee with the organization. Second, the head of the IP unit needs to synthetize external and internal information and draft all the preparatory work for the internal discussions. For instance, a representative of Company 9 commented on this point *"His job is finding potential licensees and negotiate potential offers then he goes to the division and they start discussing among themselves about the strategy and what they want to achieve. Then they turn back to him and tell him if they agreed or not and what they did evaluate."* In that regards, the head of IP becomes a depository for internal and external information that she or he needs to transfer internally during meetings and for other internal documents to promote the internal decision-making. From the studied cases it emerges that the member of the IP unit covering this role needs to be able to make sense of the licensing process from an internal perspective and to support internal decision-making. Combining the external and internal characteristics, the analysis reveals that the head of the IP department acts as a broker in the technology licensing process and she or he needs to possess outside-in licensing capabilities, which are the capabilities of connecting with the licensees and transferring relevant information in the internal decision making-process to facilitate discussion on the feasibility of the agreement.

3.5. Discussion and Future Research

The case-based study adopts the IP unit perspective and helps to shed light on how technology licensing can be managed. Its results complement previous research on the organizational design of technology licensing (A. Arora et al., 2013; Pitkethly, 2001) and thereby answer a call (Arora & Gambardella, 2010; Conti, Gambardella, & Novelli, 2013) for a more detailed explanation of organizational antecedents of the market for technologies by providing an analysis of the micro dynamics that occur in the IP departments during the licensing process.

The main purpose of this study was to better understand how IP units can manage the technology licensing process. Research into the role of in-house IP units in the licensing process is scarce, so I followed an open and theory-grounded approach on 15 cases to elicit the main conceptual categories. Hence, this study provides a starting point for such a theoretical development by observing, defining and explicating the presence of two configurations of micro-practices through which IP units can manage technology licensing. If the licensing activity is assumed as a separate function with respect to patenting and organized through a nested licensing unit, then technology licensing is managed through internalized information flow and stand-alone coordinating mechanisms. Negotiators are in charge of managing the process and they need to prove inside-out licensing capabilities, which are the abilities of absorbing internal knowledge and of conveying relevant information externally to convince the licensee of the validity of the technology. If autonomy of licensing with respect to the patenting function is not acknowledged, in-house IP units do not dedicate specific resources to licensing, which is managed through ad-hoc teams that rely on externalized information and shared coordinating mechanisms. In this configuration of practices, the management of the licensing process is contingent on the emergence of outside-in licensing negotiating capabilities, which are the competences of absorbing external information and of conveying all relevant information internally to support the internal decision making.

This study expands previous research that considered the centralization and decentralization of decision making in the management of technology licensing (A. Arora et al., 2013). The model represented in this paper focuses on the organizational design of technology licensing with an emphasis on the micro-practices adopted by the IP unit. A closer inspection of the micro-practices of the IP unit can improve our understanding of the micro-behaviour and of the capabilities that inform technology licensing process substantially. The focus on the licensor as the possessor of unique competences, for instance to transfer knowledge (Ceccagnoli & Jiang, 2013), is short-sighted , because firms are by their very nature a collection of individuals, who are the original source of knowledge and information. A deeper analysis of the micro organizational behaviour can cast light on the matching between individual and organizational goals and on the role of specific actors in acquiring certain competences that then are aggregated at firm level. Disentangling the complexity of the technology licensing process at the individual level permits delineating who interacts with whom, who has the ultimate decision rights, and so forth. These dimensions of micro-organizational behaviour are important antecedents of decision-making outcomes (Knudsen & Levinthal, 2007; Stinchombe, 1990) and they might remain latent and un-explained if scholars focus solely on the organizational structure of decision making (Barney & Felin, 2013; Felin & Foss, 2010). Therefore, a turn on the micro-practices and the IP unit as a combination of individuals permits to disentangle the micro-organizational factors associated with capability development in technology licensing decision making. This approach is also in line with a recent interest into the micro-foundations of management and a focus on how cognition and motivations of decision makers impact organizational learning, knowledge and competitive performance (Barney & Felin, 2013; Foss & Lindenberg, 2013; Greve, 2013).

In a related fashion, the paper contributes by linking market for technology literature with research on cognitive frames and interpersonal politics in decision making (Kaplan, 2008; Snow et al., 1986). Any representation of the decision to license technology can be understood as a negotiated outcome resulting from diverse internal cognitive frames. In fact, different coalitions of interests and views lead to the final decision through framing practices in particular context. This suggest that the decision to license technology is the result of contrasting interests and internal frictions, which find reconciliation through the emergence of a dominant logic.

Through the focus on cognitive frames the present study portrays the broader dynamics of internal negotiating and the role of cognitive and political models in technology licensing. Future studies, maybe lab experiments, might explore to what degree differences in frames affect the management of information and direct both authority and legitimacy in the decision making. We need to understand better how individuals involved in technology licensing deploy frames depending on the firm's strategy and other contextual elements. Such research would reinforce our comprehension of the microfoundation of cognition under uncertainty in the strategic decision making process.

Finally, this study provides novel and fine-grained insights into the processes through which the licensor manages the information flow to decrease information asymmetry with respect to the licensee and to the competitive scenario. Information asymmetry is a core topic in the market for technology and licensing literature and scholars so far assumed that the licensor can reduce information asymmetry by the virtue of close relationships with the business units, since these have a better understanding of the market (Gallini & Winter, 1985; Gallini & Wright, 1990; Katz & Shapiro, 1986). In contrast, my cases highlight that the licensor can obtain accurate information on the licensee through an internal network that may well be detached from the business units and singularly managed by the IP unit through an internal competitive analysis.

The study provides also a non-core and indirect empirical contribution to a body of existing research that characterized the organizational traits of in-house IP units (Reitzig & Puranam, 2009; Reitzig & Wagner, 2010; D.

Somaya et al., 2007). Indeed, previous research on organizational traits of IP departments focused on knowledge proximity of IP members with respect to scientists involved in innovation and on the cross-specialized capabilities that reside in IP department to obtain rapid patent protection (Reitzig and Puranam, 2009). Along these lines, Reitzig and Wagner (2010) depicted the knowledge required by IP departments to lower costs related to patent prosecution. The present research contributes by providing a qualitative model for the role of IP units to manage information flow and coordinating mechanisms in technology licensing. The study is set apart from previous anecdotal qualitative evidence of technology licensing (Davis, 2008; Phelps & Kline, 2009). Instead of focusing on a single industry or indeed on a single case study, this study analyses 15 cases spanning the healthcare, pharmaceutical, ICT and manufacturing industries and identifies common patterns across these sectors. Therefore, the research offers a high degree of generalizability of the findings.

From a normative perspective the findings can help managers involved in technology licensing to focus on, to review and to better employ internal dynamics that impact the licensing process. Corporations can benchmark their licensing practices according to two critical organizational aspects, information flow and coordinating mechanisms, in order to develop the necessary capabilities. Furthermore, findings from this research could highlight areas of attention for organizations that are considering a re-structuring of their patenting function and want to leverage their IP strategies through IP monetization via licensing. Indeed, those organizations could reflect on the IP staff profiles they may require if they want to start a licensing program and on the internal process and dynamics that a dedicated licensing structure may require to work effectively.

It is worth mentioning some limitations that affect the present research. First, this study focuses on the process of technology licensing, but does not provide any recommendation related to the final outcome of the decision making –i.e. whether there is a most efficient configuration of micro-practices among those portrayed in the model for licensing out technology. Second, the research focuses on the outbound licensing process and does not take inbound licensing of new technologies into account. Finally, in order to preserve the parsimoniousness of the model, this study refrains from taking into consideration patent characteristics, the nature of the counterpart involved in the licensing process or the presence of contingent elements, like patent pools or standards, all of which could impact the type of information available and the ways through which the licensee and licensor might communicate (Joshi & Nerkar, 2011). In turn, this means that all these aspects could open the door to further research potentially based on larger and quantitative evidence.

3.6. Conclusion

This study gives insight into the technology licensing process and the role of the IP unit. It provides a novel contribution to the theoretical developments in market for technology literature, offering a micro-foundation of practices and of capabilities that are core to technology licensing management. The comparison of cases shows that depending on the organizational design of the IP unit and the establishment of a nested licensing unit, the management of information flow and the governance of decision making can be organized in two dichotomous systems from which two opposing capabilities emerge. When a nested licensing unit is in charge of technology licensing, information flow is internalized in the IP unit and members involved align their actions through stand-alone coordinating mechanisms. This leads to the emergence of inside-out licensing negotiating capabilities, which are capabilities to convince external partners of the validity and value of the technology. In the absence of a nested licensing unit, licensing is internally orchestrated through an external flow of information, shared coordination mechanisms and outside-in negotiating capabilities, which are the capabilities to convince members of the same organization of the value of the license agreement and to moderate the various internal debates related to the agreement. The proposed theoretical framework expands current explanations on the organization of technology licensing decision making by looking at the internal perspective of the IP unit. The research disaggregates the antecedents of licensing negotiating capabilities and clarifies the relationship between the micro practices of technology licensing and internal political influences and power.

Chapter 4 Licensing price and indemnification clauses on intellectual property rights: An empirical investigation of double side moral hazard

Abstract

This study examines the role of indemnification clauses on intellectual property (IP) rights in the case of licensing deals. I propose that indemnification clauses on intellectual property rights operate as signals to share the risk and reduce moral hazard in licensing contracts. Building on market for technology literature and contract theory, I suggest that the inclusion of IP indemnification clauses in technology licensing explains the prevalence of payment schemes based on a combination of lump sum and royalty rate. Furthermore, the effect is amplified when the licensee and licensor operate in distant technological domains. Predictions are tested on data from the pharmaceutical industry and we discuss implications for the optimal design of licensing contracts.

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4.1. Introduction

Despite the extraordinary proliferation of technology licensing contracts in the last two decades (Ashish Arora & Gambardella, 2010b; WIPO, 2012), technology licensing deals remain highly uncertain in their process due to moral hazard between the licensee and licensor (Anton & Yao, 2002; Kamien & Tauman, 2002; Katz & Shapiro, 1985, 1986). Particularly, due to unpredictability of technological development and uncertainty about intellectual property (IP) rights enforcement, contracting parties could experience moral hazard leading to a more volatile payment structure, which in turn requires more intense monitoring effort and exposes to higher risk (Anton & Yao, 2002; Zuniga & Guellec, 2009).

A seemingly straightforward option to mitigate moral hazard consists in the selection of the optimal payment structure that balances conflicting interests and decreases monitoring efforts (Beggs, 1992; Choi, 2001; Gallini & Wright, 1990; Kamien, Oren, & Tauman, 1992; Kamien & Tauman, 2002). In the ideal situation that contracting parties are symmetrically informed, lump sum has been defined as the optimal payment scheme that balances interests and leads to an efficient use of technology (Gallini & Winter, 1985; Katz & Shapiro, 1985; Scotchmer, 2004). However, licensing contracts have been proven to suffer from opportunistic behaviour (Choi, 2001), which in turn prevents deals from being complete (Ashish Arora, 1995). Under these conditions, the inclusion of a lump sum is the most efficient payment structure because the licensor benefits from an easily verifiable and immediate payment, avoiding the monitoring of the licensee in the future (Sen & Tauman, 2007). However, empirical evidence has demonstrated that royalties are frequently adopted as payment structure when one-sided moral hazard emerges (Mendi, 2005). The theoretical justification in this case stems from the fact that royalties can be seen as ‘hostages’ that the licensee pays to the licensor if the latter fully collaborates in transferring technology and know-how (Choi, 2001; Macho-Stadler, Martinez-Giralt, & Pérez-Castrillo, 1996). Finally, contractual parties can agree to structure payments through a combination of lump sum and royalties. From a theoretical point of view, this type of payment structure originates from double-sided moral hazard (Bhattacharyya & Lafontaine, 1995) and is the attempt to balance risks and opportunistic behaviour through a shared remuneration.

The selection of payment structure does not operate in isolation, as other instruments have been created to decrease uncertainty on IP rights validity in licensing agreements. Indeed, another available strategy rests on including warranties and indemnification clauses within the main agreement (Furlotti, 2007; Grossman, 1981; Hagedoorn & Hesen, 2007). Warranties and indemnification clauses are promises to take responsibility for losses suffered by the counterparty due to scant product quality (Courville & Hausman, 1979; Lutz, 1989). Thus, warranties and indemnification clauses enforce contracts and protect negotiating parties in situations where it is costly to verify and communicate ex-ante complete information on the qualities of underlying goods, services or technologies included in the contract (Dyer, 1997; Grossman, 1981).

In the case of a licensing agreement, indemnification clauses on intellectual property rights provide a useful tool to overcome opportunistic behaviour of contracting parties (Hagedoorn & Hesen, 2007). Through the inclusion of the clause, the indemnifier ‘promises’ to financially compensate the prosecuted parties in the case of patent infringement (Hagedoorn & Hesen, 2007; Vukowich, 1968). Thus, an IP indemnification clause serves as a screening device for selecting committed licensors with strong and reliable IP rights. In fact, only licensors with strong IP rights would agree to indemnify the licensee, given the financial burden related to patent litigation (A. Fosfuri & Giarratana, 2010; Galasso et al., 2013). This means that, as the licensee knows that only certain types of licensors are willing to agree to an indemnification clause, the licensee might not only be keen to do without the royalty as a hostage mechanism but also reward licensor commitment and thus include a lump sum in the payment scheme. Hence, by sharing litigation risk and disclosing the level of commitment of parties, IP indemnification clauses create a situation of double-sided moral hazard that finds its correlative in the selection of the pricing scheme.

Despite its relevance, the use of indemnification clauses on intellectual property rights in licensing contracts has received limited attention by scholars. So far, contributions are limited to offer a theoretical justification for the use of IP indemnification clauses (Hagedoorn & Hesen, 2007; Ramsay, 2003; Vukowich, 1968). Furthermore, practitioners[4] assert contrasting opinions on the use of IP warranties and indemnification clauses. For instance, one focus group participant claimed *“(We) never use (them).*

[4] Researcher collected explorative data on the use of IP warranties and indemnification through a web focus group hosted by Licensing Executive Society: 11 practitioners intervened in the discussion on the use warranties and indemnification clauses in licensing contracts by describing their understanding on these legal instruments and providing examples from practice. Practitioners that attended the focus group were legal and business counsels in private practice or organizations. Furthermore, researcher personally interviewed three licensing senior managers working in the biotech and pharmaceutical companies.

We explicitly provide no warranty. Licensees' lawyers only raise it try to flush out any known potential problems", while another participant stated *"To say warranties regarding validity and enforceability in negotiated IP licenses never occur is too strong. They are not uncommon"*. That is to say, from an empirical standpoint we need to shed light on the use of IP indemnification clauses as tools to shape opportunistic behavior and moral hazard among parties. To this end, the present research aims at depicting how the choice of payment structure, particularly of two-part tariff – i.e. the combination of royalty and lump-sum- is made under the inclusion of IP indemnities and in dependence of double-sided moral hazard in technology licensing contracts.

My main assumption is that as a demonstrable signal of both patent quality and contract parties' future commitment, IP indemnification clauses mitigate information asymmetry for both the licensor and the licensee and decrease uncertainty about the exact transferred rights. Thus, IP indemnification clauses mitigate moral hazard and should be positively correlated with the use of two-part payment structure, which has been shown to be an efficient contractual feature in shared contracts (Bhattacharyya & Lafontaine, 1995).

To empirically test my assumptions, I undertook an econometric investigation on 151 licensing contracts extracted from the Recap dataset in the pharmaceutical industry over the period 1984-2005. I integrate information on licensing contracts and their payment structures with secondary data on patents disclosed in the deals and financial information on the licensees and licensors. The research implements a multinomial logit model to correlate pricing schemes with the use of IP indemnification clauses, controlling for technological characteristics of the deals. Results confirm a positive relationship between the inclusion of IP warranties and the selection of a payment scheme based on lump sum and royalties. I also found evidence that this relationship is amplified when contractual parties do not have the same expertise and technological overlap is limited.

The contributions of my research are threefold. First, I provide empirical evidence on double-sided moral hazard and its association with pricing schemes in licensing contracts. Indeed, contributions on licensing pricing scheme have largely been theoretical and sought to explain incentives on innovation and competition in the market (Gallini & Winter, 1985; Kamien & Tauman, 2002; Katz & Shapiro, 1986; Sen & Tauman, 2007). In contrast, empirical research on licensing pricing schemes still remains a limited explored field (Anand & Khanna, 2000a; Cebrian, 2009; Mendi, 2005; Sakakibara, 2010; Vishwasrao, 2007). Following recent studies by Cebrian (2009) and Sakakibara (2010), my study consequently aims at providing evidence of determinants of pricing schemes. Previous research has found support for one-side moral hazard and the use of either royalties or lump sum payment schemes (Cebrian, 2009; Mendi, 2005; Vishwasrao, 2007). Instead, to the best of my knowledge, my study is the first that proposes that contractual features in licensing agreements correlate with the selection of two-part payment scheme and double-sided moral hazard. Thus, this paper answers a call for more empirical evidence on double-sided moral hazard in licensing contracts (Cebrian, 2009; Choi, 2001; Vishwasrao, 2007). Second, the research expands the economic literature on the design of licensing contracts and the use of clauses as contractual features to model moral hazard (Keld Laursen et al., 2013; Leone & Reichstein, 2012; Deepak Somaya et al., 2010). In that respect, my study sheds light on indemnification clauses on intellectual property rights. These clauses might assume a crucial role in moderating the effect of patent litigation risk and thereby promoting the sharing of technology in a context where contractual parties might otherwise refrain from participating in the market for technologies (Clarkson & Toh, 2010; Galasso et al., 2013; Shane & Somaya, 2007; Deepak Somaya, 2003).

Third, the research is relevant for its practical implications on licensing practices, since it aims at corroborating through a systematic study previous anecdotal evidence on the best practices to optimally draft indemnification and warranties in license agreements (Doshi & Thomson, 2007; Horwitz, 2007; Ramsay, 2003).

The paper proceeds as follows. Next section reviews previous theoretical and empirical contributions and develops research hypotheses on the use of indemnification clauses and their correlation with pricing schemes. After that, I describe the research design and methodology. I then present the findings and discuss the implications for future research and repercussions for practitioners.

4.2. Pricing schemes and contractual provisions in technology licensing

Licensing contracts regulate the transfer of technology and know-how from the licensor to the licensee. Due to both the nature of technology and negotiating parties, those contracts are intrinsically uncertain. Licensed technology might evolve and lead to unexpected future implementations, exposing licensing parties to the risk of rapid obsolescence or unforeseen additional investments (Ashish Arora & Gambardella, 2010a). Furthermore, both the licensee and the licensor can be exposed to the risk of moral hazard if one of the counterparts possesses more relevant information or if it is not possible to monitor the appropriate degree of effort the two parties would have to provide for the duration of the agreement (Ashish Arora, 1995). On the one hand, the technology might still be too immature to enter into the market, requiring the licensee to continue technological exploration and development. On the other hand, the licensor might risk losing control of its proprietary technology and needs to apply instruments in the licensing deal to monitor the licensee's technological development and economic returns on invention (Keld Laursen et al., 2013; Leone & Reichstein, 2012). Alternatively, the licensor might under or over-estimate the commercialization capabilities of the licensee and its ability to disseminate knowledge from the licensed technologies. Therefore, the licensee might take advantage of the situation because there are no tools to align its interests with the licensor (Deepak Somaya et al., 2010). As a result, negotiating parties might experience difficulties in the formal agreement, slowing the overall negotiation or preventing the success of the technology partnership (Shane & Somaya, 2007).

Literature on the economics of licensing has often acknowledged the design of pricing schemes as an effective mechanism to align interests and lessen moral hazard. In general, the licensing price could be arranged through three main types of arrangements: lump-sum, royalty-based and two-part tariff, which is disposed through a combination of the previous two schemes (Kamien et al., 1992; Kamien & Tauman, 2002; Katz & Shapiro, 1986; Vishwasrao, 2007). Formal models demonstrated the efficiency of lump sum respect to royalties in case of perfect information (Gallini & Wright, 1990; Kamien & Tauman, 2002). By accepting a fixed amount, the licensor immediately secures the payment and avoids any type of opportunistic behavior from the licensee concerning future sums. Furthermore, the licensee is more willing to opt for a lump sum to not expose itself to increasing royalties during the duration of the contract. Indeed, royalty increases the marginal cost of the licensee of using the new technology and decreases the total amount the licensee is willing to pay to the licensor (Kamien et al., 1992; Macho-Stadler et al., 1996). However, licensing contracts inherently suffer from incompleteness and opportunistic behavior and empirical evidence demonstrated that licensing parties often select royalties as payment scheme (Anand & Khanna, 2000b; Cebrian, 2009). The theoretical rationale for selecting royalties in licensing contracts stems from the fact that the licensee might wish to bind the licensor to provide training and know how upon the payment of the royalties (Beggs, 1992; Choi, 2001; Mendi, 2005). In fact, the licensor would not have any incentive in sharing know-how, knowledge and capabilities with the licensee once signed the contract and secured lump sum. Instead, the prospects of obtaining royalties ex post could modify the incentives of the licensors, which could be more committed in keeping an on-going relationship with the licensee. Therefore, the selection of lump sum or royalties as payment mechanisms could prevent the aftermath of one-sided moral hazard from either the licensor or the licensee slant (Cebrian, 2009).

Alternatively, the negotiating parties could opt for a two-part tariff to turn opposing interests into double-sided moral hazard. In fact, the licensor owns the licensed technology, which is easily observable for both parties. Yet, the use of the technology requires effort from the licensee, which is not easily observable for the licensor, and potentially the transmission of additional knowledge, which depends on the degree of licensor's commitment. Thus, both parties are subject to reciprocal moral hazard. Literature postulated that when parties might incur in double-sided moral hazard, a payment scheme based on a two-part tariff is the optimal outcome as a way to share incentives (Bhattacharyya & Lafontaine, 1995; Reid, 1977). Indeed, through a two-part tariff parties share the cost of monitoring, the residual shirking and the expected penalty costs (P. Agrawal, 2002). On one side, by adding a lump sum to royalties, the licensor partly covers the initial costs of monitoring and will maintain a certain degree of commitment to permit the licensee to exploit the technology and pay the royalties. On the other side, through the imposition of the royalties the licensee needs to reveal the produced outcome, which can be monitored by the licensor. Furthermore, a combination of lump sum and royalties could be beneficial for the licensee in order to negotiate a larger initial amount and decrease the royalty rate, deflating therefore its marginal costs. In sum, contracts based on payments that include both fixed fees and royalties are assumed to balance the economic risk over the time among parties (Choi, 2001; Sen & Tauman, 2007), but empirical evidence that confirms the relationship is still missing (Cebrian, 2009).

Another solution to overcome uncertainty and moral hazard in licensing transactions consists of the inclusion of provisions and clauses

(Hagedoorn & Hesen, 2007). Indeed, by including provisions and clauses in the design of a licensing agreement, the negotiating parties aim at limiting moral hazard and adding relevant information to the contract. A more complete contract decreases the risk of moral hazard, improves the quality and the amount of information shared between parts, and allows more flexibility in the remuneration (Furlotti, 2007).

A first stream of scholars that analysed the uses of clauses in licensing contracts to mitigate moral hazard focused on limitations on the use of the technology imposed by exclusivity and grant back clauses. Indeed, Somaya and colleagues provided empirical evidence that exclusivity clauses are adopted as formal safeguards to protect the licensee's investments on complementary assets and to facilitate contractibility of early stage technologies (Deepak Somaya et al., 2010). Within exclusivity clauses, geographical or product restrictions may be included to lower the risk of the licensor of working exclusively with the licensee. Furthermore, licensor and license could monitor moral hazard on the future use and development of technology through the use of grant back clauses (Leone & Reichstein, 2012). Indeed, a grant back clause is an obligation to return to the licensor inventive upgrades of the technology. Grant back clauses are generally included in contracts, in which the licensee and the licensor share a common technological background. Moreover, technological uncertainty increases the odds of including grant back clause in the contract, particularly when the licensed technology is core for the licensee (Keld Laursen et al., 2013). Grant back clauses clearly shift incentives to the licensor's side and lower the probability that the licensee acts opportunistically with the licensed technology, decreasing therefore the chances of moral hazard. However, empirical research showed that the inclusion of grant back clauses has detrimental effects on the licensee’s future inventive efforts. Since a licensee cannot fully appropriate value from future developments of innovation, it is less likely that it would invest energy, time and financial resources in improving the licensed technology (Leone & Reichstein, 2012).

A second literature stream focused on contractual features that achieve enforcement of rights among parties as an option to overcome moral hazard (Furlotti, 2007; Grossman, 1981). With enforcement clauses, parties are guaranteed that courts would easily verify the fulfilment of contractual obligations whenever specified contingencies would occur. As a result, enforcement clauses decrease uncertainty about the proper execution of contracts and allocation of rights among parts. The inclusion of enforcement clauses decreases contract incompleteness, making sure that counterparts would have enough specifications to prove opportunistic behaviour in case certain condition would happen. In this category we can find clauses related to termination rights and indemnities (Hagedoorn & Hesen, 2007). Research found that in the biotech field those enforcing clauses coupled with access to intellectual property rights achieve higher payoffs compared to cases that omit the formal option (Lerner & Malmendier, 2010; Lerner & Merges, 1998). An explanation for these findings relies on the fact that through the inclusion of termination rights negotiating parties overcome problems related to technological uncertainty and clearly allocate decision rights. Another important type of enforcement clauses to model moral hazard refers to indemnities. Indemnification clauses act as an ex ante risk allocation mechanism, through which negotiating parties display the reciprocal knowledge on a particular state of affairs of a product and carry the risk of misrepresentation (Grossman, 1981; Lutz, 1989). Indemnities are therefore promises by one party to take responsibility for the loss the other parties would suffer if contingent circumstances were to happen.

With particular reference to licensing practice, indemnification clauses on intellectual property rights are important instruments that parties choose to negotiate to decrease one-sided moral hazard and signal commitment to the deal. Indemnification clauses against patent infringements are warranties that cover the licensee and licensor in case the patent(s) would be sued in a court for violation of the exclusivity of the registered invention. Such challenge occurs increasingly in different technological fields, with a strong impact on the organizations' budget (Galasso et al., 2013; Reitzig et al., 2007).

Following the previous argument, the event of patent litigation is an unforeseeable and distressing circumstance for the licensee. Although the duty of a thorough examination of a patent's validity lies with the licensee, it is fair to assume that the licensor has a better understanding of the degree of freedom granted by the patent(s) in the relevant technological space, given the upfront effort of registering the exclusivity of rights. However, a strong licensor that agrees to include in the contract an indemnity against IP infringement signals both the quality of the licensed patents and a high degree of commitment. Given the risk and economic exposure that patent litigation can cause, it is likely that only a contracting party well informed about the strength and validity of the licensed IP might agree to share the risk of taking part in the plaintiff. Effectively, the introduction of the IP indemnity shifts risk between the parties. Thus, the inclusion of an intellectual property indemnification clause permits both to monitor contractual partners' commitment ex ante and to enforce specific rights in case contingent events occur ex post. As a result, the inclusion of IP indemnity turns the risk of one-sided opportunistic behaviour into double-sided moral hazard, which is reflected in the selection of prices. Indeed, the licensor would be willing to accept to share part of the indemnification of the risk if it might receive a less volatile payment with respect to royalties and monetize with the inclusion of a lump sum to reduce the financial exposure that the contract gives rise to. This scenario is coherent with literature on double-sided moral hazard and the adoption of two-part tariffs (P. Agrawal, 2002; Bhattacharyya & Lafontaine, 1995). Therefore, I postulate the following hypothesis.

H1: With the inclusion of intellectual property rights indemnification clause it is more likely selecting a payment scheme based on lump sum and royalties.

Indemnification clauses on intellectual property rights might be bundled with an indemnity on products and offer the most extensive insurance on future negative events (Hagedoorn & Hesen, 2007; Ramsay, 2003). Indemnification clauses on products protect the insured parties against economic and reputational damages due to faulty products launched in the markets. The combination of those two types of indemnification clauses is particularly relevant for early stage technologies, which still do not present a clear path in terms of fields of application or future evolutions of the technology.

While indemnification clauses on intellectual property right are a screening device to select partners with a strong patents portfolio, indemnification clauses against product liability weeds out licensees with the intentions of developing risky products. Furthermore, a product indemnification clause induces the licensee to be careful when developing products as it carries the cost of a faulty product itself. In this scenario both the licensee and the licensor share the risk of negative events happening in the future. Following previous arguments, it is still fair to assume that the licensee and licensor would opt for a two-part tariff, which permits them to regulate and align different interests. Yet, the inclusion of the indemnification clause in the design of the agreement is the outcome of a rational exercise where negotiating parties consider i) the cost of specifying either unilateral or reciprocal duties, ii) the likelihood of the verification of contingent events, iii) the chance that the counterpart might act opportunistically in the future and eventually iv) the costs to be incurred in case certain provisions would be left out of the agreement (Crocker & Reynolds, 1993). Of course, the inclusion of indemnification clauses that consider both products and intellectual property rights infringements is more costly and increases the initial effort of negotiating the terms. Indeed, the bundle of clauses requires that negotiating parties properly forecast the likelihood of the occurrence of the negative events –i.e. a plaintiff for patent infringements and product liability- and design a comprehensive contract. By extending the scope of indemnification and adding additional information on future commitment, negotiating parties might find it optimal to select a more efficient payment scheme such as lump sum. It is therefore possible to assume that combining the IP and products indemnity clauses to guarantee the highest insurance coverage would have a marginal decreasing effect on the odds of selecting a two-part tariff. In other words, the magnitude of the bundle of clauses on the selection of a two-part tariff would be inferior respect to the effect of the provision of the IP indemnity only. This leads to my second hypothesis.

H2: The inclusion of an indemnification clause for both intellectual property rights and products has decreasing marginal effects on the likelihood of selecting a payment scheme based on lump sum and royalties.

4.3. Licensing price, IP indemnification clauses and technological relatedness

Previous research on the use of clauses in technology licensing agreements demonstrates that the adoption of certain obligations correlates with technological relatedness and common expertise between the licensor and the licensee (Keld Laursen et al., 2013; Leone & Reichstein, 2012). On one side, the licensor should be more advanced on the technological expertise as the originator of the licensed technology. Indeed, the licensor should possess a more in-depth technological understanding that guarantees an increasing ability of judging potential opportunities and threats (Andrea Fosfuri, 2006; Kim et al., 2006). Generally, the licensor would benefit from a favorable information asymmetry, except for the case in which uncertainty about technological future development is very high. On the other side, research reports an improvement in the transfer of knowledge and in the absorption of know how if the licensee already masters some technological background related to the licensed technology (Ceccagnoli, Higgins, & Palermo, 2013; Ceccagnoli & Jiang, 2013). The rationale here is that the existence of similarities in the knowledge base decreases information asymmetry on previous investments and requires capabilities to license in the technology, and helps to disentangle uncertainty about future technological patterns. Indeed, firms with similar knowledge background tend to show similarities in skills, cognitive structures and frameworks all of which reduce the searching costs for potential technological partner and the screening for technology (Argote & Ingram, 2000; Katila & Ahuja, 2002; Zander & Kogut, 1995). Previous empirical research demonstrated that dissimilarities in partners' technological specialization are detrimental to the establishment of the license contract, whereas if partners have developed technological expertise in the same fields, mutual learning would be more likely and it is less necessary developing structured formal arrangements to coordinate actions (Colombo, 2003).

Technological relatedness between licensing partners is correlated with the selection of payment scheme. When technological competences are aligned and there is a common understanding of capabilities and skills necessary to develop the licensed technology, information asymmetry between negotiating parties is lower and there is less risk that opportunistic behavior takes place (Beggs, 1992). Therefore, we might imagine that when technological diversity is very high between licensing partners, a royalty payment method would be selected. This method would allow the licensee to share future risks with the licensor –i.e. if future commercialization would be unsuccessful for the licensee, the licensor would receive just a small outcome based on the royalty percentage- and the licensor to induce the counterpart to commit into the commercialization process of licensed technology to sustain positive profits in front of the royalty costs. However, information asymmetry among parts might be manipulated with the inclusion of clauses. Clauses can be generally inserted to decrease information asymmetry and allow flexibility and adjustments in case specified contingencies would occur (Crocker & Masten, 1988; Crocker & Reynolds, 1993; Furlotti, 2007; Hagedoorn & Hesen, 2007). Indemnification clauses on intellectual property rights absolves to the specific function of signaling to the contracting parties future commitment in the case in which the patent licensed in the deal would be sued by a third party. Therefore, IP indemnification clauses decrease ex ante information asymmetry and re-assure the licensor and licensee about potential support in the case of the aforementioned event. We might assume that if the licensee and licensor operate in different technological streams and the licensed patent would be sued for infringement, the licensee would find herself in a difficult position. Indeed, the licensee might not have all the technical knowledge in the field where the patent has been registered and it might be difficult for the licensee sustaining the allegations of infringement on its own. Particularly under these circumstances, it would be beneficial for the licensee to have the support and technical knowledge of the licensor under the circumstances of patent litigation. When information asymmetry is high due to technological diversity, indemnification clauses would allow sharing future risks to face the event of patent litigation. However, the licensor would be more prone to support the licensee in the case of patent litigation if it would be able to anticipate some profits at the time of the licensing through a lump sum. Thus, the inclusion of the clause as a risk-sharing mechanism is reflected in pricing, as negotiating parties would select a two-part price as more efficient pricing scheme that would allow to internalize the risk of contingencies and rely on double-sided moral hazard (Cebrian, 2009; Furlotti, 2007; Gallini & Wright, 1990; Lyons, 1996). As a result, in case of high technological diversity, parties who include the IP indemnification clause in the contract would more likely opt for a combination of lump sum and royalties as the preferred payment method instead of pure royalties system. I therefore posit that:

H3: When licensing contract includes an IP indemnification clause and technological relatedness is low, licensing negotiating parties will opt for a payment scheme based on lump sum and royalties.

4.4. Data and Methodology

4.4.1. Data

The research hypotheses are tested on a dataset based on the coding of 1830 agreements in the pharmaceutical industry over the time period 1985-2004. Licensing data were retrieved from the ReCap database. A number of considerations prompted me to choose to explore the research question through ReCap database. Firstly, the dataset has been extensively used in the alliance and licensing literature, making this research comparable with previous findings (Schilling, 2009). Secondly, the dataset offers detailed information on the contractual specifications, the technology involved and the parts, which subscribed the deal. Particularly, I focused on contracts that satisfied the following requirements: i) the contract is a license; ii) information on patents and payment scheme is available; iii) the negotiating parties involved are not under the same ownership chain –therefore, we excluded cross-group deals; iv) only unilateral agreements were selected, excluding cross-licensing deals; v) contracts with universities and public institutions were excluded. At the end of this process, I had selected 151 contracts to use for my analysis.

The pharmaceutical industry is an interesting setting in which to test my initial hypotheses because licensing is at the core of large, medium and small firms' innovation strategies (Gunther McGrath & Nerkar, 2004; Schilling, 2009). Indeed, in the pharmaceutical industry it is very common that small biotech firms generate innovation that is subsequently licensed out to larger organizations, which eventually bring a technology into the market thanks to larger scale capabilities. Since the 1980s, the boost of biotechnology and drug discovery in the pharmaceutical industry increased the need for a vertical division of innovation that led to a surge of the market for technology and knowledge (A. Fosfuri & Giarratana, 2010). Hence, the selected industry is often exposed to arm's length transactions, in which pricing is a crucial determinant for the licensor to recover initial investment from innovation. Given the frequency and the professionalization of technology licensing in the pharmaceutical industry, my investigation also has profound practical relevance.

I combined patent data of available licensing contracts in the ReCap dataset with additional information available through NBER Patent dataset (Hall et al., 2001). This step allowed me to build several measures to characterize technological features of the contracts. Here, it is worth pointing out that the use of patent data is a sufficient yet imperfect proxy of innovation at firm level. For example, some firms from the contracts might be innovators in their area, but not listed as assignees on patents in the NBER dataset. As a result, my approach missed to include those firms in the analysis. I am aware of these imperfections, but take solace from the fact that other studies in the field of market for technology literature faced similar problems (A. A. Ziedonis, 2007).

Finally I retrieved financial information and firm's size measures on both the licensee and licensor from the Compustat database.

4.4.2. Variables

Dependent variable

The dependent variable *pay_scheme* is a three level categorical variable indicating the pricing mechanisms selected by the parties. Similarly to previous research (Vishwasrao, 2007), I grouped each agreement into one of those following categories: contracts with lump sum, royalties or ones with both lump sum and royalties. The category lump sum includes up-front fees, milestones payment and minimum annual royalties. Royalty category comprises royalties on net sales, royalties on gross sales and licensee's profit share. The third category, i.e. two-part tariff, incorporates deals that combine both fixed and outcome-based payment schemes.

Independent variables

The presence of IP indemnification clauses is captured by two dichotomous variables, namely IP indemnification and indemnification bundle. The first dummy dichotomous variable (*ip_ind*) is a dummy variable equal to one if the contract includes a warranty only against patent infringements. The second dichotomous variable (*indm_bundle*) assumes values equal 1 if the indemnification clause on intellectual property rights is associated to the indemnification clause on faulty products that could derive from the licensed technology. I also created a dichotomous variable (*prod_only*) to monitor when contracts include indemnifications on products derive from licensed technology, which might be proved invalid or useless during technological development, damaging the downstream commercialization.

The other explanatory variable is technological distance *(tech_dist)*. I started measuring technological relatedness between licensing partners by looking at the distribution of patents across three digits USPTO patent classes in the five years previous licensing agreement and measuring the degree of technological overlap (Branstetter & Sakakibara, 2002; Jaffe, 1986). Therefore, I calculate the following measure

$$Technological\ relatedness = \frac{F_i F_j'}{\sqrt{(F_i F_i')(F_j F_j')}}$$

Where the multidimensional vector $F_i=(F^1_i, F^S_i)$ represents the number of patents assigned to firm *i* from class 1 to S. The variable ranges from 0 to 1, where value close to 1 indicating the highest degree of technological overlap. Based on the measure of technological relatedness, I defined technological distance (*tech_dist*) as follows

$$Technological\ distance = 1 - \frac{F_i F_j'}{\sqrt{(F_i F_i')(F_j F_j')}}$$

The variable ranges from 0 to 1, where value close to 1 indicating the highest degree of technological distance.

Controls

In order to account for other effects, I include a number of controls that past research demonstrated to affect licensing process and the selection of pricing options.

Patents and technology specialization measures

I control for patents' generality for both the licensee and licensor. Based on previous literature (Hall et al., 2001), generality is defined at patent level as

$$Generality_i = 1 - \sum_j^{n_i} s_{ij}^2$$

Where s_{ij} denotes the percentage of citations received by paten i that belong to patent class j, out of n_i patent classes. Generality is a measure for innovation based on citations obtained from patents in other technological classes. If the index is high, it is possible assuming that the patent had a widespread impact. At patent portfolio level, this measure permits us to acknowledge whether the licensee (*see_generality*) and licensor (*sor_generality*) were influential innovators in a variety of fields.

I control for technological specialization by calculating the Herfindhal index for the total number of patents in the firm J's patent portfolio accumulated during 5 years before the license agreement. For the licensor, the measure (*sor_herf*) can be operationalized as follow.

$$licensor\ technological\ specialization = \sum_{j=1} (\frac{N_{ij}}{N_i})^2$$

An equal operationalization has been used to monitor licensee's technological specialization (*see_herf*).

State of technological development

A potential cause of moral hazard is the degree of exploitation of the technology from on the licensee's perspective depending upon technology maturity (K. Laursen et al., 2010; Leone & Reichstein, 2012). I build the variable *early_tech* in order to control at which stage of the development the drug or technology has been licensed out. Indeed, the stages of a drug development can be described into discovery, clinical trials and regulatory approvals. The discovery phase includes preclinical trials, in which the compound is tested to assessing safety on animal testing and biological efficacy of the molecule. In the next stage, clinical trials, the compound is tested on humans to show that the benefits of the drug out-weight the potential risks. In the last stage, the technology is under scrutiny to the authorities to obtain approval for market commercialization. I coded the dichotomous variable *early_tech* equal 1 if the technology was licensed during the first discovery phase.

Other obligations in the contract

The number of other obligations stated in the contract is another important dimension that needs to be controlled. Indeed, the higher the number of contractual clauses included in a licensing deal, the higher is the information available and the lower is the risk of moral hazard (Lerner & Malmendier, 2010; Ryall & Sampson, 2009). For each licensing agreement it was possible retrieving information whether the parties drafted additional clauses such as grant back, exclusivity and technology furnishing clause. Informed by previous research (Leone & Reichstein, 2012; Deepak Somaya et al., 2010) and general prescriptions from the business practice (Ramsay, 2003), I created a variable *other_obb* that counts the number of aforementioned additional clauses inserted in the agreement to control for degree of completeness of licensing contracts.

Trust

Previous studies found that transactions do not always occur as stand-alone events, yet they could be contextualized into on-going relationships (Cebrian, 2009; Kim et al., 2006). To operationalize this construct, the research would control though the variable *count_inter* how many previous negotiation reported in the dataset the licensee and licensor have been established before the licensing agreement.

Bargaining power

Differences in bargaining power among parts might produce different effects on the pricing outcome. The paper controls for potential issues related through bargaining power through two constructs. First, I measured the company size by counting the average number of employees of both licensee (*see_emp*) and licensor (*sor_emp*) during five years before the license agreement. These two measures control for different exploitation of market for technology by large and small-medium firms (Gambardella et al., 2007; Joshua S Gans & Stern, 2003). Second, allocation of rights between the licensee and the licensor might reflect bargaining power (Deepak Somaya et al., 2010). Thus, the research controls with a dichotomous variables (*ins_sor*) if the indemnified part is the licensor. The idea behind is that the indemnified party transfers part of the risk to the indemnifier. In a normal case we might expect the licensee be in the indemnified party. However, if the licensor is the indemnified party, we might expect that this latter has higher bargaining power in the relationship with the licensee.

4.4.3. Methodology

The observed outcome is a multi-categorical variable that codes three different payment schemes: lump sum, royalties and a combination of the previous two ones. Thus, I adopted a multinomial logistic model to estimate the likelihood of selecting a payment scheme, given the presence of indemnification clauses and technological features in the agreement. I used lump sum payment as the baseline category and then estimated two parameters for each explanatory variable. Therefore, if we define $\Pr(Y_i)$ as the probability of selecting a payment scheme, we can formalize the econometric model as

$$\Pr(Y_i = j|\boldsymbol{x_i}) = \frac{\exp(\boldsymbol{x}_i\beta_{ij})}{\sum_{l=1}^{J} exp(\boldsymbol{x}_i\beta_{il})} \qquad j = 1, \dots, J \qquad (1)$$

Where J=3 categories and in the sum in the denominator the index l takes the values 1, 2, and 3 to produce the three required terms. In this particular specification, I selected j equal 1 as the reference category –i.e. lump sum- so that the econometric model allows me to estimate the coefficients $\beta_{i,2}$ and $\beta_{i,3}$. On one side, the coefficient $\beta_{i,2}$ describes how the independent variable $\boldsymbol{x}_i$ influences the probability of selecting a royalty based payment respect to the baseline option –i.e. lump sum. On the other side, the second coefficient $\beta_{i,3}$ expresses the likelihood of selecting a two-tariff scheme instead of a lump sum. I also estimated models where the baseline category is royalty payment, in order to control for consistency in the results of two-tariff scheme respect to the likelihood of selecting either a lump sum or a royalty-based payment.

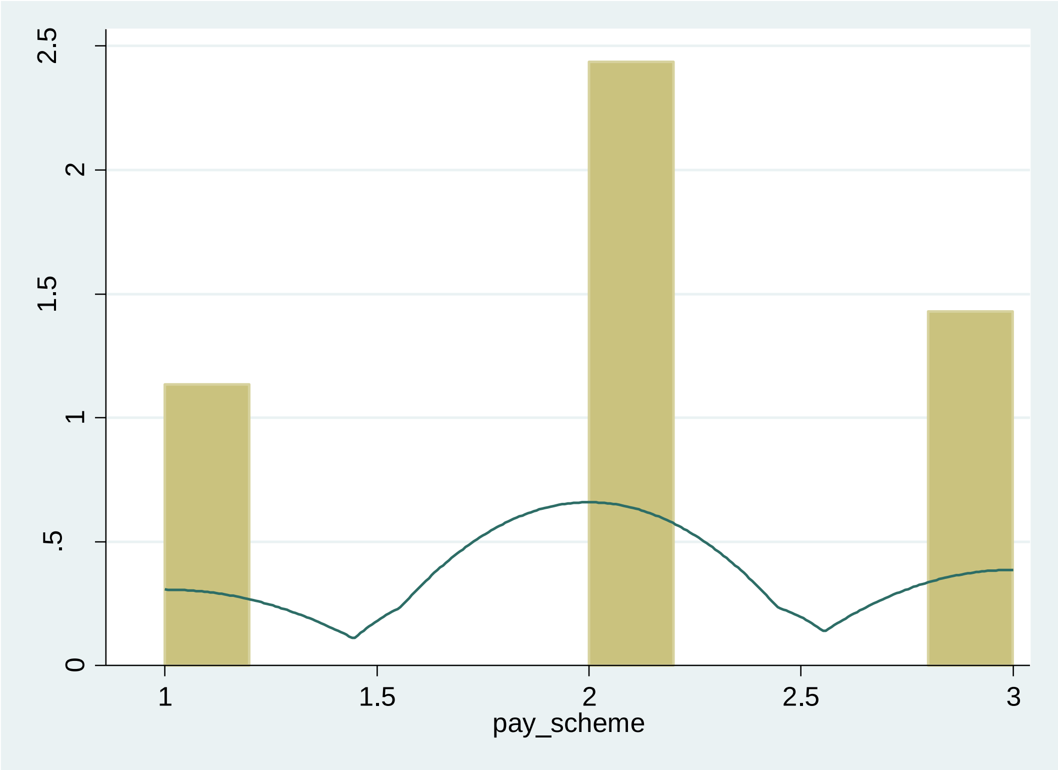
I complement the analysis of coefficients with the estimation of average marginal effects. Indeed, interpretation of regression tables of non-linear models can be overwhelming, particularly when the models contain interaction effects and categorical variables (Wooldridge, 2004). Therefore, to improve the interpretation of the results and coherently with recent research on the "observed value" approach (Hanmer & Ozan Kalkan, 2013), I report the marginal effects of each covariates, using the values actually taken on by each observation and then computing the average. The benefit of using average marginal effects in nonlinear models is providing an understanding of the magnitude of the effect, while estimated coefficients would provide information on the direction of the relationship (Cameron & Trivedi, 2009; Hanmer & Ozan Kalkan, 2013).

4.5. Results

The sample consists of 151 contracts on licensing contracts established in the pharmaceutical industry between 1985 and 2004.

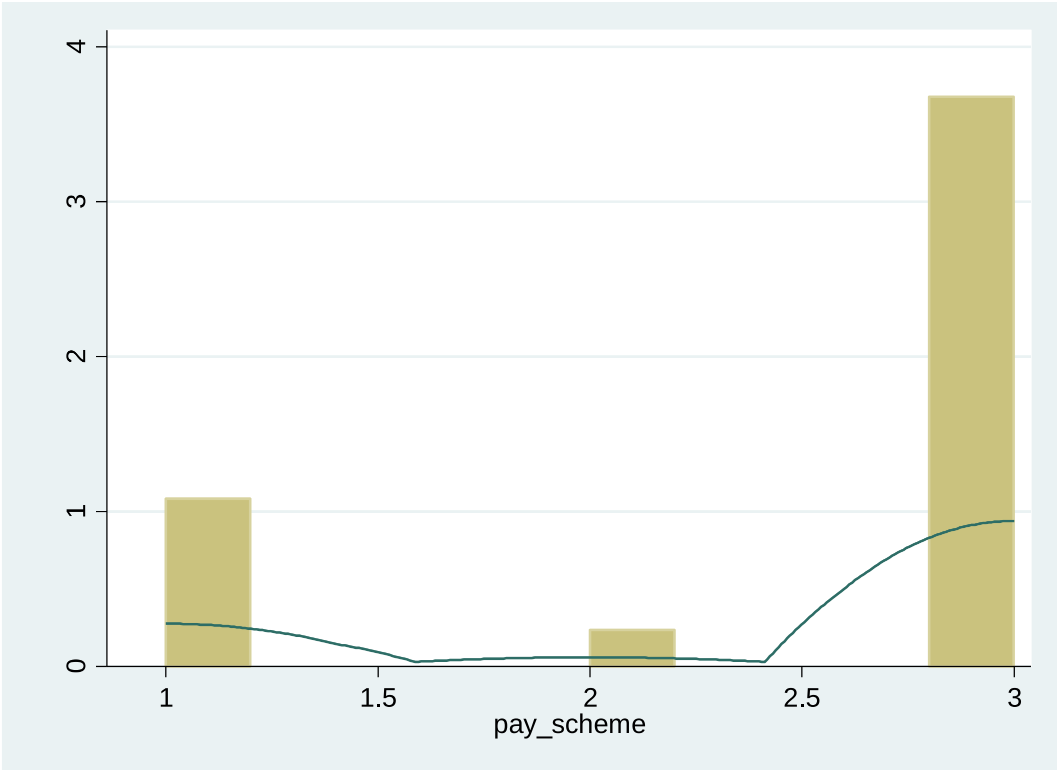
Graphs 4.1 to 4.3 provide a descriptive understanding of the distribution of the payment schemes.

Graph 4.1: Distribution of payment scheme when indemnification clauses are not included



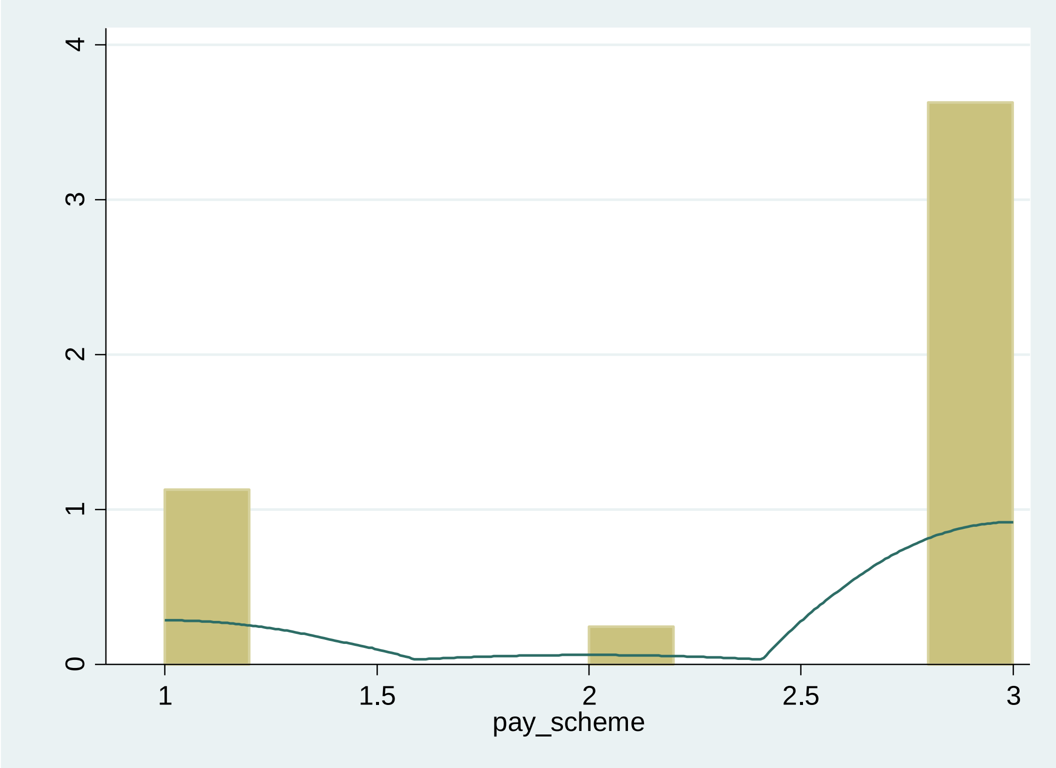
Note: (1) Lump sum; (2) Royalties; (3) Lump sum and royalties

Graph 4.2: Distribution of payment scheme when IP indemnification clauses are included



Note: (1) Lump sum; (2) Royalties; (3) Lump sum and royalties

Graph 4.3: Distribution of payment scheme when both IP and product indemnities are both included



Note: (1) Lump sum; (2) Royalties; (3) Lump sum and royalties

As graph 4.1 shows, for a subsample of contracts where the intellectual property rights indemnification clauses were not included in the agreement, the distribution of payment scheme is clustered on royalties, coherently with other empirical findings (Cebrian, 2009; Mendi, 2005). However, graphs 4.2 and 4.3 show clearly that the distribution of payment schemes shifts towards a combination of lump sum and royalties when I consider contracts that included an IP indemnification clause and a combination of this latter and products indemnity. The aforementioned graphs therefore provide a visual representation of hypothesised effect on the selection of two-part tariff as payment scheme because of double-sided moral hazard; however, through graphical representation it is not possible obtaining a clear understanding of the magnitude.

Thus, I estimated the likelihood of selecting two-part payment scheme respect to lump sum and royalties using a multinomial logistic regression model for the 151 contracts in our sample. I run regression models at technology level, clustering errors at contract level on 226 observations. Table 4.1 provides an overview of the data and some descriptive statistics. Table 4.2 reports correlates of variables included in the analysis.

Table 4.1: Summary Statistics

Variable	N	Mean	Std.Dev.	Min	Max
pay_scheme	226	2.389381	0.765171	1	3
ip_only	226	0.017699	0.132148	0	1
prod_only	226	0.477876	0.500619	0	1
indm_bundle	226	0.362832	0.481884	0	1
tech_dist	226	0.720857	0.275723	0.014421	1
count_inter	226	376.5708	574.6744	0	1560
early_tech	226	0.376106	0.485483	0	1
other_obb	226	1.486726	1.116463	0	4
sor_emp	226	16.37381	54.79823	0.015	269.465
sor_herf	226	0.55126	0.236035	0	0.974599
sor_generality	226	0.697859	0.206714	0	1
ins_sor	226	0.323009	0.468664	0	1
see_herf	226	0.661113	0.309109	0	0.968343
see_generality	226	0.635683	0.289346	0	1

Table 4.2: correlations

	ip_only	prod_only	indm_bundle	tech_dist	count_inter	early_tech	other_obb	sor_emp	sor_herf	sor_generality	ins_sor	see_herf	see_genelity
ip_only	1												
prod_only	-0.1284	1											
indm_bundle	-0.1013	-0.7219	1										
tech_dist	-0.0713	-0.081	0.1198	1									
count_inter	-0.0871	0.356	-0.1814	0.5122	1								
early_tech	-0.1042	0.2995	-0.187	0.0942	0.512	1							
other_obb	-0.0285	-0.0761	0.1494	-0.1919	-0.5135	-0.5278	1						
sor_emp	-0.0401	-0.1862	0.2198	0.2223	-0.1647	-0.2286	-0.0669	1					
sor_herf	0.0387	-0.2125	-0.0269	-0.0395	-0.5016	-0.2585	0.0389	0.4832	1				
sor_generality	0.0339	-0.3278	0.2916	0.3857	0.066	-0.0404	-0.1893	0.2914	0.2422	1			
ins_sor	-0.0927	0.5515	-0.3441	0.0189	0.5908	0.4404	-0.4802	-0.0988	-0.1561	-0.0314	1		
see_herf	0.0208	0.1418	-0.3108	-0.0795	0.2825	0.0493	-0.0076	-0.5318	-0.4936	-0.1223	0.1463	1	
see_generality	0.0061	-0.1467	0.0183	0.0147	0.044	0.0173	0.079	-0.0368	-0.029	-0.0133	0.021	-0.0138	1

Correlations among variables are below the threshold r=0.7 (Cohen, Cohen, West, & Aiken, 2003), suggesting that multi-collinearity does not affect estimation.

The results of the multinomial logistic model are reported in tables 4.3.1 (baseline payment scheme: lump sum), 4.3.2 (average marginal effects), 4.4.1 (interaction effect with technological distance, baseline payment scheme: lump sum) and 4.4.2 (average marginal effects of the interaction models). As baseline for our estimates I selected lump sum payment, because it would be the most efficient payment scheme that parties would ideally select if no moral hazard would exist and with perfect information (Kamien et al., 1992; Katz & Shapiro, 1985). In the Appendix I reported results obtained by using royalty as baseline payment scheme. I found supporting confirmatory evidence for those additional models.

Table 4.3.1: multinomial logit (baseline payment scheme: lump sum)

	Model 1		Model 2		Model 3	
	lump sum		lump sum		lump sum	
	royalty	two-part	royalty	two-part	royalty	two-part
count_inter	0.0260	0.0220	0.0199	0.0159	0.0204	0.0163
	(0.0241)	(0.0242)	(0.0232)	(0.0232)	(0.0192)	(0.0191)
early_tech	-5.143**	-3.947**	-5.287**	-4.219**	-4.854**	-4.107**
	(1.9581)	(1.2261)	(1.8311)	(1.1578)	(1.4422)	(1.1095)
other_obb	-0.5483	0.5870	-0.1037	1.0153	-0.3495	0.6527
	(0.8945)	(0.6962)	(1.0995)	(0.9148)	(0.7716)	(0.6947)
sor_emp	-0.0025	-0.0045	0.0004	-0.0057	0.0000	-0.0065
	(0.0198)	(0.0084)	(0.0216)	(0.0073)	(0.0141)	(0.0069)
sor_herf	-2.9702	-6.2205*	-4.3196	-7.0920*	-5.8077	-5.7321*
	(6.7354)	(2.9605)	(7.4647)	(3.2372)	(5.0908)	(2.7254)
sor_generality	3.2415	0.7081	2.9812	1.0624	2.8676	0.7795
	(7.8594)	(2.5510)	(8.2604)	(2.7621)	(6.1697)	(2.3007)
ins_sor	3.5980*	3.5329**	4.1572+	4.0472+	2.9543+	3.4478**
	(1.7077)	(1.2994)	(2.4807)	(2.3125)	(1.7056)	(1.3102)
see_herf	10.7842	7.0731*	10.6741	6.6667*	8.7866	7.2025*
	(7.9660)	(3.4058)	(8.7804)	(3.0967)	(5.9385)	(3.0150)
see_generality	-1.2283	-6.0637+	-0.8692	-6.1474*	-1.2072	-6.0915+
	(6.0567)	(3.5044)	(6.4267)	(2.8235)	(5.6933)	(3.3682)
ip_only	-1.2237	13.2449**				
	(2.7509)	(2.0887)				
prod_only			-1.7587	-1.6350		
			(2.1164)	(2.0337)		
indm_bundle					-1.2822	1.0937
					(1.5739)	(1.1714)
_cons	-5.3986	4.9277	-4.4784	5.8112+	-1.5771	4.3526
	(10.7493)	(3.5073)	(11.9170)	(3.2696)	(9.3262)	(3.2647)
"N"	226	226	226	226	226	226
ll	-72.8331	-72.8331	-72.6709	-72.6709	-69.3322	-69.3322

Notes: standard errors in parentheses; + p<0.10, *p<0.05, ** p<0.01

Table 4.3.2: average marginal effect when baseline payment is lump sum

	AME1		AME2		AME3	
	Lump sum		Lump sum		Lump sum	
	royalty	two-part	royalty	two-part	royalty	two-part
count_inter	0.000357	0.000422	0.000322	0.000218	0.000327+	0.000245
	(1.59)	(0.62)	(1.59)	(0.32)	(1.73)	(0.45)
early_tech	-0.0927	-0.0497	-0.0851	-0.0585	-0.0655	-0.0768
	(-0.96)	(-0.46)	(-0.87)	(-0.54)	(-0.97)	(-0.96)
other_obb	-0.0671+	0.0820*	-0.0652+	0.0937*	-0.0544+	0.0709*
	(-1.93)	(2.12)	(-1.72)	(2.14)	(-1.85)	(2.11)
sor_emp	0.000101	-0.000248	0.000360	-0.000522	0.000345	-0.000530
	(0.10)	(-0.26)	(0.31)	(-0.48)	(0.45)	(-0.71)
sor_herf	0.170	-0.370	0.141	-0.363	-0.0356	-0.158
	(0.44)	(-1.02)	(0.33)	(-0.89)	(-0.13)	(-0.61)
sor_generality	0.160	-0.123	0.124	-0.0807	0.125	-0.0874
	(0.33)	(-0.26)	(0.24)	(-0.16)	(0.34)	(-0.24)
ins_sor	0.0210	0.102	0.0247	0.109	-0.00978	0.123+
	(0.28)	(1.16)	(0.30)	(1.01)	(-0.15)	(1.66)
see_herf	0.263	-0.000156	0.279	-0.0417	0.131	0.120
	(0.70)	(-0.00)	(0.65)	(-0.10)	(0.48)	(0.48)
see_generality	0.269	-0.455+	0.301	-0.480	0.249	-0.428+
	(1.03)	(-1.78)	(0.97)	(-1.59)	(0.99)	(-1.71)
ip_only	-0.828*	1.217**				
	(-2.10)	(3.11)				
prod_only			-0.0149	-0.0395		
			(-0.29)	(-0.50)		
indm_bundle					-0.131+	0.155*
					(-1.70)	(1.98)
N	226	226	226	226	226	226

Notes: standard errors in parentheses; + p<0.10, *p<0.05, ** p<0.01

As shown in Model 1 in table 4.3.1, the inclusion of an indemnification clause on IP has a positive and significant effect on the likelihood of selecting a two-part tariff (β_{ip_only}= 13.24, $p<0.01$), confirming hypothesis 1 and the presence of double-sided moral hazard. Through the comparison with Model 2 and Model 3 in table 4.3.1, it is possible noting that the positive effect is associated with the specific inclusion of indemnities on intellectual property rights. In fact, it is interesting observing that when the contracts include products indemnification clauses, parties are more prone towards a lump sum and less likely of selecting a two-part tariff (β_{prod_only}= -1.64), although results are not fully supported by statistical significance. On the opposite side, the sign of the relationship become positive when indemnification clauses cover both products and intellectual property rights (β_{bundle}= -1.09), confirming the correlation between IP indemnities and two-part tariff in support of double-sided moral hazard. I computed the average marginal effects of the multinomial logistic regression to tease out the magnitude of the effect of IP indemnification clauses when used alone and in association with product indemnities. Results are available on table 4.3.2. The average marginal effect of the inclusion of IP indemnification clauses is positive when contracts include IP indemnities as well as the bundle of indemnification clauses. However, the average marginal effect on the odds of selecting a two-part tariff is larger when IP indemnities are adopted as stand-alone clauses (AME_{ip_only}=1.21, $p<0.01$). Indeed, what table 3.2 suggests is that at margins the effect of IP indemnification clause is decreasing when they are associated with products indemnities (AME_{indm_bundle}=0.15, $p<0.05$). Thus also hypothesis 2 is confirmed.

In table 4.4.1 and 4.4.2 I tested the effects of technological distance and IP indemnification clauses jointly on the selection of pricing scheme. First I evaluated the direct effect of technological distance on pricing scheme and I then added the interaction with indemnification clauses.

Table 4.4.1 multinomial logit (baseline payment scheme: lump sum) and technological distance is a moderator

	Model 4		Model 5		Model 6		Model 7		Model 8		Model 9	
	lump sum		lump sum		lump sum		lump sum		lump sum		lump sum	
	royalty	two-part	royalty	two-part	royalty	two-part	royalty	two-part	royalty	two-part	royalty	two-part
count_inter	0.0268	0.0228	0.0205	0.0168	0.0215	0.0176	0.0260	0.0220	0.0239	0.0201	0.0208	0.0165
	(0.0245)	(0.0246)	(0.0249)	(0.0250)	(0.0201)	(0.0201)	(0.0241)	(0.0242)	(0.0229)	(0.0229)	(0.0186)	(0.0185)
early_tech	-5.2654**	-4.0988**	-5.2934**	-4.2608**	-4.9361**	-4.1959**	-5.1424**	-3.9470**	-5.2009**	-4.1270**	-5.1150**	-4.0651**
	(1.8650)	(1.2750)	(1.7740)	(1.1712)	(1.4563)	(1.1599)	(1.9581)	(1.2260)	(1.8072)	(1.1090)	(1.5702)	(1.1218)
other_obb	-0.5328	0.6017	-0.1047	1.0224	-0.3279	0.6736	-0.5484	0.5869	-0.4874	0.6337	-0.3351	0.5752
	(0.9232)	(0.7176)	(1.1372)	(0.9678)	(0.7833)	(0.7117)	(0.8945)	(0.6961)	(0.8595)	(0.6920)	(0.8379)	(0.6996)
sor_emp	-0.0030	-0.0047	-0.0013	-0.0053	-0.0011	-0.0061	-0.0025	-0.0045	0.0007	-0.0062	0.0016	-0.0074
	(0.0220)	(0.0081)	(0.0246)	(0.0072)	(0.0157)	(0.0069)	(0.0198)	(0.0084)	(0.0200)	(0.0080)	(0.0144)	(0.0080)
sor_herf	-2.1505	-5.4045*	-3.9608	-6.8324	-4.9437	-4.9503*	-2.9703	-6.2205*	-3.4384	-6.0091*	-5.6141	-5.6473*
	(6.5738)	(2.6509)	(7.5903)	(4.2145)	(4.6545)	(2.3916)	(6.7353)	(2.9603)	(6.2819)	(2.9134)	(4.9363)	(2.6181)
sor_generality	3.1932	0.7976	2.6007	1.0441	2.6607	0.7079	3.2421	0.7086	2.8273	0.9218	2.8590	0.5977
	(8.0770)	(2.3487)	(7.7156)	(2.7569)	(5.7942)	(2.1978)	(7.8595)	(2.5508)	(6.9611)	(2.3470)	(6.7438)	(2.2891)
ins_sor	3.4119	3.3229*	4.3110	3.9589	2.9471	3.2504*	3.5979*	3.5328**	3.5048*	3.5810*	3.1541	3.6262*
	(2.4461)	(1.3767)	(3.3527)	(2.7728)	(2.2808)	(1.3971)	(1.7076)	(1.2993)	(1.7442)	(1.4196)	(1.9336)	(1.4613)
see_herf	10.9001	7.2134*	10.7794	6.7768*	8.9735	7.3864*	10.7833	7.0722*	10.9568	6.9734*	9.3853	7.1806*
	(7.9253)	(3.5368)	(8.7181)	(3.4005)	(5.9902)	(3.2552)	(7.9656)	(3.4050)	(7.9566)	(3.2134)	(6.9968)	(3.2076)
see_generality	-1.4041	-6.2470+	-0.9817	-6.2808*	-1.3923	-6.2983+	-1.2279	-6.0633+	-0.8594	-6.2193+	-1.2153	-5.9548+
	(6.1481)	(3.5792)	(6.7082)	(3.1066)	(5.8366)	(3.4643)	(6.0563)	(3.5037)	(6.4313)	(3.2975)	(5.7503)	(3.2621)
tech_dist	-0.8564	-1.0337	0.4312	-0.4248	-0.4764	-1.0696						
	(4.1327)	(2.0361)	(4.0156)	(2.5150)	(3.4100)	(1.9431)						
ip_only	-1.6306	12.7632**										
	(2.6810)	(2.2905)										
prod_only			-1.7590	-1.5726								
			(2.4467)	(2.3783)								
indm_bundle					-1.3143	1.0601						
					(1.6350)	(1.2227)						
ip_only#tech_dist							-2.9129	27.4024**				
							(6.1792)	(4.6734)				
prod_only#tech_dist									0.2285	-0.4515		
									(2.0260)	(1.6942)		
indm_bundle#tech_dist											-1.4302	1.1194
											(2.8803)	(2.2100)
_cons	-5.1936	5.1381	-4.7033	5.9233+	-1.6330	4.6482	-5.3986	4.9276	-5.2092	5.0546	-2.1836	4.5832
	(10.4860)	(3.4520)	(11.5648)	(3.3286)	(9.0860)	(3.4107)	(10.7491)	(3.5069)	(11.0388)	(3.2181)	(10.6526)	(3.3483)
N	226	226	226	226	226	226	226	226	226	226	226	226
ll	-72.7117	-72.7117	-72.5462	-72.5462	-69.1361	-69.1361	-72.8331	-72.8331	-73.2956	-73.2956	-71.3310	-71.3310

Notes: standard errors in parentheses; + p<0.10, *p<0.05, ** p<0.01

Table 4.4.2 average marginal effect when baseline payment is lump sum and technological distance is a moderator

	AME7		AME8		AME9	
	Lump sum		Lump sum		Lump sum	
	royalty	two-part	royalty	two-part	royalty	two-part
count_inter	0.000357	0.000422	0.000335	0.000378	0.000335+	0.000251
	(1.59)	(0.62)	(1.64)	(0.58)	(1.77)	(0.45)
early_tech	-0.0927	-0.0497	-0.0865	-0.0613	-0.0824	-0.0620
	(-0.96)	(-0.46)	(-0.91)	(-0.58)	(-1.06)	(-0.70)
other_obb	-0.0671+	0.0820*	-0.0668*	0.0833*	-0.0514	0.0666+
	(-1.93)	(2.12)	(-2.15)	(2.38)	(-1.44)	(1.68)
sor_emp	0.000101	-0.000248	0.000401	-0.000581	0.000498	-0.000706
	(0.10)	(-0.26)	(0.38)	(-0.58)	(0.62)	(-0.88)
sor_herf	0.170	-0.370	0.131	-0.327	-0.0256	-0.168
	(0.44)	(-1.02)	(0.37)	(-0.96)	(-0.10)	(-0.67)
sor_generality	0.160	-0.123	0.123	-0.0821	0.138	-0.106
	(0.33)	(-0.26)	(0.29)	(-0.20)	(0.34)	(-0.27)
ins_sor	0.0210	0.102	0.0123	0.111	-0.0104	0.132
	(0.28)	(1.16)	(0.17)	(1.22)	(-0.13)	(1.49)
see_herf	0.263	-0.000163	0.281	-0.0210	0.166	0.0904
	(0.70)	(-0.00)	(0.75)	(-0.06)	(0.49)	(0.28)
see_generality	0.269	-0.455+	0.304	-0.494+	0.253	-0.434
	(1.03)	(-1.78)	(1.03)	(-1.72)	(0.92)	(-1.60)
tech_dist	-0.000000133	0.000000231	0.0102	-0.0159	-0.0388+	0.0491+
	(-1.06)	(1.07)	(0.42)	(-0.48)	(-1.89)	(1.76)
ip_only#tech_dist	-1.177*	1.689**				
	(-2.06)	(2.95)				
prod_only#tech_dist			0.0271	-0.0349		
			(0.48)	(-0.56)		
indm_bundle#tech_dist					-0.0949	0.111
					(-1.28)	(1.40)
N	226	226	226	226	226	226

Notes: standard errors in parentheses; + p<0.10, *p<0.05, ** p<0.01

In Models 4 to 6 in table 4.4.1 I tested direct effect of technological distance (*tech_dist*) on pricing scheme. The sign of the relationship between technological distance (β_{tech_dist}) and the selection of two-part tariff pricing scheme is negative although not statistically significant, as shown in Models 4 to 6. Instead, when technological distance and the inclusion of IP indemnities are considered jointly, the coefficient is positive and statically significant ($\beta_{ip\_only\#tech\_dist}$=27.4, p<0.01, Model 7). Also the average marginal effects for the moderating effect of technological distance in table 4.4.2 are positive and statistically significant ($AME_{ip\_only\#tech\_dist}$=1.69, p<0.01, AME 7). Interestingly, the average marginal effect of IP indemnification clauses when associated with technological distance between the negotiating parties is higher respect to the case described in AME 1 (see table 4.3.2). It suggests that when negotiating parties might suffer from information asymmetry due to a lack of technological understanding, the inclusion of IP indemnities balances the risks and strongly shifts the odds into a shared-based payment scheme such as two-part tariff. Finally, the coefficient for the interaction between technological distance and the bundle of IP and product clauses in table 4.1 is positive although not statistically significant ($\beta_{indm\_bundle\#tech\_dist}$=1.12, Model 9) and the same results are shown also for the average marginal effects in table 4.4.2 ($AME_{indm\_bundle\#tech\_dist}$=0.11, AME 9). I can conclude that hypothesis 3 is supported for the inclusion of indemnities on IP only, but I could not find evidence to extend my reasoning to the inclusion of the indemnification on both IP and products when the licensor and licensee are technologically distant.

4.5.1 Additional analysis

The inclusion of an indemnification clause is a complex negotiating mechanism that could be influenced by additional aspects not considered in the regression analysis. Particularly, the introduction of a contractual clause could be directed by the financial stability of contracting parties (Lerner & Merges, 1998) and their patenting expertise (Leone & Reichstein, 2012). These variables are not directly correlated with the selection of the payment scheme, yet they might influence the choice of including an indemnification clause in the first instance and they might cause endogeneity in the estimates. In order to ensure that my findings are not biased by endogeneity, I tested the hypotheses using a structural equation model that consider the effect of financial stability of contracting parties and their patenting expertise as antecedents of the choice of including an indemnification clause on intellectual property rights.

Structural equations are suitable models to test endogeneity and reverse causality when dependent variables in the simultaneous equations are categorical or dichotomous and linear instrumental models would not fit the estimations (Rabe-Hesketh, Skrondal, & Pickles, 2004; Skondral & Rabe-Hesketh, 2005).

I measured financial exposure of contracting parties as the ratio between debts and activities as reported in the balance sheet of both the licensee (*debt_index_see*) and licensor (*debt_index_sor*) for the five years before the licensing deal (Lerner & Malmendier, 2010; Lerner & Merges, 1998). Following previous research (K. Laursen et al., 2010), I measured patenting experience as the lag between the license year and the year of issue of first patent for every contracting party. I computed the measure for both the licensor (*sor_pat_exp*) and licensee (*see_pat_exp*). The structure of equations is formed by two levels. In the first equation, the model aims at estimating the likelihood of drafting an IP indemnification clause (*ip_only*) in the contract, given the financial stability and (*debt_index_sor)* and patent expertise (*sor_pat_exp)* when the licensor's perspective is considered. Being the dependent variable a dichotomous one, the first equation accommodates logit estimation. The second equation simultaneously calculates the probabilities of selecting a payment scheme through a multinomial logistic model, given incorporated results from the first equation and the control variables explained in the methods section. The formalization of the structure of equations for the variable *ip_only* follows here below.

$$\begin{cases} \Pr\left(ip_{only} = 1 \middle| \boldsymbol{z}\right) = \frac{\exp(\boldsymbol{z}_i\gamma_i)}{1+\exp(\boldsymbol{z}_i\gamma_i)} \\ \Pr(pay\_scheme = j|\boldsymbol{x_i}) = \frac{\exp(\boldsymbol{x}_i\beta_{ij})}{1+\sum_{l=1}^{J} exp(\boldsymbol{x}_i\beta_{il})} \qquad j = 1, \ldots, J \end{cases} \quad (2)$$

Where $\mathbf{z_i}$=(*debt_index_sor*, *sor_pat_exp*) for the logit equation, while for the multinomial logit equation $\mathbf{x_i}$ contains the covariates (*tech_dist*, *count_inter*, *early_tech*, *other_obb*, *ins_sor*, *sor_emp*, *sor_herf*, *sor_generality*, *see_her see_generality*) and *ip_only* as estimated in the first regression, J=3 categories and in the sum in the denominator the index *l* takes the values 1, 2, and 3 to produce the three required terms. I run structural equation models also for the variables *prod_only* and *indm_bundle* and I consider both the licensor and licensee sides.

I performed the analysis using *gsem* function in STATA14. Models with results are available from the author. In order to understand whether the inclusion of the instruments is significant for the analysis, it is necessary comparing results from structural equations –i.e. the full form- with those obtained through the simplified multinomial logistic function –i.e restricted form- discussed in the results session. I performed the LM test on both full and restricted forms calculated for the variables *ip_only*, *prod_only* and *indm_bundle* and I could not reject the null hypothesis, meaning that the inclusion of the instruments is not significant and should make little if no difference to maximize the value of the likelihood function. In addition, for both the full and restricted forms I checked the Akaike information and Bayesian information criterion as test for goodness-of-fit. The test highlighted that the reduced form presents better measures of fit and complexity –i.e. lower AIV and BIC- respect to the full forms. Overall, structural equations do not provide a better specification and multinomial logit model should be preferred as parsimonious form because it demonstrated to fit better with the scope of estimation. Thus, I conclude that endogeneity is not an issue in the models.

4.6. Discussion and Conclusions

Research develops an econometric investigation on licensing contracts in the biotech industry through a multinomial logistic model to correlate licensing price schemes with indemnification clauses on intellectual property rights, controlling for technological features of contracting parties.

I propose that the selection of pricing scheme in technology licensing deals could rely on the existence of double-sided moral hazard induced through the use of IP indemnification clauses. Building on licensing literature and contract theory, I suggest that the inclusion of indemnities on intellectual property rights increases the odds of selecting a two-part tariff as payment scheme, because negotiating parties are bounded by double-sided moral hazard. Given the risks and strong financial exposure of patent litigation, the inclusion of an IP indemnity is a signal of future commitment of the negotiating parties and a flag on the quality of patents included in the contract. With the introduction of an indemnity on intellectual property rights negotiating parties share the risk of patent litigation and so they are more likely to opt for a pricing scheme that reflects the sharing of future responsibilities. Thus, negotiating parties would be more likely to opt for a pricing scheme such as a two-part tariff to justify double-sided moral hazard. Yet, the marginal effect on the selection of two-part tariff is weakened when IP indemnities are associated to product liability indemnification clauses. The rationale behind is that by enlarging the scope of insurance, licensing contracts become more complete but costly to draft. Furthermore, the inclusion of IP indemnification clauses is a useful tool when contracting parties are not technological related and the licensee might suffer from information asymmetries on the potential risks associated to the applicability of the license technology. Again, through their signalling effects, IP indemnification clauses might equilibrate the risks taken by the licensor and licensee, who might be more willing to reflect their proportion of risk with a shared pricing scheme. From a theoretical perspective, my empirical analysis complements and connects previous theoretical studies on the design of licensing contracts and pricing scheme (Choi, 2001; Gallini & Wright, 1990; Sen & Tauman, 2007) with contributions on double-sided moral hazard (P. Agrawal, 2002; Bhattacharyya & Lafontaine, 1995). In fact, my arguments extend the debate on tools available to control and assign risks between negotiating parties. Particularly, my focus on IP indemnification clauses as insurance mechanisms to signal future commitment and the quality of the underlying patent portfolio is novel in the literature. I foresee that this opening into indemnification clauses and contractual tools could further extend literature on licensing design. For instance, future research could investigate what are the antecedents of the IP indemnification clauses on both the licensee and licensor side. This empirical investigation would provide an understanding for instance on the technical instances that influence the inclusion of indemnities in the licensing contracts. Another avenue that could be explored would be the correlation between IP indemnification clauses and litigation cases handled by either the licensee or the licensor. Given the increasing relevance of patent litigation and the rise of NPE entities (A. Fosfuri & Giarratana, 2010; Galasso et al., 2013; Reitzig et al., 2007), indemnification clauses on intellectual property rights can be used as tools that parties agree to include in the contract to equilibrate the ex-post risk of infringement and show commitment in the future stages of the relationship. Exploring the correlation between the use of IP indemnities and likelihood of patent litigation can help at teasing out whether previous experience in successful litigation cases would build up specific signaling capabilities and improve the efficiency in licensing contracts.

From a managerial perspective, my research contributes in shedding lights on the optimal drafting of contracts, with a particular focus on licensing deals. In fact, our investigation demonstrates that indemnification clauses could be a useful and flexible tool to overcome information asymmetry. Yet, negotiating parties should optimally balance their insurance mechanisms in the drafting of the contract and reflect on how the inclusion of additional clauses impact incentives and the risk of opportunistic behaviour as reflected in the pricing scheme.

As a major limitation, the model focuses solely on the biotechnology field, and it does not control for industry variance. Yet, it is fair to say that biotech is one of the industry, in which licensing occurs with highest frequency (Anand & Khanna, 2000a), thus results have a distinguished practical implication. I believe that future research might address this lacuna and investigate the relationship in other industries, too.

Concluding, contributions of the present research are threefold. First, the research contributes by providing empirical evidence on licensing practices and licensing pricing options, which still remains a limited explored research area (Anand & Khanna, 2000a; Sakakibara, 2010; Vishwasrao, 2007). Particularly, the paper answers to a call for more evidence on double-sided moral hazard in licensing (Cebrian, 2009; Choi, 2001) and links licensing literature to contract theories on the use of indemnities as tools to share the risks. Second, the research expands the economic literature on the design of licensing contract when negotiating parties are not technologically aligned and might suffer from information asymmetries (Leone & Reichstein, 2012; Somaya et al., 2010). Third, the research has relevance for its practical implications, since it aims at corroborating through a systematic study previous anecdotal evidence on the best practices to optimally draft license agreements (Ramsay, 2003).

Chapter 5 Conclusions

Rooted into market for technologies theory and organizational economics, my dissertation aims at looking at organizational practices that constitute optimal coordination strategies in the case of patenting process and licensing mechanism. This dissertation as a whole contributes to the growing literature on the strategic management of patents as exemplar of intellectual property rights. Generally speaking, it provides empirical and theoretical insights into the organization of patent-related activities and capabilities. By adopting the IP department perspective, the dissertation explores the organizational design of patent-based activities and their intersection with the organizational structure to substantiate value appropriation from innovation. Through an organizational framework, the dissertation examines the conceptual interdependence between patent-related capabilities and the organizational design of patenting practices, and it provides a complementary explanation respect to RBV theory. Additionally, the dissertation focuses on the micro-practices and capabilities that generate in the technology licensing process. It builds a framework where the organizational design of licensing connects with the internal information flow and coordinating mechanisms and leads to the emergence of heterogeneous licensing negotiating capabilities. This dissertation also provides an overview of licensing practices related to the way that contractual clauses can be used to alter behavioural opportunisms and lower moral hazard in licensing deals.

The thesis provides also an empirical contribution in the field of the strategic management of patents, because it triangulates qualitative and quantitative evidence on the practices and mechanisms through which firms organize their patenting and licensing activities. Thanks to this comprehensive empirical approach, the research integrates rich and fine-grained evidence from case studies with a systematic test of secondary data obtained from large dataset.

The findings of this dissertation also have managerial implications. With reference to the activities necessary to register and maintain patent protection, this dissertation offers managers a reference framework to consider how different combinations of vertical and horizontal mechanisms permit to achieve fast patent grant achievement and so appropriate value from innovation. The findings call attention to the fact that it is does not exist a unique solution to generate value from patent-related activities, but firms need to consider carefully the complex bundle of structure and patent-related practices. Another important managerial insight refers to the organization of technology licensing process. Managers can develop either inside-out or outside-in licensing negotiating capabilities, depending on the organizational design of the licensing function and the combination of internal information flow and coordinating mechanisms. A final insight for manager derives from the third paper of the dissertation. In technology licensing, the licensee and licensor might consider the introduction of contractual clauses such as the indemnification clauses against patent infringement to avoid behavioural risk and lower moral hazard. Furthermore, managers can consider the introduction of contractual mechanisms to signal the quality of the licensed technology and the degree of commitment of the counterparty.

This dissertation opens the doors to several new research opportunities. First, the dissertation focuses mostly on activities related to the domain of patent rights and licensing. Future research can instead focus on the organizational dimensions and capabilities related to patent enforcement. This research could complement the emerging studies on nonmarket strategies. For instance, future research can explore how firms organize ad-hoc patent-related capabilities to support patent litigation in different jurisdictions through teams that to coordinate their actions with patenting and licensing functions. This line of research is relevant to understand the importance of the members involved in patent-related activities, their background and their activities in isolation or in teams. Another interesting research area would be understanding the relationship between a certain patent strategy –i.e. proprietary, defensive and leveraging strategy- the complexity of the organization of IP department –e.g. centralized and decentralized units, different functions, multiple geographical locations- and firms' performance. This research stream would give us a better understanding on patent strategies and patenting behaviour of firms. Future research can also expand our knowledge on the cognitive frames of members involved in technology licensing negotiation, maybe trough lab experiments. In pursuing this research avenue, researchers can explore if there is a particular type of cognitive frame that leads to successful results in technology licensing. Finally, the dissertation opens future lines of inquiry on the contractual design of technology licensing. For example, future research can investigate the ex-post value of IP indemnification clauses and tests whether patents associated with an IP indemnification clause are less likely to be disputed in court. In other words, it would be interesting understanding if the inclusion of the IP indemnity clauses is a sufficient signal to forecast limited disruptions due to patent litigation. The urgency of this research is justified by the increasing costs that firms need to face for patents infringement. Finally, contract theory clearly illustrates that clauses do not operate in isolation but need to be understood as a bundle. Instead, literature on the optimal design of technology licensing considered so far the effect of single clauses –e.g. exclusivity, grant-back, IP indemnification clauses- to lessen behavioural risk. A promising line of inquiry is understanding how the bundle of clauses in technology licensing contracts operate to decrease moral hazard between the licensee and the licensor. I believe that these future research opportunities might further expand our understanding of patent strategies and the strategic management of patents.

Appendix

Appendix Chapter Two: Explanation of Simplifying Assumptions and Limited Diversity

In this section we document the theories and insights that guided us in the selection of simplifying assumptions in order to obtain the intermediate solutions in our QCA analysis. First, we have included centralization in the R&D structure as a sufficient condition for fast grant achievement, because previous research has shown that organizations with a centralized R&D functions tend to be more effective in appropriating value from innovation and patenting processes (Agrawal, 2006; Arora et al., 2014; Kogut & Zander, 1996; Puranam & Srikanth, 2007; Reitzig & Wagner, 2010), since co-location of members fosters sharing of knowledge and improves the coordination through vertical architectures. Second, we included cross-functionality as a sufficient condition for fast grant achievement, because sub-units have been shown to integrate knowledge and capabilities to appropriate value from innovation through cross-functional involvement (Leiponen & Helfat, 2011; D. J. Miller et al., 2007; Reitzig & Puranam, 2009; Zander & Kogut, 1995). Third, in the analysis of sufficient conditions for configurations leading to the low patent grant achievement, we included the presence of coordination by plan and cross-functionality as horizontal mechanism and the absence of centralization of R&D. This was based on the theory and empirical knowledge that coordination can be better achieved through mechanisms that allow the formation of a common ground better than formal plans. The positive effect of coordination through informal mechanisms instead of planning is particularly evident in case of distributed work and cross-functional teams (Srikanth & Puranam, 2011). However, communication through plan instead of feedback might prevent the synergic development of a common cognitive and creative ground to process inventive activities (A. Agrawal, 2006; Argyres & Silverman, 2004; Kogut & Zander, 1996). Thus, a high degree of planning as coordination mechanism might be detrimental in case of cross-functionality among units, as those latter might be constrained in the way they transfer knowledge, discouraging on-going communication and creating interdependencies based on standardized and formal practices. Finally, in the case of IP patenting when the organization lacks vertical architectures to coordinate the process, the overall outcome might be below the expectations (Reitzig & Wagner, 2010).

Appendix Chapter Three: Additional supportive evidence

Aggregate dimensions	Second order theme	Selected quotes
Management of information flow and knowledge	Internalized information flow (cases with a nested licensing unit)	“It is quite closely connected with the patent organization: licensing people need to have information on what they are licensing. They need information when they negotiate and they are at the meetings with other companies, they also need information on patents and technology that they are licensing. (Company 4); "It can come from everywhere in the company but by and large I would say it occurs within our centralized teams in intellectual property law and license dep. " (Company 5)
	Externalized information flow (cases without a nested licensing unit)	"During the meetings when we check the patent portfolio we check especially with the scientists and with the labs what are the patents , the list of patents that are used to protect the products that are on the market or will be on the market. (Company 7)" "Looking for the licensor...it is, when we know (from) the engineers, who present during these gates process the corporate functions with the...detailed plan for what they want to introduce with the product and we make a freedom to operate analysis and during this freedom to operate analysis we may come across to patents that might be relevant and in that context" (Company 10)
Support through a parallel structure	Support through internal parallel structure (cases with a nested licensing unit)	“We have technical resources supporting the negotiation team as required” (Company 8) Well for the patent discussion we need the patent guy who can explain easily in understandable terms something which is by essence quite complicated, because the patent is by definition quite complicated because technology is complicated, so you need someone who could explain you know in understandable term that's on the patent side" (Company 13)

Aggregate dimensions	Second order theme	Selected quotes
Support through a parallel structure	Support through internal parallel structure (cases without a nested licensing unit)	“When we have a license agreement it is recorded by the legal department and we deal with the agreement; for the accounting part we have the secretary of our R&D head who is collecting the income money." (Company 15) "We often work across. For the R&D is mostly a matter of how we structure the ownership. They do not care on how we structure the license. They are interested in the portfolio. They have a very good understating of the competitors of the portfolio through normal publications reports and they have a very, very key role in looking at the portfolio." (Company 14)
Coordinating mechanisms	Stand-alone coordinating mechanisms (cases with a nested licensing unit)	“We have in-house licensing teams, so we know our licensing contracts and questions on our licensing contracts are direct we internally advice our businesses when they have questions concerning licensees and otherwise we focus on making deals. (Company 8) "We have a global licensing group who look at global opportunities, then particular regional group that look for licensing opportunities within their region and then particular organization that look for licensing of particular technology if we have a subject matter expertise they look for licensing within that subject matter expertise." (Company 12)
	Shared coordinating mechanisms (cases without a nested licensing unit)	“They have an internal database and they control who is in charge for that project and they send him or her an email for asking him what he think about the licensing and monetize and sell. And we can ask him if he can provide to the licensee some data, if there are any data available and let him know what the offer is. Then they ask to this person to go back to his manager in a senior position and ask for his advice in case he would take it or not. (Company 9) "It would be the legal head or our CEO." (Company 15)"

Aggregate dimensions	Second order theme	Selected quotes
Hierarchical Enforcement	Ex-ante hierarchical enforcement (cases with a nested licensing unit)	“We are a unit, the patent licensing is independent, so I mean we make the decision to launch or not the licensing program (Company 13) "But with the exception of those senior managers, who are familiar with the overall scope of activity, we have relatively limited knowledge by individual patent attorneys on the full scope of global licensing deals and certainly not sufficient detailed knowledge to be able to know if there is a conflict or not." (Company 12)
	On-going hierarchical enforcement (cases without a nested licensing unit)	“It is...head of the licensing and the business development department, the head of the research centre, which is involved, or the head of the department that might be involved in the operations. It is mainly top level, so the heads of the departments that are involved in the operations and -I would say- the prospective marketing people also, because we need to discuss about the potential market and sometime it could be a new market too, we need to get all the opinions." (Company 7) "We consult with the R&D and we consult with the business leaders. We want to understand what input the grant of the license would have on development plan, would have on competitors and also we want to get a sense of whether there would be enthusiasm on the license from an R&D perspective...we need to have discussions, we need to understand what are the concerns, how important they are, why they are interested in blocking a license. It depends on the credibility of the resistance, and what are the benefits of the license" (Company 14)

Aggregate dimensions	Second order theme	Selected quotes
Inside-out Negotiating Capabilities	To convince other companies because of higher business, technical and legal understanding (cases with a nested licensing unit)	"We have this unit called 'Licensing', they are about 10 people. First of all, they have geographical and not technology responsibility. Concerning the backgrounds, they are strong negotiators. Some of them have also patent technical background but some have more business background. Overall, all of them are strong in negotiation." (Company 4) "The out-licensing activities have been normally associated with products better being taken commercial, and therefore they are essentially complete in their R&D activity. Going up to regulatory approval, therefore the patent attorneys who have assisted these kind of licensing activities have been those who have relative high degree of understanding of fundamental commercial business activity and have competence in contract law and contract drafting, and so that's the kind of basic legal and technical competences that are...demonstrated...contained in the patent attorneys who help in out-licensing activity. So, those are normally senior people. " (Company 12)
Outside-in Negotiating Capabilities	To facilitate and support the internal discussion (cases without a nested licensing unit)	He is a direct boss of the Head of IP and from his presentation you know there is was the decision that the legal department has the lead for all the IP topic in Company 2 and he prepares every…if there is any direct decision from him he is preparing slides to pass to the decision board set and IP Steering IP Committee Meeting (Company 2)

Aggregate dimensions	Second order theme	Selected quotes
	To identify other companies (cases without a nested licensing unit)	“What I was talking about is licensing to engine builders and in this case these companies have long term relations. If you look at our licensees, the relationship exists since 50 years or more and therefore we expect there is a market" (Company 1) "I am in charge of the licensing activities and partnerships, it means that our top-up priority is to identify technology outside." (Company 7) "Part of our strategy is composed by a series of columns...which contain various activity, one of the columns is 'relations management' and relation management is part of my job: I know my competitors, I know the people responsible for IP in these companies and I have numerous meeting with them on annual basis and during these meetings we can discuss outstanding potential conflicts that could be handled through licensing" (Company 10)

Appendix Chapter Four: baseline payment scheme royalties

Table 4.5.1 multinomial logit (baseline payment scheme royalties)

	Model 10		Model 11		Model 12	
	royalty		royalty		royalty	
	lump sum	two-part	lump sum	two-part	lump sum	two-part
count_inter	-0.0260	-0.0041+	-0.0199	-0.0041+	-0.0204	-0.0041
	(0.0241)	(0.0022)	(0.0232)	(0.0024)	(0.0192)	(0.0027)
early_tech	5.1426**	1.1954	5.2872**	1.0685	4.8536**	0.7464
	(1.9581)	(1.6739)	(1.8311)	(1.6613)	(1.4422)	(1.1860)
other_obb	0.5483	1.1352+	0.1037	1.1190+	0.3495	1.0021*
	(0.8945)	(0.5794)	(1.0995)	(0.6430)	(0.7716)	(0.4258)
sor_emp	0.0025	-0.0020	-0.0004	-0.0062	-0.0000	-0.0066
	(0.0198)	(0.0167)	(0.0216)	(0.0195)	(0.0141)	(0.0130)
sor_herf	2.9702	-3.2503	4.3196	-2.7724	5.8077	0.0756
	(6.7354)	(6.2675)	(7.4647)	(6.9458)	(5.0908)	(4.6982)
sor_generality	-3.2415	-2.5334	-2.9812	-1.9188	-2.8676	-2.0881
	(7.8594)	(7.8042)	(8.2604)	(8.2580)	(6.1697)	(6.2899)
ins_sor	-3.5980*	-0.0651	-4.1572+	-0.1100	-2.9543+	0.4934
	(1.7077)	(1.2952)	(2.4807)	(1.4134)	(1.7056)	(1.2745)
see_herf	-10.7842	-3.7111	-10.6741	-4.0074	-8.7866	-1.5841
	(7.9660)	(6.8838)	(8.7804)	(7.8434)	(5.9385)	(4.9981)
see_generality	1.2283	-4.8354	0.8692	-5.2782	1.2072	-4.8843
	(6.0567)	(4.7731)	(6.4267)	(5.6509)	(5.6933)	(4.5856)
ip_only	1.2237	14.4687**				
	(2.7509)	(2.0850)				
prod_only			1.7587	0.1238		
			(2.1164)	(0.8735)		
indm_bundle					1.2822	2.3759+
					(1.5739)	(1.3330)
_cons	5.3986	10.3263	4.4784	10.2896	1.5771	5.9297
	(10.7493)	(10.1547)	(11.9170)	(11.4369)	(9.3262)	(8.9921)
N	226	226	226	226	226	226
ll	-72.8331	-72.8331	-72.6709	-72.6709	-69.3322	-69.3322

Notes: standard errors in parentheses; + p<0.10, *p<0.05, ** p<0.01

Table 4.5.2 multinomial logit and technological distance as moderator (baseline payment scheme royalties)

	Model 13		Model 14		Model 15		Model 16		Model 16		Model 17	
	royalty		royalty		royalty		royalty		royalty		royalty	
	lump sum	two-part	lump sum	two-part	lump sum	two-part	lump sum	two-part	lump sum	two-part	lump sum	two-part
count_inter	-0.0268	-0.0040	-0.0205	-0.0037	-0.0215	-0.0039	-0.0260	-0.0041+	-0.0239	-0.0038+	-0.0208	-0.0043
	(0.0245)	(0.0027)	(0.0249)	(0.0027)	(0.0201)	(0.0032)	(0.0241)	(0.0022)	(0.0229)	(0.0021)	(0.0186)	(0.0027)
early_tech	5.2654**	1.1665	5.2934**	1.0326	4.9361**	0.7402	5.1424**	1.1954	5.2009**	1.0739	5.1150**	1.0499
	(1.8650)	(1.5778)	(1.7740)	(1.6017)	(1.4563)	(1.2416)	(1.9581)	(1.6739)	(1.8072)	(1.5719)	(1.5702)	(1.2740)
other_obb	0.5328	1.1345*	0.1047	1.1271+	0.3279	1.0015*	0.5484	1.1352+	0.4874	1.1211*	0.3351	0.9103+
	(0.9232)	(0.5716)	(1.1372)	(0.6059)	(0.7833)	(0.4188)	(0.8945)	(0.5794)	(0.8595)	(0.5206)	(0.8379)	(0.5404)
sor_emp	0.0030	-0.0017	0.0013	-0.0040	0.0011	-0.0051	0.0025	-0.0020	-0.0007	-0.0069	-0.0016	-0.0090
	(0.0220)	(0.0201)	(0.0246)	(0.0235)	(0.0157)	(0.0147)	(0.0198)	(0.0167)	(0.0200)	(0.0177)	(0.0144)	(0.0130)
sor_herf	2.1505	-3.2541	3.9608	-2.8715	4.9437	-0.0066	2.9703	-3.2502	3.4384	-2.5708	5.6141	-0.0332
	(6.5738)	(6.2572)	(7.5903)	(6.6572)	(4.6545)	(4.4887)	(6.7353)	(6.2675)	(6.2819)	(5.8139)	(4.9363)	(4.3939)
sor_generality	-3.1932	-2.3956	-2.6007	-1.5566	-2.6607	-1.9529	-3.2421	-2.5334	-2.8273	-1.9055	-2.8590	-2.2613
	(8.0770)	(8.0673)	(7.7156)	(7.6379)	(5.7942)	(5.9780)	(7.8595)	(7.8041)	(6.9611)	(6.9179)	(6.7438)	(6.7445)
ins_sor	-3.4119	-0.0890	-4.3110	-0.3521	-2.9471	0.3033	-3.5979*	-0.0651	-3.5048*	0.0762	-3.1541	0.4721
	(2.4461)	(1.8783)	(3.3527)	(1.9057)	(2.2808)	(1.7819)	(1.7076)	(1.2952)	(1.7442)	(1.2867)	(1.9336)	(1.4617)
see_herf	-10.9001	-3.6867	-10.7794	-4.0026	-8.9735	-1.5871	-10.7833	-3.7111	-10.9568	-3.9834	-9.3853	-2.2048
	(7.9253)	(6.8654)	(8.7181)	(7.7751)	(5.9902)	(4.9137)	(7.9656)	(6.8838)	(7.9566)	(6.9537)	(6.9968)	(6.0221)
see_generality	1.4041	-4.8429	0.9817	-5.2991	1.3923	-4.9060	1.2279	-4.8354	0.8594	-5.3599	1.2153	-4.7395
	(6.1481)	(4.6494)	(6.7082)	(5.6542)	(5.8366)	(4.5034)	(6.0563)	(4.7731)	(6.4313)	(5.3922)	(5.7503)	(4.7842)
tech_dist	0.8564	-0.1773	-0.4312	-0.8560	0.4764	-0.5932						
	(4.1327)	(3.6927)	(4.0156)	(3.1606)	(3.4100)	(2.9514)						
ip_only	1.6306	14.3938**										
	(2.6810)	(1.6607)										
prod_only			1.7590	0.1864								
			(2.4467)	(0.8216)								
indm_bundle					1.3143	2.3745+						
					(1.6350)	(1.3276)						
1.ip_only#c.tech_dist							2.9129	30.3153**				
							(6.1792)	(4.6768)				
1.prod_only#c.tech_dist									-0.2285	-0.6800		
									(2.0260)	(1.2349)		
1.indm_bundle#c.tech_dist											1.4302	2.5496
											(2.8803)	(2.1698)
_cons	5.1936	10.3316	4.7033	10.6266	1.6330	6.2812	5.3986	10.3262	5.2092	10.2638	2.1836	6.7668
	(10.4860)	(9.7762)	(11.5648)	(10.9200)	(9.0860)	(8.4858)	(10.7491)	(10.1548)	(11.0388)	(10.5822)	(10.6526)	(10.3001)
N	226		226		226		226		226		226	
ll	-72.7117		-72.5462		-69.1361		-72.8331		-73.2956		-71.3310	

Notes: standard errors in parentheses; + p<0.10, *p<0.05, ** p<0.0

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