

Moreira, Solon

Doctoral Thesis

Four Essays on Technology Licensing and Firm Innovation

PhD Series, No. 1.2014

Provided in Cooperation with:

Copenhagen Business School (CBS)

Suggested Citation: Moreira, Solon (2014) : Four Essays on Technology Licensing and Firm Innovation, PhD Series, No. 1.2014, ISBN 9788793155039, Copenhagen Business School (CBS), Frederiksberg, <https://hdl.handle.net/10398/8868>

This Version is available at:

<https://hdl.handle.net/10419/208879>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by-nc-nd/3.0/>

COPENHAGEN BUSINESS SCHOOL
HANDELSHØJSKOLEN
SOLBJERG PLADS 3
DK-2000 FREDERIKSBERG
DANMARK

www.cbs.dk

ISSN 0906-6934

Print ISBN: 978-87-93155-02-2

Online ISBN: 978-87-93155-03-9



**Copenhagen
Business School**
HANDELSHØJSKOLEN

Four Essays on Technology Licensing and Firm Innovation

Four Essays on Technology Licensing and Firm Innovation

Solon Moreira

PhD Series 01.2014

The PhD School of Economics and Management

PhD Series 01.2014

Four Essays on Technology Licensing and Firm Innovation

Solon Moreira

PhD School in Economics and Management
Copenhagen Business School

Solon Moreira
Four Essays on Technology Licensing and Firm Innovation

1st edition 2014
PhD Series 01.2014

© The Author

ISSN 0906-6934

Print ISBN: 978-87-93155-02-2

Online ISBN: 978-87-93155-03-9

“The Doctoral School of Economics and Management is an active national and international research environment at CBS for research degree students who deal with economics and management at business, industry and country level in a theoretical and empirical manner”.

All rights reserved.

No parts of this book may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or by any information storage or retrieval system, without permission in writing from the publisher.

Acknowledgements

The completion of this dissertation has been a long and personal journey. The life as a graduate student, as well as all the other steps that have to be taken to obtain the PhD, sometimes may sound like a miserable process: endless hours reading papers and running models in front of the computer; come up with original research topics and find the best way to translate them into interesting papers; spend several weeks, or months, in finding the most appropriate way to operationalize a theoretical construct. However, my experience as a PhD student has been anything but miserable. Those years that I have spent at Copenhagen Business School have been some of the most challenging and rewarding of my life. I have no doubt that the days I spent at CBS will always be important for me not only as a researcher but also as a person in general. The people that I thank here are a few of the many who made this dissertation possible, and who made my time as a PhD student an enjoyable and enriching experience.

To begin, I am deeply grateful to my two supervisors Keld Laursen and Toke Reichstein. I doubt that any other combination of supervisors could have been more fruitful than the one I had. In the first place I am thankful to them for believing in me and devoting their time and efforts in training me. I am also very thankful for their guidance and demand for rigor with my research.

I would like also to thank Mark Lorenzen for the guidance and supervision, especially on the beginning of my PhD. I am sure that I will never find the words to express all my gratitude for the support that I received from Mark.

Another important person during the PhD was Thomas Rønde. I am very thankful for his insightful comments on early versions of the papers in this dissertation and also for accepting to be the Chair of my Committee. Along this line, I also want to thank Bo Nielsen for

accepting to be part of the pre-defense committee, all his comments were very useful to improve the papers in this dissertation.

I would like also to thank Atul Nerkar and Marco Giarratana for accepting to be part of my PhD committee. Their comments and suggestions on how to improve the essays in this dissertation were very opportune and valuable.

I also want to thank the other PhD students in my cohort: Arjan, Gouya, Maggie, Maria, Milan and Virgilio. We went through so many things together that is hard to imagine how the PhD would have been without those guys.

I would also like to thank my dear friends Jasim, Raphael and Stefano. Leaving Cambridge was not an easy decision for me and Lorena, but our friendship has been a great way to remain in touch with that wonderful time in our lives.

Once someone told me that it is not easy to find true friends after a certain age. After having met both Marlon and Esron I can certainly say it is not true. I am very thankful to you two for always being supportive and encouraging at the moments I thought I could not make it. Please never ask me to be your “supervisor”, I like you guys too much to do that.

Looking a little further back in time, other very important person during my academic journey has been Professor Mario Amin. He deserves special mention for his contributions during a time when I was first learning many of the issues examined here.

I am also thankful to my father for being always supportive and enthusiastic on each of the steps towards the conclusion of this PhD. Thank you dad for understanding my absence over those 4 years, we will recover this time together.

And finally, I would like to thank to my wife. I cannot express my love and gratitude for all the support that she has been giving me over those 15 years together, without her I would never make it. I dedicate this PhD to you Lorena.

English Summary

Licensing contracts represent one of the most widely used mechanisms to exchange technologies and transfer know-how between firms. Due to the opportunities that licensing creates for firms operating on both sides of the markets for technology, it has increasingly become an integral part of firms' R&D strategies. On the supply side, the existing literature has been focused on understanding how technology licensing can be used by firms as a mechanism to recover investments in innovative activities and to foster learning opportunities. On the demand side, it has been shown that licensing is an important source that firms can tap into to feed their internal needs for innovative knowledge. While several studies have examined technology licensing through the lens of the licensor, research on how firms rely on licensing contracts to acquire knowledge and improve their innovation performance still leaves much to be investigated. Furthermore, with few exceptions, neither organizational nor contractual characteristics related to the licensing deals have received enough attention as determinants of the capacity of the acquiring firm to benefit from licensing in a new technology.

The purpose of this dissertation is to investigate the relationship between technology licensing and firm innovation, also examining how the characteristics of the acquiring firm and the use of specific contractual clauses affect this main relationship. The papers in this dissertation build on a different set of theoretical perspectives connected to the licensing literature. The dissertation consists of a general introduction, four papers, and a conclusion. Although all the papers build on the same main dataset related to licensing contracts in the global pharmaceutical industry, supplementary information from different data sources was connected to the licensing contracts to answer the specific research questions. Indeed, each paper, from a different perspective, contemplates and contributes to the existing literature by

examining the relationship between technology licensing and specific dimensions of firm innovation. Understanding how licensing deals affect the performance of licensees and licensors is critical to understanding how markets for technology function.

Danish Summary

Licenskontrakter repræsenterer en af de mest udbredte mekanismer til udveksling af teknologier og overførsel af knowhow mellem virksomheder. På grund af de muligheder, som licensudstedelsen skaber for virksomheder, der opererer på begge sider af markederne for teknologi, er licensudstedelsen i stigende grad blevet en integreret del af virksomhedernes F&U-strategier. På udbudssiden har den eksisterende litteratur været fokuseret på at forstå, hvordan teknologien licensudstedelse kan bruges af virksomheder som en mekanisme til at inddrive investeringer i innovative aktiviteter og fremme læringsmuligheder. På efterspørgselsiden er det blevet påvist, at licensudstedelse er en vigtig kilde, som virksomhederne kan bruge til at brødføde deres interne behov for innovativ viden. Mens flere studier har undersøgt teknologilicensudstedelse fra licensgiverens perspektiv, er der behov for mere forskning, der undersøger, hvordan virksomhederne er afhængige af licensaftaler for at tilegne sig viden og forbedre deres innovationsresultater. Derudover har der med få undtagelser været nok opmærksomhed på de organisatoriske eller kontraktmæssige egenskaber i relation til de licensaftaler, som determinanter for kapaciteten af den overtagende virksomhed.

Formålet med denne afhandling er at undersøge forholdet mellem teknologilicenser og virksomhedsinnovation. Dette bliver gjort ved at undersøge de særlige kendetegn ved den overtagende virksomhed og anvendelse af særlige kontraktbestemmelser, som påvirker dette forhold. Essayene i denne afhandling bygger på et andet sæt af teoretiske perspektiver forbundet med licenslitteraturen. Afhandlingen består af en generel introduktion, fire essays og en konklusion. Alle essayene bygger på det samme datasæt, der omhandler licensaftaler i den globale farmaceutiske industri, men supplerende oplysninger fra forskellige

datakilder blev tilsluttet licensaftaler til at besvare de konkrete forskningsspørgsmål, foreslået i hvert essay.

Hvert essay overvejer og bidrager til den eksisterende litteratur ved at undersøge forholdet mellem teknologilicenser og særlige dimensioner af virksomhedsinnovation. Ved at forstå hvordan licensaftaler påvirker performance af licenshavere og licensgivere er afgørende for at forstå, hvordan markederne for teknologier fungerer. Derfor udforsker denne afhandling ikke kun forholdet mellem licenser og virksomhedsinnovation, men også forskellige uforudsete relationer til kontrakten, teknologierne og de organisatoriske karakteristika.

Contents

INTRODUCTION	12
1.1 Papers on Technology Licensing and Firm Innovation	17
1.1.1 Essay 1: All for one and one for all: How intrafirm inventor networks affect the speed of external knowledge recombination.....	18
1.1.2 Essay 2: A Longitudinal Study of the Influence of Technology Licensing on Firm Innovation: The Moderating effect of Slack and Organizational Myopia	19
1.1.3 Essay 3: Exploring the boomerang effect: The role of core technologies and uncertainty in explaining the use of the grant-back clause in technology licensing.....	20
1.1.4 Essay 4: Understanding the Rent Dissipation Effect in Technology Licensing Contracts.....	21
1.2 Contributions and Implications	22
1.3 References	23
ALL FOR ONE AND ONE FOR ALL: HOW INTRAFIRM INVENTOR NETWORKS AFFECT THE SPEED OF EXTERNAL KNOWLEDGE RECOMBINATION	25
2.1 Introduction	26
2.2 Theory and Hypotheses	30
2.3 Data and Methods.....	38
2.3.1 The Dependent Variable.....	40
2.3.2 Explanatory variables	41
2.3.3 Control Variables.....	44
2.4 Model Specification and Estimation.....	46
2.5 Descriptive Statistics and Correlations.....	48
2.6 Results	50
2.7 Alternative Explanations and Robustness Checks.....	52
2.8 Discussion and Conclusion.....	54
2.9 References	60
2.10 Appendix	68
A LONGITUDINAL STUDY OF THE INFLUENCE OF TECHNOLOGY LICENSING ON FIRM INNOVATION: THE MODERATING EFFECT OF RECOVERABLE SLACK AND ORGANIZATIONAL MYOPIA.....	74
3. 1 Introduction	75
3.2 Theoretical Background	78
3.3 Theory and Hypothesis.....	81
3.3.1 Technology Licensing and Firm Innovation.....	81
3.3.2 Recoverable Slack and Knowledge Integration.....	83

3.3.3 Organizational Myopia and Licensing.....	86
3.4 Empirical Design, Data, and Sample.....	88
3.5 Measures.....	91
3.6 Statistical Method.....	96
3.7 Results.....	98
3.8 Robustness Checks.....	102
3.9 Discussion and conclusions.....	105
3.10 References.....	109
3.11 Figures.....	117
EXPLORING THE BOOMERANG EFFECT: THE ROLE OF CORE TECHNOLOGIES AND UNCERTAINTY IN EXPLAINING THE USE OF THE GRANT-BACK CLAUSE IN TECHNOLOGY LICENSING.....	123
4.1 Introduction.....	124
4.2 Theoretical Background.....	128
4.3 Hypotheses.....	130
4.3.1 Licensors' core technologies.....	130
4.3.2 Licensees' core technologies.....	131
4.3.3 Licensors and uncertain technology.....	133
4.3.4 Licensors' core and uncertain technologies.....	134
4.3.5 Licensees, and core and uncertain technologies.....	135
4.4 Data and Method.....	137
4.4.1 Data.....	137
4.4.2 Dependent variable.....	138
4.4.3 Independent variables.....	139
4.4.4 Control variables.....	140
4.5 Econometric analysis and model choice.....	146
4.6 Results.....	148
4.7 Sensitivity analysis.....	151
4.8 Conclusion and Discussion.....	152
4.9 References.....	156
4.10 Figures and Tables.....	161
UNDERSTANDING THE RENT DISSIPATION EFFECT IN TECHNOLOGY LICENSING CONTRACTS.....	166
5.1 Introduction.....	167
5.2 Theory and Hypotheses.....	171

5.2.1 Licensing	171
5.2.2 Licensing out core technologies	174
5.2.3 Licensing out core technologies and licensee size.....	177
5.2.4 Technological overlap between partners	178
5.3 Data, Variables & Methodology.....	181
5.3.1 Sample selection and data.....	181
5.3.2 Method.....	184
5.3.3 Measures.....	186
5.3.4 Focal independent variables	187
5.5 Results	192
5.5.1 Descriptive statistics	192
5.6 Supplementary Analysis	194
5.7 Discussion and Conclusions	196
5.8 References	199
5.9 Appendix	204
CONCLUSION	210

CHAPTER 1

INTRODUCTION

The relationship between innovation and firm performance is well established among strategy scholars. Previous studies have shown that innovative firms are significantly more likely to outperform non-innovative firms in terms of profitability (Geroski & Machin, 1992), market value (Blundell, Griffith, & Reenen, 1999), and likelihood of survival (Cefis & Marsili, 2005). Accordingly, one of the central determinants of a firm's capacity to innovate regards the organization of internal research and development (R&D) activities (Pisano, 1990). Undoubtedly, through investment in internal R&D, firms are able to create and refine the in-house capabilities necessary to develop new products and services (Cohen & Levinthal, 1990). However, even though internal R&D has traditionally been pointed to as a major source of knowledge and technical know-how, it is not the only possible source (Chesbrough, 2003). Actually, even large innovative firms cannot rely entirely on internal sourcing to access relevant knowledge; they also need to go beyond their boundaries to feed their inventive activities (Cassiman & Veugelers, 2006). Consequently, a central part of the innovation process regards the search and acquisition of new knowledge residing in different sources (Laursen & Salter, 2006).

The fact that firms simultaneously pursue both internal and external knowledge acquisition suggests that those activities are complementary and tightly coupled (Cassiman & Veugelers, 2006). While internal R&D is necessary for firms to assimilate, recombine, and apply new knowledge (Zahra & George, 2002), the access to external sources is important to

bring heterogeneity and avoid local search bias (Rosenkopf & Nerkar, 2001; Stuart & Podolny, 1996). As a consequence, in addition to internal R&D, innovative firms invest considerable amounts of resources to access external knowledge (Laursen & Salter, 2006). Accordingly, a large number of studies have focused on different mechanisms such as licensing contracts (Atuahene-Gima, 1993; Leone & Reichstein, 2012), strategic alliances (Mowery, Oxley, & Silverman, 1996; Sampson, 2007), and the hiring of skilled employees (Singh & Agrawal, 2011; Tzabbar, Aharonson, & Amburgey, 2013) to understand the relationship between external knowledge acquisition and different dimensions of firm innovation.

The four papers in this dissertation focus specifically on technology licensing contracts as a mechanism for external knowledge acquisition. In doing so, they add mainly to the innovation literature by focusing on specific dimensions of technology licensing that have not been fully considered by the existing research. Comparatively to other formal means that firms can use to acquire external knowledge, previous studies have paid much less attention to technology licensing. Considered *vis-à-vis* different mechanisms for knowledge acquisition, licensing contracts can be defined as an arm's length contractual deal through which firms can trade know-how and intellectual property (IP) rights (Arora, 1995; Arora & Gambardella, 2010). Compared with other R&D partnerships such as joint ventures and other forms of strategic alliances, technology licensing is significantly more similar to market transactions (Fosfuri, 2006). Indeed, although firms may enter into licensing agreements to develop technologies with external partners, licensing deals are mostly represented by the trade of existing technologies (Ceccagnoli & Jiang, 2013; Grindley & Teece, 1997).

In terms of economic relevance, it is well known that licensing is one of the most important and fast-growing mechanisms for technology transfer between firms (Anand & Khanna, 2000). Indeed, the total value of technology exchange within OECD nations increased

by 63% between 1996 and 2006 (OECD, 2009). Furthermore, a 2003 OECD survey covering firms located in Europe, North America, and Asia-Pacific revealed that almost 60% of the firms in the sample reported a significant increase in licensing activities during the 1990s (Arora & Gambardella, 2010). This consistent expansion in licensing activities has major implications for firms' corporate strategies (Arora, Fosfuri, & Gambardella, 2001), dissemination of new technologies (Arora and Fosfuri, 2003), and the way that the production and use of technologies are organized between firms (Ceccagnoli & Jiang, 2013).

Previous studies have examined several reasons that firms on both sides of markets for technology (technology suppliers and buyers) have to engage in technology licensing. On the supply side, it has been shown that through licensing contracts firms are able to generate significant income (Arora et al., 2001), benefit from learning opportunities (Leone & Reichstein, 2012) and maximize return on investment in R&D activities (Atuahene-Gima, 1993). In reality, explaining the reasons behind firms' decisions to trade their technologies has been the main focus of the extant licensing literature, with several papers approaching technology licensing under the lens of the licensor. Nevertheless, a small number of studies focusing on the demand side of markets for technology has provided consistent evidence that licensing can be used by the acquiring firm to speed the innovation process (Leone & Reichstein, 2012), gain strategic flexibility (Ceccagnoli & Jiang, 2013), and explore new technological areas (Laursen, Leone, & Torrisi, 2010). Although those studies have shed light on important dimensions of technology licensing, several questions concerning the way that firms manage their licensing activities and its implications for firm performance and strategy remain unaddressed. Looking at some of those questions, the essays that follow examine four main points related to technology licensing and firm innovation:

1) How do individual and group level characteristics within firms affect the ease of knowledge absorption and recombination of licensed-in technologies?

2) What is the effect of recoverable slack and organizational myopia on the firm's capacity to deal with licensed-in technologies?

3) How do the characteristics of licensed technologies (e.g., unfamiliarity, complexity and uncertainty) affect firm performance?

4) Under what circumstances will certain contractual clauses related to the evolution and application of the licensed technologies be used in licensing contracts?

While the connecting point of the four papers lies in technology licensing literature, the papers in this dissertation also use different theoretical perspectives to integrate technological licensing within different analytical frameworks. The first paper focuses on the licensee's point of view, and builds on the absorptive capacity and network analysis literatures to examine the effects of network structure and composition on firm capacity to deal with the challenges of unfamiliarity related to licensed-in technologies. The second paper, also focusing on the licensee's perspective, builds mainly on the organizational learning literature to propose that by engaging in technology, licensing-in firms can increase their capacity to produce innovations mainly due to learning effects resulting from the access to new knowledge. The third paper considers both the licensee and the licensor within the same analytical framework, building on the extended resource based view of the firm to predict firm behavior in terms of contractual preferences. Finally, the fourth paper follows the classic tradition in the licensing literature and builds on industrial economics studies to look at the competitive implications experienced by licensors commercializing core-technologies.

In order to approach the different research questions empirically, the four essays rely on the same main dataset: Recombinant Capital's Biotech Alliance (Recap). This database is one of the most accurate sources of information regarding partnerships and technology exchange in the pharmaceutical industry (Audretsch & Feldman, 2003; Schilling, 2009). More specifically, this database offers the possibility to access the original licensing contracts, from which it was possible to extract precise information regarding the characteristics of the licensed technologies, contractual specifications, and information related to the identification of licensees and licensors (e.g., firm name, address, and operating segment). Furthermore, the fact that the licensing deals are restricted to the Pharmaceutical industry allowed me to investigate in more detail the licensing dynamics specifically related to knowledge creation. There are at least three main reasons that make this context (pharmaceutical firms) particularly appropriate to test the hypotheses proposed in the four essays. First, the pharmaceutical industry is characterized as technology driven and R&D intensive, which makes technological knowledge a critical component to develop and sustain competitive advantages (Roberts, 1999). Second, R&D collaboration with other firms and universities represents an important driver of technology development (Arora & Gambardella, 1990). Third, firms in this industry routinely and systematically protect and document their inventions through patents (Hagedoorn & Cloodt, 2003).

In connection with the last point mentioned above, the strong reliance that pharmaceutical firms have on patents to protect innovation was particularly important for me to successfully integrate the Recap database with other databases related to firm patenting activity. The novel combination of existing databases was critical for me to aim at addressing questions that previous studies left open. For example, using patent data allowed me to reconstruct intrafirm inventor networks, which made it possible to connect technology licensing to different

analytical levels within firms. Indeed, the first paper of this dissertation is the first attempt that I am aware of at considering the effect of licensing on firm innovation in light of group level characteristics within the acquiring firm. Beyond patenting activity, additional data related to firm-level information was obtained from COMPUSTAT. This database was important to obtain consistent financial information about the firms listed in the licensing database. In total, the papers in this dissertation explored four different data sources.

1.1 Papers on Technology Licensing and Firm Innovation

Several specific characteristics found in technology licensing contracts make them a particularly useful mechanism for investigating the relationship between external knowledge acquisition and firm innovation. For example, an important and distinguishing characteristic of licensing contracts regards the contractual nature of the exchanged knowledge. While ex-ante contracts such as research alliances involve higher uncertainty about their potential outcomes, in ex-post contracts such as licensing, the traded technology can be more easily defined. Furthermore, most licensing contracts signed between firms involve technologies that have already been proven (Atuahene-Gima, 1993; Leone & Reichstein, 2012). These characteristics were important for the development of the papers in this dissertation, both empirically and conceptually. On the empirical side, the fact that licensing contracts usually trade well-defined and identifiable technologies was fundamental for me to compute most of the measures used to test the proposed hypotheses. On the conceptual side, this dissertation sheds light on important dimensions of knowledge acquisition such as the use of contractual instruments to shape knowledge flows between firms that would not be easily developed without the analytical framework that is provided by technology licensing contracts. Accordingly, the four papers summarized below

develop conceptual and empirical applications of different phenomenon of interest for innovation scholars within the scope of technology licensing.

1.1.1 Essay 1: All for one and one for all: How intrafirm inventor networks affect the speed of external knowledge recombination

The first paper of this dissertation examines a relatively unexplored dimension of knowledge acquisition regarding the speed with which firms are able to recombine external and internal knowledge in order to produce innovations. Despite the fact that innovation speed has been suggested to be critical for firms to establish first-mover advantages, achieve or sustain technological leadership and overtake rivals, very few empirical studies have aimed at understanding the speed dimension related to recombination of external knowledge (e.g., Leone & Reichstein, 2012; Tzabbar et al., 2013). This paper also offers a relevant contribution to the absorptive capacity research by focusing on the interaction patterns between individuals within firms as an appropriate unit of analysis to understand the process of knowledge recombination at the firm level. We find that the higher the unfamiliarity with the licensed technology, the longer it takes the acquiring firm to successfully recombine it with internal knowledge elements. However, the results also indicate that structural and compositional characteristics of the firms' intra inventor networks related to diversity and closure ameliorate the negative effects of unfamiliarity on recombination speed. This finding provides insight into how individual-level network formation affects a firm's ability to quickly recombine and integrate external knowledge. In particular, it theoretically and empirically substantiates the idea that intraorganizational inventor networks affect the speed dimension of a firms' absorptive capacity.

1.1.2 Essay 2: A Longitudinal Study of the Influence of Technology Licensing on Firm Innovation: The Moderating effect of Slack and Organizational Myopia

The second paper in this dissertation focuses on how licensing-in of technology affects firms' subsequent capacity to produce innovations. Although licensing has repeatedly been acknowledged to be a major vehicle for firms to acquire external knowledge (Ceccagnoli & Jiang, 2013), surprisingly little is known about how firms use licensing as part of their overall inventive efforts. Furthermore, with the exception of absorptive (Laursen et al., 2010) capacity, the organizational determinants that facilitate or constrain firms' ability to deal with licensed-in technologies have received little attention. This paper starts investigating in a longitudinal setting the effect of technology licensing on the number of patents produced by the licensee within the three years subsequent to the technology acquisition. I further develop the idea that licensing is a complementary part of firms' innovation efforts using organizational learning lenses. The findings indicate that technology licensing is positively related to the number of inventions produced by the licensee in the years subsequent to the licensing deal. Subsequently, I investigate the moderating effect that organizational slack and myopia have on this main relationship. The findings also suggest that high levels of *Organizational Slack* (available financial resources) strengthen the positive effect of licensing on innovation. However, higher levels of *Organizational Myopia* (the extent to which a firm draws on its own knowledge) can decrease the main effect of licensing. Those findings go in the same direction of previous studies that have suggested the relationship between knowledge acquisition and firm innovation cannot be taken for granted but should be considered in light of specific organizational characteristics.

1.2.3 Essay 3: Exploring the boomerang effect: The role of core technologies and uncertainty in explaining the use of the grant-back clause in technology licensing

The third paper concerns the use of the technology-flow back provision (grant-back clause) in technology licensing. This clause has been described in previous studies as a relevant contractual specification with significant implications for both licensor and licensee. Despite the potential mutual benefits for firms from entering into licensing deals, previous studies have also indicated that licensing might create undesirable competition due to the transfer of the firms' knowledge capabilities related to cutting-edge technologies (Choi, 2002). In this context, the grant-back clause can be used as an instrument to ensure that the licensee will grant back to the licensor the rights to any improvement in the licensed technology (Schmalbeck, 1974). In other words, the grant-back clause can have substantial influence on the nature and amount of knowledge that will be transferred between the firms after entering in a deal. Despite this evidence, to the best of my knowledge no previous empirical study has attempted to explain the conditions under which this clause is used. This paper looks into the contingencies related to the technological aspects of the licensing deal that make it more or less likely that the grant-back clause will be used in the contract. One of the main features of this paper regards the development and empirical testing of a theoretical approach that integrates the extended resource based view of the firm into contract theory. The findings suggest that the extent to which the licensing deal involves core technologies (to the licensee and the licensor) and the uncertainty related to its future trajectory are significant predictors for this use of this clause in licensing deals

1.1.4 Essay 4: Understanding the Rent Dissipation Effect in Technology Licensing Contracts

The fourth paper introduces and empirically tests a framework to understand the profit dissipation experienced by firms that license out their technologies. While the generation of revenues is an important incentive for firms to license out, granting other firms access to relevant technologies can also produce negative implications for the licensor's competitiveness (Choi, 2002). Along this line, rent dissipation is a phenomenon related to the increasing competition that licensors with downstream assets in the product market might experience in the periods subsequent to the licensing deal (Fosfuri, 2006). The fact that the licensee can use the acquired technology to improve its own internal capabilities and become an aggressive competitor has been repeatedly suggested in conceptual papers dealing with this issue. Accordingly, the importance of this phenomenon lies of the fact that in several sectors the market for inventions might remain underdeveloped, given the licensor's concerns about undermining its competitive advantages. This paper aims at explaining the dissipation effect experienced by licensors using a perspective that incorporates three important dimensions of the markets for technology: 1) whether the licensors possess downstream assets, 2) licensee size, and 3) technological overlap between the licensor and the licensee. The results lend empirical support to the idea that licensing out core technologies is negatively related to subsequent changes in the licensor's market share. I also find that as the licensee size increases the dissipation effect is strengthened. However, if the licensee and the licensor operate in different technological areas (i.e., they are technologically fragmented) the negative effect caused by licensing core technologies becomes weaker. Those findings add to the current literature by discussing the importance of also taking into account the licensee's characteristics as a way to understand more comprehensively the dissipation effect.

1.2 Contributions and Implications

This dissertation as a whole contributes to the innovation and licensing literatures in different respects. Generally speaking, it provides empirical and theoretical insights into how firms use technology licensing to feed their demands for external knowledge. This dissertation also provides an overview of licensing practices related to the way that contractual clauses can be used to shape the incentives that those involved have to enter into licensing deals. More than that, it also looks at the motives that firms on both sides of markets for technology have to buy and sell technologies through licensing contracts. In fact, by mainly focusing on the demand side of markets for technology, the papers in this dissertation join a growing body of literature suggesting that so far little is known about the determinants of firms' decisions to license in (e.g., Laursen et al., 2010; Leone and Reichstein, 2012; Ceccagnoli & Jiang, 2013). Accordingly, in all of the four papers in this dissertation the licensee perspective is incorporated into the conceptual and empirical analysis.

1.3 References

- Anand, B. N. & Khanna, T. 2000. Do firms learn to create value? The case of alliances. *Strategic Management Journal*, 21(3): 295-315.
- Arora, A. & Gambardella, A. 1990. Complementarity and External Linkages: The Strategies of the Large Firms in Biotechnology. *Journal of Industrial Economics*, 38(4): 361-379.
- Arora, A. 1995. Licensing tacit knowledge: intellectual property rights and the market for know-how. *Economics of Innovation and New Technology*, 4(1): 41-60.
- Arora, A., Fosfuri, A., & Gambardella, A. 2001. Markets for Technology and their Implications for Corporate Strategy. *Industrial & Corporate Change*, 10(2): 419-451.
- Arora, A. & Gambardella, A. 2010. Ideas for rent: an overview of markets for technology. *Industrial & Corporate Change*, 19(3): 775-803.
- Atuahene-Gima, K. 1993. Determinants of inward technology licensing intentions: An empirical analysis of Australian engineering firms. *Journal of Product Innovation Management*, 10(3): 230-240.
- Audretsch, D. & Feldman, M. 2003. Small-Firm Strategic Research Partnerships: The Case of Biotechnology. *Technology Analysis & Strategic Management*, 15(2): 273-288.
- Blundell, R., Griffith, R., & Reenen, J. V. 1999. Market Share, Market Value and Innovation in a Panel of British Manufacturing Firms. *The Review of Economic Studies*, 66(3): 529-554.
- Cassiman, B. & Veugelers, R. 2006. In Search of Complementarity in Innovation Strategy: Internal R&D and External Knowledge Acquisition. *Management Science*, 52(1): 68-82.
- Ceccagnoli, M. & Jiang, L. 2013. The cost of integrating external technologies: Supply and demand drivers of value creation in the markets for technology. *Strategic Management Journal*, 34(4): 404-425.
- Cefis, E. & Marsili, O. 2005. A matter of life and death: innovation and firm survival. *Industrial and Corporate Change*, 14(6): 1167-1192.
- Chesbrough, H. W. 2003. *Open innovation : the new imperative for creating and profiting from technology*. Boston, Mass.: Harvard Business School Press.
- Choi, J. P. 2002. A dynamic analysis of licensing: The "boomerang" effect and grant-back clauses. *International Economic Review*, 43(3): 803-829.
- Cohen, W. M. & Levinthal, D. A. 1990. Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly*, 35(1): 128-152.
- Fosfuri, A. 2006. The licensing dilemma: understanding the determinants of the rate of technology licensing. *Strategic Management Journal*, 27(12): 1141-1158.

- Geroski, P. & Machin, S. 1992. Do Innovating Firms Outperform Non-Innovators?. *Business Strategy Review*, 3(2): 79-90.
- Grindley, P. C. & Teece, D. J. 1997. Managing Intellectual Capital: Licensing and Cross-Licensing in Semiconductors and Electronics. *California Management Review*, 39(2): 8-41.
- Hagedoorn, J. & Cloudt, M. 2003. Measuring innovative performance: is there an advantage in using multiple indicators? *Research Policy*, 32(8): 1365-1379.
- Laursen, K. & Salter, A. 2006. Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal*, 27(2): 131-150.
- Laursen, K., Leone, M. I., & Torrisi, S. 2010. Technological exploration through licensing: new insights from the licensee's point of view. *Industrial and Corporate Change*, 19(3): 871-897.
- Leone, M. I. & Reichstein, T. 2012. Licensing-in fosters rapid invention! the effect of the grant-back clause and technological unfamiliarity. *Strategic Management Journal*, 33(8): 965-985.
- Mowery, D. C., Oxley, J. E., & Silverman, B. S. 1996. Strategic Alliances and Interfirm Knowledge Transfer. *Strategic Management Journal*, 17, 77-91.
- Pisano, G. P. 1990. The R&D Boundaries of the Firm: An Empirical Analysis. *Administrative Science Quarterly*, 35(1): 153-176.
- Roberts, P. W. 1999. Product innovation, product-market competition and persistent profitability in the U.S. *Strategic Management Journal*, 20(7): 655-670.
- Rosenkopf, L. & Nerkar, A. 2001. Beyond Local Search: Boundary-Spanning, Exploration, and Impact in the Optical Disk. *Strategic Management Journal*, 22(4): 287.
- Sampson, R. C. 2007. R&D Alliances and Firm Performance: The Impact of Technological Diversity and Alliance Organization on Innovation. *Academy of Management Journal*, 50(2): 364-386.
- Schilling, M. A. 2009. Understanding the alliance data. *Strategic Management Journal*, 30(3): 233-260.
- Schmalbeck, R. 1974. Validity of Grant-Back Clauses in Patent Licensing Agreements, The. *U. Chi. L. Rev.*, 42: 733.
- Singh, J. & Agrawal, A. 2011. Recruiting for Ideas: How Firms Exploit the Prior Inventions of New Hires. *Management Science*, 57(1): 129-150.
- Stuart, T. E. & Podolny, J. M. 1996. Local search and the evolution of technological capabilities. *Strategic Management Journal*, 17(S1): 21-38.
- Tzabbar, D., Aharonson, B. S., & Amburgey, T. L. 2013. When does tapping external sources of knowledge result in knowledge integration? *Research Policy*, 42(2): 481-494.
- Zahra, S. A. & George, G. 2002. Absorptive Capacity: A Review, Reconceptualization, and Extension. *Academy of Management Review*, 27(2): 185-203.

CHAPTER 2

ALL FOR ONE AND ONE FOR ALL: HOW INTRAFIRM INVENTOR NETWORKS AFFECT THE SPEED OF EXTERNAL KNOWLEDGE RECOMBINATION

SOLON MOREIRA

Department of Innovation and Organizational Economics
Copenhagen Business School
E-mail: sm.ino@cbs.dk

ARJAN MARKUS

Department of Innovation and Organizational Economics
Copenhagen Business School
E-mail: am.ino@cbs.dk

2.1 Introduction

Firms increasingly rely on recombination of internal and external knowledge to create inventions that can be subsequently commercialized into innovations (Hargadon & Sutton, 1997; Laursen & Salter, 2006). Particularly in high-tech and fast-paced industries, external partners play a critical part in a firm's R&D process as firms gain access to complementary assets (Dyer & Singh, 1998; Sampson, 2007). Acquisition of external knowledge is an attractive alternative to in-house R&D, because firms spread the risk and cost inherent to R&D and may shorten the development of inventions (Ahuja, 2000; Kessler & Chakrabathi, 1996). Yet, firms significantly differ in the ability to draw on and benefit from acquiring external knowledge (Cohen & Levinthal, 1990). Despite our growing understanding of firms' ability to harness external knowledge for own invention, the absorptive capacity literature has overlooked the intraorganizational antecedents of knowledge integration (cf. Volberda, Foss, & Lyles, 2010). As a consequence, little is known about the role of individuals and groups in the process through which firms integrate external knowledge.

In an attempt to address this gap some scholars have alluded to intrafirm informal networks among employees as determinant of firms' absorptive capacity (Mors, 2010; Paruchuri, 2009; Volberda et al., 2010). This claim resonates well with Cohen & Levinthal's (1990) idea that the interactions and links across individuals alter the way external knowledge is absorbed into the firm as interaction facilitates knowledge-sharing within the firm (Allen & Cohen, 1969; Tushman, 1977). In this respect, the literature on knowledge recombination has recently underlined the role of intrafirm networks among inventors as the locus of firms' recombinant capacity (Carnabuci & Operti, 2013; Guler & Nerkar, 2012; Nerkar & Paruchuri, 2005).

In this paper, we build on the prior literature on absorptive capacity to examine how intrafirm networks configurations among inventors influence a firms' ability to integrate external knowledge. We specifically focus on a dimension of absorptive capacity that has received relatively little attention; the speed of external knowledge integration. Yet, prior research has pointed to the fact that firms that are able to innovate in a fast pace achieve first-mover advantages and capture new market opportunities (Markman, Gianiodis, Phan, & Balkin, 2005). More in general, examining how quick firms can internalize external knowledge is important as it is a source of competitive advantage, especially in industries where time-based competition is paramount (Kessler & Chakrabathi, 1996; Leone & Reichstein, 2012; Tzabbar, Aharonson, & Amburgey, 2012; Zahra & George, 2002). Two recent studies are worth mentioning in this respect. First, a recent study by Leone & Reichstein (2012) shows that licensing-in accelerates firms' invention speed, yet this effect reduces when firms license-in unfamiliar technologies. In similar vein, a recent paper by Tzabbar et al. (2012) shows that the rate of knowledge integration depends on the type of external knowledge sourcing mechanism (i.e. scientist recruitment vs. R&D alliance) and the degree of familiarity with the knowledge that is transferred. We depart from these two specific studies and examine how the structure and composition of intrafirm inventor networks may accelerate or slow down the integration of distant or unfamiliar external knowledge. Our choice to focus on inventors is motivated by the fact that inventors carry out inventive search using their skills and knowledge, and subsequently propose and implement solutions to problems faced during the process of external knowledge integration (Fleming, 2001). In addition, we take a social network perspective, because inventors are unlikely to operate in isolation (Singh & Fleming, 2009), but instead rely on a web of colleague-inventors through which they search for advice, obtain referrals and acquire useful knowledge for problem-solving (Singh, Hansen, & Podolny, 2010; Tsai & Ghoshal, 1998). In

sum, we develop a theoretical framework that explains how specific configurations of intrafirm networks may speed-up the recombination of external knowledge into firms' own inventions.

Building on the literature on recombinant search, absorptive capacity literature and social network theory we develop a set of hypotheses that predict how intra-firm network characteristics influence recombination of external knowledge into firms' own invention. Based on the intuition that inventors encounter difficulties in integrating external knowledge components with which they have no prior experience, we predict that firms' recombination speed decreases with the degree of unfamiliarity. Yet, we subsequently posit that certain intrafirm network configurations attenuate problems related to time-costly recombination of distant external knowledge. We follow prior social network research on search-transfer issues by focusing on intrafirm network density, diversity and average tie strength (Hansen, 1999; Phelps, 2010; Reagans & McEvily, 2003). Considering the social network literature, those three measures have been recurrently pointed out as the main group-level compositional and structural characteristics that shape knowledge flow patterns among individuals. On the structural side, network density and tie strength are particular relevant characteristics as they determine the amount and the quality of the knowledge that will flow within the network (Granovetter, 1973; Reagans & McEvily, 2003). On the compositional side, network diversity refers to the qualitative aspects (e.g., heterogeneity of the resources) of the knowledge that the network members can access when relying on their peers (Phelps, 2010). We specifically address the fact that structural and compositional characteristics have distinct benefits to inventors who are part of the network and therefore disentangle them both theoretically and empirically.

We examine our predictions in the context of 113 US pharmaceutical firms in the period 1986-2003. The pharmaceutical industry is a suitable setting as firms in this industry regularly innovate and engage in external knowledge sourcing (Arora & Gambardella, 1990; Powell, Koput, & Smith-Doerr, 1996). The analysis draws on a unique and detailed dataset

which combines data on licensing agreements, inventors and patents. A total of 708 licensed technologies serve as instances of external knowledge acquisition. We follow prior studies with the idea that co-invention or collaboration between inventors represents non-directional communication and information exchange channels (Allen, 1977; Guler & Nerkar, 2012; Singh, 2005). The observed co-invention ties between inventors then serve as inputs to construct our intrafirm knowledge networks, where inventors are represented by nodes and ties indicate co-inventions with colleagues. In the analysis we utilize event history analysis to test our hypotheses and employ a difference-in-differences method to strengthen our choice of licensing as a knowledge acquisition mechanism.

Our findings provide overall support for all hypotheses, except our prediction regarding average tie strength. Even though acquisition of a distant technology requires a firm and its inventors to devote more time to recombine this technology with internal knowledge, we find support for our predictions that intrafirm network density and diversity both shorten the time of distant external knowledge recombination. We interpret these findings as evidence of how dense networks facilitate *access* to colleagues and willingness among inventors to *support* each other. Also, the presence of a set of heterogeneous contacts in an inventor's intra-organizational network facilitates the access to a *diverse set of heuristics* increasing the collective problem-solving ability of inventors within the firm.

The main contribution of this research lies in postulating the role of intra-organizational employees' informal networks in the process of external knowledge integration. Unlike prior empirical work on absorptive capacity, we disentangle internal informal networks, to advance our understanding about the effect of group-level antecedents on firm-level absorptive capacity (cf. Volberda et al., 2010). In addition, we examine a rather unexplored dimension of absorptive capacity, the speed with which firms are able to integrate external knowledge components. Time-to-recombination is crucial in consolidating firms competitive

position and first-to-market successes (Kessler & Chakrabathi, 1996). We also add a complementary perspective to prior work on social networks as the locus of recombination (Carnabuci & Operti, 2013; Guler & Nerkar, 2012; Nerkar & Paruchuri, 2005; Phelps, Heidl, & Wadhwa, 2012) which has mostly examined internal knowledge recombination. Our study highlights the function that intrafirm networks serve in recombining external knowledge. Finally, we add to research on the role of intraorganizational social networks for overall firm innovation outcomes (Kleinbaum & Tushman, 2007).

2.2 Theory and Hypotheses

An invention is the outcome of a search process that involves problem-solving by inventors and eventually, recombination of existing knowledge components in a novel manner (Fleming, 2001; Hargadon & Sutton, 1997; Schumpeter, 1934). The invention process has shifted from taking place solely within the firm to a more open model in which firms acquire knowledge from a variety of sources (Chesbrough, Vanhaverbeke, & West, 2006; Laursen & Salter, 2006). Acquisition of external knowledge facilitates firm invention due to the complementarity between externally and internally generated knowledge components (Cassiman & Veugelers, 2006). Firms do not have all relevant knowledge in-house and therefore engage in alliances, licensing, and hiring to update their R&D process (Arora & Gambardella, 1990; Levin et al., 1987). The process of knowledge recombination thus increasingly relies on the recombination of both internal and external knowledge components. In this respect, Cohen & Levinthal (1990) argue that firms vary in the ability to draw on external knowledge. The absorptive capacity of firms refers to the ability to recognize, assimilate, and exploit external knowledge and “is largely a function of the level of prior related knowledge” (Cohen & Levinthal, 1990: 128).

According to the knowledge-based theory of the firm, knowledge is collectively stored among employees and firms can be seen as social communities (Kogut & Zander, 1996; Matusik & Heeley, 2005). Social communities are the origin of knowledge creation and knowledge transfer within the firm (Tsai, 2000, 2001). In a similar manner, the literature on organizational learning asserts that learning involves knowledge transfer among individuals and business units within the firm (Argote, Mcevily, & Reagans, 2003; Huber, 1991). Organizations can thus be understood as network arrangements (Brass, Galaskiewicz, Greve, & Tsai, 2004; Reinholt, Pedersen, & Foss, 2011; Tsai, 2001). Networks among employees, and especially those individuals that are active in a firm's R&D process, inventors, influence the extent to which knowledge is diffused and generated within a firm (Guler & Nerkar, 2012; Nerkar & Paruchuri, 2005).

Intrafirm social networks can be seen as an antecedent of a firm's absorptive capacity (Volberda et al., 2010) because intrafirm networks shape knowledge flows among individuals and determine the efficiency of communication between them. Relevant knowledge for problem-solving is distributed among individuals within the firm (Lenox & King, 2004) and can be detected and shared through networks (Brass et al., 2004; Turner & Makhija, 2012). To illustrate this, Nerkar & Paruchuri (2005:773) argue that "bounded rational inventors search across the internal knowledge network on the basis of incomplete information about which knowledge should be recombined". Networks among inventors also constitute communication patterns. The efficiency of communication (Cohen & Levinthal, 1990) refers to inward-looking absorptive capacity and determines the effectiveness of internal sharing of external knowledge (Volberda et al., 2010). In this sense, intrafirm inventor networks influence firm innovation through sharing, development, and recombination of external knowledge. As a consequence, interpersonal networks can be seen as an antecedent of a firm's capacity to deal with external

knowledge, constituting the micro-foundations of a firm's inventive capabilities (Allen & Cohen, 1969; Brown & Duguid, 2001; Tushman & Scanlan, 1981).

The use of external knowledge in a firm's R&D process may shorten the time of the invention process (Kessler & Chakrabathi, 1996; Leone & Reichstein, 2012). Speeding up the invention process is crucial to consolidate the competitive position of firms. Yet, the effect of external knowledge acquisition on subsequent invention speed depends on the channel through which external knowledge is acquired (Lee & Allen, 1982; Tzabbar, Aharonson, & Amburgey, 2012; Vasudeva & Anand, 2011) and a firm's absorptive capacity (Cohen & Levinthal, 1989, 1990). In this paper we examine the influence of specific intrafirm network configurations of inventors on the speed with which a firm integrates and recombines externally acquired knowledge. We define *external knowledge recombination speed* as the time it takes a firm to recombine externally acquired knowledge into the firm's own invention. In the next paragraphs we develop hypotheses on how structural and compositional features of intrafirm networks among inventors affect the recombination speed of external knowledge.

Technological distance and recombination speed. Firms acquire external knowledge to complement their own technological knowledge base. In fact, in order to fill in the gaps related to the lack of specific knowledge components, firms tend to reach out for technologically distant knowledge (Rosenkopf & Almeida, 2003). Yet, we argue here that even though firms are prone to engage in distant knowledge sourcing, this comes at a cost with regard to recombination speed. The ease with which firms recombine external knowledge hinges upon having related prior experience with the acquired knowledge (Cohen & Levinthal, 1990; Zahra & George, 2002). Prior experience becomes the natural starting point for subsequent searches for new knowledge, and a firm's knowledge stock, which is accumulated over the years, is used as a lens through which the firm makes sense of knowledge from the environment (Rosenkopf &

Almeida, 2003). The technological development of a firm over time thus affects the technological distance between a firm's knowledge base and external knowledge. Assimilation of external knowledge requires a common base of understanding, or overlap in the knowledge base, in order to achieve successful application of this piece of knowledge (Cohen & Levinthal, 1990). As a result, when the technological distance between the firm's knowledge base and acquired external knowledge increases, the absorptive capacity of a firm declines (Gilsing, Nootboom, Vanhaverbeke, Duysters, & Vandenoord, 2008; Lane & Lubatkin, 1998). This means that the cost and effort to recombine external knowledge increases with distance (Leone & Reichstein, 2012; Weitzman, 1998). To illustrate this, integration of distant external knowledge will require more effort and time as inventors in the firm are likely to encounter problems when they deal with unfamiliar knowledge. The solution generation process will subsequently prolong the time it takes for the firm to recombine distant external knowledge into an invention. Consequently, a firm requires more time to understand distant knowledge and may need more time to invest in its absorption, and this will slow down the process of external knowledge recombination. Our baseline hypothesis therefore states:

Hypothesis 1. The larger the distance between the externally acquired knowledge and the firm's knowledge base, the longer it takes the firm to recombine external knowledge

Intrafirm network density and the recombination speed of distant external knowledge. Dense networks (also called cohesive or closed networks) are networks in which the members are well-connected with each other. From an innovation perspective, previous studies have indicated that network density may either be beneficial or harmful for firm innovation (Burt, 1992; Coleman, 1988). On the one hand, network density leads to knowledge-sharing among members of the network and fosters information flow through the network (Gargiulo, Ertug, & Galunic, 2009; Obstfeld, 2005; Reagans & McEvily, 2003). Furthermore, dense networks are likely to have

effective norms, promote trust (Coleman, 1988), and facilitate the exchange of tacit and complex knowledge (Hansen, 1999; Hansen, Podolny, & Pfeffer, 2001; Uzzi, 1997). On the other hand, the opposite of a dense network, a sparse network, may also be effective for firm innovation (Burt, 2004). A sparse network, which features structural holes between clusters or sub-networks, enhances firm innovation through the likelihood that such a network structure exhibits diverse information and fosters creativity.

Although sparse networks have been shown to be associated with high levels of heterogeneity, which facilitate the creation of new knowledge, the absence of connections between the network members reduces the speed with which individuals can share knowledge and access information (Singh et al., 2010). In fact, even though knowledge heterogeneity is important for inventors to deal with unfamiliarity, existing ties are necessary to provide individuals the right channels to tap into each other's experience and knowledge. This is particularly true for intrafirm networks, given that relevant knowledge might exist within the firm boundaries and still remain unutilized if network configurations do not favor its detection and dissemination (Hansen, 1999).

Therefore, we claim that intrafirm network density is particularly relevant to firms' ability to quickly recombine and eventually integrate distant external knowledge. Intrafirm inventor network density shortens the time it takes to recombine distant external knowledge for at least three reasons. First, dense networks ease the search for and detection of relevant knowledge available in the network of inventors. Through their ties, inventors may hear about and observe potentially relevant inventors with the knowledge and skills needed to recombine distant external knowledge. Thus, dense networks tend to speed up the search time for relevant information within the network (Zaheer & Bell, 2005). Second, dense inventor networks tend to encourage knowledge sharing and the willingness to devote time and effort to support peers (Reagans & McEvily, 2003). Such cooperative behavior is likely to create

cooperative norms and fosters knowledge transfer between inventors in the firm. For this reason, one may expect that the prolonged recombination time inherent to distant knowledge tends to be shorter in dense networks as a result of a mutually supportive environment. Third, network density promotes the formation of norms, which, in turn, enhances mutual understanding between inventors and lowers the possibility of misinterpretation and loss of relevant information (Reagans & McEvily, 2003; Zaheer & Bell, 2005). Inventors in dense networks thus tend to save time due to the formation of successful communication routines. In line with our predictions, we claim that firms with a dense intrafirm co-invention network experience a shorter recombination time for distant external knowledge. Our second hypothesis thus states the following:

Hypothesis 2. Firms with an intrafirm inventor network that has a high level of network density recombine distant knowledge faster than firms with an intrafirm inventor network that has a low level of network density

Intrafirm average tie strength and recombination speed of distant external knowledge. Tie strength refers to the intensity of interaction between two members of the network and is “a combination of the amount of time, the emotional intensity, the intimacy (mutual confounding) and the reciprocal services which characterize the tie” (Granovetter, 1973: 1361). Tie strength characteristics tend to increase with increasing frequency of collaboration between inventors. Tie strength promotes trust and facilitates knowledge transfer, especially knowledge that is complex and tacit (Hansen, 1999; Levin, Walter, & Murnighan, 2010; McFadyen et al., 2009). While weak ties help in the search of useful knowledge it also impedes individuals to exchange complex information, limiting the extent to which complex knowledge flows within the network (Hansen, 1999). In fact, Hansen (1999) points out that, particularly in the case of innovation, useful knowledge may fail to be appropriately shared among individuals even though

information regarding the whereabouts of the knowledge is disseminated across the network. This argument emphasizes the need of strong ties in order to individuals' knowledge and expertise to move from one point to another in the network. Strong ties among inventors within a firm are likely to mitigate disadvantages related to integrating distant external knowledge according to two main arguments. First, trust and knowledge-sharing among inventors increases with recurring interaction (Hansen, 1999; Reagans & McEvily, 2003). This, in turn, increases the willingness of inventors to spend more time and effort on supporting each other (Rost, 2010; Seibert, Kraimer, & Liden, 2001; Sosa, 2010), for example in problem-solving related to the integration of unfamiliar pieces of knowledge. Second, knowledge that is tacit and highly complex is better transferred through strong ties (Hansen, 1999; Phelps et al., 2012). Distant knowledge is likely to be a complex matter for inventors within the firm, and therefore, tie strength increases the likelihood that such complexity is shared throughout the firm, which accelerates the integration process (Hansen, 1999). Taken together, we expect that high average tie strength will shorten the recombination process of distant knowledge and we therefore posit the following hypothesis:

Hypothesis 3. Firms with an intrafirm inventor network that has high average tie strength recombine distant knowledge faster than firms with an intrafirm inventor network that has low average tie strength

Intrafirm network diversity and recombination speed of distant external knowledge. Network diversity refers to the diversity of resources available in the network. Or, in other words, the extent to which network connections span boundaries (Reagans & McEvily, 2003). In the context of this paper, network diversity refers to variety in technological experience among the collaborating inventors inside the firm (Harrison & Klein, 2007) or the extent to which inventor ties span technological boundaries. Network diversity or range increases knowledge sharing among members of the network (Reagans & McEvily, 2003) and promotes the problem-solving

ability of members through access to diverse resources available in the network (Phelps, 2010). An intrafirm network composed of a diverse group of inventors will accelerate the time it takes to recombine distant external knowledge for at least three reasons. First, due to the inherent uncertainty of knowledge recombination, inventors benefit from having diverse partners in their intrafirm network. Diverse connections provide a single inventor with access to a diverse set of problem-solving heuristics (Page, 2007) and support the accomplishment of complex tasks related to recombining distant knowledge (Mors, 2010; Rodan & Galunic, 2004). Thus, the collective problem-solving ability of inventors increases with diversity and shortens the time it takes to recombine complex distant knowledge acquired from outside the boundaries of the firm. Second, when inventor with different technological backgrounds collaborate they expand their ability to convey knowledge across distinct bodies of meta-knowledge (Reagans & McEvily, 2003; Tortoriello, Reagans, & McEvily, 2012). Over time, building experience in interacting with dissimilar colleagues increases inventors' capability to efficiently and successfully frame their communication with other inventors, which, in turn, may accelerate the recombination of distant knowledge based on future interactions among heterogeneous inventors. Third, diversity within the intrafirm network increases the likelihood of overlap between the acquired external knowledge component and available relevant knowledge already existent in the intrafirm co-inventor network (Cohen & Levinthal, 1990). Diversity among collaborating inventors thus eases the comprehensibility of distant external knowledge and leads to shorter recombination time. Our final hypothesis therefore states:

Hypothesis 4. Firms with an intrafirm inventor network that has a high level of network diversity recombine distant knowledge faster than firms with an intrafirm inventor network that has a low level of network diversity

In short, we posit that while technological distance prolongs the time it takes to recombine external knowledge into own invention, network density, average tie strength and diversity shorten the recombination process of distant knowledge pieces¹.

2.3 Data and Methods

We test the aforementioned hypotheses in the context of the global pharmaceutical industry. Firms in this industry develop and commercialize drugs, chemical components, and biological products. The focus on pharmaceutical firms provides a good research context for at least four reasons. First, the pharmaceutical industry is characterized as technology driven and R&D intensive, which makes technological knowledge a critical component to develop and sustain competitive advantages (Roberts, 1999). Second, firms in this industry routinely and systematically protect and document their inventions (Hagedoorn & Cloudt, 2003). In particular, patenting is an important and common mechanism used in this industry (Levin et al., 1987). Since patents provide reliable documentation of a firm's innovative activities we rely on patent information to identify the technological profile of the firms in our sample (Roberts, 1999; Adegbesan and Higgins, 2010; Hoang and Rothaermel, 2010). Third, R&D collaboration with other firms and universities represents an important driver of technology development (Arora & Gambardella, 1990). Indeed, firms in this industry actively engage in external knowledge or technology acquisition to foster their own inventive activity. Finally, the pharmaceutical industry has proven to be a valuable context to identify and measure the effect of inventor networks on innovative output (Paruchuri, 2009).

¹ We acknowledge the fact that prior work has identified costs related to excessive network density and diversity in particular (Phelps, 2010). We address this issue empirically in the section on robustness checks and theoretically in the discussion section.

The data used in this study derive from four data sources. First, we used detailed information on licensing agreements from the Deloitte Recap Database, which covers licensing deals in the global pharmaceutical industry for the period 1983 – 2008. This database is one of the most accurate sources of information regarding partnerships and technology exchange in the pharmaceutical industry (Audretsch & Feldman, 2003; Schilling, 2009). More specifically, this database allowed us to access the original licensing contracts, from which it was possible to extract precise information regarding the date of the licensing event, characteristics of the licensed technologies, contractual specifications, and information related to the identification of licensees and licensors (e.g. firm name, address and operating segment). Second, we drew on the NBER patent project to merge the specific patent numbers connected to the traded technologies from the Deloitte Recap Database with patents registered at the United States Patent and Trademark Office (USPTO). Furthermore, the information retrieved from the NBER project was used to identify the technological profile of the firms that acquire technologies through licensing (i.e. licensees), and the firms that sell the technologies (i.e. licensors). Therefore, we were able to include in the analysis variables capturing the characteristics of firms on both sides of the licensing contract, allowing us to disentangle potentially confounding firm effects from the variables of interest. Third, we relied on the Harvard Patent Network Dataverse, which provided us with the disambiguated inventor names and inventor identification numbers. This allowed us to construct intrafirm inventor networks based on co-invention as well as to derive inventor-level information. Prior research has used qualitative evidence (i.e. interviews) to validate co-patenting ties as a measure of collaboration among inventors (Carnabuci & Operti, 2013; Fleming, King III, & Juda, 2007). Finally, we utilized the WRDS Compustat database mainly for control variables.

The final sample consists of 113 firms involved in the acquisition of 708 USPTO patents using licensing contracts. Given that the information regarding inventors' patenting

activity is only available from 1981 and explanatory variables regarding intrafirm networks are calculated based on a five-year moving window, the first licensing contract in the sample is observed in 1986. Furthermore, we ended the sample in 2003² to allow sufficient time to observe whether the patents produced by the licensee indicate that the licensed technology was successfully recombined. The number of observations used to run the econometric analysis corresponds to approximately 47% of the number of contracts registered at RECAP that was initially considered to test the hypotheses³.

2.3.1 The Dependent Variable

Time to knowledge recombination. The time it takes firms to recombine licensed technologies is calculated on the basis of the number of months between the licensing date and the first time that the licensee incorporates the licensed technology in the backward citation of a new patent. Using the dates of the patent application, instead of the grant dates, we avoid noise introduced by differences in patent office procedures. To avoid potential issues regarding bias originating from the use of the same data source to calculate the initial and the final dates, the dependent variable was calculated on the basis of information from two different (independent) databases. The date of external knowledge acquisition is defined on the basis of the licensing date specified at the RECAP database, while the recombination date comes from the Patent Network Dataverse. This variable is intended to capture how fast firms are able to recombine a new externally acquired body of knowledge with existing ones. Leone & Reichstein (2012) apply this dependent variable in a similar context as a robustness check to capture how inward licensing can shorten the time firms take to invent a new technology. In a similar way, we

² The decision to end the licensing observations three years before the latest record of patent data was based on the fact that on average, firms in our sample take 26 months (2.2 years) to recombine the licensed technology. Alternatively, we also run the models using a five year gap, instead of three, and the results remained identical.

³ In order to investigate the presence of systematic differences in invention speed of the observations (firms) that were excluded from the analysis due to missing information and the ones included in the final sample, we conducted a t-test comparing the number of months that licensees take to produce the first patent after the licensing date. The results indicate no statistically significant differences between the two groups.

consider the citation of the licensed technology in a new patent an indication that the licensee was able to assimilate and successfully apply the licensed knowledge⁴. The reliance on technology licensing to feed internal inventive efforts is particularly prominent in industries with well-functioning markets for technology, such as the pharmaceutical and biotechnology industries (Arora & Gambardella, 2010). For this reason we consider that the use of technology licensing in combination with the backward citations of patents constitutes a reliable set-up for the invention speed of pharmaceutical firms. In the section on alternative explanations and robustness checks we provide econometric evidence to alleviate endogeneity concerns regarding our dependent variable.

2.3.2 Explanatory variables

Technological distance. The distance between the licensed technology and the knowledge base of the licensee is calculated using the patenting behavior of the acquiring firm prior to the licensing agreement. We measure technological distance with the *focal index* proposed by Ziedonis (2007) as a way to capture the extent to which a firm is able to realize value from a licensed patent. The technological distance between a licensed technology and a firm's knowledge base is then measured on the basis of the patent class connected to the licensed technology and the technology classes the licensee has been active in prior to the licensing event. To illustrate this, the technological distance is high if the share of the firm's patent portfolio assigned to the same patent class as the licensed technology is low. On the other hand, the distance is low if a high share of patenting activity has been concentrated on the same primary class of the licensed technology. The measure is computed as follows:

⁴ One could argue that firms may cite a technology without having to license it. In our sample eight cases were observed in which the licensed technology was referred to in the backward citation of a patent applied to the licensee before the licensing date. These observations are excluded from the main analysis.

$$Technological\ distance = 1 - \left[\frac{\left(\sum_{t-5}^t \sum_j \tilde{C}_i \cdot \rho_i \right)_c}{\left(\sum_{t-5}^t \sum_j \tilde{C}_i \cdot \rho_i \right)} \right]$$

in which $\left(\sum_{t-5}^t \sum_j \tilde{C}_i \cdot \rho_i \right)_c$ represents the citation-weighted sum of firm i 's patents that were applied for within five years of the time of the license agreement t and that belong to the same primary patent class c as the licensed patent; and $\left(\sum_{t-5}^t \sum_j \tilde{C}_i \cdot \rho_i \right)$ is the sum of all citation-weighted patents issued to firm j that were applied for by date t following the same time window of five years. The use of weighted citations offers the possibility to capture the relative importance of each patent within the firm's portfolio (Griliches, 1990).

Network density. We measure network density by calculating the overall density of the intrafirm network (Ahuja, Soda, & Zaheer, 2011; Obstfeld, 2005). Density captures the extent to which potential linkages are realized within a network, and is a commonly used measure of network structure (Guler & Nerkar, 2012; Marsden, 1990). We calculated our density measure for five-year windows. Network density for firm i in year t is computed as follows:

$$Network\ density = \frac{Observed\ N\ inventor\ ties_{it}}{Possible\ N\ inventor\ ties_{it}}$$

The observed ties are defined as the number of unique ties existing between two inventors that appear together within the same patent, and the number of possible or potential ties follow the number of inventors (N) active in the firm $\left(\frac{N \times (N-1)}{2} \right)$.

Average tie strength. Average tie strength captures the average intensity of collaboration between inventors within the firm. We measured tie strength between each observed pair of inventors on the basis of the number of patents they have co-invented with each other. We then

averaged this across the number of inventors in the firm. We also use a five-year moving window.

Network diversity. The diversity measure aims to capture the level of technological diversity among the active inventors within the focal firm. To operationalize this measure we take into account the possibility that the inventors may also have accumulated knowledge from research activities developed prior to joining the focal firm. Therefore, rather than capturing firm-level diversity we focus on network level diversity formed by the active inventors at the year of the licensing contract. Furthermore, we only look into diversity among the inventors that have at least one intrafirm active tie, which means that inventors that produced no patent or patented only in collaboration with other individuals outside the firm or were a single inventor in all patents are not included in the analysis. The diversity measure is calculated using a Herfindahl index of the IPC codes (two digits) of the patents produced by the firm's inventors with at least one patent, connected to the licensing firm, within the five years prior to the licensing contract. We define the network diversity present in firm i 's intra inventor network in year t as:

$$\text{Network diversity} = 1 - \sum_{j=1} \left(\frac{N_{ij}}{N_i} \right)^2$$

Following previous studies (Griliches, 1990; Hall, Jaffe, & Trajtenberg, 2001) we consider that the main IPC code attributed to a patent reflects a distinct technological field $j = 1, 2, 3 \dots th$. Therefore, if the inventors within the i th firm have accumulated N_i patents within the five years prior to the licensing contract, each of the patents can be assigned to one technological field. The final measure is obtained by subtracting 1 from the value reflecting the concentration of patent classes across the different technological domains.

2.3.3 Control Variables

We include a variety of firm, technology and contract-level control variables that may affect the time it takes to recombine knowledge in order to isolate the effects of the explanatory variables. We applied moving windows of different time lengths to compute the control variables. The length of the windows ranged from four to seven and differed according to the control variable; the different lengths were determined on the basis of prior research. To check the robustness of our results we tested alternative specifications (± 1 year) for the control variables and the results of the main independent variables remained the same. In the case of the control variables regarding the intrafirm network, all the measures were calculated for the same length of time as the explanatory variables (five years). Regarding intrafirm inventors network characteristics, we control for *clustering* and *average path length*. We expect that those two structural characteristics will affect the knowledge flow across inventors by speeding up the time it takes to transfer knowledge from one point to another within the network. Our measure of clustering is scaled by the degree of clustering expected in a random bipartite network of the same size and density. Additionally, we included a dummy variable that takes value 1 if the firm has *co-patented* at least once prior to the licensing date. This variable is intended to capture the availability of external ties through which inventors can acquire relevant knowledge.

We also control for several firm characteristics. First, we included the logarithm of the number of employees in the year of the licensing deal to control for *firm size*. Second, we control for cross-firm differences in terms of *R&D intensity* by adding the total R&D expenditures divided by total sales. We also control for the amount of unabsorbed resources using licensee *slack*, which is calculated on the basis of the ratio between sales and number of employees. Another characteristic that can also influence the speed with which the licensee is able to recombine the external knowledge faster regards the familiarity that it has with other

licensor's technologies (other than the licensed technology). Therefore, we controlled for the total number of prior citations within four years prior to the licensing contract that the licensee has made to any of the licensor's patents. In order to capture fast-paced knowledge recombination driven by industry competitive pressures (Ferrier, Smith, & Grimm, 1999) we generated a dummy variable that takes value 1 when both firms operate in the same segment and 0 otherwise. We also control for the general licensee's invention speed by calculating the average time between the patents produced before acquiring the licensed technology. We included a dummy variable taking value 1 if the firm has produced a patent within the 12 months that precede the licensing date. By adding this variable we expect to control for the fact that certain technologies may be licensed in different stages of the invention process. Finally, we add a dummy variable taking value 1 if the licensee has headquarters in the United States.

We also control for contractual specifications of the licensing deal using dummy variables. The inclusion of the technology-flow back provision clause (i.e. grant-back clause) indicates that the licensor has rights over any improvement that the licensee develops with regard to the licensed technology. Therefore, we expect that signing a contract with a *grant-back* clause reduces the incentives that licensees have to further develop the licensed technology (Choi, 2002). Contracts that include the *technology furnishing* clause indicate that the licensor commits to supply know-how on the licensed technology to support the licensee in understanding and applying it, mitigating part of the problems originating from distance. Finally, the inclusion of *milestone* payments in a licensing contract offers the possibility for the licensee to receive monetary compensations for further developing the licensed technology.

Looking into technology related characteristics, we control for *technology value* using the total number of forward citations received by the licensed technology (Yang, Phelps, & Steensma, 2010). We expect that more valuable technologies are also more likely to be recombined in a faster way. Additionally, we also control for the total number of *scientific*

references listed in the backward citations of the licensed technology as a way to capture cross-technology differences in terms of the development stage. The final set of control variables is related to the licensor's characteristics. First, we control for the number of successfully applied patents that the licensor filed in the seven years prior to the licensing contract as the licensor's size and technological capabilities may also affect the licensee's willingness to quickly invent using the licensed technology. Second, in order to control for differences between firms and universities as licensors we added a dummy variable to identify the contracts in which the licensor is a university. Finally, following the convention in this literature, we added sector dummies indicating the segment within the pharmaceutical firm in which the licensee operates and year dummies.

2.4 Model Specification and Estimation

Given that the hypotheses refer to the time it takes to recombine knowledge, we generated the dependent variable following an event history analysis structure. This type of model is conventionally used to examine the conditional probability that an event occurs in a particular time interval (t) (Blossfeld, Golsch, & Rohwer, 2007; Yu & Cannella, 2007). In this respect, we apply event history analysis to model the time taken, T , between the licensing date and the first time the licensing technology is cited by the licensee in a new patent. The use of event history analysis to investigate the effect of the explanatory variables on the time it takes to recombine knowledge offers at least two major advantages. First, it makes it possible to directly model time as the dependent variable without the need to transform it into a discrete outcome (Pennings & Wezel, 2009). Second, this technique also allows for modeling the observations that do not experience the transition during the time frame covered by the data by dealing with issues emerging from right-censoring as a non-random process (Blossfeld et al., 2007). Compared to alternative model specifications (e.g. logit or OLS), employing event history analysis allows us

to include the observations for which we only have partial information, which covers the time they enter the sample (the licensing date) until the last date that patent data for backward citation are available.

In order to decide among the possible models within even history analysis we considered the underlying mechanisms driving the hazard to knowledge recombination. We expect that firms that license-in technologies with low distance will be able to recombine the new knowledge with existing components at a rapid pace, which increases the hazard to knowledge recombination as the time increases. However, as the time elapses, the technologies with lower distance exit the sample, leaving in the sample technologies that take more time to be recombined. This effect is expected to become dominant and lowers the hazard rate until a point at which the hazard function starts to decline. Accordingly, we decided to employ a log-logistic model as a way to accommodate the expected process of an initial increase followed by a decreasing rate (Mills, 2011). Alternatively, we also employed a log-normal specification as a robustness check and, as expected, both models produced comparable results.

Considering that the capacity to deal with distant knowledge is likely to be also determined by firm characteristics that are not captured by the explanatory variables used in the econometric model, we correct for potential endogeneity issues originating from the presence of unobserved heterogeneity across the firms. Prior studies using a similar setting to the one presented in this paper have dealt with unobserved firm-level differences affecting duration dependence by employing frailty estimators (e.g. Hoang & Rothaermel, 2010; Pennings & Wezel, 2009; Polidoro, Ahuja, & Mitchell, 2011). Following the recommendation by Blossfeld et al. (2007), we model the unobserved heterogeneity using a shared gamma mixture specification associated with the log-logistic model. The alternative to the use of a gamma mixture model would be the inverse Gaussian frailty model, but as demonstrated by Jenkins (2005), it is straightforward to assume a gamma or normal distribution for the frailty of log-

logistic models. The inclusion of a gamma mixture refers to the incorporation of an “error term” in the model that relates multiplicatively to the hazard rate for each firm in the analysis (Blossfeld et al., 2007; Hougaard, 1986). Additionally, the use of shared frailty also offers the possibility to model intragroup correlation, which in the case of our sample is created from repeated group observations (Gutierrez, 2002).

2.5 Descriptive Statistics and Correlations

Table 1 reports the means, standard deviations, and Pearson correlation coefficients of the variables used in the analysis. The results raised no concerns regarding collinear variables, except for the correlations between *Average path length* with *Network density* and *Clustering* with *Average Tie Strength*. The moderate correlations between those variables are in line with theoretical expectations, but in order to check for potential bias we entered the variables in a stepwise manner and the results for the main explanatory variables do not change as the variables enter the model. Additionally, the maximum variance inflation factor (VIF) associated with any of the independent variables was 4.34 (mean VIF = 2.15), which is well below the rule-of-thumb value of ten (Gujarati, 1995). In order to identify potential model estimation issues regarding the stability of the coefficients and standard error we also added the main explanatory variables one at a time. Finally, the likelihood ratio comparison test at the bottom of Table 2 indicates that models II – V provide significant improvement relative to the baseline model. Looking specifically into the likelihood ratio comparison for model V (likelihood ratio: 35, df: 4, $p < 0.001$) we observe a substantial improvement compared to the restricted model.

[Insert Table 1 around here]

We were able to track the patenting behavior of the firms in our sample until December 2006; therefore, our analysis is censored at the latest dates available in the patent citation data.

Looking into the knowledge recombination speed, the longest time to transition for the firms in our sample was 168 months. Out of 708 firm-technology observations, a total of 116 firms cited the licensed technology in a new patent (made the transition) during the time frame of our analysis. For the observations that experienced the transition, the average time for knowledge recombination was 25 months. In contrast, the average time of at-risk months for all firms in the sample (including censored observations) was 74 months. Considering the average time for knowledge recombination between the uncensored observations with high versus low technological distance (using mean values), small distance technologies are, on average, cited within 24 months, while large distance technologies are cited within 83 months. Among the 592 firm-technology observations that did not experience the transition during the time window of our analysis, 129 observations exit the sample earlier than December 2006. These observations were subject to a different type of right-censoring. In the empirical setting used in this paper these observations exit the sample earlier because their latest records on COMPUSTAT ended earlier than the latest information available in the patent data. We modeled those observations differently by setting the exit time at the date of the latest Compustat record, implying that although these observations exit the sample, they do not experience the transition. The fact that the financial records for a given firm are discontinued is likely to be due to bankruptcy or an M&A process, which eliminates the possibility of a firm being observed in the patent citation data⁵.

To supplement, we plot the cumulative hazard function after the estimation of the log-logistic model to visualize the patterns of the hazard function regarding the non-monotonic shape. Indeed, the results (see figure 1) indicate an initial increase followed by a decrease in the hazard rate for the observations in our sample, suggesting the suitability of the log-logistic

⁵ If we consider those firms exiting the sample earlier, approximately 20% of the observations experience the transition within the time frame of the event history analysis

model specification. Additionally, in order to visualize the shape of the hazard rate for observations with high and low levels of technological distance we generated two groups on the basis of the mean values of distance. As expected, the visualization of the cumulative hazards indicates that the observations that present lower levels of distance exhibit a higher hazard rate compared to those with higher levels of distance, with the curves for the two groups exhibiting a similar non-monotonic pattern. This result offers initial support for our hypothesis regarding the effect of distance on the firm's capacity to recombine external knowledge. As suggested in the graph, the firms dealing with lower levels of distance have a higher probability of experiencing a transition earlier compared to those dealing with high distance levels.

[Insert Figure 1 around here]

2.6 Results

Table 2 reports the results for the log-logistic model with the shared gamma mixture specification. The dependent variable across the six models reported in this table reflects the time gap between the licensing date and the first time the licensed technology was cited in a new patent (for the non-censored observations). Model I reports the estimators for controls and the main effects of the interaction terms. Additionally, we included year dummies to control for period effects, such as overall differences in patenting behavior in the pharmaceutical industry. In models II – VI the interaction terms capturing the relationships described in the hypotheses were entered one-by-one along with all the controls. For the sake of simplicity we will focus the discussion of the results on the full model in column VI.

[Insert Table 2 around here]

Hypothesis 1 predicted that *the larger the distance between the externally acquired knowledge and the firm's knowledge base, the longer it takes the firm to recombine external knowledge*. The coefficient for the technological distance variable is positive and significant at the 1% level when all controls are included in the equation, providing strong evidences in favor of our first hypothesis. The result lends support to the fundamental idea developed in this paper that distance (unfamiliarity) is an important predictor of a firm's capacity to recombine external knowledge at a faster pace. This finding is similar to the results obtained by Leone & Reichstein (2012) regarding the joint effect of unfamiliarity and contractual specifications (the use of grant-back clause) on the time a licensee takes to produce its first invention after a licensing contract.

Hypothesis 2 stated that *firms with an intrafirm inventor network that has a high level of network density recombine distant knowledge faster than firms with an intrafirm inventor network that has a low level of network density*. Accordingly, the interaction term between technological distance and network density exhibits a negative and significant coefficient, indicating that the positive effect of distance on the time it takes to recombine knowledge becomes less positive (or more negative) when interacted with network density. This result supports the expected effect described in hypothesis 2. Thus, the negative and significant interaction term indicate that firms with a densely connected intrafirm inventor network are better able to deal with technological distance in a faster way.

Hypothesis 3 did not find support in the results. We predicted that firms with an intrafirm inventor network that has high average tie strength recombine distant knowledge faster than firms with an intrafirm inventor network that has low average tie strength. The interaction between technological distance and tie strength did not produce significant coefficients at the conventional level. Hence, the insignificant coefficient for this interaction term indicates that distance is positively related to knowledge recombination regardless of the tie strength among the inventors within the firm. In other words, we do not find evidence of a

significant moderating effect of tie strength on the relationship between distance and the dependent variable.

Finally, the results offered support for the moderation effect predicted in hypothesis 4 regarding the fact that *firms with an intrafirm inventor network that has a high level of network diversity recombine distant knowledge faster than firms with an intrafirm inventor network that has a low level of network diversity*. Accordingly, the interaction between technological distance and network diversity produced a significant and negative coefficient. This finding supports the idea that network diversity negatively moderates the relationship between distance and the time it takes to recombine knowledge and thus accelerates the recombination of distant knowledge.

2.7 Alternative Explanations and Robustness Checks

Despite the large number of prior studies indicating that technology licensing leads to knowledge transfer (Arora, 1996; Ceccagnoli & Jiang, 2012; Laursen et al., 2010), we acknowledge that the link between licensing-in and patent citations has not yet been established in the literature. Therefore, we performed a robustness check to evaluate the number of citations received by a technology after and before the licensing date using a conditional difference-in-differences design (Singh & Agrawal, 2011). By doing so, we expect to strengthen the confidence in the main results by focusing on two important aspects. First, it could be argued that the licensing firm is more likely to cite a technology of relatively higher quality or relevance regardless of whether or not it licenses the technology. Accordingly, technologies with such characteristics may also be more likely to be commercialized in the markets for technology, which creates a selection problem in which backward citations do not reflect the true effect of licensing. Second, a licensee may be more likely to license a technology in a domain in which the firm is intending to expand its technological activities. Therefore, it is

likely that the licensing efforts would also be associated with other measures aiming to improve a firm's access to a specific technological area.

To perform the difference-in-differences we followed the steps described in the study by Singh & Agrawal (2011). First, each licensed technology in our sample was matched on the basis of propensity scores using the application year, patent class, and subclass to the closest technology in the entire technological space (USPTO patents). Second, we certified that no observation in the control group was in fact licensed by the focal firm in the sample. Third, we computed the total number of citations that the focal firm made to both groups of technologies (the treatment and control) after and before the licensing date. There were only eight observations in which the licensed technology had been cited by the licensee before the licensing contract; those observations were removed from the event history analysis but were used to estimate the difference-in-differences model. On the basis of this matching sample between licensed and non-licensed technologies sharing similar characteristics, we evaluated the change in the number of citations. The results indicate (see Table 3) a significant and substantial increase in the number of citations received by a licensed technology when the number of citations received by the technologies in the control group is taken into account. Considering the baseline period, it is observed that the patents in the control group received an average number of citations of *0.055*, while the licensed technologies had on average *0.031* citations. However, considering the years after the licensing date it is possible to observe that the average number of citations for the licensed technologies increases to *1.541* while the control group remains the same.

[Insert Table 3 around here]

Further robustness checks are not reported here because of space limitation. First, the literature on network analysis has also pointed out to limitations in the extent that increasing levels of network density and diversity can benefit knowledge sharing and diffusion within networks. This claim naturally leads to the idea that density and diversity curvilinearly moderate the effect of distance on time to knowledge recombination. We empirically investigated if that is the case by including in the log-logistic model interaction terms between *Technological Distance* and the squared version of our measures for *Network Density* and *Network Diversity*, the results were statistically insignificant. Second, an alternative explanation for the effect of distance on time to knowledge recombination is related to the fact that the distant technologies may not be licensed with the intention of applying them in a new invention. Therefore, it could also be suggested that our results regarding the effect of technological distance on time to knowledge recombination comes from the censored observations, for which we have only partial information. To address this concern and check the plausibility of this argument we conducted a t-test comparing the level of distance between those observations that experience the transition and those that do not during the time window of our analysis. We found no evidence of statistical significance between the two groups.

2.8 Discussion and Conclusion

The present study was motivated by the fact that the absorptive capacity literature has overlooked the actions and interactions of individuals within the organization in the process of external knowledge integration. In addition, research on absorptive capacity has not paid enough attention to how *quickly* firms can recombine knowledge from the external environment with internal knowledge. The ability to speed-up the process of external knowledge recombination is a competitive advantage, especially in fast-paced industries. In this paper we address these

shortcomings and examine the influence of intrafirm inventor networks on firms' ability to recombine external knowledge with internal knowledge into own invention. We specifically investigated how network structure and network composition within the firm affect the absorption speed of distant external knowledge. We made the argument that firms often engage in distant knowledge acquisition, yet distant knowledge requires substantial time to be devoted to recombination due to inventors' lack of familiarity with it. By drawing on social network theory and literature on search within organizations we subsequently claimed that network density, average tie strength and network diversity shorten the time to recombine distant external knowledge with internal knowledge pieces.

The empirical results indeed showed that technologically distant external knowledge prolongs the time of external knowledge recombination compared to close knowledge. More importantly, the results showed that intrafirm network density and diversity shorten the time in which firms assimilate distant external knowledge. This is in line with our predictions. Yet, our results did not support our prediction that tie strength moderates the relationship between technological distance and the speed of external knowledge recombination. We discuss our results in light of previous research on absorptive capacity and external knowledge sources.

Our finding that strong average intrafirm ties among inventors do not accelerate the recombination of distant knowledge is in contrast to what we expected on the basis of the literature on knowledge-sharing within firms (e.g. Hansen, 1999; McFadyen & Cannella, 2004). Two explanations can be put forward for why this is the case. First, in addition to its benefits, tie strength can also impair the inventors' ability to develop distant external knowledge. Recurring interaction between a pair of inventors may lead to a trustworthy relationship characterized by supportive behavior (Granovetter, 1973). Yet, inventors with a limited number of partners with whom they collaborate can become myopic and focus on a limited set of colleagues. As a result,

the effect of tie strength does not have a clear direction. Another possible explanation for our finding is that co-invention in itself indicates strong ties between inventors. Co-invention requires frequent meetings between inventors and significant time investments from both sides.

Previous research on network density and diversity has pointed to the costs of certain network configurations (e.g. Ahuja, 2000; Phelps, 2010). To illustrate this, excessive diversity among inventors in the intrafirm network may lead to miscommunication, confusion, and a general lack of mutual understanding (Weitzman, 1998) and may negatively affect the ability to deal with distant knowledge. In a similar vein, network density may at some point negatively influence the ability to incorporate distant knowledge. Dense networks develop norms over time and this may result in group thinking, which, in turn, impairs the ability to find creative solutions and implement distant external knowledge. We tested for such decreasing or negative returns for each of the network variables, but did not find any such effects. Two reasons can be put forward why we do not find any curvilinear effects. A possible explanation may lie in the fact that we focus on the speed with which firms recombine internal with external knowledge, rather than general innovation output or knowledge exchange among inventors. We suspect that the mechanisms that underlie our results rely on network access and the knowledge content available in the network. From this viewpoint, negative (marginal) effects from density and diversity may not necessarily affect the speed of knowledge recombination, as this recombination will not take place at all. Another reason why we do not find any curvilinear effect may relate to the specific investments made by R&D managers and firms in general to understand a certain technology, which we do not observe. In this case, negative marginal returns will not be experienced.

Another question that may arise as a result of our findings relates to fact that we do not find strong evidence of direct effects of intrafirm network characteristics on external knowledge integration. We attribute this finding to the specific role intrafirm networks play in

the integration process of external knowledge. We claim that intrafirm network characteristics do not affect general acquisition of knowledge but become important when inventors face difficulties in providing solutions for the implementation of unfamiliar knowledge. In the latter case inventors are likely to activate their professional network and search for solutions among their fellow inventors (Singh et al., 2010).

This study contributes to several bodies of literature. Our main contribution lies in the literature on absorptive capacity (Cohen & Levinthal, 1990; Zahra & George, 2002). Social integration mechanisms and social networks within the firm are considered to be important antecedents of absorptive capacity (Volberda et al., 2010; Zahra & George, 2002). Despite these claims, we are not aware of any study that has focused on intrafirm networks as determinants of absorptive capacity. We provide evidence that intrafirm network cohesion and diversity indeed accelerate knowledge assimilation. In particular, our study supports the notion of inward-looking absorptive capacity, which refers to the efficiency of internal communication (Cohen & Levinthal, 1990). External knowledge can only be effectively absorbed when a firm has the ability to internally share this knowledge among the members of the firm (Lenox & King, 2004; Rothaermel & Alexandre, 2008; Volberda et al., 2010).

Another important contribution of our study pertains to exploring the speed dimension of external knowledge integration. We are not only aware of few empirical studies in this area (e.g. Leone & Reichstein, 2012), but our findings also raise implications for research on recombinant search. Indeed, firms tend to update their knowledge base with unfamiliar knowledge (e.g. Rosenkopf & Almeida, 2003), but recombination of distant knowledge comes at a cost; it appears to be a relatively long process. Future research on this paradox is important as time becomes an increasingly scarce resource in innovation processes (Kessler & Chakrabathi, 1996).

This study also contributes to the literature on organizational learning and the knowledge-based view of the firm by following the idea that firms contain social communities (Argote, 1999; Argote et al., 2003; Kogut & Zander, 1992). Informal networks among employees affect knowledge sharing and the creation of new knowledge. We add to this literature the idea that social networks indirectly affect the ability of organizations to learn from knowledge previously external to the firm. The notion that social networks within the firm are fundamental to learning from external knowledge resonates well with recent studies that claim that inventors and their knowledge networks constitute the micro-foundations of a firm's R&D capabilities (Guler & Nerkar, 2012; Nerkar & Paruchuri, 2005; Paruchuri, Nerkar, & Hambrick, 2006).

The results of our study also have managerial implications. Our findings point to the indirect influence of network structure on the ability of firms to quickly integrate external knowledge. Thus, managers should direct their attention to the collaborative behavior of their employees. We acknowledge the fact that a manager may not have full control over the social interactions that take place among employees. Yet, managers may assign inventors to participate in short-term projects to foster collaborative efforts between otherwise unconnected employees. Managers should evaluate how inventor network structure in the R&D department can be improved in such a way that an atmosphere of knowledge sharing and transfer among inventors and research units is guaranteed.

The results and contributions of this paper should be considered in the light of its limitations. Our findings may be specific to the pharmaceutical context, which is characterized by a mature market for technology, in which patent protection and licensing is the norm rather than the exception. Future research could therefore examine how quickly firms learn from other external sourcing mechanisms such as hiring in variety of industries (see Tzabbar et al., 2012, for a recent example). Second, we utilize co-patenting to capture collaboration and knowledge

networks, following recent literature (Fleming et al., 2007; Paruchuri, 2009; Singh, 2005). Although our focus on co-invention is particularly relevant in the context of knowledge recombination, we acknowledge the fact that patent collaborations only capture a subset of the present interpersonal ties within a firm. Future research could advance our understanding of intrafirm networks and recombination speed by focusing on different types of interpersonal networks, including friendship networks. Third, we focus specifically on the role of intrafirm co-invention ties as antecedents of absorption speed. Inventors that maintain ties that span firm boundaries may also have an impact on a firm's absorptive capacity (Perry-Smith, 2006; Tortoriello & Krackhardt, 2010; Tushman & Scanlan, 1981). Yet, individual external ties are beyond the scope of this paper. We encourage future research to investigate how the interaction of individuals' internal and external ties affects firm absorptive capacity.

Finally, we believe our empirical strategy reduced concerns with endogeneity issues as a result of unobserved heterogeneity and omitted variable bias. First, we employed a frailty estimator in our hazard models, which captures unobserved heterogeneity through the inclusion of a shared gamma mixture specification. In addition to this, our difference-in-differences approach towards the relationship between licensing-in and citation patterns strengthens our view that licensing represents a mechanism through which firms acquire external knowledge, which, in turn, fuels firms' inventive performance.

2.9 References

- Ahuja, G. 2000. Collaboration Networks, Structural Holes, and Innovation: A Longitudinal Study. *Administrative Science Quarterly*, 45(3): 425–455.
- Ahuja, G., Soda, G., & Zaheer, A. 2011. The Genesis and Dynamics of Organizational Networks. *Organization Science*, 23(2): 434–448.
- Allen, T. J. 1977. *Managing the Flow of Technology: Technology Transfer and the Dissemination of Technological Information within the R&D Organization*. Cambridge, MA: MIT Press.
- Allen, T. J., & Cohen, S. I. 1969. Information Flow in Research and Development Laboratories. *Administrative Science Quarterly*, 14(1): 12–19.
- Argote, L. 1999. *Organizational Learning: Creating, Retaining and Transferring Knowledge*: 24–43. Boston: Kluwer Academic Publishers.
- Argote, L., Mcevily, B., & Reagans, R. 2003. Managing Knowledge in Organizations: An Integrative Framework and Review of Emerging Themes. *Management Science*, 49(4): 571–582.
- Arora, A., & Gambardella, A. 1990. Complementarity and External Linkages: The Strategies of the Large Firms in Biotechnology. *The Journal of Industrial Economics*, 38(4): 361–379.
- Arora, A., & Gambardella, A. 2010. Ideas for Rent: An Overview of Markets for Technology. *Industrial and Corporate Change*, 19(3): 775–803.
- Audretsch, D. B., & Feldman, M. P. 2003. Small-Firm Strategic Research Partnerships: The Case of Biotechnology. *Technology Analysis & Strategic Management*, 15(2).
- Blossfeld, H. P., Golsch, K., & Rohwer, G. 2007. *Event History Analysis with Stata*. Mahwah, New Jersey: Lawrence Erlbaum Associates.
- Brass, D. J., Galaskiewicz, J., Greve, H. R., & Tsai, W. 2004. Taking Stock of Networks and Organizations: A Multilevel Perspective. *Academy of Management Journal*, 47(6): 795–817.
- Brown, J. S., & Duguid, P. 2001. Knowledge and Organization: A Social-Practice Perspective. *Organization Science*, 12(2): 198–213.
- Burt, R. S. 1992. *Structural Holes: The Social Structure of Competition*. Cambridge, MA: Harvard University Press.
- Burt, R. S. 2004. Structural Holes and Good Ideas. *American Journal of Sociology*, 110(2): 349–399.

- Carnabuci, G., & Operti, E. 2013. Where Do Firms' Recombinant Capabilities Come From? Intra-Organizational Networks, Knowledge, and Firms' Ability to Innovate through Technological Recombination. *Strategic Management Journal*.
- Cassiman, B., & Veugelers, R. 2006. In Search of Complementarity in Innovation Strategy: Internal R&D and External Knowledge Acquisition. *Management Science*, 52(1): 68–82.
- Chesbrough, H., Vanhaverbeke, W., & West, J. 2006. *Open Innovation: Researching a New Paradigm*. Oxford: Oxford University Press.
- Choi, J. P. 2002. A Dynamic Analysis of Licensing: The “Boomerang” Effect and Grant-Back Clauses. *International Economic Review*, 43(3): 803–829.
- Cohen, W. M., & Levinthal, D. A. 1989. Innovation and Learning: The Two Faces of R&D. *The Economic Journal*, 99(397): 569–596.
- Cohen, W. M., & Levinthal, D. A. 1990. Absorptive Capacity: A New Perspective on Innovation and Learning. *Administrative Science Quarterly*, 35(1): 128–152.
- Coleman, J. S. 1988. Social Capital in the Creation of Human Capital. *American Journal of Sociology*, 94.
- Dyer, J. H., & Singh, H. 1998. The Relational View: Cooperative Strategy and Sources of Interorganizational Competitive Advantage. *Academy of Management Review*, 23(4): 660–679.
- Ferrier, W. J., Smith, K. G., & Grimm, C. M. 1999. The Role of Competitive Action in Market Share Erosion and Industry Dethronement: A Study of Industry Leaders and Challengers. *Academy of Management Journal*, 42(4): 372–388.
- Fleming, L. 2001. Recombinant Uncertainty in Technological Search. *Management Science*, 47(1): 117–132.
- Fleming, L., King III, C., & Juda, A. I. 2007. Small Worlds and Regional Innovation. *Organization Science*, 18(6): 938–954.
- Gargiulo, M., Ertug, G., & Galunic, C. 2009. The Two Faces of Control: Network Closure and Individual Performance among Knowledge Workers. *Administrative Science Quarterly*, 54(2): 299–333.
- Gilsing, V., Nooteboom, B., Vanhaverbeke, W., Duysters, G., & Vandenoord, A. 2008. Network Embeddedness and the Exploration of Novel Technologies: Technological Distance, Betweenness Centrality and Density. *Research Policy*, 37(10): 1717–1731.
- Granovetter, M. S. 1973. The Strength of Weak Ties. *American Journal of Sociology*, 78(6): 1360–1380.

- Griliches, Z. 1990. Patent Statistics as Economic Indicators: A Survey. *Journal of Economic Literature*, 28(4): 1661–1707.
- Gujarati, D. N. 1995. *Basic Econometrics*. New York: McGraw-Hill.
- Guler, I., & Nerkar, A. 2012. The Impact of Global and Local Cohesion on Innovation in the Pharmaceutical Industry. *Strategic Management Journal*, 33: 535–549.
- Gutierrez, R. G. 2002. Parametric frailty and shared frailty survival models. *Stata Journal*, 2(1): 22–44.
- Hagedoorn, J., & Cloudt, M. 2003. Measuring Innovative Performance: Is There an Advantage in Using Multiple Indicators ? *Research Policy*, 32: 1365–1379.
- Hall, B. H., Jaffe, A. B., & Trajtenberg, M. 2001. The NBER Patent Citations Data File: Lessons, Insights and Methodological Tools. *Working paper no. 8498, National Bureau of Economic Research, Cambridge, MA*, 1–74.
- Hansen, M., Podolny, J. M., & Pfeffer, J. 2001. So Many Ties, So Little Time: A Task Contingency Perspective on Corporate Social Capital in Organizations. In S. M. Gabbay & R. T. A. J. Leenders (Eds.), *Social Capital of Organizations (Research in the Sociology of Organizations, Volume 18)*. Emerald Group Publishing Limited.
- Hansen, M. T. 1999. The Search-Transfer Problem: The Role of Weak Ties in Sharing Knowledge across Organization Subunits. *Administrative Science Quarterly*, 44(1): 82–111.
- Hargadon, A., & Sutton, R. 1997. Technology Brokering and Innovation in a Product Development Firm. *Administrative Science Quarterly*, 42(4): 716–749.
- Harrison, D. A., & Klein, K. J. 2007. What’s the Difference? Diversity Constructs as Separation, Variety, or Disparity in Organizations. *Academy of Management Review*, 32(4): 1199–1228.
- Hoang, H. A., & Rothaermel, F. T. 2010. Leveraging Internal and External Experience: Exploration, Exploitation, and R&D Project Performance. *Strategic Management Journal*, 31: 734–758.
- Hougaard, P. 1986. Survival Models for Heterogeneous Populations Derived from Stable Distributions. *Biometrika*, 73(2): 387–396.
- Huber, G. P. 1991. Organizational Learning: The Contributing Processes and the Literatures. *Organization Science*, 2(1): 88–115.
- Jenkins, S. 2005. *Survival analysis*. Unpublished manuscript, Institute for Social and Economic Research, University of Essex, Colchester, Essex, UK.

- Kessler, E. H., & Chakrabathi, A. K. 1996. Innovation Speed: A Conceptual Model of Context, Antecedents, and Outcomes. *The Academy of Management Review*, 21(4): 1143–1191.
- Kleinbaum, A. M., & Tushman, M. L. 2007. Building Bridges: The Social Structure of Interdependent Innovation. *Strategic Entrepreneurship Journal*, 1: 103–122.
- Kogut, B., & Zander, U. 1992. Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology. *Organization Science*, 3(3): 383–397.
- Kogut, B., & Zander, U. 1996. What Firms Do? Coordination, Identity, and Learning. *Organization Science*, 7(5): 502–518.
- Lane, P. J., & Lubatkin, M. 1998. Relative Absorptive Capacity and Interorganizational Learning. *Strategic Management Journal*, 19: 461–477.
- Laursen, & Salter, A. 2006. Open for Innovation: The Role of Openness in Explaining Innovation Performance among U.K. Manufacturing Firms. *Strategic Management Journal*, 27(2): 131–150.
- Lee, D. M. ., & Allen, T. J. 1982. Integrating New Technical Staff: Implications for Acquiring New Technology. *Management Science*, 28(12): 1405–1421.
- Lenox, M., & King, A. 2004. Prospects for Developing Absorptive Capacity through Internal Information Provision. *Strategic Management Journal*, 25: 331–345.
- Leone, M. I., & Reichstein, T. 2012. Licensing-In Fosters Rapid Invention! The Effect of the Grant-Back Clause and Technological Unfamiliarity. *Strategic Management Journal*, 33(8): 965–985.
- Levin, D. Z., Walter, J., & Murnighan, J. K. 2010. Dormant Ties: The Value Of Reconnecting. *Organization Science*, 22(4): 923–939.
- Levin, R. C., Klevorick, A. K., Nelson, R. R., Winter, S. G., Gilbert, R., & Griliches, Z. 1987. Appropriating the Returns from Industrial Research and Development. *Brookings Papers on Economic Activity*, (3): 783–831.
- Markman, G. D., Gianiodis, P. T., Phan, P. H., & Balkin, D. B. 2005. Innovation Speed: Transferring University Technology to Market. *Research Policy*, 34(7): 1058–1075.
- Marsden, P. V. 1990. Network Data and Measurement. *Annual Review of Sociology*, 16: 435–463.
- Matusik, S. F., & Heeley, M. B. 2005. Absorptive Capacity in the Software Industry: Identifying Dimensions That Affect Knowledge and Knowledge Creation Activities. *Journal of Management*, 31(4): 549–572.

- McFadyen, M. A., & Cannella, A. A. 2004. Social Capital and Knowledge Creation: Diminishing Returns of the Number and Strength of Exchange. *The Academy of Management Journal*, 47(5): 735–746.
- McFadyen, M. A., Semadeni, M., & Cannella, A. A. 2009. Value of Strong Ties to Disconnected Others: Examining Knowledge Creation in Biomedicine. *Organization Science*, 20(3): 552–564.
- Mors, M. L. 2010. Innovation in a Global Consulting Firm: When the Problem is Too Much Diversity. *Strategic Management Journal*.
- Nerkar, A., & Paruchuri, S. 2005. Evolution of R&D Capabilities: The Role of Knowledge Networks within a Firm. *Management Science*, 51(5): 771–785.
- Obstfeld, D. 2005. Social Networks, the Tertius iungens Orientation, and Involvement in Innovation. *Administrative Science Quarterly*, 50(1): 100–130.
- Page, S. E. 2007. *The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies*. Princeton, NJ: Princeton University Press.
- Paruchuri, S. 2009. Intraorganizational Networks, Interorganizational Networks, and the Impact of Central Inventors: A Longitudinal Study of Pharmaceutical Firms. *Organization Science*, 21(1): 63–80.
- Paruchuri, S., Nerkar, A., & Hambrick, D. C. 2006. Acquisition Integration and Productivity Losses in the Technical Core: Disruption of Inventors in Acquired Companies. *Organization Science*, 17(5): 545–562.
- Pennings, J. M., & Wezel, F. C. 2009. Faraway, Yet So Close: Organizations in Demographic Flux. *Organization Science*, 21(2): 451–468.
- Perry-Smith, J. E. 2006. Social Yet Creative: The role of Social Relationships in Facilitating Individual Creativity. *Academy of Management Journal*, 49(1): 85–101.
- Phelps, C. C. 2010. A Longitudinal Study of the Influence of Alliance Network Structure and Composition on Firm Exploratory Innovation. *The Academy of Management Journal*, 53(4): 890–913.
- Phelps, C. C., Heidl, R., & Wadhwa, A. 2012. Knowledge, Networks, and Knowledge Networks: A Review and Research Agenda. *Journal of Management*, 38(4): 1115–1166.
- Polidoro, F., Ahuja, G., & Mitchell, W. 2011. When the Social Structure Overshadows Competitive Incentives: The Effects of Network Embeddedness on Joint Venture Dissolution. *The Academy of Management Journal*, 54(1): 203–223.
- Powell, W. W., Koput, K. W., & Smith-Doerr, L. 1996. Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology. *Administrative Science Quarterly*, 41(1): 116–145.

- Reagans, R., & McEvily, B. 2003. Network Structure and Knowledge Transfer: The Effects of Cohesion and Range. *Administrative Science Quarterly*, 48(2): 240–267.
- Reinholt, M., Pedersen, T., & Foss, N. J. 2011. Why a Central Network Position Isn't Enough: The Role of Motivation and Ability for Knowledge Sharing in Employee Networks. *Academy of Management Journal*, 54(6): 1277–1297.
- Roberts, P. W. 1999. Product Innovation, Product-Market Competition and Persistent Profitability in the U.S. Pharmaceutical Industry. *Strategic Management Journal*, 20: 655–670.
- Rodan, S., & Galunic, C. 2004. More than Network Structure: How Knowledge Heterogeneity Influences Managerial Performance and Innovativeness. *Strategic Management Journal*, 25(6): 541–562.
- Rosenkopf, L., & Almeida, P. 2003. Overcoming Local Search through Alliances and Mobility. *Management Science*, 49(6): 751–766.
- Rost, K. 2010. The Strength of Strong Ties in the Creation of Innovation. *Research Policy*, 40(4): 588–604.
- Rothaermel, F. T., & Alexandre, M. T. 2008. Ambidexterity in Technology Sourcing: The Moderating Role of Absorptive Capacity. *Organization Science*, 20(4): 759–780.
- Sampson, R. C. 2007. R&D Alliances and Firm Performance: The Impact of Technological Diversity and Alliance Organization on Innovation. *Academy of Management Journal*, 50(2): 364–386.
- Schilling, M. A. 2009. Understanding the Alliance Data. *Strategic Management Journal*, 30: 233–260.
- Schumpeter, J. 1934. *The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest and the Business Cycle*. Cambridge, MA: Harvard University Press.
- Seibert, S. E., Kraimer, M. L., & Liden, R. C. 2001. A Social Capital Theory of Career Success. *Academy of Management Journal*, 44(2): 219–237.
- Singh, J. 2005. Collaborative Networks as Determinants of Knowledge Diffusion Patterns. *Management Science*, 51(5): 756–770.
- Singh, J., & Agrawal, A. 2011. Recruiting for Ideas: How Firms Exploit the Prior Inventions of New Hires. *Management Science*, 57(1): 129–150.
- Singh, J., & Fleming, L. 2009. Lone Inventors as Sources of Breakthroughs: Myth or Reality? *Management Science*, 56(1): 41–56.

- Singh, J., Hansen, M. T., & Podolny, J. M. 2010. The World Is Not Small for Everyone: Inequity in Searching for Knowledge in Organizations. *Management Science*, 56(9): 1415–1438.
- Sosa, M. E. 2010. Where Do Creative Interactions Come From? The Role of Tie Content and Social Networks. *Organization Science*, 22(1): 1–21.
- Tortoriello, M., & Krackhardt, D. 2010. Activating Cross-Boundary Knowledge: The Role of Simmelian Ties in the Generation of Innovations. *Academy of Management Journal*, 53(1): 167–181.
- Tortoriello, M., Reagans, R., & McEvily, B. 2012. Bridging the Knowledge Gap: The Influence of Strong Ties, Network Cohesion, and Network Range on the Transfer of Knowledge Between Organizational Units. *Organization Science*, 23(4): 1024–1039.
- Tsai, W. 2000. Social Capital, Strategic Relatedness and the Formation of Intraorganizational Linkages. *Strategic Management Journal*, 21(9): 925–939.
- Tsai, W. 2001. Knowledge Transfer in Intraorganizational Networks: Effects of Network Position and Absorptive Capacity on Business Unit Innovation and Performance. *The Academy of Management Journal*, 44(5): 996–1004.
- Tsai, W., & Ghoshal, S. 1998. Social Capital and Value Creation: The Role of Intrafirm Networks. *The Academy of Management Journal*, 41(4): 464–476.
- Turner, K. L., & Makhija, M. V. 2012. The Role of Individuals in the Information Processing Perspective. *Strategic Management Journal*, 680: 661–680.
- Tushman, M. L. 1977. Special Boundary Roles in the Innovation Process. *Administrative Science Quarterly*, 22(4): 587–605.
- Tushman, M. L., & Scanlan, T. J. 1981. Boundary Spanning Individuals: Their Role in Information Transfer and Their Antecedents. *The Academy of Management Journal*, 24(2): 289–305.
- Tzabbar, D., Aharonson, B. S., & Amburgey, T. L. 2012. When Does Tapping External Sources of Knowledge Result in Knowledge Integration? *Research Policy*, (Advance Access).
- Uzzi, B. 1997. Social Structure and Competition in Interfirm Networks: The Paradox of Embeddedness. *Administrative Science Quarterly*, 42(1): 35–67.
- Vasudeva, G., & Anand, J. 2011. Unpacking Absorptive Capacity: A Study of Knowledge Utilization from Alliance Portfolios. *Academy of Management Journal*, 54(3): 611–623.
- Volberda, H. W., Foss, N. J., & Lyles, M. A. 2010. Absorbing the Concept of Absorptive Capacity: How to Realize Its Potential in the Organization Field. *Organization Science*, 21(4): 931–951.

- Weitzman, M. L. 1998. Recombinant Growth. *Quarterly Journal of Economics*, 113(2).
- Yang, H., Phelps, C. C., & Steensma, H. K. 2010. Learning from What Others Have Learned from You: The Effects of Knowledge Spillovers on Originating Firms. *Academy of Management Journal*, 53(2): 371–389.
- Yu, T., & Cannella, A. A. 2007. Rivalry between Multinational Enterprises: An Event History Approach. *Academy of Management Journal*, 50(3): 665–686.
- Zaheer, A., & Bell, G. G. 2005. Benefiting from Network Position: Firm Capabilities, Structural Holes, and Performance. *Strategic Management Journal*, 26(9): 809–825.
- Zahra, S. A., & George, G. 2002. Absorptive Capacity: A Review, Reconceptualization, and Extension. *The Academy of Management Review*, 27(2): 185–203.
- Ziedonis, A. A. 2007. Real Options in Technology Licensing. *Management Science*, 53(10): 1618–1633.

2.10 Appendix

Figure 1. Estimated Hazard Functions of Small versus Large Distance Licensed Technologies

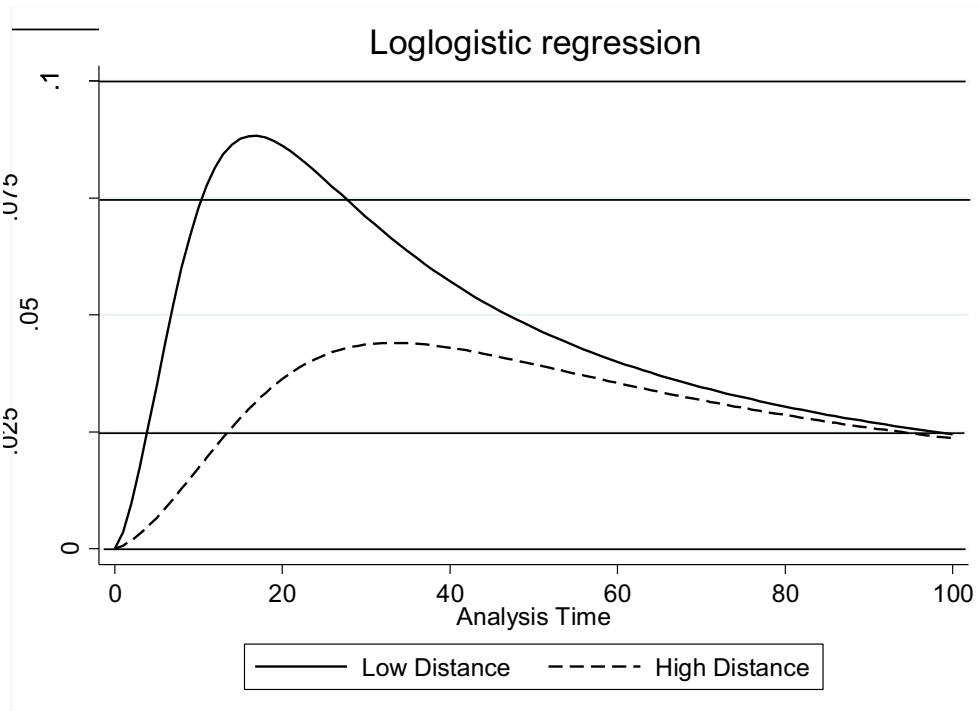


Table 1. Descriptive Statistics and Correlations Coefficients (N = 708)

Variable	Mean	S.D.	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
[1] Technological Distance	0.824	0.280	1.00										
[2] Network Density	0.259	0.285	-0.19	1.00									
[3] Average Tie Strength	1.581	1.007	-0.01	-0.21	1.00								
[4] Network Diversity	0.622	0.228	0.15	-0.57	0.13	1.00							
[5] Clustering	2.246	0.854	-0.07	-0.05	0.77	0.09	1.00						
[6] Average Path Length	2.557	1.632	0.20	-0.64	0.25	0.43	0.10	1.00					
[7] Same Sector	0.357	0.479	0.01	0.07	0.10	0.06	-0.07	-0.18	1.00				
[8] Co Patent	0.892	0.310	-0.18	-0.08	0.05	0.07	0.07	0.04	-0.04	1.00			
[9] Prior Citations	1.261	7.847	-0.04	0.12	-0.06	0.01	0.03	-0.12	-0.05	0.04	1.00		
[10] Scientific References	30.381	52.714	-0.01	-0.06	0.11	0.02	0.10	0.07	0.05	0.07	-0.01	1.00	
[11] Technology Value	60.671	155.548	-0.11	0.14	-0.03	0.00	0.02	-0.08	-0.01	0.07	0.07	0.00	1.00
[12] Technological Furnishing	0.559	0.497	0.08	-0.29	-0.01	0.15	-0.06	0.26	0.15	0.05	-0.10	-0.05	-0.11
[13] Grant-back Clause	0.242	0.429	0.02	-0.03	-0.05	0.04	-0.13	0.08	0.17	-0.08	-0.07	-0.07	0.00
[14] Milestone	0.613	0.487	-0.00	-0.05	0.12	-0.15	0.13	0.07	-0.01	-0.03	0.08	-0.04	-0.08
[15] R&D Intensity	124.633	132.409	-0.21	0.26	-0.02	-0.20	0.05	-0.32	0.13	0.00	-0.01	0.01	-0.10
[16] Licensor University	0.177	0.381	-0.12	0.21	-0.11	-0.34	-0.04	-0.27	-0.35	-0.18	0.03	-0.07	-0.06
[17] Licensor Number of Patents	334.927	1,451.046	-0.05	0.16	-0.07	-0.11	0.00	-0.17	-0.11	0.00	0.77	-0.04	0.03
[18] US Firm	0.898	0.303	0.01	0.12	-0.00	-0.06	-0.05	-0.09	0.08	-0.09	0.05	-0.06	-0.04
[19] Log(Number Employees)	7.129	2.844	0.24	-0.52	0.16	0.32	0.08	0.68	-0.25	0.25	-0.08	0.10	0.06
[20] Average Patenting Time	4.091	5.165	-0.05	0.39	-0.24	-0.38	-0.31	-0.51	0.11	-0.39	-0.07	-0.13	-0.04
[21] Previous Year Patent	0.766	0.423	0.09	-0.27	0.13	0.34	0.13	0.33	-0.01	0.63	0.03	0.09	0.06
[22] Slack	165.471	149.181	0.09	-0.37	0.35	0.28	0.21	0.42	-0.01	0.24	-0.11	0.14	-0.09

Variable	Mean	S.D.	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]
[12] Technological Furnishing	0.559	0.497	1.00										
[13] Grant-back Clause	0.242	0.429	0.18	1.00									
[14] Milestone	0.613	0.487	0.17	0.04	1.00								
[15] R&D Intensity	124.633	132.409	-0.06	-0.07	0.15	1.00							
[16] Licensor University	0.177	0.381	-0.32	-0.23	0.08	0.28	1.00						
[17] Licensor Number of Patents	334.927	1,451.046	-0.13	-0.02	0.12	0.21	0.06	1.00					

Table 2. Results of Log-Logistic Hazard Models with Gamma Frailty Predicting the Time to Knowledge Recombination

Variable	Model I	Model II	Model III	Model IV	Model V	Model VI
Technological Distance		2.439*** (0.614)	2.339*** (0.555)	2.446*** (0.605)	2.019*** (0.530)	1.915*** (0.460)
Technological Distance x Network Density			-6.418** (2.191)			-12.107*** (3.433)
Technological Distance x Avg. Tie Strength				1.368 (1.629)		0.959 (0.972)
Technological Distance x Network Diversity					-9.815** (3.234)	-10.860** (4.008)
Network Density	-2.561+ (1.484)	-1.309 (2.132)	-1.160 (1.325)	-1.014 (2.075)	-1.238 (1.779)	-1.097 (1.219)
Average Tie Strength	0.184 (0.312)	0.374 (0.395)	0.504+ (0.295)	0.424 (0.419)	0.535+ (0.296)	0.617+ (0.349)
Network Diversity	-1.083 (1.255)	0.332 (1.684)	-0.282 (1.070)	0.123 (1.838)	1.828 (1.404)	0.227 (1.330)
Clustering	-0.428 (0.371)	-0.677 (0.526)	-0.933** (0.326)	-0.649 (0.569)	-0.930** (0.326)	-0.867* (0.380)
Average Path Length	-0.499* (0.197)	-0.633*** (0.177)	-0.688*** (0.168)	-0.584** (0.178)	-0.745*** (0.163)	-0.713*** (0.156)
Same Sector	0.235 (0.457)	-0.190 (0.546)	-0.103 (0.449)	-0.238 (0.581)	-0.020 (0.398)	-0.198 (0.394)
Co Patent	7.060** (2.401)	6.449* (3.045)	3.483 (2.291)	8.458+ (4.779)	13.465*** (3.323)	6.821 (5.064)
Prior Citations	0.060* (0.029)	0.038 (0.037)	0.024 (0.037)	0.032 (0.040)	0.040+ (0.023)	0.020 (0.023)
Scientific References	0.003 (0.004)	0.005 (0.005)	0.006 (0.005)	0.006 (0.005)	0.004 (0.005)	0.006 (0.004)
Technology Value	-0.011*** (0.003)	-0.010** (0.003)	-0.011*** (0.002)	-0.010** (0.003)	-0.008* (0.003)	-0.010*** (0.003)
Technological Furnishing	-0.078 (0.454)	-0.360 (0.412)	-0.154 (0.383)	-0.331 (0.419)	-0.323 (0.453)	-0.374 (0.397)
Grant-back Clause	-1.186** (0.429)	-1.116** (0.385)	-1.225*** (0.353)	-1.152** (0.394)	-0.823* (0.362)	-1.020** (0.341)

Milestone	1.405*** (0.374)	1.129** (0.430)	1.353*** (0.345)	1.073* (0.432)	1.151*** (0.329)	1.288*** (0.297)
R&D Intensity	0.004* (0.002)	0.007** (0.002)	0.006*** (0.002)	0.007** (0.002)	0.008*** (0.002)	0.007*** (0.002)
Licensor University	-1.309* (0.613)	-1.413* (0.703)	-1.119* (0.521)	-1.426* (0.710)	-1.048+ (0.557)	-1.034* (0.515)
Licensor Number of Patents	0.000 (0.000)	0.000 (0.000)	0.000+ (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
US Firm	-0.880 (0.697)	-1.490* (0.709)	-1.323* (0.583)	-1.440* (0.733)	-1.978*** (0.584)	-1.356* (0.646)
Log (Number Employees)	0.574** (0.213)	0.461* (0.183)	0.474** (0.149)	0.448* (0.186)	0.500*** (0.144)	0.544*** (0.141)
Average Patenting Time	0.084 (0.107)	0.002 (0.088)	-0.012 (0.081)	-0.003 (0.097)	0.018 (0.061)	-0.020 (0.077)
Previous Year Patent	-4.202** (1.462)	-5.654** (1.877)	-2.385+ (1.331)	-7.873* (3.892)	-11.820*** (2.457)	-5.386 (4.381)
Slack	-0.001 (0.002)	0.001 (0.003)	0.001 (0.002)	0.000 (0.003)	0.002 (0.002)	0.000 (0.002)
Sector Dummies	YES	YES	YES	YES	YES	YES
Year Dummies	YES	YES	YES	YES	YES	YES
Constant	-1.818 (4.452)	3.108 (4.422)	3.013 (3.139)	3.405 (4.840)	2.093 (2.838)	1.964 (3.054)
log(G) constant	-0.532*** (0.154)	-0.746*** (0.168)	-0.835*** (0.148)	-0.760*** (0.165)	-0.938*** (0.220)	-1.006*** (0.175)
log (-) constant	1.648*** (0.245)	1.818*** (0.219)	1.869*** (0.207)	1.826*** (0.218)	1.902*** (0.232)	1.960*** (0.203)
Number of observations	708	708	708	708	708	708
Log-likelihood	-383.459	-375.553	-372.579	-374.985	-371.680	-365.758
Chi2	86.523***	102.335***	108.284***	103.472***	110.081***	121.926***
Likelihood ratio comparison	15.812***	21.761***	16.949***	23.559***	35.403***	

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Table 3. Difference-in-Differences Estimators with robust standard errors (N=708)

Outcome Variable	Base Line		Follow Up				
	Control	Treated	Difference	Control	Treated	Difference	Difference-in-Differences
Number of Citations	0.055	0.031	-0.024	0.055	1.541	1.486	1.510
Standard Deviation	0.034	0.017	0.038	0.034	0.181	0.184	0.188
T	1.61	-1.39	-0.63	0.06	8.38	8.18	8.04
P> t	0.107	0.061	0.527	0.107	0.000	0.000***	0.000***

*<0.10, **p<0.05, ***<0.001

CHAPTER 3

A LONGITUDINAL STUDY OF THE INFLUENCE OF TECHNOLOGY LICENSING ON FIRM INNOVATION: THE MODERATING EFFECT OF RECOVERABLE SLACK AND ORGANIZATIONAL MYOPIA

SOLON MOREIRA

Department of Innovation and Organizational Economics
Copenhagen Business School
E-mail: sm.ino@cbs.dk

3. 1 Introduction

Technology licensing is acknowledged as one of the most important contractual mechanisms for knowledge transfer between firms (Anand & Khanna, 2000). Indeed, over the last two decades a substantial increase in the number of interfirm licensing agreements has been observed, with most deals concentrated in high-tech industries such as the pharmaceutical and ICT industries (Arora & Gambardella, 2010). As a consequence of the continuous development of technology markets firms have increasingly adopted of less integrated and more open models to manage innovation (Chesbrough, 2003). Although knowledge outsourcing cannot completely replace firms' internal research and development (R&D), licensing-in can be used as a complementary part of firms' overall innovation efforts (Cassiman & Veugelers, 2006). Furthermore, even for large innovative firms, licensing provides greater strategic flexibility and a larger number of feasible options for novel combinations as compared to solely in-house alternatives (Laursen, Leone, & Torrisi, 2010).

Despite the evidence that licensing is an important mechanism for knowledge acquisition, the literature on markets for technology that has evolved over the years focuses almost exclusively on the incentives and motives behind firms' decisions to trade their technologies (e.g., Gans & Stern, 2003, 2010; McGahan & Silverman, 2006; Teece, 1986). Although the determinants of technology trade are certainly relevant, understanding the link between licensing and firm innovation is also important. In fact, it is surprising that only a few empirical studies have considered licensing-in within the context of firm innovation (e.g., Ceccagnoli & Jiang, 2012; Laursen et al., 2010; Leone & Reichstein, 2012). These studies have found that through licensing deals firms can speed the invention process (Leone & Reichstein, 2012) and search more distantly in the technological space (Laursen et al., 2010). However, to

the best of my knowledge no previous study has investigated to what extent there is a direct link between technology licensing-in and firms' capacity to produce innovations⁶. Furthermore, apart from absorptive capacity (Ceccagnoli & Hicks, 2012; Laursen et al., 2010), organizational characteristics have not received enough attention as a determinant of firms' ability to deal with licensed-in technologies.

It is well documented that firms do not possess all relevant knowledge in-house and therefore need to use external channels to sustain their internal R&D (Cassiman & Veugelers, 2006). As a consequence, innovations are generated through a combinatorial process in which internally and externally developed knowledge is put together in novel ways (Arora & Gambardella, 1990; Fleming, 2001). In fact, the need to feed internal inventive demands is increasingly leading firms to use licensing as a mechanism to absorb externally developed knowledge (Anand & Khanna, 2000). The idea that licensing-in can be used to support firm innovation is evident in the assessment made by the CEO of *Iris Pharma* regarding the licensing-in of a novel technology: "*Using this new device into our preclinical models will improve them greatly. We will be able for example to assess many other endpoints [...]*". In another example, the executive director of process science at *Boehringer Ingelheim* states that "*We will be able to leverage BaroFold's high pressure refold technology on a variety of proteins under development [...]*", referring to a technology recently licensed to support the development of drugs at the preclinical stage. Those descriptions suggest that licensing-in can be seen as an option for firms to access cutting-edge technologies and improve their capacity to produce innovations (Atuahene-Gima, 1993; Leone & Reichstein, 2012).

Building on previous studies indicating a positive effect of technology licensing-in on firm innovation, this paper examines the moderating effect that organizational slack and

⁶ One exception is the work by Johnson (2002), but his study is specifically concerned with how licensing-in adds to the R&D productivity of firms in developing countries.

myopia have on this main relationship. In the first case, I expect that high levels of slack will increase the positive effect of licensing on innovation due to the existence of redeployable resources that can be directed to exploit the newly acquired technology. Furthermore, previous studies have suggested that under circumstances of high slack it is more favorable for firms to engage in experimentation and more risk R&D projects (Cheng & Kesner, 1997; Miller & Leiblein, 1996; Nohria & Gulati, 1996). Regarding organizational myopia, I build on the “not-invented-here” syndrome literature to develop the idea that organizations in which inventors disproportionately build on internally generated knowledge to the detriment of external knowledge are less likely to benefit from licensing-in a technology (Arora & Gambardella, 2010).

The hypotheses were tested in a longitudinal setting in which I tracked the licensing and patenting behavior of 206 firms operating in the global pharmaceutical industry. This paper is among the first to investigate technology licensing-in using a large longitudinal sample that makes it possible to observe how this mechanism for knowledge acquisition can be used as an integral part of a firm’s innovation strategy. The empirical analyses were performed using the Deloitte Recap Database for the period 1983–2004, which contains detailed information on licensing deals between pharmaceutical firms. I integrate this dataset with information collected from three other sources: COMPUSTAT, United States Patent and Trademark Office (USPTO) data, and the Harvard Patent Network Dataverse. The resulting database contains annual information about firms’ financial records, licensing, and patenting activities. Using a firm fixed effects model, I find that licensing-in is positively associated with an increase in firm patenting activity in the three years subsequent to the licensing deal. Furthermore, the results also confirmed the idea that firm slack increases the positive effect of licensing on innovation, while high levels of organizational myopia decrease the main effect.

3.2 Theoretical Background

As the traditional integrated R&D models have been replaced for more open and collaborative forms of partnerships (Chesbrough, 2003; Laursen and Salter, 2006), the importance of markets for technology has dramatically increased (Ceccagnoli & Jiang, 2012). In a context of knowledge transactions, licensing contracts are one of the main mechanisms used by firms to trade know-how and technologies (Arora & Gambardella, 2010). Accordingly, licensing can be described as an arm's length contractual deal through which firms can trade know-how and intellectual property (IP) rights (Arora, 1995). Arora & Gambardella (2010) proposes that a distinguishing feature of licensing in contrast to other mechanisms for knowledge acquisition (i.e., joint ventures, M&A, and the mobility of human capital) regards the contractual nature of the knowledge. While ex-ante contracts such as research alliances involve higher uncertainty about potential outcomes, in ex-post contracts such as licensing, the traded technology can be more easily defined. Furthermore, in most licensing contracts between firms, as in the two examples mentioned earlier, the deals involve already developed and proven technologies (Atuahene-Gima, 1993; Leone & Reichstein, 2012).

As the exchange of knowledge is at the core of technology licensing, it is a mechanism that is closely related to the notion of organizational learning. Indeed, the idea of organizational learning as “a change in an organization's capacity for doing something new” (Tannenbaum, 1997, p. 438) can be closely connected with the licensee's position in a licensing deal. In fact, existing literature focusing on understating the motives for firms to license-in indicates that the acquisition of new technologies through licensing-in positively affects distinct dimensions of firm innovation. For example, Laursen et al. (2010) suggested that firms can explore more distantly from their current technological trajectory using licensed technologies. Leone and Reichstein (2012) found that licensees are able to innovate faster than non-licensees

due to the possibility to build on technologies that are already developed. However, although previous studies have documented the importance of technology licensing, little is known about how the licensee's organizational characteristics affect its capacity to innovate based on the licensed technologies.

Along this line, it is well established in the organizational literature that one of the main determinants of a firm's capacity to assimilate and integrate external knowledge regards its level of absorptive capacity. Accordingly, recent studies on technology licensing have shown that firms with high levels of absorptive capacity are better able to deal with technologies acquired through a licensing contract (e.g., Laursen et al., 2010; Ceccagnoli & Jiang, 2012). Despite the fact that absorptive capacity is one of the main determinants of a firm's ability to benefit from licensing-in, it is not the only one. Considering the existing literature on technology licensing, it is possible to identify other relevant contingencies that are expected to affect the licensee's capacity to draw on and learn from licensing-in. For example, Ceccagnoli & Jiang (2012) argue that integration costs caused by a high degree of cospecialization between R&D and downstream activities can limit the licensee's capacity to deal with licensed-in technologies. In another example, Arora & Gambardella (2010) call attention to the importance of understanding how internal resistance to external knowledge affects firms operating on the demand side of markets for technology.

Following the idea of integration costs proposed by Ceccagnoli & Jiang (2012), it is expected that the successful assimilation and application of licensed-in technologies will require the licensee to allocate substantial resources in the exploitation of the newly acquired technology. Consequently, unabsorbed resources at the time that a technology has been acquired can be necessary for the licensee to be able to deal with integration challenges. Furthermore, previous studies have shown that certain levels of organizational slack are not only relevant in

terms of the resource availability but also to induce experimentation and risk taking and to absorb the uncertainty related to the development and exploitation of new technologies (Cyert and March, 1963; Nohria and Gulati, 1996).

The second point, regarding the internal resistance that licensed-in technologies can experience, is also at the core of the integration process that licensees have to go through in order to benefit from licensing-in. Thus, even if a firm spends large amounts to license-in a technology, internal resistance from individuals or groups can significantly reduce or prevent the newly acquired knowledge from being assimilated and disseminated within the organization. This type of resistance against external knowledge can be fostered by lack of familiarity or skills (Cohen & Levinthal, 1990), path-dependency (Dosi 1982), and the concern that individuals' or groups' own ideas may be disregarded within the organization (Katz & Allen, 1982; Gupta & Govindarajan, 2000). Considering the impact that internal resistance may have on firm capacity to benefit from external knowledge acquisition, I operationalize the concept of myopia using the licensee perspective.

To summarize, previous studies have analyzed whether firms can use technology licensing-in as a mechanism to acquire external knowledge, but little is yet known about firm-specific characteristics that affect the process through which licensed technologies can foster organizational learning. In this paper I focus on how the knowledge acquired through licensing affects the number of innovations produced by the licensee and also on the moderating effect that organizational slack and myopia have on this main relationship.

3.3 Theory and Hypothesis

3.3.1 Technology Licensing and Firm Innovation

Firms can use licensing contracts as a main mechanism to acquire externally developed technologies and feed their needs for inventive knowledge (Laursen, et al., 2010). Indeed, through licensing contracts the acquiring firm can improve its innovation performance by assimilating and adapting new knowledge connected to the licensed technologies. In this sense, the reliance on technologies that have already been developed and proven not only saves efforts that would otherwise have been spent on creating a totally new technology, but also provides the acquiring firm with a larger set of technological opportunities (Klevorick, Levin, Nelson, & Winter, 1995). Furthermore, the fact that the licensed technology was developed by a different organization that naturally possesses a different set of capabilities and skills (Teece, Pisano, & Shuen, 1997) opens up new learning opportunities to the licensee.

Considering the link between licensing and organizational learning, previous studies have proposed the term “*learning-by-licensing*” (Johnson, 2002) to indicate the learning possibilities that firms can access when engaging in licensing agreements. According to this perspective, the acquisition of new knowledge results in organizational learning through an interactive combinatorial process in which new and existing elements are linked together through a continuous process of experimentation (Pisano, 1996). In this context, a licensed technology can be understood as an input that increases the size and diversity of the firm’s knowledge base. Indeed, following the knowledge-based theory of the firm, in order to develop and sustain innovation, firms must be able to manage previously accumulated knowledge as well as the inflow of knowledge generated outside their boundaries (Deeds & Decarolis, 1999). Accordingly, licensing-in is expected to have a positive impact on the number of innovations

produced by the licensee, and also provide the grounds for the adoption of new search trajectories (Laursen et al., 2010).

There are at least two distinct mechanisms through which licensing-in leads to organizational learning that can be subsequently converted into innovations. First, licensing agreements can be considered as an alternative for firms to directly acquiring/buying the IP rights to exploit a specific technology (Arora & Ceccagnoli, 2011; Ziedonis, 2004). In this case, the acquiring firm can experience learning benefits from gaining access to state-of-the-art methods and process, which can increase the R&D efficiency and the way that innovations are internally produced and managed (Gallini & Winter, 1985). Second, the other possibility for organizational learning relates to the acquisition of technologies associated with knowledge that the firm knows very little or nothing about. The unfamiliarity of the licensee with the licensed technology regards the degree to which the knowledge about the technology is not present within the firm. In this situation, the newly acquired knowledge provides the licensee with a context for novel combinations between existing and new elements (Grant, 1996; Nooteboom, Van Haverbeke, Duysters, Gilsing, & van den Oord, 2007).

Accordingly, previous research indicates that licensing is an efficient mechanism for firms to fill internal gaps in their knowledge bases, complement internal capabilities, and create the potential for new knowledge combinations. Therefore, my baseline hypothesis is the following:

Hypothesis 1: Engaging in technology licensing will be positively related to a firm's subsequent capacity to produce innovations

However, despite the positive effect that licensing-in is expected to have on firms' capacity to produce innovations, I propose that integrating a new technology can also be challenging for the licensee. Indeed, the process of knowledge transfer and integration is directly dependent on the

organizational capabilities and resources that the acquiring firm possesses to tap into external knowledge sources (Grant, 1996; Van Den Bosch, Volberda, & De Boer, 1999). Therefore, I also focus on organizational factors related to resource availability and firms' capacity to draw on external knowledge to explain cross-firm differences in benefiting from licensing-in. Following this baseline hypothesis, in the next sections I will focus on the moderating effect that recoverable slack and organizational myopia have on the main relationship between licensing-in and innovation.

3.3.2 Recoverable Slack and Knowledge Integration

Previous studies have pointed out that despite the fundamental role that external knowledge acquisition has for firms' innovation performance, the assimilation and integration of knowledge generated outside the firms' boundaries can pose several difficulties and risks (Grant, 1996). Specifically examining the case of licensing-in, there is the possibility that the acquiring firm will face significant challenges in understanding and successfully applying the new knowledge (Ceccagnoli & Jiang, 2012). Furthermore, in several cases, firms will have limited comprehension of how the new technology can be further developed, becoming dependent on the licensor to support the process of knowledge integration (Arora, 1995). Consequently, given that external technologies can be difficult to assimilate and integrate, it is not uncommon that the acquiring firm needs to invest significant efforts and resources in order to benefit from it (Ceccagnoli & Jiang, 2012; Kotha et al., 2013). In fact, successful integration requires the licensed-in technology to go through a process of experimentation, refinement and, especially in the case of licensing, adaptation to the specific needs of the acquiring firm (Jensen & Thursby, 2001).

The licensee's difficulties in integrating a newly licensed-in technology increase if the licensor and the licensee operate in different industries or at different stages of the value

chain (Wilcox King & Zeithaml, 2003). This can be attributed to the fact that in most cases, a technology has been developed to be applied and to meet the needs of a firm in a specific context (Gambardella & Giarratana, 2012). In fact, it is not uncommon that licensors choose to license their technologies only to firms operating in different industries in order to avoid an increase in the number of direct competitors with similar technological capabilities (Arora, Fosfuri, & Gambardella, 2001; Fosfuri, 2006). This fact suggests that the licensee needs to possess high levels of absorptive capacity relative to the licensed technology (Lane & Lubatkin, 1998) or the necessary resources to deal with the integration challenges in a timely manner (Ceccagnoli & Jiang, 2012).

Given those challenges, the integration process of licensed-in technologies can be associated with high uncertainty regarding its potential outcomes. Indeed, several studies have pointed out that the process of external knowledge acquisition and development is associated with high failure rates (Das & Teng, 2000; Park & Russo, 1996). In this context, Laursen et al., (2010) argue that licensing-in can also be considered a form of exploratory search that firms use to reach distant (unfamiliar) technological domains. In fact, if we refer back to the seminal work of March (1991), exploratory search is described as being directly associated with high risk and experimentation.

Departing from this perspective, I argue that the level of recoverable slack within the acquiring firm is critical for the process of assimilating and integrating licensed-in technologies. Organizational literature has conceptualized recoverable slack as “the pool of resources in an organization that is in excess of the minimum necessary to produce a given level of organizational output” (Nohria & Gulati, 1996). Indeed, slack resources can be observed in the form of excess inputs such as unused capacity, unnecessary capital expenditures, and unexploited opportunities to increase outputs (Cheng & Kesner, 1997; George, 2005; Nohria & Gulati, 1996; Singh, 1986). High levels of slack are particularly useful for firms when dealing

with environmental jolts (Meyer, 1982) and engaging in high-risk R&D activities (George, 2005). Hence, I expect slack to directly affect firm capacity to benefit from licensing-in.

Therefore, I propose that the positive effect of technology licensing-in on a firm's capacity to produce innovations will be stronger under conditions of high recoverable slack. As the level of unabsorbed slack available to the licensee increases, the amount of resources that can be redeployed for the successful integration of the newly acquired technology grows. Indeed, considering that before being able to benefit from a licensed-in technology a firm must first be able to assimilate it, the availability of resources can be particularly critical to the integration process. Under conditions of resource constraint, firms are more likely to prioritize R&D projects that have more certain outcomes and a low risk of failure (Nohria & Gulati, 1996). Consequently, licensed technologies may remain underutilized in terms of their potential as inputs in the generation of innovations under conditions of limited resources. On the other hand, when the amount of resources available to be redeployed in the assimilation and application of licensed-in technologies is high, firms are likely to increase the effects of licensing-in on innovation.

Therefore, I argue that when the knowledge inputs provided by technology licensing-in are held constant, the capacity that the licensee will have to assimilate and to produce novel combinations from the licensed technologies will increase under conditions of a high level of recoverable slack. Consequently, the positive effect of licensing-in on the number of innovations produced by a firm tends to increase with the total amount of unobserved resources at the time of the licensing agreement. Based on those arguments I propose the following moderating effect for recoverable slack:

Hypothesis 2: The effect of technology licensing on innovation will be moderated by the firm's level of recoverable slack in such a fashion that increasing slack will increase the positive effect of licensing on the firm's subsequent capacity to produce innovations

3.3.3 Organizational Myopia and Licensing

My first hypothesis argues that licensing-in increases firms' subsequent capacity to produce innovations. However, this effect may be also contingent upon the openness of the acquiring firm to build upon and learn from external knowledge. Katz and Allen (1982) proposed the term "Not Invented Here (NIH) Syndrome" to describe the propensity that stable research teams have to systematically overlook and reject the ideas generated by outsiders. As suggested by the NIH literature, especially among individuals affiliated with highly cohesive groups within organizations, the knowledge possessed by insiders is often seem as superior to the knowledge that lies outside the firm's boundaries (Katz and Allen, 1982). Indeed, Katz and Allen define the NIH syndrome as a the fact that "*...stable project teams become increasingly cohesive over time and begin to separate themselves from external sources of technical information and influence by communicating less frequently with professional colleagues outside their teams*" (1982, p. 7). In this context, it is well known that organizations often draw disproportionately on internally developed technologies and do not pay enough attention to external sources (Agrawal, Cockburn, & Rosell, 2009; Arora & Gambardella, 2010). This is especially true for large firms, where inventors are more likely to find a larger set of technological alternatives generated in-house (Agrawal et al., 2009).

Relying on the NIH syndrome definition, Agrawal et al. (2009) describe as myopic organizations firms in which inventors disproportionately build upon their own innovations⁷. The presence of persistent myopic behavior in the process of generating innovations is, at least partially, a consequence of the lower incentives that single individuals or groups have to use external knowledge as compared to their own (Katz & Allen, 1982). For

⁷ In their paper, Agrawal et al. propose five different types of myopia: 1) *Self-citation to Own Prior Inventions*; 2) *Use of New Knowledge*; 3) *Technological Myopia*; 4) *Locational Myopia*; and 5) *Temporal Myopia*. Because I am interested in firms' resistance to external knowledge, I focus in my analysis on the first concept of myopia.

example, apart from the fact that inventors are likely to find it simpler to continuously build on their own inventions and accumulated knowledge, individuals tend to be rewarded if their ideas are recurrently used and applied within the organization (Rotemberg & Saloner, 1994). In fact, putting aside the implications related to the lack of access to external knowledge sources, it is less costly and simpler to access and use internal knowledge relative to external knowledge. However, as the NIH syndrome emerges, organizations' capacity to absorb and use external knowledge becomes jeopardized (Agrawal et al., 2009). Furthermore, given that firms need to continuously tap into knowledge sources to learn and absorb new technological knowledge, internal resistance can harm their capacity to stay competitive.

I expect the deleterious bias created by the NIH syndrome to be particularly prominent in the case of licensed-in technologies. Given that licensing agreements often involve technologies that are already substantially developed, individuals may not find space to incorporate their own previous innovations into the core of the licensed-in technology. Consequently, in comparison with strategic alliances, where the output is usually the fruit of joint development efforts between inventors in two or more firms (Sampson, 2007; Schilling & Phelps, 2007), licensed technologies are more prone to suffer internal resistance. Individuals and teams might see their position and expertise threatened if a technology whose development they had relatively little, or no, influence on is adopted instead of their own. In other words, they have stronger incentives to invest more effort and time into developing and incorporating knowledge generated by themselves or by other members of their group. Consequently, licensed-in technologies may be overlooked in favor of internally developed ones.

Another explanation of why individuals might resist a licensed-in technology is related to the path-dependent nature of organizational routines and capabilities (Dosi & Marengo, 2007; Pentland, Feldman, Becker, & Liu, 2012). While developing and establishing routines that allow individuals to work in teams and facilitate collaboration between employees

with different backgrounds is important, it also generates organizational rigidities (Schreyögg & Kliesch-Eberl, 2007). One way in which those rigidities can manifest themselves is in the form of resistance to external knowledge. In fact, the novelty that is usually associated with licensed-in technologies (Laursen et al., 2010) is likely to require employees to adopt meaningful changes such as restructuring their immediate network (Paruchuri & Eisenman, 2012), learning new skills, and changing routines in order to accommodate the integration of the new technology (Dosi & Marengo, 2007).

Consequently, even if firms license-in to gain access to external knowledge, the process of integrating the licensed technology into the firms' knowledge base might still be met with internal resistance. On the background of these arguments, I expect that firms that exhibit high levels of myopic behavior in the way that their inventions are conceived will face challenges in integrating licensed-in technologies. Therefore, my final hypothesis states that:

Hypothesis 3: The effect of technology licensing on innovation will be moderated by the firm's level of organizational myopia in such a fashion that increasing myopia will decrease the positive effect of licensing on the firm's subsequent capacity to produce innovations

3.4 Empirical Design, Data, and Sample

To test the proposed hypotheses, I constructed a panel of firms operating in the global pharmaceutical industry. Firms in this industry develop and commercialize drugs, chemical components, biological products, and medical devices. Several studies have indicated that pharmaceutical firms provide an appropriate empirical setting to test hypotheses related to knowledge acquisition and innovation (e.g., Gambardella, 1992; Paruchuri, 2009; Roberts, 1999). The information used in this study derives from four data sources. First, in order to select a sample of firms that use technology licensing-in as a mechanism to acquire knowledge, I

closely examined the licensing deals listed at the Deloitte Recap Database in the period 1983-2004. The Recap database is acknowledged as one of the most accurate and comprehensive sources of information regarding partnerships and technology exchange involving pharmaceutical firms (Schilling, 2009). This database allowed me to access the original licensing contracts, from which it was possible to extract precise information regarding the date of the licensing event and to identify unambiguously the firm acquiring the technology. The second step was to use the firms' names and addresses to identify licensing contracts in which the licensee was a public firm listed in COMPUSTAT. I decided to focus only on public firms to ensure that I was able to obtain consistent financial information over long periods of time and also to reduce excessive heterogeneity in the sample. Furthermore, although the Recap database covers only pharmaceutical deals, it also includes firms that primarily operate in different industries. To overcome this issue, I use the Standard Industrial Classification system (SIC) to define empirically whether a firm belongs to the pharmaceutical industry. To do so, I restrict the initial sample to firms that have their primary activities in one of the following four-digit SIC codes: 28- (2833, 2834, 2835, 2836) and 38- (3826, 3841, 3842, 3844)⁸. Restricting the sample to a limited number of SIC codes reduces concerns about potential bias originating from differences in firms' propensity to innovate across industries (Levin, Klevorick, Nelson, & Winter, 1987).

After matching those databases I was left with 312 unique firms involved in at least one licensing contract⁹ during the period covered by the data. Because I measure firm innovation using patents, I further matched those firms with the NBER patent database and the

⁸ Those four-digit SIC codes cover the following segments: 2833- *Medicinal Chemicals & Botanical Products*, 2834- *Pharmaceutical Preparations*; 2835- *In Vitro & In Vivo Diagnostic Substances*; 2836- *Biological Products, (No Diagnostic Substances)*; 3826- *Laboratory Analytical Instruments*; 3841- *Orthopedic, Prosthetic & Surgical Appliances & Supplies*, 3842- *Orthopedic, Prosthetic & Surgical Appliances & Supplies*, 3844- *X-Ray Apparatus & Tubes & Related Irradiation Apparatus*

⁹ I removed the observations regarding licensing contracts signed between firms belonging to the same group (i.e., owned subsidiaries)

Harvard Patent Network Dataverse. This implied dropping from the sample 68 firms that never patented. On the basis of those two databases I was able to compute firms patenting behavior. This setting produced a panel structure with unique observations for each firm-year unit of analysis.

Because not all financial information was available for all the years for all firms, the resulting dataset has different numbers of time series per firm. This translates into an unbalanced panel consisting of 206 firms for which all the variables were available for at least three years¹⁰. Each firm appears in the sample on average 12.1 times, with a minimum of three and a maximum of 22 observations for the same firm¹¹. Because the patent data is censored in 2004 I limited the last licensing deal in the sample to 2001. This allowed me to observe the effect of licensing-in on firm patenting within three subsequent years. I define a licensing year event on the basis of whether firm i signs at least one licensing contract in year t . In total there are 456 licensing year events in the period 1983-2001, inclusive. Compared to the total sample, this number of licensing deals represents 18.17% of all firm-year observations. I also looked at the distribution of licensing deals over the years to ensure that there is no overrepresentation of licensing activity in certain periods. I observe that the highest number of firm licensing events in a single year was 53 in 1997, which represents only 11.62% of the total number of deals observed in the sample. Figure 1 displays the yearly distribution of licensing events and the number of firms observed in each specific year. It is possible to see a clear drop in the number of deals reported in 1998; this pattern is similar to the findings reported by Schilling (2009) and is likely to be caused by volatility in firms' licensing behavior. Furthermore, the average number of licensing-in deals per firm was 2.81, with a minimum of 1 and a maximum of 11. Finally, for

¹⁰ I removed from the sample firms that appear for less than three years to increase the overall balance of the panel and to ensure enough observations regarding the same firm to run the econometric analysis.

¹¹ Later in the paper I provide evidence that the unbalanced nature of the panel does not raise concerns regarding selectivity bias.

firms involved in more than one licensing deal within the same year, I aggregate all the deals into one single observation¹². Although aggregating the number of licensing deals might lead to loss of information, it simplifies the data structure and the interpretation of the results. Overall, the dataset this study draws on includes 2,509 firm-year observations regarding 206 firms tracked over the period 1983-2004.

[Insert Figure 1 around here]

3.5 Measures

Firm Innovation: I measure firm innovation as the count of successful patent applications from firm i in year t . Prior studies have shown that patents are strongly correlated with new product introductions as well as with non-patentable innovations (Trajtenberg, 1987). In order to avoid noise produced by differences in evaluation procedures across patent offices, I only consider the patents applied for at the United States Patent and Trademark Office (USPTO). Given that the U.S. market represents the world's largest market for high-tech products, global firms have large incentives to apply for patents at the USPTO (Phelps, 2010; Rivette, 1993). To compute the total number of patents firm i applied for in year t , I use the patent application date because it is closely related to the timing of knowledge creation (Ahuja, 2000). To account for the heterogeneity across patents in terms of value and quality, I weight each patent in the sample with the number of forward citations that it received from other patents (Griliches, 1990).

Although licensing contracts provide a range of legal clauses and mechanisms that facilitate the process of knowledge transfer (Choi, 2002; David & Olsen, 1992), the assimilation and use of external technologies involve more than the simple permission to use certain knowledge covered by a group of patents (Arora, 1995). Therefore, given that firms might need

¹² Only 4.8% of the observations in the final sample regard firms that engaged in more than one licensing contract in the same year, with the maximum being three contracts per year.

more than one period to assimilate and apply the licensed technology to the generation of innovations (Leone & Reichstein, 2012), I used three different lags for the dependent variable (Patents $t+1$; Patent $t+2$; Patents $t+3$). This strategy not only makes it possible to capture the effect of licensing-in on firm patenting over a longer period of time, but also reduces concerns about reverse causality¹³ (Angrist & Pischke, 2009).

Independent Variables

Technology Licensing-in. To capture the effect of licensing-in on subsequent firm innovation I generated a dummy variable that takes the value 1 if firm i has been involved in at least one licensing deal at year t , and 0 otherwise. In this setting firms might enter into several licensing-in deals over the period covered by the data.

Recoverable Slack. Several studies have operationalized *Recoverable Slack* on the basis of financial ratio measures (Bourgeois, 1981; Cheng & Kesner, 1997; Miller & Leiblein, 1996). Compared to other finer-grained indicators (e.g., surveys), financial ratios offer the advantage of being consistent and verifiable indicators of managerial behavior over time (George, 2005). Therefore, I measure *Recoverable Slack* by dividing firm i 's inventory¹⁴ in year t by the total sales. This variable is intended to capture the amount of resources that the firm has already absorbed as excess costs, but can be recovered for necessary redeployment. Instead, one could suggest that the use of *Available Slack* would be more appropriate in the context of this paper.

¹³ One could argue that firms would first produce an invention and subsequently engage in licensing contracts as a strategy to avoid infringing on technology holders' rights. As a consequence, if this were the case, I would capture the effect of innovation on the licensing decision and not the other way around. However, I do not expect that a firm producing an innovation at year t will license a technology to avoid infringement problems in year $t+1$, and then patent the initial invention only at year $t+3$. Especially in the context of the pharmaceutical industry, where patents are a major source of competitive advantage, firms try to patent innovations as soon as possible as a way to exclude competitors and secure rents (Roberts, 1999).

¹⁴ The COMPUSTAT database describes Inventory as '*merchandise bought for resale and materials and supplies purchased for use in production of revenue*'. This is in line with Bourgeois' (1981) description of recoverable slack as being absorbed resources that are recoverable 'with some effort'.

However, as suggested in prior studies, an increase in a firm's liquidity and the existing amount of unabsorbed resources is likely to result from anticipated needs to meet short term obligations (Bourgeois, 1981; Cheng & Kesner, 1997). In other words, *Available Slack* is likely to represent resources that are already committed.

Finally, financial ratio measures, such as *recoverable slack*, might present exceptionally high variance across industries. Therefore, measures regarding financial ratios should not be generalized for firms in different industries given that the absolute comparisons mean very little (Miller & Leiblein, 1996). To account for this variance, I normalize this measure by dividing firm *i*'s *recoverable slack* by the four-digit SIC code industry median in the year of observation.

Organizational Myopia. Previous studies have shown several facets of myopia related to organizational learning (Levinthal & March, 1993), lack of capacity to identify opportunities and threats (Wuyts, Colombo, Dutta, & Nooteboom, 2005), negligence of cross-cultural differences (Saner, Yiu, & Søndergaard, 2000), and resistance to new technologies (Mezias & Glynn, 1993). In this paper I am specifically interested in firms' myopic behavior related to the use of knowledge generated outside their boundaries. To operationalize this construct I employ Agrawal, Cockburn, & Rosell's (2009) measure of organizational myopia, which is computed on the basis of the backward citations of firms' patents. Patent citations have been recurrently used as an indication of built-upon knowledge that firms rely on to produce innovations (Katila & Ahuja, 2002; Rosenkopf & Nerkar, 2001). Accordingly, I calculate this measure in the following way:

$$\text{Organizational Myopia } it = \frac{C_{it}^s}{C_{it}}$$

where C_{it}^S represents the total number citations that firm i made to its own patents, and C_{it} , the total number of citations, regardless of the ownership of the cited patent. Following previous studies I applied a seven year moving window to allow for enough patents to be produced and to account for knowledge depreciation over time (Phelps, 2010).

- **Control Variables**

Presample Patents. To control for unobserved heterogeneity concerning firms' patenting propensity, I use the presample average innovation count proposed by (Blundell, Griffith, & Reenen, 1995). To operationalize this variable I calculate the cumulative number of patents obtained by a firm in the five years prior to its entry in the sample.

Industry Competition. Given that both the decision to license in and the decision to innovate might be triggered by competitive pressures, I include as a control variable the total number of firms listed in the same four-digit SIC code of firm i in COMPUSTAT in year t .

Technological Collaborator. One way that firms have to deal with problem solving related to the assimilation of new technologies is the use of external partners (Powell, Koput, & Smith-Doerr, 1996). Therefore, I account for the number of co-patents applied for by firm i in the five years prior to the licensing-in deal as a proxy for propensity to collaborate with external partners.

Patenting Experience. I control for technological experience using the number of years that elapsed between the first time the firm applied for a patent and year t . Firms with more experience in innovating might also be better at managing licensed technologies. Furthermore, I also expect this variable to be significantly correlated with firm age, which has been shown to affect innovation (e.g., Owen-Smith & Powell, 2004; Sørensen & Stuart, 2000).

Technological Complexity. I control for firms' ability to handle technological complexity by computing the average number of claims on patents applied for in the seven years preceding year t . Experience in dealing with complex bodies of knowledge makes it easier for firms to integrate the acquired technology into their own knowledge bases (Leone & Reichstein, 2012).

Evaluation Capacity. Firms differ significantly in their capacity to evaluate external knowledge. On the basis of Arora and Gambardella (1994), I calculate the *Evaluation Capacity* variable using the average number of scientific references in the backward citations of patents accumulated in the seven years preceding year t . This measure aims to capture firms' in-house scientific capabilities, which reflect both the extent to which a firm's inventors search the frontier of technological space and also their ability to deal with scientific knowledge¹⁵.

Technology Diversity. Higher levels of diversity in a firm's knowledge base increase the likelihood that a licensed technology will be easily absorbed (Laursen et al., 2010). I measure firm technology diversity in year t using the Herfindahl index applied to the technological classes of the patents that firm i produced before year t :

$$\text{Technology diversity } it = 1 - \sum_{j=1} \left(\frac{N_{ijt}}{N_{it}} \right)^2$$

Where N_{it} is the total number of patents that a firm accumulated in the previous seven years and N_{jit} represents the number of patents in technology class j . The final measure is obtained by subtracting 1 from the value reflecting the concentration of patent classes across the different technological domains.

¹⁵ In their paper, Arora and Gambardella measure Evaluation Capacity using the number of scientific publications produced by a firm's inventors. I do not have information on the scientific outputs of inventors; nevertheless, I expect that the extent to which firms rely on scientific references to produce innovations is also a good indicator of inventors' search behavior and their capacity to deal with scientific knowledge.

Licensing Experience. Accumulated experience with licensing-in might enhance firms' overall innovation capabilities by establishing internal routines related to the way that licensed-in technologies are managed. Furthermore, as discussed earlier, the effect of licensing-in on innovation might extend over more than one period. I control for the number of licensing deals that firm i has accumulated in the three years before year t .

Firm R&D Intensity. A firm's expenditure in R&D activities is one of the main determinants of its capacity to absorb external knowledge (Cohen & Levinthal, 1990). So, in order to control for firm differences in terms of absorptive capacity, I measure R&D intensity by dividing a firm's R&D expenses by its sales in year t .

Firm Size. To control for firm size, I used the natural log of the number of employees (thousands) for firm i in year t .

U.S./Canada Firm. I used a region dummy that takes the value 1 if the firms' headquarter is located in U.S. or Canada.

3.6 Statistical Method

Given that I measure firm innovation performance using citation-weighted patents, the model used to conduct the empirical analysis had to appropriately accommodate non-negative integer count values. Furthermore, previous studies have shown that modeling patent count requires using a regression approach that deals with many zeros (Sampson, 2007; Ziedonis, 2004). I first considered using a Poisson model as it is one of the simplest alternatives to deal with count data (Hausman, Hall, & Griliches, 1984). However, the Poisson distribution has the strong assumption that the variance is proportional to the mean, $r(Y) = E(Y) = \mu$. If this assumption is violated, one of the implications concerns the fact that the coefficients will be estimated

consistently, but underestimated standard errors might be reflected in spurious significance levels (Cameron & Trivedi, 1986; Gourieroux, Monfort, & Trognon, 1984). The test for overdispersion provided evidence against using a Poisson model and in favor of a model that allows the variance of the dependent variable to exceed its mean.

The usual alternative to the pure Poisson model is the conditional Negative Binomial specification (Hausman et al., 1984), which is a generalization of the Poisson that is appropriate under conditions of overdispersion. The estimation of a Negative Binomial model in a longitudinal setting allows implementing either fixed or random effects as an alternative to deal with unobserved characteristics regarding the subjects in the sample. I chose to use the fixed effects specification as it allows for arbitrary correlation between unobserved time-constant factors and the explanatory variables (Wooldridge, 2012), providing more conservative estimators. In the case of the present study, I expect that not all relevant time invariant attributes simultaneously affecting firm capacity to deal with licensed-in technologies and to innovate can be successfully incorporated into the model. Furthermore, although the fixed effects estimators remove both desirable and undesirable variation across subjects (Angrist & Pischke, 2009), failing to control for unobserved heterogeneity might result in significant specification errors (Heckman, 1979).

Despite the large number of studies applying the conditional Negative Binomial fixed effects model, this model has been criticized for not providing “true” fixed effects estimators as it does not control for all time-invariant attributes (Allison & Waterman, 2002). Schilling & Phelps (2007) suggest that incorporating into the model firm attributes to account for the residual unobserved heterogeneity specifically associated with firm patenting behavior helps to deal with this problem. Following Schilling and Phelps’ steps, in addition to firm fixed effects, I also used the presample information approach of Blundell et al. (1995) as an

explanatory variable. In their approach, Blundell et al. argued that, in innovation models, one of the main sources of firm heterogeneity comes from differences in the knowledge stock that firms enter the sample. They propose that using the “entry stock” of patents can adequately control for fixed effects and virtually eliminate persistent serial correlation in count models (i.e., Poisson and Negative Binomial). This approach has also been applied in several studies related to innovation performance as a way to minimize the failure of negative binomial fixed effects to capture all firm-specific effects (e.g., Ahuja & Katila, 2001; Keil, Maula, Schildt, & Zahra, 2008; Schilling & Phelps, 2007). Accordingly, I included in the Negative Binomial model the *Presample Patents* as an explanatory variable. Finally, I also used year and industry dummies to control for unobserved industry and period effects not captured by the firm fixed effects.

3.7 Results

Table 1 reports descriptive statistics and simple correlations between the variables used in the regression analysis. The reported dependent variable corresponds to the citation-weighted count of patents following a one year lag (Patents_{t+1})¹⁶. Results of the pairwise correlation raised no concerns regarding multicollinearity. Particularly, the explanatory variables concerning the hypothesized effects do not present any strong correlations among themselves or with the control variables. Additionally, the maximum variance inflation factor (VIF) associated with any of the independent variables was 2.17 (mean VIF = 1.31), which is well below the rule-of-thumb value of ten (Gujarati, 2003). On average, 18% of the firm year observations in the sample involve a *Technology Licensing* deal, with larger firms being more likely to license in. In line with my expectations, the presample estimator presented a moderate correlation with the dependent variable ($r=0.29$), suggesting that firms’ pre-entry patent stock is positively associated with firms’ future capacity to produce innovations.

¹⁶ There are no substantial changes in the correlation between the dependent variable and the main explanatory variables, except to the fact that some of the correlations decrease in magnitude.

[Insert Table 1 around here]

Table 2 reports the negative binomial panel with fixed effects for the three dependent variables (Patents_{t+1} ; Patent_{t+2} ; Patents_{t+3}). The results for the different year lags are reported in different models. Models 1, 2, 3, and 4 report the results for a one-year lag between the explanatory variables and the citation-weighted patent count (Patents_{t+1}). Models 5, 6, 7, and 8 report the results using a two-year lag (Patents_{t+2}). Finally, models 9, 10, 11, and 12 report the results using a three-year lag (Patents_{t+3}). In order to check the stability of the coefficients and standard errors, I added the main explanatory variables one at a time. For each of the three dependent variables, the first models (1, 5, and 9) include the control variables and the main explanatory variable *Technology Licensing*. In the second models (2, 6, and 10), I included the interaction *Technology Licensing X Organizational Myopia*. In the third group of models (3, 7, and 11), the interaction term *Technology Licensing X Recoverable Slack* also enters the regression without the previous interaction term. Finally, the final models (4, 8, and 12) include the main explanatory variable and the two interaction terms simultaneously. I will focus on the interpretation of the coefficients estimated in the final models. To conserve space, the coefficients regarding industry and time period effects, while estimated in all models, are not reported.

[Insert Table 2 around here]

The results provided support for *Hypothesis 1*, which stated that *engaging in technology licensing will be positively related to a firm's subsequent capacity to produce innovation*. While the reported coefficients for *Technology Licensing* are positive and statistically significant ($p < 0.001$) across all the models, it is possible to observe a decrease in their magnitude from *Model 4* to *Model 8* and *Model 12*. I estimated the marginal effects for the coefficients regarding

the *Technology Licensing* variable in order to compare their magnitudes in absolute terms¹⁷. The marginal effects estimated on the basis of the full models indicated that licensing-in is associated with an increase of 7.2% in firm patenting after a one-year lag, 5.8% after a two-year lag, and 5.2% after a three-year lag.

Hypothesis 2 proposed *that the effect of technology licensing on innovation will be moderated by the firm's level of recoverable slack in such a fashion that increasing slack will reinforce the positive effect of licensing on the firm's subsequent capacity to produce innovations*. The coefficient for the interaction term between *Technology Licensing* and *Recoverable Slack* is positive and significant, exhibiting different levels of significance, across the models. This result suggests that the positive effect of licensing-in on firm patenting is augmented in conditions of high levels of recoverable slack, supporting the effect described in hypothesis 2. Additionally, I used a Wald test to verify whether the combined effect of this interaction term and *Technology Licensing* are simultaneously equal to zero, which would suggest that removing the interaction term would not significantly reduce the model fit. The results for the three dependent variables rejected the null hypothesis that both terms are simultaneously equal to zero (for a one-year lag: $\chi^2(2) = 49.47, p < 0.001$).

Finally, the results supported the moderation effect predicted in Hypothesis 3 regarding the fact that *the effect of technology licensing on innovation will be moderated by the firm's level of organizational myopia in such a fashion that increasing myopia will weaken the positive effect of licensing on the firm's subsequent capacity to produce innovations*. Accordingly, the interaction term between technology licensing and organizational myopia produced statistically significant and negative coefficients ($p < 0.001$). This finding supports the idea that organizational myopia negatively moderates the relationship between technology

¹⁷ The other independent variables were set to equal the sample means.

licensing and firm innovation. I also used the Wald test to check whether the joint effect of *Technology Licensing X Organizational Myopia* and the main variable is statistically different from zero. The results also indicated that the inclusion of the interaction term creates a statistically significant improvement in the fit of the model for the three dependent variables (for a one year lag: $chi^2(2) = 63.84, p < 0.001$).

In sum, the overall results support the idea that recoverable slack and organizational myopia are important moderators for firms' capacity to produce innovations out of technology licensing-in. To illustrate the magnitude of the interaction effect, Figure 2 presents the plot of the two interactions regarding *Recoverable Slack* and *Organizational Myopia* with the variable *Technology Licensing*. The graphs are calculated on the basis of the effect of one standard deviation above and below the mean. The graphic representation of the interaction effects is consistent with the results in model 4 reported on table 2, with increasing levels of slack leading to an increase in the positive effect of licensing on patenting. On the other hand, the graph shows increasing levels of myopia leading to a decrease in the effect of licensing-in on firm patenting.

[Insert Figure 2 around here]

The examination of the control variables reveals that, as expected, *Size* and *R&D Intensity* had significant and positive effects on firm patenting. In addition to that, *Licensing Experience* also displays a positive and significant coefficient. This result could be attributed to either the residual effect of previous licensing deals on firm patenting or an improvement on firm capacity to deal with licensing through accumulated experience. The fact that the coefficients for *Presample Patents* remained significant across all the models reinforces the importance of controlling for firm heterogeneity in terms of “pre-entry” knowledge stock.

Finally, the result related to the direct effect of *Recoverable Slack* also merits more detailed discussion. The main term for *Recoverable Slack* remained negative and highly significant across all the models ($p < 0.001$), which suggests that this type of slack has a negative effect on firm patenting. This result is similar to the one found by Geiger & Makri (2006), which reported that for firms with high levels of R&D intensity (which is the case for pharmaceutical firms) the effect of *Recoverable Slack* on the firms' number of new patents is negative. Furthermore, Geiger & Makri also found that Recoverable Slack is particularly important for firms' engagement in exploratory innovation¹⁸, which is also in line with my findings. Scholars have attributed the negative effect of slack on firm innovation to inefficiencies associated with resource allocation and adaptation processes (Nohria & Gulati, 1996).

3.8 Robustness Checks

I performed a number of additional robustness checks to verify whether the main results are sensitive to alternative specifications. First, I analyzed the data using a Poisson model with fixed effects. I chose to re-estimate the analysis using a Poisson model because although it is likely to suffer from overdispersion, the estimators can be regarded as true fixed effects providing robust results related to unobservable (stable) firm attributes (Allison & Waterman, 2002). Table 3 reports the results for a one-year lag¹⁹ without the time invariant explanatory variables. The Poisson model produced similar estimators to the Negative Binomial model with fixed effects, suggesting that the specification used in the main regression analysis adequately accounts for the simultaneous effect of firms' stable attributes on the dependent and independent variables. I also assessed the marginal effects of the *Technology Licensing* variable on firm patenting using the

¹⁸Laursen et al., (2010) show that licensing-in is an effective mechanism for firms to engage in exploratory search.

¹⁹ I choose to report a one-year lag in the robustness check because that is the period in which the effect of licensing-in on patenting is more pronounced, but the results for the other two dependent variables (Patent $t+2$; Patents $t+3$) are qualitatively similar to the Negative Binomial estimators.

Poisson estimator; the result indicates a reduction of 3% compared to the Negative Binomial model.

[Insert Table 3 around here]

A source of potential concern regards the presence of significant heterogeneity across the technologies in the sample. The empirical strategy that I chose to test the hypotheses did not allow me to incorporate variables that relate only to the licensing contracts and the licensors. Nevertheless, I also investigated potential bias related to the origin of the licensed technology, if it comes from a university or from another firm. In fact, Jensen & Thursby (2001) concluded that in most cases, the technologies commercialized by universities are at early stages, requiring substantial further work to reach a stage that would allow them to be commercially exploited by firms. In my sample, 12% of the licensing contracts have a university as the licensor. While this is not a large number, I still decided to investigate whether there are difference between those contracts and pure inter-firm agreements. Although I cannot assess precisely the stage of development related to the technologies in the sample, I have information regarding the age of those technologies²⁰. Considering the full sample, the average age of the licensed technologies is 6.3 years. However, the results of a t-test indicate that when accounting only for the contracts coming from universities, this value is reduced to 4.8 years. Considering this fact, I also estimated the econometric models without university contracts and the results remained the same in terms of significance and direction. In addition, I also calculated the marginal effect for the variable *technology licensing* on the dependent variable using a one-year lag; the results indicate an increase in the order of 1.8% in the sample without university contracts. As expected, if the licensed technology is more developed, the effect on firm

²⁰ While age is not an ideal proxy for the stage of development of a certain technology, I expect that the higher the age, the longer the time the technology had to be refined and further developed.

innovation is stronger. Given that the effect of university contracts seems to indicate a downward bias in my estimators, I decided to keep them in the main analysis.

Another potential concern regards the unbalanced nature of the panel structure used in the regression analysis. If the structure of the panel is unbalanced, some firms might be overrepresented in data, leading to potential selectivity bias. I examine this issue using the approach suggested by Verbeek & Nijman (1992), which consists of using a *Hausman test* to compare the coefficients of an artificially generated balanced version of the panel against the version used in the original regression analysis (naturally unbalanced). The overall results of the *Hausman test* were highly insignificant ($\chi^2 = 1.55$, $\text{Prob} > \chi^2 = 0.67$), with very small differences in the coefficients for the main explanatory variables. On the basis of this result, I found no evidence that the results are biased due to sample selectivity.

Further robustness checks, available from the author upon request, are not reported here because of space limitations. First, although I track firms' licensing behavior over a long period of time (on average 12.2 years), it is still possible that substantial firm heterogeneity explaining the licensing-in decision would affect my results. For example, firms with high levels of *Organizational Myopia* would, in the first place, be less likely to engage in licensing-in and also be less likely to improve their subsequent patenting activity. To test whether this is the case, I estimated a logit model with random effects predicting the likelihood that firm i will license a technology in year t . I used the same explanatory variables reported in the main regression analysis, except the variable *Technology Licensing-in*, which is used as the dependent variable. The coefficients for the main explanatory variables were highly insignificant, suggesting that neither *Organizational Myopia* nor *Recoverable Slack* can explain firms' decisions to engage in licensing-in. Furthermore, in line with the licensing literature, I find that *Firm Size* is a positive and statistically significant predictor for firm licensing behavior.

Finally, I also estimated the regressions using the number of technologies a firm licensed within the year of interest, instead of a dummy, to compute the variable *Technology Licensing*. The results remained the same, which can be attributed to the fact that a very low number of firms engage in more than one licensing deal within the same year.

3.9 Discussion and conclusions

This paper was mainly motivated by the scarcity of studies examining the demand side of markets for technology. This literature stream has largely ignored the fact that firms can use technology licensing-in as a learning mechanism connected to their overall innovation strategy. This paper addressed this limitation by examining the effect of technology licensing-in on firm capacity to produce innovations. Furthermore, the relationship between licensing-in and firm innovation is considered in light of organizational characteristics. The central idea developed in this paper is that firms can use technology licensing-in as a mechanism to access external knowledge, which provides learning opportunities and opens up new possibilities for knowledge generation. However, given the challenges that are associated with knowledge acquisition, I also propose that recoverable slack and organizational myopia play a critical role in the extent to which firms' innovation will benefit from licensing. While previous studies have examined specific dimensions of the relationship between technology licensing and firm innovation, this paper is among the first to investigate how licensing-in affects firm innovation over time. Furthermore, it is also one of the first to consider the licensees' organizational characteristics as an integral part of the licensing-in process.

Consistently with my expectations, the results provided broad support for the idea that by engaging in licensing-in deals, firms can increase their subsequent capacity to produce innovations. In addition to that, the empirical models also corroborated the idea that if the

licensee presents higher levels of recoverable slack at the moment of the licensing agreement, the main effect of licensing-in on innovation will be augmented. On the other hand, the higher the level of organizational myopia among the inventors within the acquiring firm, the weaker will be the effect of licensing-in on innovation. This result is in line with the idea that the NIH syndrome can prevent firms from benefitting from licensing in technology. The empirical setting used to test the proposed hypotheses was particularly appropriate as it allowed me to consistently track both licensing and patenting firm behaviors over long periods of time. This setting was also particularly important to observe the effect of licensing-in on innovation in more than one period after the licensing deal was signed. The empirical results are robust to firm fixed effects, several firm-level control variables, and different estimation strategies.

This study mainly contributes to two bodies of literature. First, its main contribution is related to the technology licensing research stream (Arora et al., 2001; Fosfuri, 2006; Laursen et al., 2010; Leone & Reichstein, 2012). Understanding the dynamics of the demand side of markets for technology is as important as a deep comprehension of the reasons behind the decision to license out a technology (Fosfuri, 2006). Given that firms are becoming more open to acquiring knowledge from external sources, it is particularly relevant to understand the link between licensing-in and innovation. Second, this paper also adds to the organizational learning literature by focusing on specific firm characteristics that affect the process of integrating external knowledge. Although several studies have discussed the effect of slack on innovation (Bourgeois, 1981; Nohria & Gulati, 1996), this is the first paper that I am aware of to consider it as moderator for external knowledge acquisition and innovation. Furthermore, while the literature on the NIH syndrome is not scarce, the number of empirical studies examining it within the context of technology licensing-in is very limited.

The findings in this paper also have managerial implications. Considering that the relationship between licensing-in and innovation can be significantly affected by recoverable slack and organizational myopia, managers should pay attention to those two characteristics when deciding to use licensing agreements to acquire new technologies. I acknowledge the fact that it might not be simple for managers to directly influence inventors to search more openly and incorporate external knowledge as an input in their innovations. Nevertheless, it is possible for firms to adopt innovation strategies that are less likely to allow persistent organizational myopia to be disseminated among individuals. Regarding recoverable slack, the results in this paper provide evidence that firms should provide individuals with an appropriate environment for experimentation and risk-taking when inventors are supposed to engage in the development of technologies acquired from external sources, as in the case of licensing agreements.

This study should also be considered in light of some limitations. First, although I emphasized the benefits of technology licensing-in for firm innovation, I did not consider that in the long-term it might also impose costs. Previous research suggests that firms need to maintain a satisfactory level of internal R&D in order to sustain innovation. Therefore, strong reliance on mechanisms like licensing agreements may jeopardize the appropriate balance between internal and external knowledge flows (Mulotte, Dussauge, & Mitchell, 2013). Furthermore, the licensee might become dangerously reliant on the licensor to further develop the licensed technology. This is particularly true in licensing contracts trading technologies that are highly unfamiliar to the licensee (Leone & Reichstein, 2012). This argument implies that when considering a making or buying decision, it is also important for firms to take into account how strategic the technology under consideration is for the firm's main activities.

Next, because the literature on organizational slack draws a clear line indicating substantial differences between potential, recoverable, and available slack, it is important that

future studies also consider how the other two forms of slack moderate the relationship between knowledge acquisition and innovation. I decided to focus on the recoverable form of organizational slack because it was more directly related to risk-taking and resource deployability. However, future studies could also consider how available slack affects the quality of the innovations that firms acquire through licensing contracts. I tried to provide evidence that recoverable slack was not able to predict firm licensing-in behavior, but this topic merits further investigation. Another potential issue regards reverse causality. Although the use of different time lags alleviates this concern, it is still possible that the licensing decision spans over longer time horizons. Along this line, future studies should also consider different types of innovation output, for example, exploratory and exploitative innovations.

Finally, I believe that the robustness of the econometric specifications have substantially reduced endogeneity concerns. First, I employed firm fixed effects to control for unobserved (stable) firm characteristics. In this case, one potential criticism to my main model would be related to the fact that negative binomial estimators do not provide true fixed effects, leaving space for bias emerging from cross-firm heterogeneity. Although this might be a potential source of concern, the robustness check using the Poisson fixed effects substantially mitigates potential concerns with this issue. Second, the use of the pre-sample estimator proposed by Blundell et al., (1995) should account for any residual heterogeneity related to innovation performance that has not been accounted by firm fixed effects. Furthermore, the pre-sample estimator is also an efficient way to deal with potential persistent serial correlation (Blundell et al., 1995). While this study was mostly concerned with firm-level characteristics that can explain differences in innovation performance, future studies should also consider examining in detail how differences at the technology level affect the relationship between technology licensing and firm innovation.

3.10 References

- Agrawal, A., Cockburn, I., & Rosell, C. 2009. Not invented here: creative myopia and company towns. *Journal of Urban Economics*, 64: 258-269.
- Ahuja, G. 2000. Collaboration Networks, Structural Holes, and Innovation: A Longitudinal Study. *Administrative Science Quarterly*, 45(3): 425-455.
- Ahuja, G. & Katila, R. 2001. Technological acquisitions and the innovation performance of acquiring firms: a longitudinal study. *Strategic Management Journal*, 22(3): 197.
- Ahuja, G. & Katila, R. 2004. Where do resources come from? The role of idiosyncratic situations. *Strategic Management Journal*, 25(8-9): 887-907.
- Allison, P. D. & Waterman, R. P. 2002. Fixed-Effects Negative Binomial Regression Models. *Sociological Methodology*, 32: 247-265.
- Anand, B. N. & Khanna, T. 2000. The Structure of Licensing Contracts. *Journal of Industrial Economics*, 48(1): 103-135.
- Angrist, J. D. & Pischke, J.-S. 2009. *Mostly harmless econometrics : an empiricist's companion*. Princeton: Princeton University Press.
- Arora, A. & Gambardella, A. 1990. Complementarity and External Linkages: The Strategies of the Large Firms in Biotechnology. *Journal of Industrial Economics*, 38(4): 361-379.
- Arora, A. & Gambardella, A. 1994. Evaluating technological information and utilizing it: Scientific knowledge, technological capability, and external linkages in biotechnology. *Journal of Economic Behavior & Organization*, 24(1): 91-114.
- Arora, A. 1995. Licensing tacit knowledge: intellectual property rights and the market for know-how. *Economics of Innovation and New Technology*, 4(1): 41-60.
- Arora, A. 1996. Contracting for Tacit Knowledge: The Provision of Technical Services in Technology Licensing Contracts. *Journal of Development Economics*, 50(2): 233-256.
- Arora, A., Fosfuri, A., & Gambardella, A. 2001. Markets for Technology and their Implications for Corporate Strategy. *Industrial & Corporate Change*, 10(2): 419-451.
- Arora, A. & Gambardella, A. 2010. Ideas for rent: an overview of markets for technology. *Industrial & Corporate Change*, 19(3): 775-803.
- Arora, A. & Ceccagnoli, M. 2011. Patent Protection, Complementary Assets, and Firms' Incentives for Technology Licensing. In M. J. Leiblein & A. A. Ziedonis (Eds.), *Technology Strategy and Innovation Management*: 193-208: Strategic Management series, vol. 4. Cheltenham, U.K. and Northampton, Mass.: Elgar.

- Atuahene-Gima, K. 1993. Determinants of inward technology licensing intentions: An empirical analysis of Australian engineering firms. *Journal of Product Innovation Management*, 10(3): 230-240.
- Blundell, R., Griffith, R., & Reenen, J. V. 1995. Dynamic Count Data Models of Technological Innovation. *Economic Journal*, 105(429): 333-344.
- Bourgeois, L. J. 1981. On the Measurement of Organizational Slack. *Academy of Management Review*, 6(1): 29-39.
- Bromiley, P. 1991. Testing a Causal Model of Corporate Risk Taking and Performance. *The Academy of Management Journal*, 34(1): 37-59.
- Cameron, A. C. & Trivedi, P. K. 1986. Econometric Models Based on Count Data: Comparisons and Applications of Some Estimators and Tests. *Journal of Applied Econometrics*, 1(1): 29-53.
- Cassiman, B. & Veugelers, R. 2006. In Search of Complementarity in Innovation Strategy: Internal R&D and External Knowledge Acquisition. *Management Science*, 52(1): 68-82.
- Ceccagnoli, M. & Hicks, D. 2012. Complementary Assets and the Choice of Organizational Governance: Empirical Evidence From a Large Sample of U.S. Technology-Based Firms. *IEEE Trans. Eng. Manage. IEEE Transactions on Engineering Management*: 1-14.
- Ceccagnoli, M. & Jiang, L. 2012. The cost of integrating external technologies: Supply and demand drivers of value creation in the markets for technology. *Strategic Management Journal*(forthcoming).
- Ceccagnoli, M. & Jiang, L. 2013. The cost of integrating external technologies: Supply and demand drivers of value creation in the markets for technology. *Strategic Management Journal*, 34(4): 404-425.
- Cheng, J. L. C. & Kesner, I. F. 1997. Organizational Slack and Response to Environmental Shifts: The Impact of Resource Allocation Patterns. *Journal of Management*, 23(1): 1.
- Chesbrough, H. W. 2003. *Open innovation : the new imperative for creating and profiting from technology*. Boston, Mass.: Harvard Business School Press.
- Choi, J. P. 2002. A dynamic analysis of licensing: The "boomerang" effect and grant-back clauses. *International Economic Review*, 43(3): 803-829.
- Cohen, W. M. & Levinthal, D. A. 1990. Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly*, 35(1): 128-152.
- Conti, R., Gambardella, A., & Novelli, E. 2013. Research on Markets for Inventions and Implications for R&D Allocation Strategies. *The Academy of Management Annals*, 7(1): 717-774.

- Das, T. K. & Teng, B.-S. 2000. Instabilities of Strategic Alliances: An Internal Tensions Perspective. *Organization Science*, 11(1): 77-101.
- David, P. A. & Olsen, T. E. 1992. Technology adoption, learning spillovers, and the optimal duration of patent-based monopolies. *International Journal of Industrial Organization*, 10(4): 517-543.
- Deeds, D. L. & Decarolis, D. M. 1999. The impact of stocks and flows of organizational knowledge on firm performance: an empirical investigation of the biotechnology industry. *Strategic Management Journal*.
- Dosi, G. & Marengo, L. 2007. On the Evolutionary and Behavioral Theories of Organizations: A Tentative Roadmap. *Organization Science*, 18(3): 491-502.
- Fleming, L. 2001. Recombinant uncertainty in technological search. *Management Science*, 47(1): 117-132.
- Fosfuri, A. 2006. The licensing dilemma: understanding the determinants of the rate of technology licensing. *Strategic Management Journal*, 27(12): 1141-1158.
- Gallini, N. T. & Winter, R. A. 1985. Licensing in the theory of innovation. *RAND Journal of Economics (RAND Journal of Economics)*, 16(2): 237-252.
- Gambardella, A. 1992. Competitive advantages from in-house scientific research: The US pharmaceutical industry in the 1980s. *Research Policy*, 21(5): 391-407.
- Gambardella, A. & Giarratana, M. S. 2012. General technological capabilities, product market fragmentation, and markets for technology. *Research Policy*(forthcoming).
- Gans, J. S. & Stern, S. 2003. The product market and the market for “ideas”: commercialization strategies for technology entrepreneurs. *Research Policy*, 32(2): 333-350.
- Gans, J. S. & Stern, S. 2010. Is there a market for ideas? *Industrial and Corporate Change*, 19(3): 805-837.
- Geiger, S. W. & Makri, M. 2006. Exploration and exploitation innovation processes: The role of organizational slack in R & D intensive firms. *The Journal of High Technology Management Research*, 17(1): 97-108.
- George, G. 2005. Slack Resources and the Performance of Privately Held Firms. *The Academy of Management Journal*, 48(4): 661-676.
- Gourieroux, C., Monfort, A., & Trognon, A. 1984. Pseudo Maximum Likelihood Methods: Applications to Poisson Models. *Econometrica*, 52(3): 701-720.
- Grant, R. M. 1996. Prospering in Dynamically-Competitive Environments: Organizational Capability as Knowledge Integration. *Organization Science*, 7(4): 375-387.

- Griliches, Z. 1990. Patent Statistics as Economic Indicators - a Survey. *Journal of Economic Literature*, 28(4): 1661-1707.
- Grindley, P. C. & Teece, D. J. 1997. Managing Intellectual Capital: Licensing and Cross-Licensing in Semiconductors and Electronics. *California Management Review*, 39(2): 8-41.
- Gujarati, D. N. 2003. Basic Econometrics. 4th: New York: McGraw-Hill.
- Hausman, J., Hall, B. H., & Griliches, Z. 1984. Econometric Models for Count Data with an Application to the Patents-R&D Relationship. *Econometrica*, 52(4): 909-938.
- Heckman, J. J. 1979. Sample Selection Bias as a Specification Error. *Econometrica*, 47(1): 153-161.
- Hornsby, J. S., Kuratko, D. F., & Zahra, S. A. 2002. Middle managers' perception of the internal environment for corporate entrepreneurship: assessing a measurement scale. *Journal of Business Venturing*, 17(3): 253-273.
- Jensen, R. & Thursby, M. 2001. Proofs and Prototypes for Sale: The Licensing of University Inventions. *The American Economic Review*, 91(1): 240-259.
- Johnson, D. K. N. 2002. "Learning-by-Licensing": R&D and Technology Licensing in Brazilian Invention. *Economics of Innovation and New Technology*, 11(3): 163-177.
- Katila, R. & Ahuja, G. 2002. Something Old, Something New: A Longitudinal Study of Search Behavior and New Product Introduction. *The Academy of Management Journal*, 45(6): 1183-1194.
- Katila, R. & Shane, S. 2005. When Does Lack of Resources Make New Firms Innovative? *The Academy of Management Journal*, 48(5): 814-829.
- Katz, R. & Allen, T. J. 1982. Investigating the Not Invented Here (NIH) syndrome: A look at the performance, tenure, and communication patterns of 50 R & D Project Groups. *R&D Management*, 12(1): 7-20.
- Keil, T., Maula, M., Schildt, H., & Zahra, S. A. 2008. The effect of governance modes and relatedness of external business development activities on innovative performance. *Strategic Management Journal*, 29(8): 895-907.
- Klevorick, A. K., Levin, R. C., Nelson, R. R., & Winter, S. G. 1995. On the sources and significance of interindustry differences in technological opportunities. *Research Policy*, 24(2): 185-205.
- Kotha, R., George, G., & Srikanth, K. 2013. Bridging the mutual knowledge gap: coordination and the commercialization of university science. *Academy of Management Journal*, 56(2): 498-524.

- Lane, P. J. & Lubatkin, M. 1998. Relative absorptive capacity and interorganizational learning. *Strategic Management Journal*, 19(5): 461.
- Laursen, K. & Salter, A. 2006. Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal*, 27(2): 131-150.
- Laursen, K., Leone, M. I., & Torrisi, S. 2010. Technological exploration through licensing: new insights from the licensee's point of view. *Industrial and Corporate Change*, 19(3): 871-897.
- Leone, M. I. & Reichstein, T. 2012. Licensing-in fosters rapid invention! the effect of the grant-back clause and technological unfamiliarity. *Strategic Management Journal*, 33(8): 965-985.
- Levin, R. C., Klevorick, A. K., Nelson, R. R., & Winter, S. G. 1987. Appropriating the Returns from Industrial Research and Development. *Brookings Papers on Economic Activity*(3): 783.
- Levinthal, D. A. & March, J. G. 1993. The myopia of learning. *Strategic Management Journal*, 14: 95-112.
- March, J. G. 1991. Exploration and Exploitation in Organizational Learning. *Organization Science*, 2(1): 71-87.
- McGahan, A. M. & Silverman, B. S. 2006. Profiting from technological innovation by others: The effect of competitor patenting on firm value. *Research Policy*, 35(8): 1222-1242.
- Meyer, A. D. 1982. Adapting to Environmental Jolts. *Administrative Science Quarterly*, 27(4): 515-537.
- Mezias, S. J. & Glynn, M. A. 1993. The three faces of corporate renewal: institutional, revolution, and evolution. *Strategic Management Journal*, 14(2): 77-101.
- Miller, K. D. & Leiblein, M. J. 1996. Corporate Risk-Return Relations: Returns Variability versus Downside Risk. *The Academy of Management Journal*, 39(1): 91-122.
- Mulotte, L., Dussauge, P., & Mitchell, W. 2013. Does pre-entry licensing undermine the performance of subsequent independent activities? Evidence from the global aerospace industry, 1944–2000. *Strategic Management Journal*, 34(3): 358-372.
- Nohria, N. & Gulati, R. 1996. Is slack good or bad for innovation? *Academy of Management Journal*, 39(5): 1245-1264.
- Nooteboom, B., Van Haverbeke, W., Duysters, G., Gilsing, V., & van den Oord, A. 2007. Optimal cognitive distance and absorptive capacity. *Research Policy*, 36(7): 1016-1034.

- Owen-Smith, J. & Powell, W. W. 2004. Knowledge Networks as Channels and Conduits: The Effects of Spillovers in the Boston Biotechnology Community. *Organization Science*, 15(1): 5-21.
- Oxley, J. E., Sampson, R. C., & Silverman, B. S. 2009. Arms race or détente? How interfirm alliance announcements change the stock market valuation of rivals. *Management Science*, 55(8): 1321-1337.
- Park, S. H. & Russo, M. V. 1996. When Competition Eclipses Cooperation: An Event History Analysis of Joint Venture Failure. *Management Science*, 42(6): 875-890.
- Paruchuri, S. 2009. Intraorganizational Networks, Interorganizational Networks, and the Impact of Central Inventors: A Longitudinal Study of Pharmaceutical Firms. *Organization Science*, 21(1): 63-80.
- Paruchuri, S. & Eisenman, M. 2012. Microfoundations of Firm R&D Capabilities: A Study of Inventor Networks in a Merger. *Journal of Management Studies*, 49(8): 1509-1535.
- Pentland, B. T., Feldman, M. S., Becker, M. C., & Liu, P. 2012. Dynamics of Organizational Routines: A Generative Model. *Journal of Management Studies*, 49(8): 1484-1508.
- Phelps, C. C. 2010. longitudinal study of the influence of alliance network structure and composition on firm exploratory innovation. *Academy of Management Journal*, 53(4): 890-913.
- Phene, A., Fladmoe-Lindquist, K., & Marsh, L. 2006. Breakthrough innovations in the U.S. biotechnology industry: the effects of technological space and geographic origin. *Strategic Management Journal*, 27(4): 369-388.
- Powell, W. W. 1990. Neither market nor hierarchy: Network forms of organization. *Research in Organizational Behavior*, 12: 295.
- Powell, W. W., Koput, K. W., & Smith-Doerr, L. 1996. Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology. *Administrative Science Quarterly*, 41(1): 116-145.
- Radjou, N. P. J. C. A. S.; Jugaad innovation think frugal, be flexible, generate breakthrough growth.
- Rivette, K. G. 1993. Corporate patent portfolios. *Technology Forecast. Price Waterhouse: New York.*, Price Waterhouse: New York.
- Roberts, P. W. 1999. Product innovation, product-market competition and persistent profitability in the U.S. *Strategic Management Journal*, 20(7): 655-670.
- Rosenkopf, L. & Nerkar, A. 2001. Beyond Local Search: Boundary-Spanning, Exploration, and Impact in the Optical Disk. *Strategic Management Journal*, 22(4): 287.

- Rosenkopf, L. & Almeida, P. 2003. Overcoming local search through alliances and mobility. *Management Science*, 49(6): 751-766.
- Rotemberg, J. J. & Saloner, G. 1994. Benefits of Narrow Business Strategies. *The American Economic Review*, 84(5): 1330-1349.
- Sampson, R. C. 2007. R&D Alliances and Firm Performance: The Impact of Technological Diversity and Alliance Organization on Innovation. *Academy of Management Journal*, 50(2): 364-386.
- Saner, R., Yiu, L., & Søndergaard, M. 2000. Business diplomacy management: A core competency for global companies. *Academy of Management Executive*, 14(1): 80-92.
- Schilling, M. A. & Phelps, C. C. 2007. Interfirm Collaboration Networks: The Impact of Large-Scale Network Structure on Firm Innovation. *Management Science*, 53(7): 1113-1126.
- Schilling, M. A. 2009. Understanding the alliance data. *Strategic Management Journal*, 30(3): 233-260.
- Schreyögg, G. & Kliesch-Eberl, M. 2007. How dynamic can organizational capabilities be? Towards a dual-process model of capability dynamization. *Strategic Management Journal*, 28(9): 913-933.
- Singh, J. V. 1986. Performance, slack, and risk taking in organizational decision making. *Academy of Management Journal*, 29(3): 562-585.
- Sørensen, J. B. & Stuart, T. E. 2000. Aging, Obsolescence, and Organizational Innovation. *Administrative Science Quarterly*, 45(1): 81-112.
- Teece, D. J. 1986. Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy*, 15(6): 285-305.
- Teece, D. J., Pisano, G., & Shuen, A. 1997. Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7): 509-533.
- Trajtenberg, M. 1987. Patents, Citations and Innovations: Tracing the Links: National Bureau of Economic Research, Inc, NBER Working Papers: 2457.
- Van Den Bosch, F. A., Volberda, H. W., & De Boer, M. 1999. Coevolution of firm absorptive capacity and knowledge environment: Organizational forms and combinative capabilities. *Organization Science*, 10(5): 551-568.
- Verbeek, M. & Nijman, T. 1992. Testing for Selectivity Bias in Panel Data Models. *International Economic Review*, 33(3): 681-703.
- Wilcox King, A. & Zeithaml, C. P. 2003. Measuring organizational knowledge: a conceptual and methodological framework. *Strategic Management Journal*, 24(8): 763-772.

- Wooldridge, J. M. 2012. *Introductory econometrics: a modern approach*: Cengage Learning.
- Wuyts, S., Colombo, M. G., Dutta, S., & Nooteboom, B. 2005. Empirical tests of optimal cognitive distance. *Journal of Economic Behavior & Organization*, 58(2): 277-302.
- Ziedonis, R. H. 2004. Don't Fence Me In: Fragmented Markets for Technology and the Patent Acquisition Strategies of Firms. *Management Science*, 50(6): 804-820.

3.11 Figures

Figure 1: Distribution of Licensing Events and Number of Firms (1983-2004)

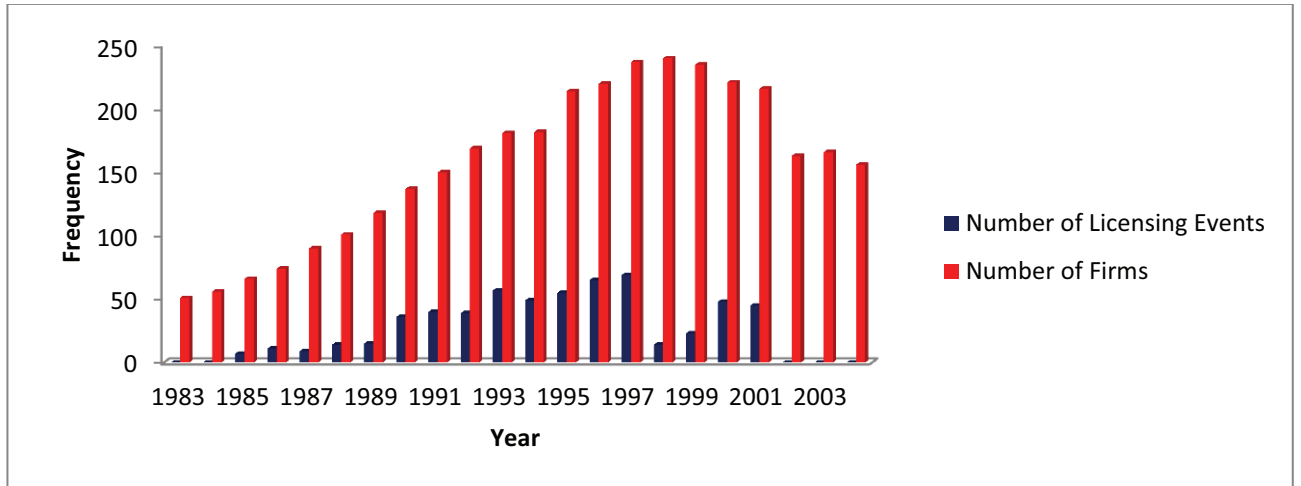
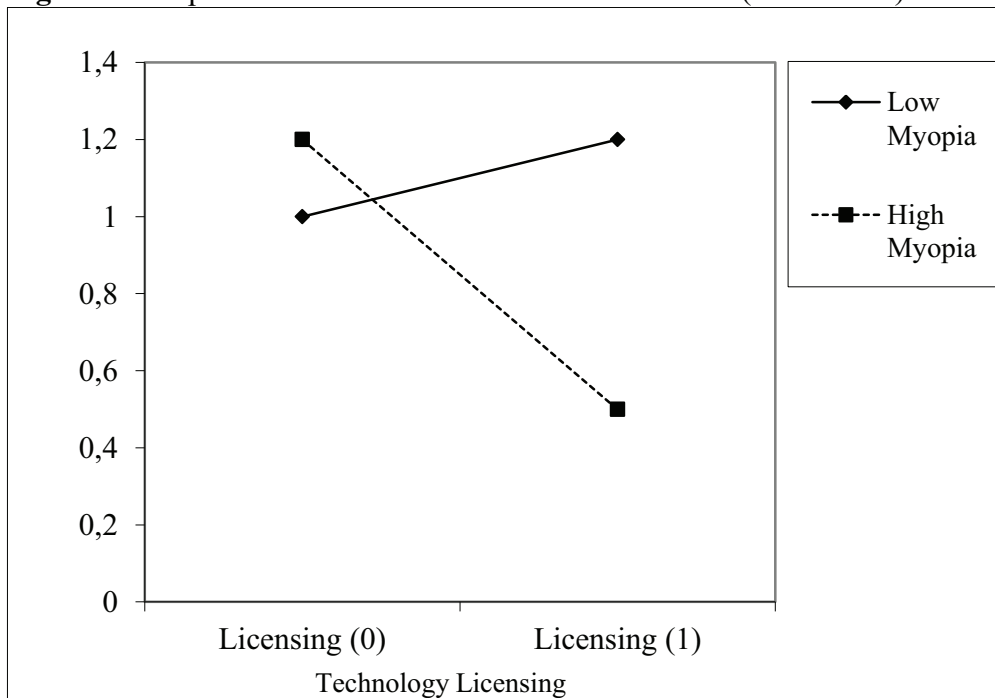


Figure 2: Graph of Interactions of Fixed Effects Models (Patents $t+1$)



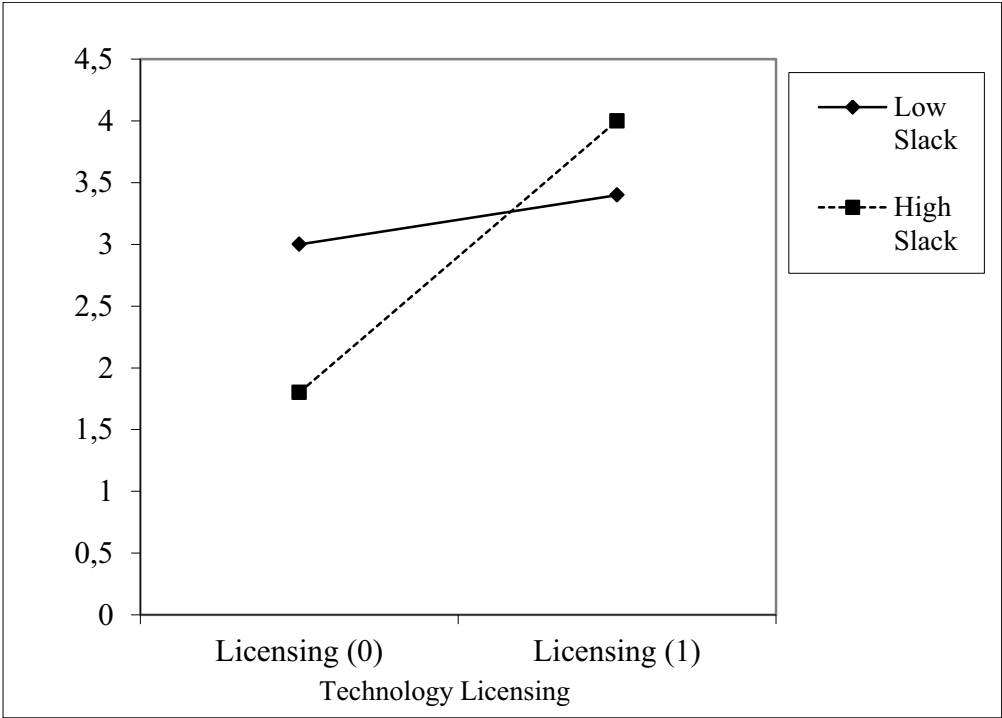


Table 1. Descriptive Statistics and Correlation Coefficients (N = 2,509)

	Mean	S.D.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) Patents $it+1$	264.138	598.055	1.00														
(2) Technology Licensing	0.180	0.384	0.11	1.00													
(3) Recoverable Slack	1.077	1.114	0.02	-0.04	1.00												
(4) Organizational Myopia	0.335	0.293	-0.03	-0.00	0.03	1.00											
(5) Firm Size	6.548	2.558	0.50	0.08	0.19	0.05	1.00										
(6) Firm R&D Intensity	149.692	286.873	-0.17	0.01	-0.16	-0.07	-0.38	1.00									
(7) Licensing Experience	0.496	0.734	0.10	0.14	-0.01	-0.03	0.08	0.01	1.00								
(8) Technology Diversity	0.612	0.303	0.23	0.03	0.01	-0.27	0.36	-0.09	0.01	1.00							
(9) Evaluation Capacity	18.239	27.767	-0.18	0.04	-0.21	-0.13	-0.28	0.23	0.13	-0.24	1.00						
(10) Technological Complexity	15.511	11.160	-0.11	-0.03	0.02	0.08	-0.16	0.04	0.02	-0.42	0.35	1.00					
(11) Patenting Experience	9.279	7.102	0.23	0.02	0.22	-0.03	0.54	-0.26	0.15	0.15	-0.10	0.09	1.00				
(12) Technological Collaborator	2.747	9.474	0.09	0.05	0.07	-0.04	0.26	-0.05	0.11	0.13	0.06	0.02	0.30	1.00			
(13) Industry Competition	146.007	84.928	-0.10	0.06	-0.01	-0.11	0.03	0.11	0.23	-0.11	0.15	0.04	0.15	0.13	1.00		
(14) U.S./Canada Firm	0.959	0.198	0.07	-0.04	-0.10	-0.07	-0.18	0.02	0.10	-0.10	0.09	0.08	-0.07	-0.14	-0.01	1.00	
(15) Presample Patents	72.675	258.379	0.29	0.09	0.10	0.01	0.44	-0.13	0.02	0.23	-0.13	-0.07	0.35	0.57	-0.05	-0.30	1.00

Table 2. Panel Negative Binomial Regression Model with Fixed Effects (N= 206; Obs= 2,509)

	Patents it+1			Patents it+2			Patents it+3					
	1	2	3	4	5	6	7	8	9	10	11	12
Technology Licensing X Recoverable Slack		0.214** (0.060)		0.240*** (0.059)		0.232*** (0.067)		0.245*** (0.066)		0.132+ (0.070)		0.153* (0.068)
Technology Licensing X Organizational Myopia			-0.732*** (0.202)	-0.828*** (0.206)			-0.885*** (0.207)	-0.931*** (0.210)			-0.947*** (0.225)	-0.987*** (0.227)
Technology Licensing	0.348*** (0.060)	0.401*** (0.061)	0.343*** (0.060)	0.401*** (0.061)	0.268*** (0.063)	0.327*** (0.065)	0.264*** (0.063)	0.326*** (0.064)	0.259*** (0.067)	0.295*** (0.069)	0.252*** (0.067)	0.291*** (0.068)
Recoverable Slack	-0.169*** (0.033)	-0.217*** (0.036)	-0.164*** (0.033)	-0.218*** (0.037)	-0.195*** (0.036)	-0.241*** (0.039)	-0.189*** (0.035)	-0.240*** (0.039)	-0.132*** (0.036)	-0.157*** (0.039)	-0.123*** (0.036)	-0.154*** (0.039)
Organizational Myopia	0.066 (0.107)	0.049 (0.107)	0.241* (0.115)	0.237* (0.115)	-0.078 (0.110)	-0.081 (0.111)	0.157 (0.121)	0.157 (0.121)	-0.086 (0.113)	-0.095 (0.113)	0.135 (0.122)	0.130 (0.122)
Firm Size	0.218*** (0.018)	0.217*** (0.018)	0.222*** (0.018)	0.221*** (0.018)	0.207*** (0.019)	0.204*** (0.019)	0.210*** (0.019)	0.207*** (0.019)	0.186*** (0.020)	0.184*** (0.020)	0.190*** (0.020)	0.187*** (0.020)
Firm R&D Intensity	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000* (0.000)	0.000* (0.000)	0.000* (0.000)	0.000* (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
Licensing Experience	0.255*** (0.036)	0.253*** (0.036)	0.250*** (0.036)	0.247*** (0.035)	0.141*** (0.038)	0.139*** (0.038)	0.144*** (0.038)	0.143*** (0.038)	0.100* (0.041)	0.100* (0.041)	0.101* (0.041)	0.100* (0.040)
Technology Diversity	-0.129 (0.114)	-0.139 (0.114)	-0.126 (0.113)	-0.137 (0.113)	-0.191 (0.118)	-0.180 (0.118)	-0.176 (0.117)	-0.164 (0.117)	-0.115 (0.124)	-0.109 (0.124)	-0.105 (0.122)	-0.096 (0.123)
Evaluation Capacity	-0.002 (0.001)	-0.002 (0.001)	-0.002 (0.001)	-0.002 (0.001)	-0.005** (0.002)	-0.005** (0.002)	-0.005** (0.002)	-0.005** (0.002)	-0.003 (0.002)	-0.003 (0.002)	-0.003 (0.002)	-0.003 (0.002)
Technological Complexity	0.006+ (0.003)	0.006* (0.003)	0.007* (0.003)	0.007* (0.003)	0.004 (0.004)	0.004 (0.004)	0.005 (0.003)	0.005 (0.003)	-0.003 (0.004)	-0.003 (0.004)	-0.002 (0.004)	-0.002 (0.004)
Patenting Experience	-0.028*** (0.006)	-0.027*** (0.006)	-0.028*** (0.006)	-0.028*** (0.006)	-0.036*** (0.006)	-0.035*** (0.006)	-0.036*** (0.006)	-0.035*** (0.006)	-0.041*** (0.007)	-0.041*** (0.007)	-0.042*** (0.007)	-0.041*** (0.007)
Technological Collaborator	-0.011*** (0.003)	-0.011*** (0.003)	-0.012*** (0.003)	-0.012*** (0.003)	-0.014*** (0.004)	-0.014*** (0.004)	-0.014*** (0.004)	-0.014*** (0.004)	-0.017*** (0.005)	-0.017*** (0.005)	-0.018*** (0.005)	-0.018*** (0.005)
U.S./Canada Firm	2.606*** (0.003)	2.623*** (0.003)	2.615*** (0.003)	2.633*** (0.003)	2.424*** (0.004)	2.425*** (0.004)	2.433*** (0.004)	2.432*** (0.004)	2.020*** (0.005)	2.023*** (0.005)	2.025*** (0.005)	2.027*** (0.005)

Industry Competition	(0.252)	(0.252)	(0.252)	(0.251)	(0.245)	(0.244)	(0.245)	(0.244)	(0.244)	(0.232)	(0.231)	(0.232)	(0.231)
	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Presample Patents	0.000*	0.000*	0.000*	0.000*	0.001***	0.001**	0.001***	0.001**	0.001**	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-5.993***	-5.947***	-6.032***	-5.981***	-6.406***	-6.365***	-6.434***	-6.388***	-6.212***	-6.212***	-6.193***	-6.235***	-6.210***
	(0.506)	(0.506)	(0.506)	(0.507)	(0.517)	(0.516)	(0.517)	(0.516)	(0.527)	(0.527)	(0.526)	(0.527)	(0.526)
Chi2	74.994	764.768	763.410	781.696	801.693	812.412	822.163	833.672	819.154	821.640	821.640	841.631	845.173
Log likelihood	-990.360	-989.761	-989.684	-988.921	-922.928	-922.351	-921.989	-921.333	-849.586	-849.415	-849.415	-848.669	-848.431

Note. All models include firm, time period, and industry effects. Standard errors are in parentheses.
+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001 (two-tailed tests for all variables)

Table 3: Panel Poisson Regression Model with Fixed Effects and Robust Standard Errors (N= 206 Obs= 2.509)

Variables	Patents it+1			
	1	2	3	4
Technology Licensing X Recoverable Slack		0.224*		0.257**
		(0.088)		(0.091)
Technology Licensing X Organizational Myopia			-0.549*	-0.630**
			(0.225)	(0.238)
Technology Licensing	0.237***	0.245***	0.222***	0.228***
	(0.060)	(0.060)	(0.055)	(0.051)
Recoverable Slack	-0.071	-0.124+	-0.072	-0.136+
	(0.067)	(0.072)	(0.068)	(0.075)
Organizational Myopia	0.198	0.181	0.305	0.299
	(0.213)	(0.213)	(0.231)	(0.229)
Firm Size	0.112	0.104	0.109	0.099
	(0.107)	(0.108)	(0.108)	(0.108)
Firm R&D Intensity	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Licensing Experience	0.199***	0.196***	0.191***	0.187***
	(0.047)	(0.046)	(0.049)	(0.048)
Technology Diversity	0.221	0.238	0.213	0.231
	(0.182)	(0.180)	(0.183)	(0.183)
Evaluation Capacity	0.003	0.002	0.002	0.002
	(0.003)	(0.003)	(0.003)	(0.003)
Technological Complexity	0.006	0.006	0.007	0.007
	(0.009)	(0.009)	(0.009)	(0.009)
Patenting Experience	-0.086***	-0.086***	-0.085***	-0.085***
	(0.010)	(0.010)	(0.010)	(0.010)
Technological Collaborator	-0.008*	-0.007*	-0.008*	-0.008*
	(0.003)	(0.004)	(0.003)	(0.004)
Industry Competition	-0.000	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Chi2	101.556	121.383	116.299	130.526
Log likelihood	-1.726.659	-1.717.926	-1.717.436	-1.706.114

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001 (two-tailed tests for all variables)

CHAPTER 4

EXPLORING THE BOOMERANG EFFECT: THE ROLE OF CORE TECHNOLOGIES AND UNCERTAINTY IN EXPLAINING THE USE OF THE GRANT-BACK CLAUSE IN TECHNOLOGY LICENSING

KELD LAURSEN

Department of Innovation and Organizational Economics
Copenhagen Business School
kl.ino@cbs.dk

MARIA ISABELLA LEONE

Department of Economics and Business
LUISS Guido Carli University
mleone@luiss.it

SOLON MOREIRA

Department of Innovation and Organizational Economics
Copenhagen Business School
E-mail: sm.ino@cbs.dk

TOKE REICHSTEIN

Department of Innovation and Organizational Economics
Copenhagen Business School
tr.ino@cbs.dk

4.1 Introduction

The modern innovative firm operates in a world characterized by specialization advantages, and uses many different inputs to its knowledge production (Pavitt 1998). This implies that firms can achieve competitive advantage by outdoing the efforts of competitors to combine knowledge from internal and external sources in the production of new and superior products (Kogut and Zander 1992, Lavie 2006). Licensing agreements are an important channel for knowledge exchange: Anand and Khanna (2000) suggest that “Licensing...is one of only a few significant methods of technology transfer between firms, and one of the most commonly observed inter-firm contractual agreements.”

However, although there may be potentially large mutual gains from trading in knowledge, these transactions may be hampered by the nature of the knowledge. It is not possible to specify exactly in a contract knowledge that is not well defined - perhaps because the technology includes a strong tacit component. This can make it cumbersome and costly for licensees to integrate the licensors' technology in their own activities (Ceccagnoli and Jiang 2012). However, it may also give licensee the option to act opportunistically, which hampers the licensors willingness to license out technology. The impossibility of specifying a complete contract may prevent trade in cutting-edge technologies because of the possibility it allows for the licensee to develop the technology further and to overtake the licensor—the so-called “boomerang effect” (Choi 2002, Van Dijk 2000).

For these reasons technology licensing is not a priority for many high-tech firms (Arora and Gambardella 2010). However, some of the problems inherent to licensing can be overcome by well-designed contracts that include clauses that align the incentives of the trading parties. The strategic management literature suggests that contractual clauses are essential for aligning the interests of the parties in an inter-firm relationship such as a strategic alliance. In

particular, they may enable transactions that require investment in specific assets by coordinating the resources and mitigating the risk of opportunistic behavior (Hoetker and Mellewigt 2009, Poppo and Zenger 2002).

While technology licensing has been investigated in economics (e.g., Arora and Fosfuri 2003, Gallini 1984, Rockett 1990) and strategic management (e.g., Arora and Ceccagnoli 2006, Ceccagnoli and Jiang 2012, Fosfuri 2006), the role played by contract design in relation to the specific clauses included in licensing contracts has been mostly ignored. There are some exceptions. Hagedoorn and Hesen (2007) assess typical contracting perspectives by analyzing the types of clauses included in various contractual agreements such as licensing agreements. Hagedoorn et al. (2009) scrutinize licensing to other firms, focusing on the conditions that lead firms to use standard licensing contracts or to construct more elaborate partnership-embedded licensing agreements. Cebrién (2009) proposes an empirical model that includes options for royalties or fixed payments, or a combination of the two, through the inclusion of clauses relating to contractual hazards. Somaya et al. (2011) examine the conditions leading to licensing agreements including exclusivity clauses.

While this body of work adds to our understanding of the functioning of technological licensing and licensing contracts, we know very little about an important and frequent clause in licensing contracts designed to alleviate the boomerang effect mentioned above: this is the grant-back clause.²¹ In many cases that (potentially) involve the dynamic effects of licensing on the competitiveness of the licensor in the innovation market (i.e., the “boomerang effect”), grant back clauses are essential since they can facilitate trade that otherwise would not take place (Choi 2002).

²¹ Caves et al. (1983) report that in their sample, 43% of firms’ licensing agreements included a grant-back clause. In our sample 17% of the licensing agreements include a grant-back clause.

The grant-back clause “requires the potential licensee to agree to grant back to the patentee [i.e., the licensor] rights to improvement patents developed by the licensee that relate to the original patent as partial consideration for the license right” (Schmalbeck 1975: 733). In this context, Leone and Reichstein (2012) show that generally licensees achieve more rapid innovation than comparable non-licensees but that this effect is negated by the inclusion in the contract of a grant-back clause. It is argued that this is because the grant-back clause reduces the licensee’s incentive to develop the licensed technology further.

This paper aims to increase our rather limited knowledge on the contingencies that determine when the contracting parties agree to the inclusion of a grant-back clause, by focusing on the factors that might explain its inclusion in a technology licensing agreement. In this case, it is a result of negotiation between licensor and licensee. To our knowledge, this attempt to try systematically to explain this phenomenon is unique. We consider especially the characteristics of the licensed technology in terms of the similarities between licensor’s and licensee’s knowledge bases, and technical uncertainties about the scope, level, and quality of follow-on innovations.

We combine insights from the resource-based view (RBV) of the firm and contract economics to build theoretical arguments regarding the inclusion of grant-back clauses in technology licensing contracts. Our fundamental theoretical argument centers on the contracting firm’s need to balance protection of its technological resources with learning through internal and external processes. We argue that licensing agreements are increasingly more likely to include a grant-back clause, the closer is the licensed technology to the core of the licensor’s patent portfolio. On the licensee’s side, we conjecture that such agreements are decreasingly likely to include a grant-back clause, the closer the licensed technology to the core of the licensee’s patent portfolio.

In addition to those effects described above, we also hypothesize that a licensing agreement will be increasingly likely to include a grant-back clause if the licensed technology is associated with high uncertainty. We expect that the contracts negotiating uncertain technologies are more likely to include the grant-back clause as licensors have incentives to reduce future threats that uncertain technologies may pose. However, these variables interact in important ways: We would argue that technology licensing agreements involving technologies that are core to the licensor and are at the same time uncertain will further increase the probability of inclusion of a grant back-clause. We argue also that the lower likelihood of a grant-back clause in technology licensing agreements involving technologies that are related to the licensee's core knowledge will be reversed if the licensed technology is uncertain.

We test the proposed hypotheses using a sample of 404 licensed technologies extracted from Recombinant Capital's Biotech Alliance (Recap) Database for the period 1984-2004. We merge the information retrieved for licensing deals with patent data from the NBER project and with firm information from the COMPUSTAT database. We employ a hierarchical nested decision model to account for the fact that the inclusion in a licensing contract of a grant-back clause is nested in the decision about which technologies to out-license. Accordingly, the empirical model comprises a two-level asymmetric nested tree in which the option of a grant-back clause is available only if the licensor decides to out-license a technology. To implement this technique we use the unique USPTO (United States Patent and Trademark Office) patent number assigned to each technology in the licensing database to estimate the likelihood that a specific technology will be licensed. Then we estimate the extent to which the licensed technology represents a core technological activity for licensor and licensee, and the level of technological uncertainty, to estimate the likelihood that a grant-back clause will be included in the contract. We find overall empirical support for our theoretical arguments.

4.2 Theoretical Background

The RBV and the competence-based view of the firm highlight that sustained competitive advantage can be achieved through ownership of valuable resources that are imperfectly mobile and imperfectly imitable (Barney 1991, Peteraf 1993, Wernerfelt 1984). We draw on these perspectives and the extension proposed by Lavie (2006) who relaxes the fundamental assumption of the original RBV that firms must own or at least fully control the resources that confer competitive advantage. Relaxation of this assumption is central to the extended RBV which claims that firms achieve sustained competitive advantage through collaboration with other firms.

The conventional RBV frame considers only *internal rents*. Internal rents are a combination of Ricardian rents and quasi-rents derived from the focal firm's internal resources (Lavie 2006, Peteraf 1993). Lavie (2006) also considers three additional types of rents that are related to the focal firm's external relations. *Appropriated relational rents* refer to the joint benefit that accrues to collaboration partners through the combination, exchange, and co-development of unique resources, and are the rents considered in the relational view of the firm (Dyer and Singh 1998). *Inbound spillover rents* are the private benefits that are derived by the focal firm exclusively from external resources subject to unintended leakages of knowledge from collaboration partners related to the partners' shared and non-shared resources.²² *Outbound spillover rents* refer to the opposite situation where the unintended leakage of the resources of the focal firm produces private benefits for the collaborating partners, thereby reducing the focal firm's competitive advantage. In our hypotheses we apply these distinctions to the types of rents relating to the benefits/rents that can be gained or lost in interactions with collaboration partners.

²² The two-sided nature of spillovers is acknowledged and exploited analytically in Myles, Shaver and Flyer (2000). The notion of inbound and outbound spillovers corresponds to Cassiman and Veugelers's (2002) concepts of incoming and outgoing spillovers, which are applied for instance, in Alcácer and Chung (2007).

In the present paper, we focus on technological resources. In many industries, technological resources are vital for sustained competitive advantage (Silverman 1999).

To understand the inclusion of a grant-back clause in licensing contracts we combine insights from the RBV of the firm with the logic of incomplete contract theory in contract economics. Under the assumption of information asymmetry between trading parties, incomplete contract theory studies whether either of the contracting parties has an incentive to act opportunistically, and relatedly, whether either party has an incentive to invest effort in the transaction (Bolton and Dewatripont 2005). In this context, Choi (2002) is a particularly important contribution which is based on incomplete contract theory and addresses the already mentioned boomerang effect. The boomerang effect implies that granting licensees the right to use the licensors' intellectual property "may enable them to develop new products, which make the licensed technology obsolete and leave the licensor in backwater of technology" (Choi 2002: 804). This possibility indicates that the risk of increasing future competition can distort the licensing relationship, preventing deals to take place. Choi (2002) shows that a quantity-dependent royalty payment can act as a "hostage" to help facilitate the transfer of the cutting-edge technology. However, even though the use of royalty payments can deal with the licensor's concerns regarding monetary compensations, the use of a royalty rate might incur in high costs for the licensee. Accordingly, if the royalty payments are too high, then the best technology will not be traded. As an alternative, a grant-back clause can reduce the costs imposed by a quantity-dependent royalty payment, thereby facilitating trade by providing both parts the incentives to trade cutting-edge technologies. However, depending on the type of technology and its importance in the trading parties' technological portfolios—related to their ability to maintain competitive advantage—a grant-back clause will be more or less likely to be included in the licensing contract.

4.3 Hypotheses

4.3.1 Licensors' core technologies

A given firm possessing technological resources will have a portfolio of core and non-core technologies related to its activities (Granstrand, Patel and Pavitt 1997). The firm's core technologies will be underpinned by a set of in-house core competencies (Prahalad and Hamel 1990).

The licensing literature generally does not consider the licensing out of core technologies, because of the potential for loss of competitive advantage (see e.g., Caves, et al. 1983). However, firms do license-out core technologies if they can avoid creating direct competitors (for an overview, see Leone and Laursen 2011). In these cases, licensing contracts are more likely to include a grant-back clause for three main reasons. First, the potential boomerang effect will be more severe for the licensor if core technology and related core competencies are involved, because of the competitive advantage and internal rents they provide. If these advantages are eliminated through the boomerang effect and resulting obsolescence of the core technology, the consequences for the licensor may be dire: There will be a strong likelihood that competition in the market will increase and new competitors will emerge. However, a grant-back clause reduces these risks. From the licensee's perspective, although the inclusion of a grant-back may reduce the potential advantages of investing in the licensing deal, it still assures access to a technology with a high potential, which subsequently may result in a successful commercial exploitation.

Second, assigning more residual rights of control to the principal (licensor) shifts the incentives for opportunistic and distorting behavior as a result of the lower *ex-post* returns to the agent (licensee). As a result, the licensee will commit fewer resources to the development of the in-licensed technology since the potential for achieving competitive advantage based on

development of the technology will be reduced. Van Dijk (2000: 1433) states that “future exchange clauses obviously weaken (licensee’s) incentives to improve current technology.” For licensees, the potential competitive advantage deriving from technology improvements is reduced because the advances achieved have to be transferred to the licensor. For the licensor, the risk of being overtaken by the licensee in a core technology is reduced as the result of a grant-back clause which increases the chances of maintaining the internal rents related to the core technology.

Third, the inclusion of a grant-back clause provides an incentive for the licensor to assist the licensee in developing the technology further and forging a collaborative learning-related arrangement based on the license (Leone and Reichstein 2012). A collaborative arrangement will increase the possibility of outbound spillover rents from the point of view of the licensor. This may be particularly dangerous if the collaboration is related to core technologies and the associated core competencies. However, the inclusion of a grant-back clause means that the potential outbound spillover rents become realized relational rents. In sum, we propose:

Hypothesis 1: Technology license agreements, ceteris paribus, are increasingly likely to include a grant-back clause the closer the licensed technology is to the core of the licensor’s patent portfolio.

4.3.2 Licensees’ core technologies

There are many reasons why firms choose to in-license technologies. In the standard licensing literature, potential licensees are attracted by rapid access to technologies that have been developed and proven by their licensors in other competitive arenas (Atuahene-Gima 1992, Atuahene-Gima 1993). In this literature, licensing-in is seen as a tactical response to a shortfall in internal R&D capabilities (Lowe and Taylor 1998). However, in-licensing is also considered

a learning mechanism allowing combinations of complementary pieces of internal and external knowledge (Choi 2002, Johnson 2002, Laursen, Leone and Torrisi 2010, Leone and Reichstein 2012, Lowe and Taylor 1998). According to Choi (2002: 807): “licensing of a new technology serves as a stepping stone for further developments of the licensed technology.”

We hypothesize that a licensing agreement related to a core technology in the licensee’s patent portfolio is very unlikely to contain a grant-back clause for two main reasons. The first is the level of absorptive capacity needed to integrate the in-licensed technology (Laursen, et al. 2010). Cohen and Levinthal (1990: 128) argue that a firm’s absorptive capacity is “largely a function of the level of prior related knowledge.” This related prior knowledge allows “the firm to better understand and therefore evaluate the import of intermediate technological advances that provide signals to the eventual merit of a new technological development” (Cohen and Levinthal 1990: 136). If the licensee’s core technology and related core competencies are technologically proximate to the in-licensed technology, it is likely that the licensee firm will have identified the appropriate patent and will be able to assimilate and exploit the knowledge contained in the in-licensed technology (for a similar logic applied to R&D-related strategic alliances, see Mowery, Oxley and Silverman 1996): Based on its prior knowledge, the licensee will probably understand the externally acquired technology. However, in the case of an unfamiliar technology, it will be difficult for the licensee to integrate the licensed technology into its activities. In this case, a grant-back clause will create an incentive for the licensor to help the licensee to integrate and develop this new technology (Leone and Reichstein 2012). This is unnecessary for a technology that is close to the licensee’s core technologies.

The second and closely related reason is that licensing agreements entail the risk of involuntary bidirectional spillovers. They hold the potential for outbound spillover rents seen

from the point of view of either party. As already mentioned, grant-back clauses are often included to facilitate technological cooperation, and provide the licensor with an incentive to help the licensee understand, integrate, and develop the in-licensed knowledge. The licensor might be encouraged to invest extra time and resources to provide supplementary knowledge if there is some potential for future benefits from grant-backs (Parr and Smith 2005). However, when the licensed in technology is close to the licensee's core technology (involving a high probability of absorption without direct technological collaboration with the licensor) then the licensee will not be keen to work cooperatively. It will be more interested in avoiding leaks of knowledge about core technologies and related core competencies to the licensor (inbound spillover rents for the licensor/outbound spillover rents for the licensee). Indeed, if the licensee is legally committed to transfer back to the licensor any technological improvement related its core technologies, there is always the risk that the licensee might lose its competitive advantages. On this basis, we posit the following:

Hypothesis 2: Technology license agreements, ceteris paribus, are decreasingly likely to include grant-back clauses the closer the licensed technology is to the core of the licensee's patent portfolio

4.3.3 Licensors and uncertain technology

Another aspect affecting the structure of contracts is the level of uncertainty of the licensed technology. According to Ziedonis (2007: 2624), technological uncertainty is related to “the commercial potential of the patent [...] and is likely to be higher for technologies that are more ‘basic’ or more ‘distant’ from commercialization.” It is more difficult to forecast the technical performance and feasibility of these types of technologies since they have not been commercialized. In other words, technological uncertainty refers to the uncertain future payoffs from investment in the new technology (Ziedonis 2007). In line with this definition, our measure

of uncertainty is intended to reflect the level of uncertainty related to the future development of the licensed technology.

If the licensor cannot predict the future trajectory of the licensed technology it will be less inclined to license it out. A licensee's attempt to improve on the original technology may fail totally, may result in an incremental improvement to the original technology, or may materialize as a radical innovation that challenges the licensor's competitive advantage. Therefore, the licensor cannot predict what might happen but will hedge against the worst possible outcome, which could result in it being overtaken by the licensee. As we pointed out earlier, the inclusion of a grant-back clause provides a safeguard to the licensor by ensuring it access to the results of developments undertaken by the licensee before the latter can exploit them in the market (Schmalbeck 1975). Hence, the potential utility of a grant-back clause increase with the uncertainty of the technology since such a clause may facilitate technology transfer that otherwise would not have happened due to the licensor's fear of being overtaken by the licensee. In the case of uncertainty about the future of a technology, joint learning may attribute more competencies to the development of the intellectual asset than possessed by either individual firm, as well as introduce risk sharing. This may hence be a feasible way to resolve development problems (e.g., Mariti and Smiley 1983, Sampson 2007). A grant-back clause provides the licensor with an incentive to collaborate with the licensee over the technology, which can benefit both contracting parties. Based on these considerations, we conjecture that:

Hypothesis 3: Technology license agreements are, ceteris paribus, increasingly likely to include a grant-back clause with increasing levels of uncertainty.

4.3.4 Licensors' core and uncertain technologies

We have argued that licensing agreements are more likely to include a grant-back clause if they represent a core technology of the licensor, or if there is uncertainty about the future

development of the technology. When both conditions hold, this should further increase the likelihood of a grant-back clause.

We argue that if the given development of the technology is relatively predictable and “safe”, then even if it is a core technology of the licensor, the license may not include a grant-back clause because the risk of a critical boomerang effect will be small. If the technology is uncertain and non-core, the licensor firm might consider not including a grant-back clause because the damage caused by a boomerang effect—and the consequential reduction in the internal rents—will likely be small in the case of a non-core technology. However, if the technology is core to the licensor and also uncertain regarding future opportunities, the potential damage to the competitive advantage of the licensor firm could be huge. Therefore, we posit that the relationship between licensors’ core technologies and the likelihood of a using the grant-back clause will be positively moderated by the level of uncertainty related to the licensed technology. In other words, we expect that increasing levels of uncertainty will reinforce the positive effect of licensor’s core technology on the likelihood of including the grant-back clause in a contract. Consequently, we suggest:

Hypothesis 4: Ceteris paribus, the increasing likelihood of a grant-back clause appearing in technology licensing agreements involving technologies that are core to the licensor increases further when the uncertainty of the licensed technology is high.

4.3.5 Licensees, and core and uncertain technologies

We have argued that the inclusion of a grant back-clause will be less likely if the licensed technology is close to the licensee’s core technologies. However, we would argue also that this effect will be reversed if the technology is also uncertain in relation to its application and development. The theory is that, as discussed above, the effect of uncertainty on its own typically leads the licensor to require the inclusion of a grant-back clause to reduce the

boomerang effect. However, in the case of uncertain technology, the licensee may require the assistance of the licensor to exploit the technology in its processes, especially when it is close to its core technological area.

A technology that is not close to commercialization generally involves a relatively high proportion of tacit knowledge. This uncodified knowledge is embedded in the licensor and can be transferred only through direct collaboration (Nelson and Winter 1982, Szulanski 1996). A grant-back clause secures the sharing of property rights *ex post* (giving rise to appropriated relational rents), and gives the licensor an incentive to assist the licensee in the development of the technology (Leone and Reichstein 2012). Given that the licensee's core technologies are critical to the licensee, under conditions of strong uncertainty, the licensee will be inclined to plead for a grant-back clause to make sure of the licensor's assistance in developing the technology in the licensee's context. This argument leads to the idea that, specifically in the case of core technologies, it is on the licensee's best interest to have the grant-back clause in deals concerning uncertain technologies. In fact, considering that licensees are likely to be keen on the further development of technologies that are core to their activities, high levels of uncertainty are expected to switch from negative into positive the likelihood that the grant-back clause will be used when the technology is core to the licensee. Indeed, accepting the grant-back clause to be included in the contract is an attractive alternative to secure that an important (core) technology, for which the licensee has invested on, will continue to be developed by the licensor. Accordingly, we conjecture:

Hypothesis 5: Ceteris paribus, the decreasing likelihood of a grant-back clause appearing in technology licensing agreements involving technologies that are core to the licensee is overturned to an increasing likelihood, when the uncertainty of the licensed technology is high.

4.4 Data and Method

4.4.1 Data

This study exploits multiple data sources. First, it utilizes U.S. pharmaceutical industry technology licensing contracts drawn from the Recap database. The Recap database is used extensively in the licensing literature making this study comparable with and integral to other work in this area (e.g., Ceccagnoli, Graham, Higgings and Lee 2010, Schilling 2009). It allows direct access to original contracts, inspection and cross checking of contracts, and extraction of detailed and precise information on the technology, the involved parties, and the contractual specifications. While Recap includes several types of contracts the present study is interested only in technology licensing contracts, and specifically, those involving the transfer of patented inventions listed at the USPTO. This allows the extraction of additional data on the traded technology from the NBER Patent database, which covers all granted USPTO patents.²³ Matching of these datasets in relation to the technology is based on the 7 digit USPTO patent numbers listed in the licensing agreements. It allows us to attach technology related variables to the licensing contracts (e.g. technology age and value).

The licensing agreements also contain licensor and licensee company names. Matching licensors' company names with the patent database identifies sub-contracting deals,²⁴ which are excluded since sub-contracting generally differs from regular contracting: The licensor's attachment to and insight into the underlying technology is different if it was not the original developer. Sub-contracts may also be subject to contractual conditions dictated by the original out-licensing to the current licensor.

²³ NBER patent data are described in detail in Hall et al. (2001).

²⁴ We identify cases where the licensor firm is different from the patenting firm.

We extracted information on licensors from COMPUSTAT. The two datasets were integrated using company name, address, and industry affiliation. This gives the COMPUSTAT firm identifier (GVKEY) used also in the NBER USPTO database, and describes the technological profiles of licensors *ex ante* licensing-out. We are able to extract all patents applied for by the licensor which eventually were granted, and which the licensor could consider potential technologies for licensing-out.

NBER patent data are matched with the Recap licensees using company name and country affiliation, providing the firm's technological profile. Use of patent data for this purpose is imperfect. For example, some firms are not listed as assignees on patents, but this does not mean they do not have a technological profile. For these few firms it is impossible to operationalize the key variables of interest. Our results therefore are conditional on firms having patented at least once before entering into a technology-licensing contract agreement. Although this is a second-best solution, the results are comparable to other studies of the markets for technology (see e.g. Parrotta and Pozzoli 2012, Ziedonis 2007)

The USPTO patent numbers are used to combine the licensed technologies with the Harvard Patent Network Dataverse. This database contains additional information on the nature of the backward citations in each patent. We use the Dataverse database to retrieve further information on the number of scientific references cited by the patents in our sample. This information is used to calculate the uncertainty related to the licensed technologies.

4.4.2 Dependent variable

The dependent variable is built using the portfolio of patents of identified licensors and the licensed technology. We scrutinized the contracts for grant-back clauses, generally to the effect that the licensee must grant back any future improvements to the licensed technology to the

licensor. The dependent variable is a three level categorical variable indicating the status of a patent with respect to licensing, and the inclusion of a grant-back clause. Some technology is not licensed out, some is licensed out under a contract that does not include a grant-back clause, and some technology is licensed in under a contract that includes a grant-back clause. The three categorical levels therefore are: (1) *non-licensed technology*, (2) *licensed technology without the grant-back clause*, and (3) *licensed technology with the grant-back clause*. The unit of analysis for the empirical investigation is the level of the technology. This set-up allows us, at least partially, to circumvent any potential self-selection issues that arise from the inclusion of a grant-back clause being conditioned by the decision to license the technology in the first place. Relatedly, due to self-selection issues, we need also to consider controls for the likelihood of the technology being exchanged in the market.

4.4.3 Independent variables

The first explanatory variable is whether the license is for the firm's *core technology*. This is measured by the firm's patenting activity prior to the licensing agreement. This measure is operationalized using the *focal index* proposed by Ziedonis (2007), which captures the degree of overlap of the firm's core technology with the licensed technology. Higher values indicate that the licensed technology is nearer to the licensor's or licensee's core technological activity. The measure is computed as follow:

$$\text{Licensor/licensee core technology} = \frac{\left[\left(\sum_{t-6}^t \sum_j \tilde{c}_i \cdot \rho_i \right)_c \right]}{\left[\left(\sum_{t-6}^t \sum_j \tilde{c}_i \cdot \rho_i \right) \right]}$$

where $\left(\sum_{t-6}^t \sum_j \tilde{c}_i \cdot \rho_i \right)_c$ represents the citation-weighted sum of firm i 's patents applied for within six years of the date of the license agreement t and which belongs to the same primary patent class c as the licensed technology, and $\left(\sum_{t-6}^t \sum_j \tilde{c}_i \cdot \rho_i \right)$ is the sum of all citation-

weighted patents issued to the firm j that were applied for by date t . The use of weighted citations allows us to capture the relative importance of each patent in the firm's portfolio (Griliches 1990). The index is calculated separately and independently for licensors and licensees. It ranges between 0 and 1 where 1 indicates that the technology is a core technology and there is a complete overlap of the primary patent class of the licensed technology and the technologies of the focal firm.

The second explanatory variable refers to *technological uncertainty*. The uncertainty of a technology relates to its technical features and potential development into commercial products or its market applicability (Huchzermeier and Loch 2001, Rosenberg 1996). Technological uncertainty is calculated as the share of scientific references listed in backward citations on the licensed patent. While “*early-stage*” technologies are founded on basic research (scientific knowledge), technologies that are closer to commercial application include fewer references to basic knowledge and a larger share of references to other patented inventions (Narin, Noma and Perry 1987, Rosenberg 1996). This measure of technology uncertainty also takes account of the qualitative aspects of backward citations.

4.4.4 Control variables

Royalty rate: The inclusion of royalty fees in licensing contracts ensures that the licensor will generate sufficient revenue from the licensing deal to overcome any decrease in profits caused by future competition (Fosfuri 2006). For this reason, licensing deals involving a licensor's core technologies are expected to include higher monetary compensation than contracts dealing with peripheral technologies²⁵ (Choi 2002). Also, the inclusion of royalty payments in the remuneration structure of licensing contracts gives the licensor a greater incentive to commit to

²⁵ In fact, Choi (2002, p. 812) explicitly proposes that “*the increase in royalty income by transferring the core technology should be sufficiently large to overcome the decrease in the profit due to future competition*”.

transferring the knowledge required by the licensee to fully exploit the licensed-in technology. Building on this perspective on knowledge transfer and learning possibilities, our conceptual model differs from Choi's in the extent that we don't expect the grant-back clause and royalty rates to be substitutes. In fact, given that we consider the grant-back clause as an indication that the licensor is willing to support the licensee to overcome assimilation issues related to the licensed technology, we assume that in the presence of the grant-back clause the licensor is more likely to require further monetary compensations related to this support. We control for a contractually-specified, fixed royalty rate that the licensee must pay to the licensor.²⁶

Technological superiority: The likelihood of a grant-back clause being included in a technology licensing deal may be associated with the licensee's and licensor's relative technological capabilities. Licensors that are technologically superior will have fewer incentives to demand a grant-back clause, given that the recipient firm is unlikely to develop the technology at a rate or in a direction that would represent a threat to the licensor in either the technology or product markets. Licensors instead will seek to negotiate other conditions favorable to them. The licensor's technological superiority is measured as the difference between the logarithm of licensor and licensee's patent stock accumulated over the eight years prior to the licensing year. Positive values indicate that the licensor is technologically superior, negative values indicate that the licensee is superior.

Exclusivity: An important contractual specification in licensing contracts regards the use of an exclusivity clause. The inclusion of such a clause in a contract implies that the licensor agrees to work with only one licensee, preventing other firms from acquiring the same technology

²⁶ The royalty rate and the grant-back clause may be an integral part of the negotiation of contractual specifications, which normally would demand a modeling approach that takes account of the simultaneity in their determination. This would redefine the royalty rate from a control to an endogenous variable. We ignore this option since the royalty rate is not the main focus of the paper and because the two variables exhibit very low levels of correlation in the empirical data (in terms of both Pearson correlations and Chi2 test statistics in a two-by-two matrix).

(Somaya, et al. 2011). Therefore, the use of this clause has implication for both parts involved in the licensing deal. While for licensee it provides the right incentives to commit more resources and actively engage in the exploitation of the licensed technology, for the licensor it is a relevant contractual mechanism to ensure the commercial success of the deal. Accordingly, given the value creation possibilities associated with this clause, we expect that the grant-back clause is more likely to be used in exclusive licensing contracts.

Technological overlap: The decision to include the grant-back clause in a licensing contract might also be affected by the extent to which licensor and licensee build on the same technological fields. In order to capture technological overlap we use the measure proposed by Jaffe (1986) which indicates the technological position of firm *A* relative to firm *B* in terms of the technological classes in which both firms have patented. In order to construct our measure we generated the technological profile of licensors and licensees by computing the distribution of accumulated patents across different classes in the five years previous to the licensing contract. Accordingly, we obtained a multidimensional vector $F_i = (F_i^1 \dots F_i^S)$ where F_i^s represents the number of patents assigned to firm *i* in the patent class *s*. The final measure is computed as follows:

$$\text{Technological overlap: } \frac{F_i F_j}{\sqrt{(F_i F_i) (F_j F_j)}}$$

This measure takes the value 0 for firms that have orthogonal vectors, value 1 for firms with identical vectors, and a value between 0 and 1 for the cases in which there is an intermediate degree of orthogonality between the firms.

Patent value: Following the convention in patent studies (Lahiri 2010, Trajtenberg 1990, Yang, Phelps and Steensma 2010, Ziedonis 2007), we proxy the economic value of a technology as a

time invariant measure of the total number of forward citations received by a patent from its date of publication to 2006.²⁷

Technology radicalness: Radical technologies have higher potential to produce significant changes in the way that economic activities are organized (Shane, 2001). Therefore, we expect licensors to be more likely to request the use of the grant-back clause as the level of radicalness of a certain technology increases. The radicalness of the technology is measured following Rosenkopf and Nerkar (1999). They use the number of different three-digit level International Patent Classification (IPC) categories related to the patents cited by the patent for the focal technology, excluding the class of the focal patent. The fact that a patent's backward citations refer to different classes (from its own) indicates that the invention builds on several different technological fields (Shane 2001).

Technology scope: Technology scope is an indication of its applicability which may be a sign of the potential for further development and may increase the licensor's incentive to include a grant-back clause in a licensing contract with another firm. We follow the measure for scope proposed in Lerner (1994), which considers the number of IPCs that USPTO assigns to a patent as an indication of the breadth of its technology base and intellectual property protection.

Technology age: The age of a technology can influence the licensor's decision to commercialize it by licensing it out or exploiting it in-house. Several studies suggest that licensors are less likely to license out technologies that might undermine their competitive position in the industry (see e.g. Leone and Reichstein 2012). Firms will therefore be less likely to commercialize more recent inventions, given that these technologies supposedly are at the technological frontier of their inventive activities.

²⁷ The latest year available in the NBER patent database.

Backward citations: It has been claimed that the total number of backward citations in a patent is a good indicator of the size of the technological space and scope of the intellectual property rights of a given technology (Harhoff and Reitzig 2004, Reitzig, Henkel and Schneider 2010). Technologies with a large number of backward citations may be more likely to be licensed since they may overlap more technological actors and be attractive to more agents on the demand side of the market for technology.

R&D intensity: The firm's relative R&D expenditure may affect its decisions regarding technology licensing. Firms that are R&D intensive are likely to be less dependent on specific technologies, while firms with low levels of in-house R&D are likely to have fewer technological opportunities (Dosi, Marengo and Pasquali 2006). It is likely also that firms that invest hugely in R&D are pursuing purely technology driven strategies which do not include traditional commercialization, and whose profits lie in exchanges of intellectual property. In addition to that, firms that exhibit high levels of R&D intensity are also more likely to have in-house capabilities to internally develop and exploit technologies. This may introduce heterogeneity in the decision to enter the markets for technology. R&D intensity is measured as firm i 's total amount of R&D investment divided by its sales in year t .

Licensor technological specialization: The firm's level of technological specialization is likely to affect the way it operates in the markets for technology: narrower technological scope renders the firm more susceptible to rent dissipation when licensing core technologies. Therefore, we include a measure of technological specialization by calculating a Herfindahl index for the total number of patents in the firm j 's patent portfolio accumulated during in the seven years before the license agreement. We operationalize this measure as follows:

Licensor technological specialization:
$$\sum_{j=1} \left(\frac{N_{ij}}{N_i} \right)^2$$

Firm slack. The availability of slack resources can affect the novelty of innovations (Nohria and Gulati 1996). Given that a firm's ability to introduce innovations characterized by a high degree of novelty may affect the firm's licensing decision, we control for firm *i*'s slack, using the ratio current assets/current liabilities in year *t*.

Firm size. We control for firm size using the logarithm of total number of employees in a given year.

Licensor market diversification: We control for the number of different markets in which the licensor operates by counting the total number of different SIC codes reported in the COMPUSTAT database at year *t*. This may spread the risks for the licensor, which might influence the inclusion or not of a grant-back clause.

Technological fragmentation. The degree of fragmentation of ownership in the firm's patent portfolio has been shown to affect patenting behavior and the strategic decisions related to exploiting the market to commercialize new technologies (Ziedonis 2004). We control for fragmentation of ownership rights of firm *j*'s patents produced at year *t* are using the fragmentation index proposed in Ziedonis (2004):

$$\text{Technological fragmentation} = 1 - \sum_{j=1} \left(\frac{NBCITES_{ij}}{NBCITES_i} \right)^2, \quad i \neq j,$$

where *j* refers to the unique entities cited by the patents granted to firm *i* in a given year. Based on this idea, *NBCITES_i* concerns to the aggregate(total) number of backward citations present in firms' *i* patents within year *t*, and *NBCITES_{ij}* to the number of unique entities listed in those backward citations²⁸.

²⁸ In line with how the measure was calculated originally we exclude from the backward citations references to the firm's own patents, to expired patents, and to scientific references.

Sales change. Licensors that experience a decrease in their sales may be under pressure to generate short-term revenue by licensing their more valuable technologies (Katz and Shapiro 1986). Percentage change in licensor's sales between the licensing years t and $t-1$ is used to control for a licensing decision motivated by financial pressures.

Finally, patenting propensity varies across years and industry segments, resulting in the need to protect an invention differing across and within the firms in our sample. To account for these effects we include dummy variables for biotech firms and medical firms (in the pharmaceutical industry) and year of the licensing contract.

4.5 Econometric analysis and model choice

With a categorical multinomial dependent variable, the first modeling choice is a multinomial logit. However, the grant-back clause cannot be considered independently of the likelihood that a technology is licensed-out. The likelihood of a technology being licensed may have an impact on the inclusion of a grant-back clause, and the grant-back clause may be subject to bias depending on the possibility of its inclusion. Hence, the different outcomes for the dependent variable may not be considered independent irrelevant alternatives (IIA), as assumed by the multinomial logit. We investigate also whether the IIA problem persists only theoretically or is an empirical challenge as well. Using a Brant test, we find strong evidence of a violation of the IIA assumption when applying multinomial logit estimation.

This paper applies a hierarchical nested logit specification to model the likelihood that a grant-back clause will be included in the licensing contract. These specifications split the categorical values into nests representing mutually dependent decisions (Manski and McFadden 1981). The nested logit therefore, is congruent with the decisions over licensing the technology and including a grant-back clause being interlinked. This model choice enables joint estimation

of the impact of firm and technology characteristics on the licensing decision and inclusion of a grant-back clause. The applied specification is a two-level nested logit model with random utility maximization (RUM) and full information maximum-likelihood estimation. This setting allows separation between use of a grant-back clause and the licensing decision while preserving the correlation between these two outcomes (Ziedonis 2007).

[Insert Figure 1 around here]

Figure 1 shows that the nest splits the sample across the three levels of the dependent categorical variable creating an asymmetric tree structure. The first nest utilizes all the USPTO patents granted to the licensor in the same year as the licensed technology on the assumption that they are all included in the portfolio of technologies that potentially could be licensed out. We identified a total of 7416 technologies of which 7012 patents were not included in the Recap dataset and we assume they were never licensed out, leaving 404 patents which we classified as being licensed out.²⁹

A potential limitation of this setting is that firms might also license non-patented inventions, which are not included in this empirical setting. However, previous studies (Arora and Ceccagnoli 2006: 294) show that there is a connection between patenting behavior and licensing activity, suggesting “the presence of a patent is almost essential for licensing.” These authors show that less than 10 percent of licensors do not patent.³⁰ Additionally, using only patented inventions to compare licensed versus non-licensed technologies ensures analytical consistency. Another potential issue related to our setting is that a certain technology may have been licensed but not reported in the Recap database. However, we have no reason to suspect

²⁹ We excluded 239 technologies produced in the same year as the licensed technologies because they had two or more different assignees, indicating that the property rights for those patents were shared among firms.

³⁰ In the Recap database, after dropping the firms for which there was no publicly available information, we had no cases of licensors that did not patent.

that, were this the case the technologies not reported in the licensing database would be systematically correlated with the likelihood of being licensed under a grant-back clause.

This study uses interaction terms to estimate the determinants of the likelihood of a grant-back clause in a licensing contract. This modeling technique requires some shaping of the data (Drucker and Puri 2005) so that observations are classified as: (1) *non licensed technology*, (2) *licensed technology without the grant-back clause*, or (3) *licensed technology with the grant-back clause*. This increases the number of observations threefold, transforming the 7416 observations into 22,248 and generating three evenly-distributed dummy variables, with 7416 positive outcomes for the three possible outcomes. Because there is no within-case variability in the second nest, following Drucker and Puri (2005) we created pseudo alternative specific outcomes for the explanatory variables by interacting them, in this nest, with the outcome variable (grant-back clause).

To assess the magnitudes of the effects of a marginal change in the explanatory variables on the probability of observing a grant-back clause in a technology license contract, we estimate marginal effects. This requires partially differentiating the probability of the grant-back clause with respect to the explanatory variables. This is problematic given the equations underlying the nested logit. There is no standardized method for capturing marginal effects for the nested logit. We follow Cameron and Trevedi's (2009) recommendations and estimate only the marginal effects not their significances. These are estimates at mean values.

4.6 Results

Table 1 reports the descriptive statistics for the variables considered in the analysis and their Pearson correlation coefficients (N=22 347). None of the correlations suggest any multicollinearity problems in the regression analysis. This is confirmed by variance inflation

factor (VIF) analysis. The maximum VIF associated with any of the independent variables is 2.78 (mean VIF = 1.40). Where it is possible to use the entire dataset for those variables, the statistics are consistent.

[Insert Table 1 around here]

Table 2 summarizes the results of the regression analysis. Model I reports the results considering only the controls, while models II-V introduce the explanatory variables and their interactions gradually. Table 2 provides support for Hypothesis 1, suggesting technology license agreements are increasingly likely to contain a grant-back clause the closer the licensed technology is to the licensor's core technology. Hypothesis 2 is also supported: Technology license agreements are decreasingly likely to contain a grant-back clause the closer is the licensed technology to the licensee's core technology. The parameter estimates for licensor's/licensee's core technology are statistically positively/negatively significant in all the models in which they are considered (II-V). The evidence slightly favors Hypothesis 1 compared to Hypothesis 2. However, both hypotheses are supported at a minimum 5 percent level of significance.

[Insert Table 2 around here]

Table 2 provides also supports Hypothesis 3 that the more uncertain the licensed technology, the more likely the technology license agreement will include a grant-back clause. The parameter estimates for uncertainty are significantly positive in all the models. Model II provides weak support at the 10 percent level of significance; the significance level is higher in models III, IV and V.

The data do not support Hypothesis 4 regarding the likelihood of a grant-back clause in technology licensing agreements involving technologies that are core to the licensor increasing if the licensed technology is uncertain. None of the interaction parameter estimates

between uncertainty and licensor core technology are significant. Accordingly, we find no evidence to suggest that the parameter estimate of the interaction between the licensor's core technology and technological uncertainty will be greater in absolute terms than the estimate associated with the licensor's core technology. This is confirmed by a Wald test.

We find statistical support for Hypothesis 5 that the decreasing likelihood of a grant-back clause in a technology licensing agreement involving technology that is core to the licensee will become an increasing likelihood if the licensed technology is uncertain. The Wald test suggests that the parameter associated with the interaction between licensee's core technology and uncertainty is significantly greater than the absolute value of the parameter estimate for licensee's core technology. Model V shows that $(1.8+4.7=0)$ is statistically greater than zero.

Among the controls we find that contracts specifying higher royalty rates are more likely to include grant-back clauses, and that contracts between parties where the licensor is technological superior tend not to contain grant-back clauses. The evidence suggests that higher value, more radical, and older technologies are more likely to be licensed. We find evidence also that technologies that are broader in scope typically are not licensed. Among firm characteristics, the empirical results suggest that R&D intensive and more technologically specialized licensors tend to engage in licensing activity. In line with previous studies, we find that larger firms, and firms characterized by a higher level of technological fragmentation tend not to engage in technology licensing.

[Insert Table 3 around here]

In order to test if the inclusion of the main explanatory variables provides significant improvement in the model fit, we used a log likelihood test to compare unrestricted

models against the restricted ones (reported at the bottom of table 2). Given that the Model 1 represents a baseline, there are no statistics reported for this model. The comparison for Model 2 - Model 1 indicates that adding the two main explanatory variables regarding Licensor and Licensee core technology significantly increased the overall model fit. To access Models III – V we used Model II as a baseline, with the results for all comparisons indicating statistically significant improvement in the overall model fit.

Table 3 reports the marginal effects corresponding to the estimates of Model V in Table 2. These estimates basically confirm the direction indicated in the standard nested logit parameters. In addition, the marginal effects reveal that a one unit increase in how core the technology is for the licensor results in a 0.03 increase in the probability of a grant-back clause for the average observation. The corresponding number for the licensee is a 0.035 decrease in the probability of a grant-back clause. The comparative effect of the interaction between licensee core technology and technological uncertainty is more than double in absolute terms exhibiting a marginal effect of 0.076.

4.7 Sensitivity analysis

We conducted several additional analyses to ensure that our results were not a by-product of our empirical choices. First, we considered those variables where we chose a particular time window, and varied the time dimensions (plus/minus 2 years). We found no evidence that our choice had any impact on the overall results of the model.

We considered the fact that some firms appear more than once in the dataset since they had licensed-out more than one technology. This means that not all observations are independent of one another, which potentially could introduce some bias in our estimators because it is standard practice in some firms and not a by-product of a general tendency in a

random sample of observations. To consider this potential source of bias, we ran a nested logit model with the bootstrap specification on the data. The results were similar to those presented in the main analysis. We can conclude that the issue is of limited concern.

Since the statistical significance of the uncertainty variable increases with the introduction of the interaction terms, we investigated the degree to which the statistical evidence and support for the hypothesis might be attributable to a potential multicollinearity problem. We ran split regressions based on mean values of the uncertainty variable. This provided evidence supporting the reported results showing that the analysis is generally robust to this potential source of bias.

4.8 Conclusion and Discussion

We began the paper by discussing the so-called “boomerang effect” proposed by the theoretical technological licensing literature. In this context, we examined the effect of the match between licensed technologies, and the characteristics of licensors’, licensees’, and the technology in determining the probability of a grant-back clause being included in the licensing agreement. By combining insights from the RBV of the firm with contract economics, we proposed theoretical arguments related to contracting firms’ need to balance protection of their technological resources with learning through internal and external processes. We theorized and found empirical support for the idea that licensing agreements are increasingly likely to contain a grant-back clause if the licensed technology is close to the licensor’s core technologies. We found also that licensing agreements are decreasingly likely to contain a grant-back clause if the licensed technology is close to the licensee’s core technologies. We found support for the idea that licensing agreements are increasingly likely to contain a grant-back clause if the licensed technology is uncertain/unproven.

We identified how these variables interact: We argued that technology licensing agreements involving technologies that are both core to the licensor and are also uncertain, should further increase the probability of a grant back-clause being included. However, we found no support for this idea: The two variables have a separate influence, but we observed no evidence of complementarity to make their combined effect even stronger. We interpret this result to imply that technology licensing agreements involving technologies that are core to the licensor and are also uncertain are very rare (this is confirmed by inspection of the descriptive statistics); Thus rather than leading to the inclusion of a grant-back clause, this situation appears to lead to a break-down in the market for technology. Finally, we explored whether the decreasing likelihood of a grant-back clause in technology licensing agreements involving technologies that are core to the licensee is overturned if the licensed technology is uncertain. We found empirical support for this argument.

Our work provides two main contributions. First, we extend the theoretical understanding of the functioning of the markets for technology as expressed in the strategic management literature (e.g. Ceccagnoli and Jiang 2012, Fosfuri 2006), by identifying the beneficiaries of the rents from potential licensing relationships, which often preclude potentially mutually beneficial deals. We show how these undesirable potential rents can be prevented by an appropriate contract design. More broadly, we provide further evidence that the design of contracts matters for firm behavior (Li, Poppo and Zhou 2010, Poppo and Zenger 2002). Second and related, we extend the RBV to predict important aspects of licensing behavior. Using a combination of the RBV and contract economics to highlight the conditions under which competitive advantage can be lost (or achieved) through licensing agreements, we propose a theory that predicts an important part of contractual behavior in licensing agreements. Basically, if the core technologies of the licensor (key resources underlying the licensor's competitive

advantage) are potentially at risk due to follow-up innovations by the licensee, a grant back-clause will be included in the licensing contract. Peripheral technologies do not pose a major threat to a licensor firm's competitive advantage and in these cases a grant back clause is not likely to be observed.

On the other hand, if the agreement concerns a technology that is core to the licensee (key resources underlying the licensee's competitive advantage), a grant-back clause is, *ceteris paribus*, not likely to be included because there is a risk of outbound spillover rents on the part of the licensee when engaging in the co-development of the technology with the licensor. Moreover, the licensee is not likely to require assistance from the licensor (the licensee has strong absorptive capacity in this case), so the incentive for co-development by the licensor is not required. However, if application of the technology in question is uncertain, and despite the risk of outbound spillover rents, the licensee will prioritize co-development with the licensee with the aim of obtaining appropriated relational rents, particularly if the technology in question is important (i.e., core) to the licensee. Therefore, the licensee will want to share the relevant property rights through a grant-back clause so that the licensor has an incentive to co-invest in the follow-up innovation. Note, though, that although we do not directly observe firm performance in this research, the actions of firms are very revealing.

The findings in this study have implications for managerial practice. They should help guide managers' decision making about how to manage and design licensing agreements. The licensing literature stresses the importance of contract design to avoid *ex-post* problems such as the boomerang effect. In this context, this paper has implications for firms seeking to achieve strategic advantage from a licensing deal. From the licensor's point of view, if the firm decides to out-license a core technology in order to generate licensing revenue and to have a technology further developed by a licensee, it is more beneficial to find a partner with a small

technological overlap with the technology to be out-licensed. Given that the grant-back clause reduces the licensee's incentive to invest in the technology, striking a deal with a dissimilar company could increase the licensor's advantage. On the licensee's side, our findings suggest that in the situation where the licensee needs support from the licensor to continue development of the technology, a grant back clause may be "a price worth paying".

This study has some limitations. First, firms may choose not to disclose certain licensing deals for secrecy and strategic reasons. If this is the case, then the representativeness of our database might be affected by selection issues. However, we have no reason to expect that if firms choose not to report certain deals, those unreported observations will be systematically correlated with the dependent variable. Second, the use of patents to calculate how core the licensed technology is to the contracting parties has some limitations. Firms may rely on other appropriability mechanisms than patents to protect their most valuable technologies, which would thus not be captured by our core technology measure. Despite this limitation regarding the use of patents, we believe that the choice of the pharmaceutical industry as the empirical context for this paper to a large degree alleviates these concerns. In this paper we do not examine how participation in the licensing market interacts with other types of knowledge acquisition (for instance, R&D collaboration). This could be an interesting direction for future research and might produce insights that would provide important guidance for managers involved in decisions about how to manage and design licensing agreements.

4.9 References

- Alcácer, J., W. Chung. 2007. Location Strategies and Knowledge Spillovers *Management Science*. 53(5) 760-776.
- Anand, B.N., T. Khanna. 2000. The Structure of Licensing Contracts. *The Journal of Industrial Economics*. 48(1) 103-135.
- Arora, A., M. Ceccagnoli. 2006. Patent Protection, Complementary Assets, and Firms' Incentives for Technology Licensing. *Management Science*. 52(2) 293-308.
- Arora, A., A. Fosfuri. 2003. Licensing the market for technology. *Journal of Economic Behavior & Organization*. 52(2) 277.
- Arora, A., A. Gambardella. 2010. Ideas for rent: an overview of markets for technology. *Industrial & Corporate Change*. 19(3) 775-803.
- Atuahene-Gima, K. 1992. Inward Technology Licensing as an Alternative to Internal R&D in New Product Development: A Conceptual Framework. *Journal of Product Innovation Management*. 10 156-167.
- Atuahene-Gima, K. 1993. Determinants of Inward Technology Licensing Intentions: An Empirical Analysis of Australian Engineering Firms. *Journal of Product Innovation Management*. 10 230-240.
- Barney, J.B. 1991. Firm Resources and Sustained Competitive Advantage. *Journal of Management*. 17 99-120.
- Bolton, P., M. Dewatripont. 2005. *Contract Theory*. MIT Press, Cambridge, Massachusetts.
- Cameron, A.C., P.K. Trivedi. 2009. *Microeconometrics Using Stata*. Stata Press, College Station, Texas.
- Cassiman, B., R. Veugelers. 2002. Spillovers and R&D Cooperation: some Empirical Evidence. *American Economic Review*. 92(4) 1169-1184.
- Caves, R.E., H. Crookell, J.P. Killing. 1983. The Imperfect Market for Technology Licenses. *Oxford Bulletin of Economics and Statistics*. 45 249-267.
- Cebrién, M. 2009. The structure of payments as a way to alleviate contractual hazards in international technology licensing. *Industrial & Corporate Change*. 18(6) 1135-1160.
- Ceccagnoli, M., S. Graham, M. Higgings, J. Lee. 2010. Productivity and the role of complementary assets in firms' demand for technology innovations. *Industrial and Corporate Change* 19(3): . 19(3) 839-869.

- Ceccagnoli, M., L. Jiang. 2012. The cost of integrating external technologies: Supply and demand drivers of value creation in the markets for technology. *Strategic Management Journal* doi: 10.1002/smj.2020.
- Choi, J.P. 2002. A dynamic analysis of licensing: The "boomerang" effect and grant-back clauses. *International Economic Review*. 43(3) 803-829.
- Cohen, W.M., D.A. Levinthal. 1990. Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly*. 35(1) 128-152.
- Dosi, G., L. Marengo, C. Pasquali. 2006. How much should society fuel the greed of innovators?: On the relations between appropriability, opportunities and rates of innovation. *Research Policy*. 35(8) 1110-1121.
- Drucker, S., M. Puri. 2005. On the Benefits of Concurrent Lending and Underwriting. *Journal of Finance*. 60(6) 2763-2799.
- Dyer, J.H., H. Singh. 1998. The Relational View: Cooperative Strategy and Sources of Interorganizational Competitive Advantage. *The Academy of Management Review* 23(4) 660-679
- Fosfuri, A. 2006. The licensing dilemma: understanding the determinants of the rate of technology licensing. *Strategic Management Journal*. 27(12) 1141-1158.
- Gallini, N.T. 1984. Deterrence by Market Sharing: A Strategic Incentive for Licensing. *American Economic Review*. 74(5) 931-941.
- Granstrand, O., P. Patel, K.L.R. Pavitt. 1997. Multi-Technology Corporations: Why They Have 'Distributed' Rather than 'Distinctive Core' Competencies. *California Management Review*. 39(4) 8-25.
- Griliches, Z. 1990. Patent Statistics as Economic Indicators - a Survey. *Journal of Economic Literature*. 28(4) 1661-1707.
- Hagedoorn, J., G. Hesen. 2007. Contract Law and the Governance of Inter-Firm Technology Partnerships – An Analysis of Different Modes of Partnering and Their Contractual Implications. *Journal of Management Studies*. 44(3) 342-366.
- Hagedoorn, J., S. Lorenz-Orlean, H. van Kranenburg. 2009. Inter-firm technology transfer: partnership-embedded licensing or standard licensing agreements? *Industrial and Corporate Change*. 18(3) 529-550.
- Hall, B.H., A.B. Jaffe, M. Trajtenberg. 2001. *The NBER Patent Citations Data File: Lessons, Insights and Methodological Tools*. **NBER Working Paper**, No. 8498.
- Harhoff, D., M. Reitzig. 2004. Determinants of opposition against EPO patent grants—the case of biotechnology and pharmaceuticals. *International Journal of Industrial Organization*. 22(4) 443.

- Hoetker, G., T. Mellewigt. 2009. Choice and performance of governance mechanisms: matching alliance governance to asset type. *Strategic Management Journal*. 30(10) 1025-1044.
- Huchzermeier, A., C.H. Loch. 2001. Project Management Under Risk: Using the Real Options Approach to Evaluate Flexibility in R&D. *Management Science*. 47(1) 85.
- Johnson, D.K.N. 2002. "Learning-by-Licensing": R&D and Technology Licensing in Brazilian Invention. *Economics of Innovation and New Technology*. 11(3) 163-177.
- Katz, M.L., C. Shapiro. 1986. Technology Adoption in the Presence of Network Externalities. *Journal of Political Economy*. 94(4) 822-841.
- Kogut, B., U. Zander. 1992. Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science*. 3(3) 383-397.
- Lahiri, N. 2010. Geographic distribution of R&D activity: how does it affect innovation quality? *Academy of Management Journal*. 53(5) 1194-1209.
- Laursen, K., M.I. Leone, S. Torrisi. 2010. Technological exploration through licensing: new insights from the licensee's point of view. *Industrial and Corporate Change*. 19(3) 871-897.
- Lavie, D. 2006. The Competitive Advantage of Interconnected Firms: An Extension of the Resource-Based View. *The Academy of Management Review*. 31(3) 638-658.
- Leone, M.I., K. Laursen. 2011. *Patent exploitation strategies and value creation*. Cheltenham, UK Edward Elgar.
- Leone, M.I., T. Reichstein. 2012. Licensing-in fosters rapid invention! the effect of the grant-back clause and technological unfamiliarity. *Strategic Management Journal*. 33(8) 965-985.
- Lerner, J. 1994. The importance of patent scope: An empirical analysis. *RAND Journal of Economics*. 25(2) 319-333.
- Li, J.J., L. Poppo, K.Z. Zhou. 2010. Relational mechanisms, formal contracts, and local knowledge acquisition by international subsidiaries. *Strategic Management Journal*. 31(4) 349-370.
- Lowe, J., P. Taylor. 1998. R&D and technology purchase through licence agreements: complementary strategies and complementary assets. *R&D Management*. 28(4) 263-278.
- Manski, C.F., D. McFadden. 1981. *Structural analysis of discrete data with econometric applications*. MIT Press, Cambridge, Mass.
- Mariti, P., R.H. Smiley. 1983. Co-operative agreements and the organization of industry. *Journal of Industrial Economics* 41(4) 437-451.
- Mowery, D.C., J.E. Oxley, B.S. Silverman. 1996. Strategic alliances and interfirm knowledge transfer. *Strategic Management Journal*. 17 77-91.

- Myles Shaver, J., F. Flyer. 2000. Agglomeration economies, firm heterogeneity, and foreign direct investment in the United States. *Strategic Management Journal*. 21(12) 1175-1193.
- Narin, F., E. Noma, R. Perry. 1987. Patents as indicators of corporate technological strength. *Research Policy Research Policy*. 16(2-4) 143-155.
- Nelson, R.R., S.G. Winter. 1982. The Schumpeterian Trade-off Revisited. *American Economic Review*. 67(1) 114-132.
- Nohria, N., R. Gulati. 1996. Is slack good or bad for innovation? *Academy of Management Journal*. 39(5) 1245-1264.
- Parr, R.L., G.V. Smith. 2005. *Intellectual property: valuation, exploitation, and infringement damages*. Wiley, New York.
- Parrotta, P., D. Pozzoli. 2012. The effect of learning by hiring on productivity. *RAND Journal of Economics*. 43(1) 167-185.
- Pavitt, K.L.R. 1998. Technologies, Products and Organization in the Innovating Firm: What Adam Smith Tells us and Joseph Schumpeter Doesn't. *Industrial and Corporate Change*. 7 433-452.
- Peteraf, M.A. 1993. The cornerstones of competitive advantage: A resource-based view. *Strategic Management Journal*. 14 179-191.
- Poppo, L., T. Zenger. 2002. Do formal contracts and relational governance function as substitutes or complements? *Strategic Management Journal*. 23(8) 707-725.
- Prahalad, C.K., G. Hamel. 1990. The core competence of the corporation. *Harvard Business Review*. 68(3) 79-91.
- Reitzig, M., J. Henkel, F. Schneider. 2010. Collateral damage for R&D manufacturers: how patent sharks operate in markets for technology. *Industrial & Corporate Change*. 19(3) 947-967.
- Rockett, K. 1990. Choosing the Competition and Patent Licensing. *RAND Journal of Economics*. 21(1) 161-171.
- Rosenberg, N. 1996. *Uncertainty and Technological Change*. Stanford: Stanford University Press
- Rosenkopf, L., A. Nerkar. 1999. On the complexity of technological evolution: exploring coevolution within and across hierarchical levels in optical disc technology. *Variations in Organization Science: In Honor of D. T. Campbell, Baum J, McKelvey W (eds)*. Sage: Thousand Oaks, CA 169-183.

- Sampson, R.C. 2007. R&D alliances and firm performance: The impact of technological diversity and alliance organization on innovation. *Academy of Management Journal*. 50(2) 364-386.
- Schilling, M.A. 2009. Understanding the alliance data. *Strategic Management Journal*. 30(3) 233-260.
- Schmalbeck, R. 1975. The Validity of Grant-Back Clauses in Patent Licensing Agreements. *The University of Chicago Law Review*. 42(4) 733-748.
- Shane, S. 2001. Technological Opportunities and New Firm Creation. *Management Science*. 47(2) 205.
- Silverman, B.S. 1999. Technological Resources and the Direction of Corporate Diversification: Toward an Integration of the Resource-Based View and Transaction Cost Economics. *Management Science*. 45(8) 1109-1124.
- Somaya, D., Y. Kim, N.S. Vonortas. 2011. Exclusivity in licensing alliances: using hostages to support technology commercialization. *Strategic Management Journal*. 32(2) 159-186.
- Szulanski, G. 1996. Exploiting internal stickiness: impediments to the transfer of best practice. *Strategic Management Journal*. 17(3) 27-43.
- Trajtenberg, M. 1990. A penny for your quotes: patent citations and the value of innovations. *RAND Journal of Economics*. 21(1) 172-187.
- Van Dijk, T. 2000. License Contracts, Future Exchange Clauses, and Technological Competition. *European Economic Review*. 44(8) 1431-1448.
- Wernerfelt, B. 1984. A resource-based view of the firm. *Strategic Management Journal*. 14 4-12.
- Yang, H., C. Phelps, H.K. Steensma. 2010. Learning from What Others Have Learned from You: The Effects of Knowledge Spillovers on Originating Firms. *Academy of Management Journal*. 53(2) 371-389.
- Ziedonis, A. 2007. Real options in technology licensing. *Management Science*. 53(10) 1618-1633.
- Ziedonis, R.H. 2004. Don't Fence Me In: Fragmented Markets for Technology and the Patent Acquisition Strategies of Firms. *Management Science*. 50(6) 804-820.

4.10 Figures and Tables

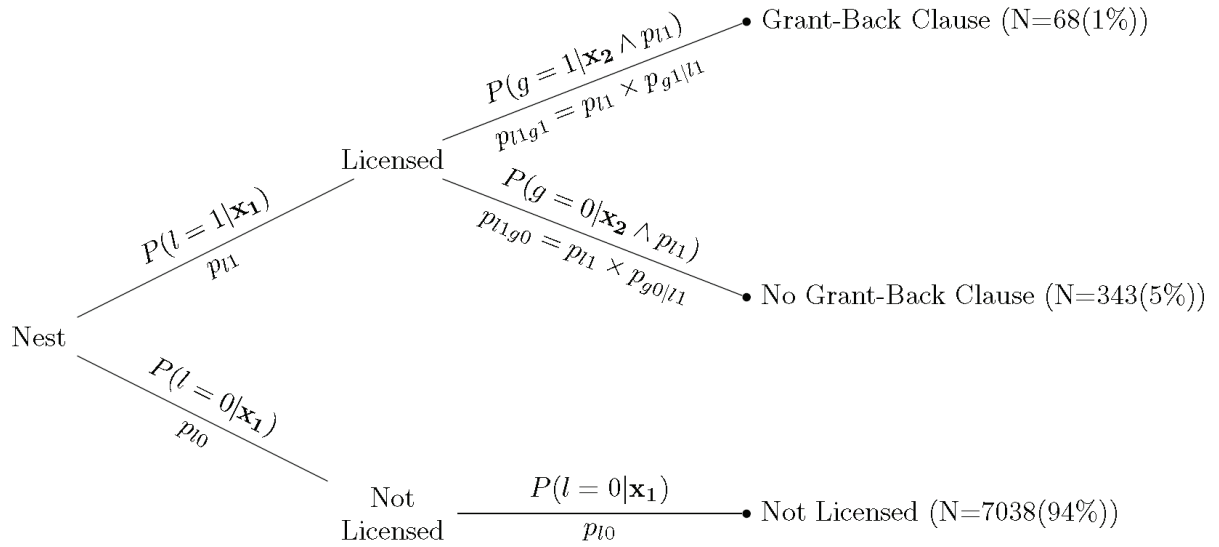


Figure 1: The Hierarchical Nested Tree Structure

Table 1: Descriptive Statistics and Correlation Coefficients (N=22 347)

Variables	Mean	S.D.	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
[1] Grant-back Clause Alternative	0.333	0.471	1.00									
[2] Licensor core technology	0.091	0.207	0.62	1.00								
[3] Licensee core technology	0.034	0.155	0.31	0.18	1.00							
[4] Technological uncertainty	0.171	0.328	0.74	0.58	0.27	1.00						
[5] Royalty rate	1.888	5.754	0.46	0.36	0.11	0.48	1.00					
[6] Technological superiority	1.386	2.795	0.70	0.17	0.14	0.40	0.29	1.00				
[7] Exclusivity	0.216	0.411	0.74	0.49	0.29	0.58	0.54	0.52	1.00			
[8] Technological overlap	0.073	0.213	0.49	0.41	0.37	0.47	0.29	0.08	0.49	1.00		
[9] Patent value	14.029	48.672	0.00	0.06	0.01	0.02	0.02	-0.05	-0.01	0.03	1.00	
[10] Technology radicalness	1.666	2.171	0.00	0.02	0.01	-0.02	-0.00	-0.12	-0.01	0.03	0.02	1.00
[11] Technology scope	2.292	1.391	0.00	0.09	0.00	0.08	0.03	-0.04	-0.00	0.04	0.11	-0.02
[12] Technology age	5.586	3.161	0.00	-0.11	-0.08	-0.10	-0.18	0.11	-0.13	-0.05	-0.01	-0.06
[13] Backward citations	30.394	47.806	0.00	0.08	0.04	0.16	0.09	-0.10	0.04	0.05	0.02	0.40
[14] Licensor technological specialization	0.255	0.157	0.00	0.28	-0.02	0.11	0.14	-0.29	0.05	0.07	0.10	0.21
[15] Licensor market diversification	4.547	4.835	0.00	-0.09	0.06	-0.05	-0.13	0.06	0.08	0.08	-0.07	0.07
[16] Firm size	8.651	2.596	0.00	-0.20	-0.01	-0.14	-0.13	0.27	-0.05	-0.15	-0.11	-0.20
[17] Firm slack	2.079	12.454	0.00	0.04	-0.00	0.02	0.01	-0.05	0.01	0.03	0.01	0.02
[18] R&D intensity	57.945	73.471	0.00	0.12	0.05	0.12	0.08	-0.14	0.11	0.19	-0.02	0.06
[19] Technological fragmentation	0.063	0.205	0.00	0.13	-0.04	0.04	-0.04	-0.21	-0.09	-0.06	0.00	0.38
[20] Sales change	1.129	5.784	0.00	0.02	0.03	0.01	-0.02	-0.06	0.03	0.08	0.01	0.05

Variables	Mean	S.D.	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]
[11] Technology scope	2.292	1.391	1.00									
[12] Technology age	5.586	3.161	-0.10	1.00								
[13] Backward citations	30.394	47.806	0.09	-0.20	1.00							
[14] Licensor technological specialization	0.255	0.157	0.14	-0.39	0.27	1.00						
[15] Licensor market diversification	4.547	4.835	-0.05	0.34	-0.03	-0.36	1.00					
[16] Firm size	8.651	2.596	-0.14	0.29	-0.30	-0.66	0.34	1.00				

[17]	Firm slack	2.079	12.454	0.03	-0.07	0.09	0.14	-0.03	-0.18	1.00
[18]	R&D intensity	57.945	73.471	0.08	-0.36	0.24	0.37	-0.06	-0.45	0.06
[19]	Technological fragmentation	0.063	0.205	0.05	-0.03	0.22	0.51	-0.13	-0.34	-0.01
[20]	Sales change	1.129	5.784	0.00	-0.08	0.02	0.04	-0.10	-0.24	0.04
										0.15
										-0.01
										1.00

Table2: Nested Logit Results for Grant-back Clause and Licensing Decisions

Variables	Model I	Model II	Model III	Model IV	Model V
<i>Grant-back Clause Equation</i>					
Licensor core technology		1.827*** (0.550)	2.025*** (0.588)	1.778** (0.553)	1.986*** (0.593)
Licensee core technology		-2.049** (0.636)	-2.004** (0.642)	-3.162*** (0.873)	-3.151*** (0.893)
Technological uncertainty		0.160+ (0.090)	0.189* (0.095)	0.216* (0.097)	0.247* (0.102)
Licensor core technology × Technological Uncertainty			-1.407 (1.209)		-1.460 (1.227)
Licensee core technology × Technological Uncertainty				5.095* (2.451)	5.233* (2.523)
Royalty rate	0.021 (0.017)	0.012 (0.018)	0.011 (0.018)	0.009 (0.018)	0.008 (0.018)
Technological superiority	-0.240*** (0.050)	-0.246*** (0.055)	-0.250*** (0.055)	-0.262*** (0.057)	-0.267*** (0.057)
Exclusivity	1.413*** (0.365)	1.492*** (0.412)	1.539*** (0.415)	1.531*** (0.419)	1.578*** (0.422)
Technological overlap	0.390*** (0.113)	0.400** (0.127)	0.393** (0.129)	0.387** (0.129)	0.377** (0.130)
<i>Technology Licensing Equation</i>					
<i>Technology Characteristics</i>					
Patent value	0.004*** (0.001)	0.004*** (0.001)	0.004*** (0.001)	0.003*** (0.001)	0.003*** (0.001)
Technology radicalness	0.045+ (0.023)	0.057* (0.024)	0.057* (0.024)	0.060* (0.024)	0.061* (0.024)
Technology scope	-0.056 (0.040)	-0.075+ (0.040)	-0.075+ (0.040)	-0.076+ (0.040)	-0.077+ (0.040)
Technology age	0.154*** (0.023)	0.141*** (0.023)	0.145*** (0.023)	0.140*** (0.023)	0.145*** (0.024)
Backward citations	0.000 (0.001)	-0.000 (0.001)	-0.000 (0.001)	-0.000 (0.001)	-0.000 (0.001)
<i>Firm Characteristics</i>					
Licensor technological specialization	2.599*** (0.415)	2.179*** (0.443)	2.118*** (0.448)	2.126*** (0.444)	2.063*** (0.450)
Licensor market diversification	-0.082*** (0.021)	-0.074*** (0.021)	-0.076*** (0.021)	-0.077*** (0.021)	-0.079*** (0.021)
Firm size	-0.205*** (0.028)	-0.188*** (0.029)	-0.184*** (0.030)	-0.188*** (0.030)	-0.184*** (0.030)
Firm slack	0.000+ (0.000)	0.000+ (0.000)	0.000+ (0.000)	0.000+ (0.000)	0.000+ (0.000)
R&D intensity	0.002** (0.001)	0.002** (0.001)	0.002** (0.001)	0.002** (0.001)	0.002** (0.001)
Technological fragmentation	-0.829** (0.262)	-0.887*** (0.259)	-0.880*** (0.260)	-0.909*** (0.260)	-0.903*** (0.261)
Sales change	0.002 (0.005)	0.003 (0.005)	0.003 (0.005)	0.003 (0.005)	0.003 (0.005)
Industry Dummy	YES	YES	YES	YES	YES
Year Dummy	YES	YES	YES	YES	YES
Number of Observations	22.347	22.347	22.347	22.347	22.347
Number of Cases	7.449	7.449	7.449	7.449	7.449

Log Likelihood	-1498.681	-1482.662	-1481.949	-1480.158	-1479.414
Likelihood Ratio Comparison		32.038***	1.426***	5.007***	6.495***

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Table 3: Marginal Effects (dp/dx) from Table 2, Model V

Variable	(dp/dx)
<i>Second nest - Grant-Back Clause Equation</i>	
Licensor core technology	0.02935
Licensee core technology	-0.03519
Technological uncertainty	0.00356
Licensor core technology \times Technological uncertainty	-0.01868
Licensee core technology \times Technological uncertainty	0.07644
Royalty rate	0.00011
Technological superiority	-0.00269
Exclusivity	0.02602
Technological overlap	0.00568
<i>First nest - Technology Licensing Equation</i>	
Patent value	0.00007
Technology radicalness	0.00120
Technology scope	-0.00150
Technology age	0.00290
Backward citations	-0.00074
Licensor technological specialization	0.04127
Licensor market diversification	-0.00149
Firm size	-0.00345
Firm slack	0.00008
R&D intensity	0.00003
Technological fragmentation	-0.01751
Sales change	0.00006

CHAPTER 5

UNDERSTANDING THE RENT DISSIPATION EFFECT IN TECHNOLOGY LICENSING CONTRACTS

GORETTI CABALEIRO CERVINO

Universidad Carlos III de Madrid
gcabalei@emp.uc3m.es

SOLON MOREIRA

Department of Innovation and Organizational Economics
Copenhagen Business School
E-mail: sm.ino@cbs.dk

5.1 Introduction

Over the last years substantial changes have been observed in the way firms organize their activities related to the production of new technologies (Cassiman & Veugelers, 2006). Given the strong competition in the product market, the shorter product life cycles, and the increase in the use of information and communication technologies, firms are continuously adopting business models that allow for more strategic flexibility (Chesbrough, 2003). Accordingly, firms rely on networks, new entrants, and technology based organizations in order to generate and sustain competitive advantages (Arora & Ceccagnoli, 2011). As licensing is a less integrated alternative and the most direct way to acquire technologies developed by other companies (Fosfuri, 2006), these agreements have dramatically increased in importance and volume over the last decades (Anand & Khanna, 2000a; Hagedoorn, 2002; Somaya, Kim, & Vonortas, 2011). Accordingly, in several industries the use of royalty payments and licensing fees have become an important mechanism for firms to profit from their investments in innovation (Arora & Gambardella, 2010).

Surveys conducted by Gambardella, Giuri, & Luzzi (2007) and Zuniga & Guellec (2009) show that among the main motivations for companies to license out technologies is the revenue that it generates, that is, the present value of the fixed fee and/or the royalties that the licensee has to pay to the licensor (Arora & Fosfuri, 2003). Actually, in several industries it is common to observe even large established companies actively engaging in licensing to generate revenues (Shepard, 1987). Some notable examples of firms profiting from licensing can be found in the chemical, computer, and semiconductor industries (Arora & Fosfuri, 2003). While the generation of revenues is an important incentive for firms to license out, granting other firms access to relevant technologies can also produce negative implications for the licensor competitiveness (Choi, 2002). Indeed, as a consequence of licensing out a technology, licensors

may also experience a reduction in their market share or price cost margin as a result of the additional competition in the product market (Fosfuri, 2006). This reduction in the licensor's market share caused by increased competition has been named the rent dissipation effect. While several studies have examined questions related to the revenue generated from technology licensing (e.g., Choi, 2002; Sakakibara, 2010; Wang, 1998), empirical research focused on explaining the rent dissipation effect is still scarce.

The central role that the rent dissipation effect plays in licensing contracts is evident in comments from the managing director of an intellectual property consulting company called Intercap: *'On the one hand, you don't want to abandon your patents' ability to exclude competitors from your market. But, on the other hand, you could be talking about hundreds of millions of dollars in new revenue from strategic licensing'* (Rivette & Kline, 2000). In this regard, firms' decisions to license a technology have been shown to be grounded on the interplay between the revenues generated by the licensing deal and the negative effects resulting from additional competition in the downstream product market (Fosfuri, 2006). Despite this potential negative effect, prior studies have indicated that not only firms lacking the necessary resources to generate commercial value from their innovations, but also large established ones use licensing as a strategic alternative to profit from investment in inventive activities (Arora & Fosfuri, 2003).

In one of the few studies examining the rent dissipation effect, Arora & Fosfuri (2003) develop a model in which firms with downstream assets decide whether or not a technology will be licensed on the basis of the comparison between the rent dissipation caused by a new competitor (the licensee) and the revenues generated from the licensing deal. Arora & Fosfuri's findings suggest that firms selling their technologies through licensing can increase their share of industry profits while imposing negative externalities upon other incumbents

operating in the same product market. In a similar direction, Fosfuri (2006) offers empirical evidence of the rent dissipation effect by focusing on the supply side of markets for technology to demonstrate how the competition among multiple technology holders triggers a more aggressive licensing behavior. In a more recent study, Gambardella & Giarratana (2012) relax some of the assumptions found in Arora & Fosfuri's model to show that high heterogeneity among players within the same industry reduces the extent to which licensors will experience rent dissipation. Altogether, this stream of literature has consistently indicated that a firm's decision to license out its technologies is directly related to competitive implications experienced in the product market (Choi, 2002; Katz & Shapiro, 1985). However, although those studies have comprehensively increased our understanding about how markets for technology function, to the best of our knowledge no previous study has developed empirical evidence directly linking licensing out and the dissipation effect.

In this paper, we develop and empirically test a model that explains the dissipation effect experienced by licensors using a perspective that incorporates three important dimensions of the markets for technology: 1) whether the licensors possess downstream assets, 2) licensee size, and 3) technological overlap between the licensor and the licensee. The main contribution of this paper lies in the development of an empirically testable model concerning one of the central assumptions of markets for technology (the dissipation effect), which has not been tested against empirical data. Furthermore, we integrate the insights from previous studies in a novel way to build and test our hypotheses. First, we draw on Arora & Fosfuri's (2003) proposition that the dissipation effect tends to be higher for firms with downstream assets in the product market. Second, we also consider the licensee's perspective (Ceccagnoli & Hicks, 2012; Ceccagnoli & Jiang, 2012; Laursen, Leone, & Torrisi, 2010) to account for the fact that the licensee's capacity to commercially exploit the licensed technology plays an important

moderating role between the licensing out of technology and the rent dissipation effect. In this regard, Arora & Gambardella (2010) call attention to the fact that the demand side of markets for technology has received less attention in licensing literature. Therefore, in our model we incorporate the view that licensees differ in their capacity to commercially exploit the licensed technology, which naturally impacts on the licensor's rent dissipation. Finally, our model also considers the effect of the technological overlap between the licensor and the licensee. Previous research has shown that the licensing decision depends on how technologically close the patent portfolios of both companies are (Arora & Fosfuri, 2003; Laursen et al., 2010). Hence, we apply this idea of technological proximity to propose that the dissipation effect resulting from licensing out core technologies will be weaker in a context where the technological overlap between the parties is low. In testing those three propositions we are not supposing that firms make inefficient decisions that lead to rent dissipation. On the contrary, we build on Arora & Fosfuri's (2003) proposition that the licensing decision is based on the balance between dissipation and revenue effects³¹.

We test our hypotheses using a sample of 163 licensors involved in licensing contracts within the U.S. pharmaceutical industry during the period 1984 – 2004. We use supplemental data from COMPUSTAT and the United States Patent and Trademark Office (USPTO) to obtain specific characteristics of licensors, licensees, and the licensed technology. A major strength of our dataset regards the fine-grained information that we were able to obtain from the licensing contracts, which allowed us to combine three different data sources to estimate the effect of technology licensing on subsequent changes in the licensor's share in the product market. We used a fixed effect model as the econometric technique to model the

³¹ Given the scarcity of data that make it possible to connect firms' overall revenues to a specific licensing deal, we decided to focus mainly on the dissipation effect and only supplement the main analysis with information regarding the remuneration structure of the licensing contracts as a proxy for the revenue effect.

relationship between the dependent and independent variables. The results offered robust support for most of our hypotheses.

The paper is organized as follows. First, we present theoretical arguments and hypotheses. Second, we describe the databases used in this study and how the dependent and independent variables were calculated, followed by the econometric technique used to estimate our models. Finally, we present the results and conclusion.

5.2 Theory and Hypotheses

5.2.1 Licensing

Licensing contracts are agreements between companies through which the owner of the technology (licensor) allows the other company (licensee) to make, sell, and use a technology without transferring its ownership in exchange for economic compensation (Granstrand, 1999). Over the past years there has been an unprecedented growth in licensing agreements (Kamiyama, Sheehan, & Martínez, 2006; Zuniga & Guellec, 2009) and, nowadays, they represent one of the most important options available to transfer technology (Anand & Khanna, 2000b; Arora & Fosfuri, 2003). In fact, due to the importance of licensing, the U.S. Department of Justice has defined markets for technology as “*markets that consist of intellectual property that is licensed and its close substitutes*” (U.S. Department of Justice, 1995). Although it is also possible for firms to enter into licensing agreements concerning the joint development of licensed technologies, this type of contract is usually characterized as an arm’s length contractual deal with a low level of vertical integration (Ceccagnoli & Jiang, 2013; Grindley &

Teece, 1997). Indeed, in most licensing deals signed between firms, the traded technology is already developed and commercially proven³² (Atuahene-Gima, 1993).

In principle, licensing offers strategic advantages for licensors and licensees. On the demand side, licensees can benefit from acquiring externally developed and proven technologies (Atuahene-Gima, 1993), from reducing product development risks and costs (Lowe & Taylor, 1999), and from adopting more diversified and less integrated R&D structures (Chesbrough, 2003). On the supply side, licensors increase the possibilities to recover the investments and generate revenue from innovations (Arora & Ceccagnoli, 2006; Teece, 1986), achieve rapid market penetration (Lei & Slocum Jr, 1991), and facilitate the development of complementary products (Shepard, 1987). However, using licensing as a means to commercialize technologies may also impose risks. On the demand side, licensees could become highly dependent on the licensors for the maintenance of the technology (Walter, 2012) and lack insight into how to further develop the licensed technology (Leone & Reichstein, 2012). On the supply side, in addition to the rent dissipation effect, licensors could lose the control of the licensed technology and become heavily dependent on the licensee to generate revenue (Arora & Fosfuri, 2003; Fosfuri, 2006).

As a consequence, the licensing decision is far from straightforward for firms. Arora & Fosfuri (2003) focus on the licensors' point of view to propose a framework for predicting the firm's rate of licensing. In their model, the licensing decision is the result of the interplay between two opposite effects: the revenue effect versus the dissipation effect. The revenue effect refers to the benefits that licensing generates, which consist of the present value of the payments that the licensee will make to the licensor, net of transaction costs. Accordingly,

³² Jensen & Thursby (2001) identified that in most cases the technologies commercialized by universities are at early stages, requiring substantial further work to reach a stage that would allow them to be commercially exploited by firms. However, we restrict our analysis to licensing contracts between firms.

the pecuniary benefits that are connected to licensing contracts are one of the main factors that firms take into account when deciding whether or not to license out a specific technology (Kulatilaka & Lin, 2006). On the other hand, the dissipation effect refers to the potential reduction in the licensor's benefits, measured as a lower market share or a lower price cost margin, as a consequence of additional competition in the final product market. Even though previous research has proposed several strategies to limit the latter effect (Cohen, Nelson, & Walsh, 2000; Granstrand, Patel, & Pavitt, 1997), an additional competitor may always be considered a potential threat for the licensor (Fosfuri, 2006). Therefore, firms seek to balance the revenue effect, which is a short-term effect, against the dissipation effect, which can influence firm performance in the long run (Arora & Fosfuri, 2003; Fosfuri, 2006).

Beyond the monetary compensation that licensing generates, firms may also choose not to exploit a technology in house as a consequence of several other factors. First, in order to commercialize a technology independently, firms must develop specific assets and capabilities such as commercialization channels, a sales workforce, and infrastructure to service clients (Gans & Stern, 2003). When considering the expected return from those investments, licensing may appear to be an interesting alternative as other firms in the market may already possess the necessary assets. Second, established firms launching a new product run the risk of cannibalizing their own market and eroding their competitive position (Hill & Rothaermel, 2003). Third, licensing creates possibilities for cooperation between the licensor and the licensee, which mitigate risks inherent to investments that are necessary to turn a technology into a marketable product (Gans & Stern, 2003, 2010). In line with the third point, Choi (2002) proposed a distinction between the competition that a firm faces in the current product market (Kamien, 1992; Katz & Shapiro, 1985) and the competition it faces in the innovation market (Choi, 2002; Gans & Stern, 2010). While the first regards the competition that licensing triggers

within the product markets that the licensor operates in at the moment of the licensing deal, the second is related to a more dynamic process through which competition is increased in the long run as a consequence of technological developments in the licensed technology.

Despite the fact that previous studies have pointed out certain contingencies and characteristics related to the licensing process that accentuate the dissipation effect (Arora & Ceccagnoli, 2011; Cohen et al., 2000; Granstrand et al., 1997; Helpman, 1998), no empirical evidence has been produced indicating the direct relationship between rent dissipation and technology licensing. On the basis of previous research, we focus on three main factors regarding technology and firm specificities that could influence the dissipation effect experienced by the licensor. First, we consider that licensors are more likely to be susceptible to the dissipation effect in cases where the licensed technology constitutes a core, rather than a peripheral, technology. We expect that the degree to which a technology is connected to the licensors' main technological activities is an indication of the possession of the downstream assets. Furthermore, core technologies are mostly observed to be superior to peripheral ones in terms of production costs, market value and potential for further refinement (Choi, 2002). Second, licensors are more susceptible to the dissipation effect if the licensee is increasing in size. Large companies are more able to appropriate value from inward licensing (Walter, 2012). Finally, we also expect the magnitude of the dissipation effect to be affected by the level of technological overlap between the licensor and the licensee. In this case, it is expected that lower technological overlap reduces the dissipation effect resulting from licensing out core technologies.

5.2.2 Licensing out core technologies

The technological portfolio of a firm is formed by core and non-core technologies that are related to the markets in which the firm operates (Granstrand et al., 1997). Core technologies

represent a firm's main source of competitive advantage as they constitute the outcome of a path dependent process regarding the accumulations of unique expertise (Prahalad & Hamel, 1993). In general, core technologies are distinct, given their potential access to a wide variety of markets, their significant contribution to the perceived customer benefits of the end product, and how difficult it is for competitors to imitate them (Choi, 2002; Prahalad & Hamel, 1993). Given the competitive potential implications of licensing out core technologies for the licensor, the licensing literature does not frequently consider it to be a viable alternative for firms. However, if the licensor is able to either avoid creating direct competitors (Fosfuri, 2006; Leone & Reichstein, 2012) or to receive monetary remuneration that is compatible with the potential rent dissipation, core technologies will also be licensed (Choi, 2002).

In fact, considering both sides of the markets for technologies, deals involving core technologies are more likely to take place than deals regarding peripheral technologies. Indeed, core technologies are more valuable to licensees as they have the potential to lead to the generation of related products in future while at the same time allowing the acquiring firm to produce more revenue in the short term (Choi, 2002). Therefore, considering this perspective, if the licensor can use licensing payments (e.g., fixed fees and royalty rates) to appropriate a sufficiently large amount to overcome the decrease in profits due to future competition, then deals exchanging core technologies are likely to happen. Furthermore, even if the uncertainty related to the licensed technology is as high as to prevent all contingencies from being fully foreseen in a licensing contract, the use of a royalty-based payment is an option to ensure that the (valuable) core technologies will be traded (Gallini & Wright, 1990).

There are also other factors, in addition to revenue generation, that may affect a firm's decision to license out core technologies. First, by engaging in licensing deals, firms may access the licensee's assets and capabilities, which can be useful in further developing the

licensed technology (Leone & Reichstein, 2012). The complexity related to the development of certain technologies can lead firms to enter into R&D partnerships (in the form of licensing contracts) in order to mitigate risks and increase the chances that a technology will continue to be developed (Duysters & Hagedoorn, 2000). This is particularly true for firms that are strongly centered around a small group of core capabilities in a particular technological field, as those firms are more likely to develop rigidities and are also more susceptible to fail to keep up with environmental changes (Song, Almeida, & Wu, 2003). Furthermore, licensing is also an alternative for firms to implementing open innovation strategies (Chesbrough, 2003). Second, it is not uncommon that the development and introduction of a new product require several complementary technologies that a single firm may not possess. Under these circumstances firms may possess in house a technology that only has the potential to generate rents when combined with those of other firms (Fershtman & Kamien, 1992). In this case, a firm may pursue the development of technologies that are related to its core business and agree to provide its access to other firms in exchange for access to their technologies (Eswaran, 1994).

In spite of the different motivations that firms might have to license out core technologies, we expect that technologies that are close to the firm's main business reflect the areas in which the licensor possesses downstream assets (Arora, Fosfuri, & Gambardella, 2001). This observation leads to the assumption that licensors will experience stronger competition originating from licensing out a technology if it is closely related to the firm's main line of business. Therefore, we follow the argument developed by Arora & Fosfuri (2001) that licensors are more likely to experience rent dissipation in cases where downstream assets related to the licensed technology are possessed in house. Our baseline hypothesis therefore states:

Hypothesis 1: The closer a technology is to the licensor's core technological activities, the stronger the dissipation effect, all else being equal.

5.2.3 Licensing out core technologies and licensee size

The relationship between firm size and the propensity to license out has been explored in depth by previous literature. Several studies have identified size as one of the main determinants that explain licensing out activities (Fosfuri, 2006; Gambardella et al., 2007; Kani & Motohashi, 2012), with the results indicating that as size increases, the propensity to license out decreases (Gambardella et al., 2007). In particular, previous research has found that smaller firms license out more technologies as a consequence of the lack of legitimacy and the downstream assets. Therefore, in most of the cases, licensing out is the only way to appropriate rents from their investments (Arora & Fosfuri, 2003; Fosfuri, 2006). From the point of view of the licensee, size is expected not only to increase the propensity to license in, but also to explain the capacity that the acquiring firm will need to exploit the acquired technology (Walter, 2012). Indeed, as larger firms have several advantages in exploiting resources from the environment (Atuahene-Gima, 1993), many cross-firm differences in terms of the capacity to exploit licensed-in technologies comes from differential advantages related to size and R&D intensity.

One of the key factors of the licensing process is the efficiency of the licensee in applying the newly acquired technology in the product market (Arora & Gambardella, 2010). No doubt, this efficiency is highly dependent on the licensee's capabilities, which in turn, are closely connected to firm size. Accordingly, Walter (2012) has shown a positive relationship between firm size and the propensity to license in. Given that large firms are characterized by greater economies of scale in R&D, faster learning curves and the downstream assets needed to commercialize the final product (Cohen & Levinthal, 1990; Van Wijk, Jansen, & Lyles, 2008), they are able to capture more value from licensing in. Although larger firms also have a number of disadvantages related to innovation, such as rigidities (Dosi & Marengo, 2007) and organizational inertia (Chen & Hambrick, 1995), we expect the effect of size on firm capacity to

commercially exploit a newly acquired technology in the product market to be positive. Moreover, considering Teece's (1986) seminal work on firm capacity to profit from innovation, the successful commercialization of externally acquired technologies is conditional upon capabilities and other complementary resources, which are more likely to be present in larger firms.

Following this line of reasoning, large firms vis-à-vis small firms are more likely to invest a substantial amount of resources in the commercialization and manufacturing of the licensed technologies (Teece, 1986). This conclusion naturally has implications for the rent dissipation effect that licensors experience when licensing out core technologies. Considering the baseline hypothesis regarding the extent to which a technology is core to the licensor's main technological activities, we expect that as the licensee increases in size the competition within the licensor's main business lines will also increase. Actually, given that peripheral technologies are unlikely to cause meaningful rent dissipation for the licensor, we expect that licensee size will increase rent dissipation only when the licensing deal involves licensor's core technologies. Therefore, we expect that the dissipation effect caused by licensing out core technologies will increase with licensee size. Our second hypothesis thus states that:

Hypothesis 2: All else being equal, the larger the licensee firm, the stronger the dissipation effect caused by licensing core technologies.

5.2.4 Technological overlap between partners

Another important dimension of the licensing process that directly affects the dissipation effect regards the extent to which the licensor and the licensee operate in the same niches within the product market (Gambardella & Giarratana, 2012). Actually, from the licensor's perspective it would be preferable to license to firms that build on a different set of technological capabilities

as they would be less likely to turn into a competitor in the product space (Arora & Gambardella, 2010). Indeed, if the licensor can supply a technology to a firm with which it has a low level of overlap, the effect of increasing competition observed on both the technology and product markets will be substantially smaller as compared to licensing to a firm with a high technological overlap. Firms operating within close technological fields are more likely to share similar resource bases (Hannan & Freeman, 1977), which increases the likelihood that they will commercially exploit the licensed technology in similar ways. As a result, high overlap puts licensor and licensee in more direct competition with each other (Gambardella & Giarratana, 2012; Walter, 2012).

Although licensing out a technology to firms with low technological overlap would be an optimal alternative from the licensor perspective, licensing deals between firms operating in different technological segments are not always possible. Indeed, markets for technology are mainly characterized by asymmetric information between the parties, by difficulties in describing and valuing the technology and by uncertainty about the validity and applicability of the traded technology (Arora & Gambardella, 2010). As a consequence, firms can reduce those problems if they belong to a close technological field (high overlap), which significantly limits the extent to which deals between firms with no technological overlap happen. In this context, from the licensee point of view, it is easier to identify and understand the value of a specific technology when operating with technologies similar to those of the licensor (Gambardella & Giarratana, 2012). Furthermore, technologies licensed from a firm with a similar technological portfolio are easier to evaluate, assimilate, and apply (Arora & Gambardella, 1994; Cohen & Levinthal, 1990). On the licensor side, it is easier to screen the technological space for potential licensees that operate in closer technological fields. In

summary, high technological overlap between the parties reduces search costs and other frictions that are inherently present on the markets for technology.

Building on the arguments presented above, we claim that licensing deals are most likely to involve firms with some degree of technological overlap in their portfolio. In other words, deals are unlikely to happen between firms with absolutely no overlap as several issues ranging from partner identification to technology transferability can prevent those deals from happening. On the other hand, firms with perfectly similar technological portfolios are unlikely to enter into licensing deals as the risk of generating competition becomes too high³³. Those arguments lead to the idea that the technological overlap between the firms signing a licensing contract will fall between perfect and no overlap.

Similarities between the licensor and the licensee in the technological space are also likely to be reflected in the product market. Accordingly, we consider the effect that a low level of technological overlap has on the magnitude of the dissipation effect experienced by the licensor. We propose that companies with low technological overlap are less likely to compete directly within the same technological niche, which weakens the dissipation effect caused by licensing out core technologies. Therefore, we state:

Hypothesis 3: All else being equal, the lower the technological overlap between the licensor and the licensee, the weaker the dissipation effect of licensing out core technologies.

Figure 1 provides an overview of the conceptual model proposed in this paper³⁴. First, the arrow referring to Hypothesis 1 indicates a positive relationship between licensor core technologies

³³ Choi (2002) proposes that such deals could still take place if the licensee agrees to pay a high lump-sum payment and/or royalty fee to the licensor. However, if the total amount to be paid becomes too high the licensee is unlikely to pursue those deals.

³⁴ Figure 1 summarizes the conceptual model developed in this paper, but the way that the dissipation effect is operationalized in the empirical model uses the inverse interpretation for the direction of the coefficients for the main independent variables.

and the dissipation effect. Second, this relationship is positively moderated by the licensee size (H2). Finally, the lower level of technological overlap between licensor and licensee negatively moderates the relationship between the licensor's core technology and the dissipation effect (H3).

[Insert Figure 1 around here]

5.3 Data, Variables & Methodology

5.3.1 Sample selection and data

Studying the rent dissipation effect empirically is a challenge. The availability of public data for systematic quantitative studies that make it possible to model the relationship between technology licensing and rent dissipation is limited. Licensors do not usually report publicly what technologies they have licensed out, and the financial filings rarely allow for the connection of firm revenue to a specific licensing deal. An alternative to overcome the lack of public data could be to use interviews or questionnaires, but these methods would impose significant limitations. First, respondents may be unwilling to reveal strategic information regarding the nature of the licensed technologies as well as the contractual specifications of the deal. Second, there are substantial timing effects and cross-firm heterogeneity that could also explain a reduction of the licensor's share in the product market, but which are hard to consider without the use of a longitudinal setting. To overcome those issues and test the proposed hypotheses we relied on detailed information extracted from a sample of licensing contracts that allowed us to link licensing contracts to patent data and the financial performance of the licensors. The sample, measures, and methods are summarized below.

The research setting for this study is the U.S. pharmaceutical industry. Firms in this industry produce and commercialize drugs, chemical components, and technologies. Several characteristics of the pharmaceutical industry make it a useful empirical setting for testing the relationship between technology licensing and the rent dissipation effect. First, licensing is one of the most common methods of technology transfer among pharmaceutical companies. Second, the pharmaceutical industry is characterized as technology driven and research intensive, which makes technological knowledge a critical component in developing and sustaining competitive advantages (Roberts, 1999). Third, since our main analysis relies on patent data, we have chosen an industry in which firms routinely and systematically use patents to protect their inventions (Hagedoorn & Cloudt, 2003). Those characteristics correspond to an industry in which markets for technology are well developed and present lower frictions, which facilitates the transaction of technologies using licensing contracts. Accordingly, the fact that the pharmaceutical industry presents those specific features creates a trade-off in terms of the generalizability of results and how precisely we are able to measure the variables used in the econometric analysis. However, given the scarcity of empirical evidences on this topic we believe the purposeful choice of this industry to be appropriate to shed light on important, and yet empirically unexplored, aspects of technology licensing and the rent dissipation effect.

The data used to develop the empirical analysis come from three different sources. First, as a starting point, we used the Deloitte Recap Database to obtain the licensing contracts involving U.S. pharmaceutical firms. We choose this database because it is one of the most accurate sources of information regarding partnerships in the pharmaceutical industry (Audretsch & Feldman, 2003; Schilling, 2009). Additionally, it allowed us to access the original licensing contracts from which we could extract precise information regarding the contractual and technological aspects of the licensing deals. Second, we obtained information regarding the patenting activity of licensors and licensees from the National Bureau of Economic Research

(NBER) patent database. Finally, we extracted firms' financial information from the Compustat database.

Considering that one of the main ideas developed in this paper regards the degree to which the licensed technology represents a core activity for licensors, we focus only on contracts in which it was possible to identify the licensed technologies in an unambiguous manner. The way to do so was to focus on licensing contracts containing a seven-digit patent number connecting a specific technology to the United States Patent and Trademark Office (USPTO). This setting allows for calculating the relative importance of the licensed technology in relation to the licensor's overall activities. Although we use patent data to calculate how core a technology is, our analysis only concerns the rent dissipation related to product market activity. For example, if licensor *A* decides to license a specific technology to licensee *B*, the effect that we are trying to capture is a consequence of licensee *B* commercially exploiting the licensed technology and consequently putting competitive pressure on licensor *A*. Additionally, we acknowledge that the dissipation effect can also increase over time as a consequence of learning effects experienced by the licensee and not only as a consequence of the immediate commercial exploitation of the licensed technology. However, following an innovation perspective, the time that licensees may take to assimilate, recombine, and apply the licensed-in technology to something new is too long to be captured in the empirical setting adopted in this paper. For this reason, we only use licensing contracts that include commercialization clauses in their contractual scope, which implies that the licensee is allowed to commercialize the licensed technology without the need to further develop or incorporate it in a new product (Parr & Sullivan, 1996).

The matching process between the licensing contracts extracted from the Recap and the two other databases was done as follow. The first step was to use the licensor's name and industry as described in the licensing contract to identify the corresponding observation in

the Compustat database. Second, using the Compustat firm identifier (GVKEY), we also connected the licensors with the National Bureau of Economic Research (NBER) U.S. patent data file³⁵. To ensure an accurate match we manually checked each individual GVKEY match between the Compustat and NBER datasets. Given that a substantial number of licensees in our sample are non-public firms we were not able to satisfactorily match the licensee firms with Compustat, but because the patent data is less restrictive³⁶ we were able to connect the licensees with the NBER database. In order to drive the matching process for the licensees we relied on firm name and country. On the basis of licensors' and licensees' patent information it was possible to construct measures for the firm's technological assets using the patenting behavior prior to the licensing date. However, measures based on patent information are poor indicators of firms' technological profile in cases where the firm is not listed as an assignee on any patent within the years prior to the licensing contract. Therefore, firms that have not filed at least one patent during the time frame used to calculate the variables were omitted from the final sample.

After selecting the contracts that met those specifications and conducting the matching process between the three databases, we arrived at an estimation sample of 330 observations regarding 163 unique licensors and 198 unique licensees involved in licensing contracts during the period 1984-2004³⁷. This number corresponds to approximately 69% of the original contracts that matched the required characteristics to be used in the empirical analysis.

5.3.2 Method

To estimate the rent dissipation effect experienced by each licensor after the licensing deal, we follow the conceptual references offered by prior literature on markets for technology (Arora &

³⁵ We employed the NBER data version that provides the GVKEY numbers linked to the assignee number of patent applicants.

³⁶ While Compustat only includes public firms, the patent data list all the firms that filed at least one patent between 1976 and 2006

³⁷ Although the NBER patent database would allow tracking firms patents until 2006, we decided to include the observations only until 2004 as a way to deal with potential truncation issues regarding the number of forward citations received by patents.

Fosfuri, 2003; Arora & Gambardella, 2010; Fosfuri, 2006) and specify the dependent variable as a relative change in the licensor market share. Despite the fact that we are not aware of any previous attempt at measuring the dissipation effect in this way, a number of studies have applied this variable in a similar manner for different purposes (Ferrier, Smith, & Grimm, 1999; Giroud & Mueller, 2011). One potential issue in estimating the relative changes in the licensor market share after a licensing deal regards the fact that a firm already experiencing financial problems may also be more likely to engage in licensing deals as a way to generate short-term revenue, which would produce biased estimates due to simultaneity (Verbeek, 2000). In order to try to deal with this problem, we added the change on the licensor market share in the year prior to the licensing date as one of the predictors that should capture the effect of the past performance on the subsequent changes in the licensor market share. As a robustness check, we also applied the Wooldridge (2002) test for autocorrelation in panel data and the estimators indicated no evidence of first-order autocorrelation.

The first approach we considered to test the proposed hypotheses was a fixed effects model as a way to account for the substantial unobserved firm heterogeneity that commonly affects studies dealing with corporate performance measures (Coles, Lemmon, & Felix Meschke, 2012). However, if the unobserved firm-specific effects are uncorrelated with the regressors, the use of the random effects model would be most appropriate since it produces more efficient estimators (Greene, 2003). In the case of modeling the dissipation effect, the random effects assumption implies that unobserved characteristics of firm *i* affecting the relative changes in the licensor's market share, such as aspects of corporate governance and firm inability to innovate, are not correlated with licensing strategy, technological overlap, and licensee size. To test whether the use of random effects is appropriate, we applied a Hausman (1978) test to compare the coefficients and capture systematic differences between both fixed and random effects. The results indicated significant differences between the random and fixed

effects estimators ($\chi = 69.83$, $p < 0.001$), confirming the suitability of fixed effects to model the effect of technology licensing on subsequent changes in the licensor's market share. Additionally, we included year dummies to control for period effects, such as differences in macroeconomic conditions that could also affect firm performance. Finally, robust standard errors were used to rule out heteroskedasticity concerns (Wooldridge, 2002).

One of the main advantages of this empirical setting regards the use independent data sources to calculate the variables applied in the econometric analysis. The combination of multiple sources is a useful strategy to mitigate bias issues related to artificial variance created from a single database (Avolio, Yammarino, & Bass, 1991; Doty & Glick, 1998). Accordingly, while the dependent variable is calculated on the basis of Compustat information, the main explanatory variables are a composition of information extracted from the Recap and NBER patent databases.

5.3.3 Measures

Dissipation effect

We compute the dependent variable as a continuous change in the licensor market share in the first year after signing a licensing contract. Following a similar approach to (Ferrier et al., 1999), the first step to calculate this variable was to compute the licensor's market share using the ratio between the licensor's sales and the total sales in the licensor's industry reported in Compustat. The industry sales were calculated on the basis of all U.S pharmaceutical firms operating within the same four-digit SIC code at year t . Following prior research (Giroud & Mueller, 2011), we used all available Compustat firms within the same licensor's SIC code. We excluded firms for

which the sales were either negative or missing. Our final measure is derived from the differences in the logarithm of the licensor's market:

$$\text{Dissipation Effect} = \ln(MS_{t+1}) - \ln(MS_t)$$

where $\ln(MS_{t+1})$ represents the licensor's market share in the first year after signing the license contract; and $\ln(MS_t)$ in the same year. This measure can be interpreted as yielding positive values representing an increase and negative values, a decrease on licensors' relative market share in the year subsequent to the license agreement. The rent dissipation effect measure is thus consistent with the concepts proposed in the markets for technology literature, according to which licensors are likely to experience increasing competition in the product market in the period that follows the licensing deal (Arora & Fosfuri, 2003; Arora & Gambardella, 2010; Fosfuri, 2006).

5.3.4 Focal independent variables

Licensor's core technology

The extent to which the licensed technology represents a licensor's core technological activity is calculated using the licensor's overall patenting activity in the years preceding the licensing deal. This measure is operationalized on the basis of the *focal index* proposed by Ziedonis (2007). One of the key underlying assumptions in the use of the focal index regards the fact that the licensor's patenting activity represents a good indication of overall technological and market activities, which has been shown to be the case in the context of the pharmaceutical industry (Hoang & Rothaermel, 2010; Roberts, 1999). Accordingly, how core the licensed technology is to the licensor is then measured on the basis of the patent class connected to the licensed

technology and the technology classes the licensor has been active in prior to the licensing date³⁸. To illustrate this, if the share of the licensor's patent portfolio assigned to the same patent class as the licensed technology is high then the technology in question is considered a core technology. This variable will be calculated as follows:

$$\text{Licensor's core technology} = \frac{\left[\left(\sum_{t-6}^t \sum_j \tilde{c}_i \cdot \rho_i \right)_c \right]}{\left[\left(\sum_{t-6}^t \sum_j \tilde{c}_i \cdot \rho_i \right) \right]}$$

in which $\left(\sum_{t-6}^t \sum_j \tilde{c}_i \cdot \rho_i \right)_c$ represents the citation-weighted sum of firm i 's patents that were applied for within five years at the time of the license agreement t and belong to the same primary patent class c as the licensed patent; and $\left(\sum_{t-6}^t \sum_j \tilde{c}_i \cdot \rho_i \right)$ is the sum of all citation-weighted patents issued to firm j that were applied for by date t following the same time window of five years. The use of weighted citations offers the possibility to capture the relative importance of each patent within the firm's portfolio (Griliches, 1990). Additionally, Hall, Jaffe, & Trajtenberg (2001) call attention to the fact that the number of citations received by any given patent is naturally right-truncated in time, since it is only possible to observe the citations received so far. Furthermore, the fact that patents differ in age results in different degrees of truncation³⁹. To overcome this issue we use a multiplier factor that corrects for the truncation problem by considering differences between the patent's grant years and the technological categories.

Technological overlap

To measure the technological overlap between licensee and licensor we also rely on the patent classes in which both firms have been active prior to the licensing contract (Jaffe, 1986;

³⁸ For the contracts negotiating more than one technology we calculated focal index on the basis of the average values of all technologies identified by a patent number

³⁹ 50% of citations are made to patents at least 10 years older than the citing patent, 25% to patents 20 years older or more, and 5% of citations refer to patents that are at least 50 years older than the citing one (Hall et al., 2001)

Sampson, 2007). Prior studies have indicated that patent classes can be used as a reliable indicator of the specific technological fields in which the patenting firm operates (Lanjouw & Schankerman, 2004; Nooteboom, Van Haverbeke, Duysters, Gilsing, & van den Oord, 2007). Therefore, we use the measure proposed by (Jaffe, 1986) to capture the technological position of the licensor relative to the licensee in terms of the technological fields in which both firms have patented. In order to construct our measure we first generated the technological profile of licensors and licensees separately by measuring the distribution of accumulated patents across different classes in the five years prior to the licensing contract. Similarly to prior studies (e.g., Sampson, 2007), we obtained a multidimensional vector, $F_i = (F_i^1 \dots F_i^S)$, according to which F_i^S represents the number of patents assigned to firm i in the patent class s . Because we are interested in investigating how low levels of technological overlap moderate the relationship between licensing and rent dissipation, we inverted this variable by subtracting it from 1, as follows:

$$\text{Technological overlap} = 1 - \frac{F_i F_j}{\sqrt{(F_i F_i) (F_j F_j)}}$$

Accordingly, this measure takes value 1 for firms that have orthogonal vectors, value 0 for firms with full overlap in their patenting activity, and a value between 0 and 1 for the cases in which there is an intermediate degree of orthogonality between licensor and licensee.

Licensee size

Given that we could not successfully match a satisfactory number of licensee firms with the Compustat database, we relied on a patent stock measure as a proxy for licensee size. Therefore, the measure for licensee's size is based on the logarithm of the total number of patents filed by

the licensee within 10 years⁴⁰ before the licensing contract. Although we recognize that this proxy has limitations, there are reasons to consider the licensee's patent stock a reliable proxy for firm size. Examining the relationship between patent stock and the number of employees for the licensor firms in our sample, we observe a significant correlation of 63% between those two variables. Furthermore, a number of previous studies have also proxied firm size using the total number of patents accumulated over time (Cantwell & Santangelo, 2000; Quintana-García & Benavides-Velasco, 2008). Still, one could argue that in certain circumstances small firms may display an extensive patenting activity as compared to large firms, but if that is the case then the size measure would lead to a downwards bias (against the results we expect), given that small firms are less likely to cause more rent dissipation vis-à-vis large ones.

Control variables

To minimize alternative explanations and isolate the effects of the explanatory variables, we controlled for several factors regarding firm, contract, and technology characteristics that could also explain changes in the licensor's market share. Regarding firm characteristics, we control for size using the logarithm of the licensor's number of employees at year t . We control for licensor's *R&D intensity* by including the R&D expenditures divided by the firm total sales. How specialized the licensor is in terms of different technological fields may also affect the extent to which it is subject to the rent dissipation effect. In order to control for this characteristic, we calculated a Herfindahl index on the basis of the classes connected to all the patents the licensor successfully applied prior to the licensing date.

We also control for contractual specification by adding dummy variables capturing four legal aspects of the deal. First, licensing contracts that allow the licensee to sub-license the

⁴⁰ As an alternative, we also estimated the models using 5 and 15 years to calculate the licensee's patent stock and the results remained the same.

acquired technology are likely to amplify the dissipation effect experienced by the licensor, so we added a dummy variable indicating whether the licensing deal regards a contract that allows *sub-licensing*. Second, licensing contracts may stipulate whether or not the licensee is exclusive; we expect that the exclusivity clauses may affect the dependent variable in either a positive or a negative way. On the one hand, if the licensee is exclusive, it may be more willing to commercially exploit the licensed technology in a more aggressive way. On the other hand, the fact that the technology is restricted to a single firm could also reduce the rent dissipation. Third, we also use a dummy variable to indicate whether the licensing contract includes royalty fees in its remuneration structure (Choi, 2002). Finally, we also include a dummy variable in the econometric analysis, indicating whether the licensing contract allows the licensee to further develop the licensed technology. We expect that licensees are more likely to require this clause to be included in the contract when the licensed technology presents a high potential to be further developed and commercially exploited, which may also affect the rent dissipation experienced by the licensor.

The final set of control variables regards specific characteristics of the licensed technology. We expect that more valuable technologies are also more likely to result in stronger rent dissipation; therefore, following the convention in the patent literature, we use the total number of forward citations received by a given technology to proxy value (Trajtenberg, 1990). We control for the age of the licensed technology using the time difference between the application date of a patent and the date of the licensing deal. Finally, in order to account for heterogeneity originating from differences in the technological fields of licensed technologies, we follow prior studies (Gambardella, Harhoff, & Verspagen, 2008; Jaffe, 1989; Mowery, Sampat, & Ziedonis, 2002) and group the patent classes into four main patent classes according

to the relevant fields of technology and generate dummy variables for each of them (Hall et al., 2001).

5.5 Results

5.5.1 Descriptive statistics

Table 1 reports the means, standard deviations, and Pearson correlation coefficients of the variables used in the fixed effects model. The correlation does not warrant further examination with respect to multicollinearity. Additionally, the maximum variance inflation factor (VIF) associated with any of the independent variables was 1.66 (mean VIF = 1.39), which is well below the rule-of-thumb value of ten (Wooldridge, 2012). It is possible to observe a moderate correlation between *licensor's core technology* and the *number of employees*, indicating that larger firms are less likely to license core technologies. We expect this relationship to be a result of the fact that larger firms have more diverse (less specialized) patent portfolios given their capacity to operate in different technological fields simultaneously. Finally, we used the likelihood ratio test to check how the stepwise inclusion of the variables changes the likelihood statistics. The results indicate a significant improvement in the overall fit of the Model 7 (*likelihood ratio*: 80.506, $p < 0.001$).

[Insert Table 1 around here]

Table 2 reports the results for the fixed-effects model with robust standard errors. The dependent variable across the seven models reported in this table regards the relative changes in the licensor's market share in the year subsequent to the licensing deal. Model 1 reports the estimators for the control variables. Model 2 introduces the main independent variable *licensor's core technology*. The variables *technological overlap* and *licensee size* are entered into the Models 3 and 4, respectively. The two-way interaction between *licensor's core technology* and

technological overlap (low) is estimated in Model 5. In Model 6, the interaction between *licensee size* and *licensor's core technology* is included in the regression. Finally, Model 7 is estimated by including all explanatory variables.

Hypothesis 1 predicted that the closer a technology is to the licensor's core technological activities, the stronger the dissipation effect. Accordingly, the results of Table 2 indicate that the coefficient for the *licensor's core technology* variable is negative and significant at the 1% level when all controls are included in the equation, providing strong evidence in favor of our first hypothesis. This result lends support to one of the main ideas proposed in this paper, namely, that the closer the licensed technology is to the licensor's main technological activities, the stronger will be the rent dissipation effect experienced in the product market. Hypothesis 2 predicts that the larger the licensee firm, the stronger will be the dissipation effect caused by licensing core technologies. As reported in Table 2, the interaction term between *licensor's core technology* and *licensee size* consistently presents a negative and significant coefficient across the models, suggesting that licensee size negatively moderates the relationship between licensing core technologies and subsequent changes in the licensor's market share. This result offers support for the relationship stated in Hypothesis 2. Finally, Hypothesis 3 predicts that a lower level of technological overlap between licensor and licensee will decrease the negative effect of licensing out core technologies and the licensor's market share. The statistical significant and positive coefficient for the interaction between *licensor's core technology and technological overlap (low)* lends support for Hypothesis 3.

[Insert Table 2 around here]

Concerning the control variables, the results indicate a negative and significant effect of sub-licensing on the dependent variable. This result goes in the same direction of our expectations,

indicating that signing licensing contracts with a sub-licensing clause is negatively related to subsequent changes in the licensor's market share. Indeed, the fact that the licensee is able to transfer the commercialization rights of a specific technology to other firms is likely to increase the number of potential competitors that will also use the licensed technology to compete against the licensor.

5.6 Supplementary Analysis

The literature on markets for technology describes the 'dilemma' that licensors face when deciding whether or not to license out a technology (Fosfuri, 2006). On the one hand, licensing creates a dissipation effect caused by increasing competition in the product market (Arora & Fosfuri, 2003; Choi, 2002), which we operationalize on the basis of a relative change in the licensor's market share. On the other hand, the decreasing shares in the product market experienced by the licensor should be compensated for by licensing revenues; otherwise firms would have no stimulus to enter into licensing or other forms of technology exchange (Choi, 2002). In this paper we focus on the dissipation effect caused by licensing core technologies and two main contingencies regarding the licensee size and the overlap between licensor and licensee. Given the scarcity of empirical evidence on this topic this focus contributes to a better understanding of the rent dissipation effect as an important part of the market for technology dynamics. Although relevant, it is still only a partial picture of the licensing 'dilemma'. Unfortunately, the dataset combination that we used to test the proposed hypotheses does not allow us to extract information about the revenue generated by each licensing deal. As a consequence, we are not able to test whether the licensing revenues will increase as the dissipation effect also increases. However, looking into each individual contract we were able to extract certain information regarding the remuneration structure of each deal in order to supplement the main analysis regarding the rent dissipation effect.

In order to do so we estimated an additional econometric model based on the remuneration conditions of the licensing contracts. We generated a dummy variable that takes the value 1 if the licensing contract includes a granted minimum royalty clause. This clause indicates that the licensor will receive a given minimum royalty independently of the licensee's performance in exploiting the licensed technology, even if it is necessary for the licensee to supplement the royalty payment to reach the stipulated amount (Battersby & Grimes, 2005). Apart from being a contractual mechanism to ensure that the licensor will receive monetary compensation regardless of the licensee's performance, this contractual specification can be also used as a way to guarantee that the licensee will not use the licensing agreement to avoid or delay the introduction of a competitive technology in the market (Goldscheider, 1995; Welch, Benito, & Petersen, 2008). Accordingly, this clause can be applied to contracts that exchange valuable technologies with a high potential to generate revenue in order to avoid the risk to the licensor of becoming licensee's hostage in terms of revenue generation. Indeed, according to Goldscheider. "*minimum royalties may also be used to eliminate licensees who cannot perform adequately by providing a mechanism to "weed out" the unsuccessful licensees*" (1995, p.12). Therefore, we generated a dependent variable calculated on the basis of a binary outcome with the observations taking value 1 if the contract includes the payment of minimum royalty fees and 0 otherwise. Consequently, we expect that the main independent variables used to predict the dissipation effect equation will have the opposite direction when estimated against this dependent variable capturing the remuneration conditions of a licensing deal. We expect that the negative and significant effect that licensing a core technology has on the licensor's market share will be positive in terms of the likelihood that this remuneration clause will be evoked. Following this logic, we also expect the opposite moderating effects for licensee size and technological overlap.

Considering the discrete nature of the dependent variable we used a logit model with robust standard errors to estimate the likelihood that this clause will be used in a licensing contract. We included the same explanatory variables used in the fixed effects model, apart from the variable *Royalty Sales* and the licensor market share in the year prior to the licensing date.

[Insert Table 3 around here]

In line with our expectations we find a positive and significant effect of the licensor's core technology on the likelihood that the licensing contract will include a minimum royalty fee clause. This result suggests that the licensor is more likely to require safer remuneration conditions (that do not depend on licensee performance) as a way to compensate for the dissipation effect caused by licensing out core technologies. Examining the interaction between the licensor's core technology and technological overlap (low) between the licensor and the licensee, we also find support for the idea that low levels of overlap between both parts negatively moderate the relationship between core technology and remuneration conditions. Our results do not lend support to the moderating effect that licensee size is expected to have on the remuneration conditions of licensing contracts.

5.7 Discussion and Conclusions

This article started by developing a conceptual model to explain the rent dissipation effect using the concepts found in the markets for technology literature. Despite the fact that the dissipation effect has been recurrently mentioned as one of the main dimensions of technology licensing, only few studies have examined this topic. In this paper, we focus on the extent to which the licensed technology represents a licensor's core technology. We posit that licensing core technologies is more likely to increase the dissipation effect caused by the existence of downstream market assets. Furthermore, we incorporate into our model the licensee's point of

view by considering that licensee size plays an important role in moderating the negative effects of licensing core technologies. Finally, we draw on recent advances in the markets for technology literature and test the effect of technological overlap in the context of licensing contracts. Indeed, the fact that the licensor and the licensee operate in different technological niches within the same industry alleviates the rent dissipation effect experienced by the licensor.

The results should also be considered in light of some limitations. First, the literature on markets for technology conceptualizes the dissipation effect as a direct effect of increasing competition on the licensor's product market. However, the way that we are able to operationalize our dependent variable does not allow us to distinguish between a relative reduction in the licensor's current market share as a consequence of fiercer competition and the cases in which firms purposefully choose to reduce their share in the product market (e.g., by licensing out a specific line of business). This is a limitation that future research should try to deal with. Second, although we try to rule out issues of reverse causality (a firm licenses a core technology because it is experiencing financial problems), it is possible that other unobserved factors related to firm performance could lead to the decision to license core technologies. However, we believe that the use of fixed effects associated with several firm, technology, and industry control variables from the econometric model offers a robust setting to minimize such concerns. Third, because our proxy for how core a technology is to the licensor is based on patenting information, the most appropriate solution would be to use a measure connecting the licensed technology directly with produce market. Nevertheless, several studies have indicated patent data to be a robust indicator of firm technological activities, which is naturally reflected in the firm's product market. Fourth, despite the fact that we believe the number of patents to be a reliable proxy for licensee size, further studies should use a more precise measure that makes it possible to examine how the licensee downstream assets affect the rent dissipation. Finally, the

results are not directly generalizable; the pharmaceutical industry is a specific case in which several characteristics offer the necessary conditions for a well-functioning market for technology where patents work as the main appropriability strategy. Despite those limitations we believe that this paper contributes by shedding light on important, and relatively unexplored, dimensions of the licensing literature. We encourage future research to explore further the contingencies related to the dissipation effect against empirical data. Along these lines, a possible extension would be how firms can use the contractual design of licensing contracts to prevent licensees from becoming potential competitors.

5.8 References

- Anand, B. N. & Khanna, T. 2000a. The Structure of Licensing Contracts. *Journal of Industrial Economics*, 48(1): 103-135.
- Anand, B. N. & Khanna, T. 2000b. Do firms learn to create value? The case of alliances. *Strategic Management Journal*, 21(3): 295-315.
- Arora, A. & Gambardella, A. 1994. Evaluating technological information and utilizing it: Scientific knowledge, technological capability, and external linkages in biotechnology. *Journal of Economic Behavior & Organization*, 24(1): 91-114.
- Arora, A., Fosfuri, A., & Gambardella, A. 2001. Markets for Technology and their Implications for Corporate Strategy. *Industrial & Corporate Change*, 10(2): 419-451.
- Arora, A. & Fosfuri, A. 2003. Licensing the market for technology. *Journal of Economic Behavior & Organization*, 52(2): 277.
- Arora, A. & Ceccagnoli, M. 2006. Patent Protection, Complementary Assets, and Firms' Incentives for Technology Licensing. *Management Science*, 52(2): 293-308.
- Arora, A. & Gambardella, A. 2010. Ideas for rent: an overview of markets for technology. *Industrial & Corporate Change*, 19(3): 775-803.
- Arora, A. & Ceccagnoli, M. 2011. Patent Protection, Complementary Assets, and Firms' Incentives for Technology Licensing. In M. J. Leiblein & A. A. Ziedonis (Eds.), *Technology Strategy and Innovation Management*: 193-208: Strategic Management series, vol. 4. Cheltenham, U.K. and Northampton, Mass.: Elgar.
- Atuahene-Gima, K. 1993. Determinants of inward technology licensing intentions: An empirical analysis of Australian engineering firms. *Journal of Product Innovation Management*, 10(3): 230-240.
- Audretsch, D. & Feldman, M. 2003. Small-Firm Strategic Research Partnerships: The Case of Biotechnology. *Technology Analysis & Strategic Management*, 15(2): 273-288.
- Avolio, B. J., Yammarino, F. J., & Bass, B. M. 1991. Identifying Common Methods Variance With Data Collected From A Single Source: An Unresolved Sticky Issue. *Journal of Management*, 17(3): 571-587.
- Battersby, G. J. & Grimes, C. W. 2005. *Licensing royalty rates*. New York: Aspen Publishers.
- Cantwell, J. & Santangelo, G. D. 2000. Capitalism, profits and innovation in the new techno-economic paradigm. *Journal of Evolutionary Economics*, 10(1-2): 131-157.
- Cassiman, B. & Veugelers, R. 2006. In Search of Complementarity in Innovation Strategy: Internal R&D and External Knowledge Acquisition. *Management Science*, 52(1): 68-82.
- Ceccagnoli, M. & Hicks, D. 2012. Complementary Assets and the Choice of Organizational Governance: Empirical Evidence From a Large Sample of U.S. Technology-Based Firms. *IEEE Trans. Eng. Manage. IEEE Transactions on Engineering Management*: 1-14.
- Ceccagnoli, M. & Jiang, L. 2012. The cost of integrating external technologies: Supply and demand drivers of value creation in the markets for technology. *Strategic Management Journal*(forthcoming).

- Ceccagnoli, M. & Jiang, L. 2013. The cost of integrating external technologies: Supply and demand drivers of value creation in the markets for technology. *Strategic Management Journal*, 34(4): 404-425.
- Chen, M.-J. & Hambrick, D. C. 1995. Speed, Stealth, and Selective Attack: How Small Firms Differ from Large Firms in Competitive Behavior. *The Academy of Management Journal*, 38(2): 453-482.
- Chesbrough, H. W. 2003. *Open innovation : the new imperative for creating and profiting from technology*. Boston, Mass.: Harvard Business School Press.
- Choi, J. P. 2002. A dynamic analysis of licensing: The "boomerang" effect and grant-back clauses. *International Economic Review*, 43(3): 803-829.
- Cohen, W. M. & Levinthal, D. A. 1990. Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly*, 35(1): 128-152.
- Cohen, W. M., Nelson, R. R., & Walsh, J. P. 2000. Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not). *Working paper series*.(7552).
- Coles, J. L., Lemmon, M. L., & Felix Meschke, J. 2012. Structural models and endogeneity in corporate finance: The link between managerial ownership and corporate performance. *Journal of Financial Economics*, 103(1): 149-168.
- Dosi, G. & Marengo, L. 2007. On the Evolutionary and Behavioral Theories of Organizations: A Tentative Roadmap. *Organization Science*, 18(3): 491-502.
- Doty, D. H. & Glick, W. H. 1998. Common Methods Bias: Does Common Methods Variance Really Bias Results? *Organizational Research Methods*, 1(4): 374-406.
- Duysters, G. & Hagedoorn, J. 2000. Core competences and company performance in the worldwide computer industry. *Journal of High Technology Management Research*, 11(1): 75-91.
- Eswaran, M. 1994. Cross-Licensing of Competing Patents as a Facilitating Device. *The Canadian Journal of Economics / Revue canadienne d'Economique*, 27(3): 689-708.
- Ferrier, W. J., Smith, K. G., & Grimm, C. M. 1999. The Role of Competitive Action in Market Share Erosion and Industry Dethronement: A Study of Industry Leaders and Challengers. *The Academy of Management Journal*, 42(4): 372-388.
- Fershtman, C. & Kamien, M. I. 1992. Cross licensing of complementary technologies. *International Journal of Industrial Organization*, 10(3): 329-348.
- Fosfuri, A. 2006. The licensing dilemma: understanding the determinants of the rate of technology licensing. *Strategic Management Journal*, 27(12): 1141-1158.
- Gallini, N. T. & Wright, B. D. 1990. Technology Transfer under Asymmetric Information. *The RAND Journal of Economics*, 21(1): 147-160.
- Gambardella, A., Giuri, P., & Luzzi, A. 2007. The market for patents in Europe. *Research Policy*, 36(8): 1163-1183.
- Gambardella, A., Harhoff, D., & Verspagen, B. 2008. The value of European patents. *European Management Review*, 5(2): 69-84.

- Gambardella, A. & Giarratana, M. S. 2012. General technological capabilities, product market fragmentation, and markets for technology. *Research Policy*(forthcoming).
- Gans, J. S. & Stern, S. 2003. The product market and the market for “ideas”: commercialization strategies for technology entrepreneurs. *Research Policy*, 32(2): 333-350.
- Gans, J. S., Hsu, D. H., & Stern, S. 2008. The Impact of Uncertain Intellectual Property Rights on the Market for Ideas: Evidence from Patent Grant Delays. *Management Science*, 54(5): 982-997.
- Gans, J. S. & Stern, S. 2010. Is there a market for ideas? *Industrial and Corporate Change*, 19(3): 805-837.
- Giroud, X. & Mueller, H. M. 2011. Corporate Governance, Product Market Competition, and Equity Prices. *The Journal of Finance*, 66(2): 563-600.
- Goldscheider, R. 1995. Negotiation of Royalties and Other Sources of Income from Licensing, The. *IDEA*, 36: 1.
- Granstrand, O., Patel, P., & Pavitt, K. 1997. Multi-Technology Corporations: Why They Have "Distributed" Rather than "Distinctive Core" Competencies. *California management review*., 39(4): 8.
- Granstrand, O. 1999. *The economics and management of intellectual property: Towards intellectual capitalism*: Edward Elgar Cheltenham, UK.
- Greene, W. H. 2003. *Econometric analysis*. Upper Saddle River, N.J.: Prentice Hall.
- Griliches, Z. 1990. Patent Statistics as Economic Indicators - a Survey. *Journal of Economic Literature*, 28(4): 1661-1707.
- Grindley, P. C. & Teece, D. J. 1997. Managing Intellectual Capital: Licensing and Cross-Licensing in Semiconductors and Electronics. *California Management Review*, 39(2): 8-41.
- Hagedoorn, J. 2002. Inter-firm R&D partnerships: an overview of major trends and patterns since 1960. *Research Policy Research Policy*, 31(4): 477-492.
- Hagedoorn, J. & Cloudt, M. 2003. Measuring innovative performance: is there an advantage in using multiple indicators? *Research Policy*, 32(8): 1365-1379.
- Hall, B. H., Jaffe, A. B., & Trajtenberg, M. 2001. The NBER Patent Citations Data File: Lessons, Insights and Methodological Tools: NBER Working Paper, No. 8498.
- Hannan, M. T. & Freeman, J. 1977. The Population Ecology of Organizations. *American Journal of Sociology*, 82(5): 929-964.
- Hausman, J. A. 1978. Specification Test in Econometrics. *Econometrica*, 46(6): 1251-1271.
- Helpman, E. 1998. *General purpose technologies and economic growth*: The MIT press.
- Hill, C. W. L. & Rothaermel, F. T. 2003. The Performance of Incumbent Firms in the Face of Radical Technological Innovation. *The Academy of Management Review*, 28(2): 257-274.
- Hoang, H. & Rothaermel, F. T. 2010. Leveraging internal and external experience: exploration, exploitation, and R&D project performance. *Strategic Management Journal*, 31(7): 734-758.

- Jaffe, A. B. 1986. Technological opportunity and spillovers of R&D : evidence from firm's patents, profits and market value.
- Jaffe, A. B. 1989. Real effects of academic research. *American Economic Review*, 79(5): 957-970.
- Jensen, R. & Thursby, M. 2001. Proofs and Prototypes for Sale: The Licensing of University Inventions. *The American Economic Review*, 91(1): 240-259.
- Kamien, M. I. 1992. Patent licensing. *Handbook of game theory with economic applications*, 1: 331-354.
- Kamiyama, S., Sheehan, J., & Martínez, C. 2006. Valuation and Exploitation of Intellectual Property. *OECD Publishing*.
- Kani, M. & Motohashi, K. 2012. Understanding the technology market for patents: New insights from a licensing survey of Japanese firms. *Research Policy*, 41(1): 226-235.
- Katz, M. L. & Shapiro, C. 1985. On the Licensing of Innovations. *The RAND Journal of Economics*, 16(4): 504-520.
- Kulatilaka, N. & Lin, L. 2006. Impact of Licensing on Investment and Financing of Technology Development. *Management Science*, 52(12): 1824-1837.
- Lanjouw, J. O. & Schankerman, M. 2004. Patent Quality and Research Productivity: Measuring Innovation with Multiple Indicators. *Economic Journal*, 114(495): 441-465.
- Laursen, K., Leone, M. I., & Torrisi, S. 2010. Technological exploration through licensing: new insights from the licensee's point of view. *Industrial and Corporate Change*, 19(3): 871-897.
- Lei, D. & Slocum Jr, J. W. 1991. Global Strategic Alliances: Payoffs and Pitfalls. *Organizational Dynamics*, 19(3): 44-62.
- Leone, M. I. & Reichstein, T. 2012. Licensing-in fosters rapid invention! the effect of the grant-back clause and technological unfamiliarity. *Strategic Management Journal*, 33(8): 965-985.
- Lowe, J. & Taylor, P. 1999. Imitation through technology licensing: strategic implications for smaller firms. *International Journal of Innovation Management*, 3(02): 185-207.
- Mowery, D. C., Sampat, B. N., & Ziedonis, A. A. 2002. Learning to Patent: Institutional Experience, Learning, and the Characteristics of U. S. University Patents after the Bayh-Dole Act, 1981-1992. *Management Science*, 48(1): 73-89.
- Nooteboom, B., Van Haverbeke, W., Duysters, G., Gilsing, V., & van den Oord, A. 2007. Optimal cognitive distance and absorptive capacity. *Research Policy*, 36(7): 1016-1034.
- Parr, R. L. & Sullivan, P. H. 1996. *Technology licensing : corporate strategies for maximizing value*. New York: Wiley.
- Prahalad, C. K. & Hamel, G. 1993. *The core competence of the corporation*. Boston, MA: Harvard Business School.
- Quintana-García, C. & Benavides-Velasco, C. A. 2008. Innovative competence, exploration and exploitation: The influence of technological diversification. *Research Policy*, 37(3): 492-507.

- Rivette, K. G. & Kline, D. 2000. Discovering New Value in Intellectual Property. *Harvard business review.*, 78(1): 54.
- Roberts, P. W. 1999. Product innovation, product-market competition and persistent profitability in the U.S. *Strategic Management Journal*, 20(7): 655-670.
- Sakakibara, M. 2010. An empirical analysis of pricing in patent licensing contracts. *Industrial and Corporate Change*, 19(3): 927-945.
- Sampson, R. C. 2007. R&D Alliances and Firm Performance: The Impact of Technological Diversity and Alliance Organization on Innovation. *Academy of Management Journal*, 50(2): 364-386.
- Schilling, M. A. 2009. Understanding the alliance data. *Strategic Management Journal*, 30(3): 233-260.
- Shepard, A. 1987. Licensing to Enhance Demand for New Technologies. *The RAND Journal of Economics*, 18(3): 360-368.
- Somaya, D., Kim, Y., & Vonortas, N. S. 2011. Exclusivity in licensing alliances: using hostages to support technology commercialization. *Strategic Management Journal*, 32(2): 159-186.
- Song, J., Almeida, P., & Wu, G. 2003. Learning-by-Hiring: When Is Mobility More Likely to Facilitate Interfirm Knowledge Transfer? *Management Science*, 49(4): 351-365.
- Teece, D. J. 1986. Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy*, 15(6): 285-305.
- Trajtenberg, M. 1990. A penny for your quotes: patent citations and the value of innovations. *RAND Journal of Economics (RAND Journal of Economics)*, 21(1): 172-187.
- Van Wijk, R., Jansen, J. J. P., & Lyles, M. A. 2008. Inter- and Intra-Organizational Knowledge Transfer: A Meta-Analytic Review and Assessment of its Antecedents and Consequences. *Journal of Management Studies*, 45(4): 830-853.
- Verbeek, M. 2000. *A guide to modern econometrics*. Chichester; New York: Wiley.
- Walter, J. 2012. The influence of firm and industry characteristics on returns from technology licensing deals: evidence from the US computer and pharmaceutical sectors. *R&D Management*, 42(5): 435-454.
- Wang, X. H. 1998. Fee versus royalty licensing in a Cournot duopoly model. *Economics Letters*, 60(1): 55-62.
- Welch, L. S., Benito, G. R., & Petersen, B. 2008. *Foreign operation methods: Theory, analysis, strategy*: Edward Elgar Publishing.
- Wooldridge, J. M. 2002. *Econometric analysis of cross section and panel data*. Cambridge, Mass.: MIT Press.
- Wooldridge, J. M. 2012. *Introductory econometrics : a modern approach*. Mason, Ohio: South-Western Cengage Learning.
- Zuniga, M. & Guellec, D. 2009. Who Licenses out Patents and Why? Lessons from a Business Survey, *STI Working Paper 2009/5*.

5.9 Appendix

Figure 1. Conceptual Model

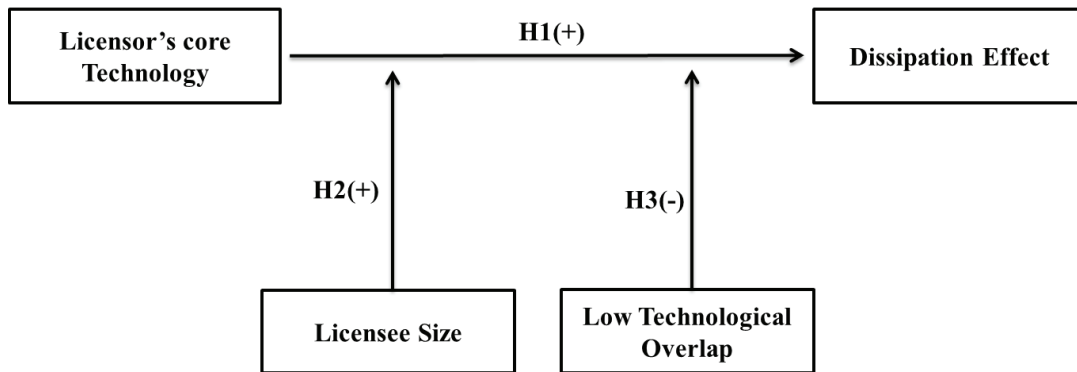


Table 1. Descriptive Statistics and Correlations Coefficients (N = 334)

Variables	Mean	S.D.	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
[1] Licensor's core Technology	0.35	0.30	1.00							
[2] Technological Overlap (Low)	0.70	0.34	-0.12	1.00						
[3] Log(Licensee Size)	3.32	2.67	0.19	-0.25	1.00					
[4] Previous Change in Licensor's Market Share	0.02	0.99	-0.10	0.02	-0.01	1.00				
[5] R&D Intensity	3.87	15.37	0.04	-0.09	0.11	-0.32	1.00			
[6] Log (Employees)	5.96	2.68	-0.35	0.10	-0.37	0.01	-0.17	1.00		
[7] Licensor Technological Specialization	0.40	0.24	0.46	-0.02	0.21	-0.04	0.01	-0.47	1.00	
[8] Sub-Licensing	0.73	0.45	0.17	-0.02	-0.00	-0.05	0.04	-0.11	0.08	1.00
[9] Exclusivity	0.74	0.44	0.21	0.01	0.08	-0.01	0.07	-0.21	0.21	0.44
[10] Royalty Sales	0.85	0.36	0.02	0.03	-0.00	-0.05	0.07	-0.04	-0.02	0.07
[11] License Development	0.70	0.46	0.09	-0.16	-0.00	0.07	-0.06	-0.13	0.16	0.25
[12] Technology Value	95.62	213.35	-0.11	-0.02	0.02	0.01	-0.03	0.13	-0.01	-0.22
[13] Technology Age	6.65	3.69	-0.20	-0.00	-0.14	0.05	0.10	0.19	-0.16	-0.12

Variables	Mean	S.D.	[9]	[10]	[11]	[12]	[13]
[9] Exclusivity	0.74	0.44	1.00				
[10] Royalty Sales	0.85	0.36	0.05	1.00			
[11] License Development	0.70	0.46	0.17	0.09	1.00		
[12] Technology Value	95.62	213.35	-0.23	0.02	-0.11	1.00	
[13] Technology Age	6.65	3.69	-0.22	0.01	-0.15	0.13	1.00

Table 2. Results of Fixed Effects Panel Linear Regression Analysis Predicting Dissipation Effect

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Licensor's core Technology		-1.179** (0.441)	-1.440** (0.439)	-1.440** (0.435)	-1.402** (0.420)	-1.368** (0.419)	-1.351** (0.413)
Technological Overlap (Low)			-0.685** (0.224)	-0.712** (0.229)	-0.753** (0.237)	-0.724** (0.229)	-0.758** (0.236)
Licensee Size				-0.012 (0.026)	-0.014 (0.026)	-0.006 (0.026)	-0.010 (0.027)
Licensor's core Technology x Technological Overlap (Low)					1.403* (0.618)		1.250* (0.608)
Licensor's core Technology x Licensee Size						-0.128* (0.062)	-0.098+ (0.059)
Previous Change in Licensor's Market Share	-0.338** (0.128)	-0.337** (0.111)	-0.351** (0.107)	-0.349** (0.110)	-0.352** (0.107)	-0.347** (0.106)	-0.350** (0.104)
R&D Intensity	-0.010 (0.007)	-0.011+ (0.006)	-0.013+ (0.006)	-0.012+ (0.006)	-0.014* (0.006)	-0.013* (0.006)	-0.014** (0.006)
Log (Employees)	0.112 (0.223)	0.161 (0.224)	0.166 (0.194)	0.173 (0.193)	0.121 (0.192)	0.216 (0.182)	0.160 (0.181)
Licensor Technological Specialization	0.085 (0.719)	0.361 (0.649)	0.090 (0.581)	0.094 (0.582)	-0.254 (0.618)	0.230 (0.537)	-0.111 (0.571)
Sub-Licensing	-0.306* (0.137)	-0.324* (0.140)	-0.303* (0.146)	-0.303* (0.146)	-0.255+ (0.140)	-0.251+ (0.143)	-0.221 (0.141)
Exclusivity	-0.049 (0.151)	-0.035 (0.157)	0.002 (0.157)	-0.003 (0.154)	0.022 (0.154)	-0.035 (0.145)	-0.005 (0.147)
License Development	0.022 (0.116)	-0.000 (0.118)	-0.106 (0.113)	-0.110 (0.112)	-0.075 (0.103)	-0.131 (0.109)	-0.095 (0.100)
Royalty Sales	0.113 (0.159)	0.077 (0.162)	0.103 (0.140)	0.106 (0.139)	0.054 (0.137)	0.063 (0.147)	0.027 (0.143)

Technology Value	0.003	0.030	0.039	0.039	0.039	0.052	0.033	0.046
	(0.021)	(0.027)	(0.028)	(0.028)	(0.028)	(0.033)	(0.026)	(0.031)
Technology Age	0.833	0.793	0.317	0.313	0.840	0.840	0.382	0.835
	(2.186)	(2.074)	(1.821)	(1.813)	(1.698)	(1.698)	(1.793)	(1.698)
Technology Field Dummy	YES	YES	YES	YES	YES	YES	YES	YES
Year Dummy	YES	YES	YES	YES	YES	YES	YES	YES
Constant	0.767	0.720	1.007	1.024	1.385	1.385	0.855	1.215
	(1.308)	(1.305)	(1.122)	(1.123)	(1.129)	(1.129)	(1.060)	(1.070)
Number of observations	330	330	330	330	330	330	330	330
R2	0.348	0.416	0.461	0.462	0.483	0.483	0.473	0.489
L1	-195.045	-176.932	-163.597	-163.348	-156.849	-156.849	-159.843	-154.792
Likelihood ratio comparison	-	36.226***	62.896***	63.395***	76.391***	76.391***	70.403***	80.506***

+ p<0.10, * p<0.05, ** p<0.01, ***p<0.001 at a two sided test, Robust Standard errors in parentheses

Table 3: Results of Logit Model Predicting Remuneration Clauses

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Licensor's core Technology	1.546* (0.694)	1.765* (0.742)	1.822* (0.736)	2.065** (0.751)	1.819* (0.760)	2.117** (0.792)	
Technological Overlap (Low)		1.199+ (0.657)	1.375* (0.666)	1.712* (0.694)	1.374* (0.669)	1.732* (0.701)	
Licensee Size			0.075 (0.064)	0.086 (0.066)	0.075 (0.064)	0.090 (0.067)	
Licensor's core Technology x Technological Overlap (Low)				-4.060* (1.670)		-4.155* (1.657)	
Licensor's core Technology x Licensee Size					0.006 (0.207)	-0.067 (0.205)	
R&D Intensity	-0.001 (0.009)	-0.002 (0.009)	-0.000 (0.010)	-0.001 (0.009)	-0.002 (0.009)	-0.001 (0.009)	-0.002 (0.009)
Log (Employees)	0.141+ (0.076)	0.161* (0.077)	0.147+ (0.078)	0.175* (0.081)	0.172* (0.085)	0.174* (0.086)	0.180* (0.088)
Licensor Technological Specialization	0.925 (0.764)	0.072 (0.866)	-0.128 (0.945)	-0.277 (0.955)	-0.172 (0.968)	-0.281 (0.967)	-0.128 (0.975)
Sub-Licensing	0.293 (0.414)	0.229 (0.410)	0.173 (0.412)	0.145 (0.408)	0.066 (0.413)	0.144 (0.407)	0.068 (0.416)
Exclusivity	0.328 (0.387)	0.384 (0.388)	0.361 (0.385)	0.391 (0.384)	0.497 (0.395)	0.392 (0.385)	0.493 (0.397)
Royalty Sales	2.652* (1.064)	2.673* (1.099)	2.588* (1.086)	2.665* (1.133)	2.732* (1.117)	2.665* (1.134)	2.740* (1.116)
Technology Value	-0.056 (0.112)	-0.027 (0.101)	-0.022 (0.111)	-0.020 (0.112)	-0.026 (0.101)	-0.020 (0.112)	-0.028 (0.101)
Technology Age	1.238 (5.015)	2.939 (4.947)	3.385 (4.959)	3.664 (5.107)	2.492 (5.347)	3.662 (5.104)	2.484 (5.362)
License Development	-0.001 (0.168)	0.052 (0.168)	0.197 (0.168)	0.224 (0.168)	0.189 (0.168)	0.226 (0.168)	0.168 (0.168)

Technology Field Dummy	(0.443)	(0.430)	(0.445)	(0.446)	(0.455)	(0.454)	(0.468)
Year Dummy	YES	YES	YES	YES	YES	YES	YES
Constant	-4.128*	-3.661*	-3.603*	-3.970*	-4.273**	-3.965*	-4.338**
	(1.666)	(1.711)	(1.582)	(1.607)	(1.638)	(1.616)	(1.644)
Number of observations	319	319	319	319	319	319	319
L1	-126.718	-124.303	-122.162	-121.593	-119.537	-121.593	-119.491
Chi2	56.995**	59.016**	63.575***	66.565***	68.624***	69.949***	69.694***

+ p<0.10, * p<0.05, ** p<0.01, ***p<0.001 at a two sided test, Robust Standard errors in parentheses

CHAPTER 6

CONCLUSION

This PhD dissertation aims to improve our understanding of firms' use of technology licensing as a complementary part of their efforts to innovate. The main question concerning the relationship between licensing and innovation was explored using a combination of different theoretical perspectives based on contract theory, organizational learning, network analysis, and industrial organization. Additionally, the point of departure for all four papers was the implications and the benefits that firm may experience by entering into licensing deals. Although prior studies have comprehensively increased our understanding of the use of licensing contracts as a mechanism to trade technologies and exchange know-how, several important questions remain open. Accordingly, the papers in this dissertation join the existing literature that aims at understanding how technology licensing is used by firms to tap into external sources of knowledge.

More than just exploring the relationship between technology licensing and firm innovation, this dissertation's contribution also lies in understanding a set of contractual and organizational contingencies that are prominently relevant for organizations involved in licensing deals. For example, in the third paper of this dissertation I examine the use of the grant-back clause in licensing contracts. While contractual mechanisms shaping knowledge spillovers between firms are relevant in several contexts, this clause is used distinctively in licensing contracts. Another example can be observed in the first paper of this dissertation, although the notion of speed of external knowledge recombination can be applied to different

settings, the use of licensed technologies is a critical methodological and conceptual instance to identify the precise time of knowledge acquisition and recombination.

The findings in this dissertation also have managerial implications for firms operating in both the demand and the supply side of markets for technology. From the licensee's perspective, this dissertation offers managers a reference framework to consider how specific organizational characteristics such as inventor networks can affect a firm's capacity to deal with licensed-in technologies. These findings call attention to the fact that a firm's decision to outsource part of its internal R&D should be made in alignment with other important dimensions of the internal organization of innovation activities. From the licensor's perspective, even though in a less pronounced way, this dissertation emphasizes the market implications that licensing out core technologies may impose on the licensor. Understanding the dissipation effect and the contingencies that can make it more or less stringent can be crucial for managers when deciding to license a certain technology. Additionally, another important aspect that is also considered in the third paper in this dissertation regards the use of contractual mechanisms to avoid competition created from licensing. Indeed, contractual clauses can shape incentives and also avoid undesirable outcomes related to the loss of control of the licensed technology. Those points represent relevant aspects that managers can consider when deciding to enter into licensing deals.

This dissertation also opens several directions for future research. First, future research could look at different organizational factors that affect firms' capacity to benefit from licensing in new technologies. In particular, I believe that it is relevant to increase our understanding of the importance that employees, in isolation or in teams, have for the process of knowledge acquisition and assimilation at the firm level. Although in first and second papers I use different levels of analysis regarding organizational characteristics affecting firms' capacity

to deal with licensed technologies, I believe more research should be done in this area. Second, despite the fact that the grant-back clause is a major contractual clause in licensing contracts, several other clauses merit attention in future research. For example, the technology furnishing clause, which commits the licensor to support the licensee to understand the technology that is being negotiated is very important for the function of markets for technology. Despite its relevance, I am not aware of any existing study aiming at explaining its use. In fact, the existing literature on technology licensing has mostly looked at contractual clauses as important moderators for specific outcomes (e.g., innovation and market performance), but very few empirical studies have tried to explain when or under what circumstances they will be used in licensing contracts. This is one of the approaches that future research on this topic should try to pursue. In a broader perspective, future research should aim at integrating different dimensions (e.g., technological, contractual or competitive) of the licensing process within the same analytical framework

TITLER I PH.D.SERIEN:

– a Field Study of the Rise and Fall of a Bottom-Up Process

2004

1. Martin Grieger
Internet-based Electronic Marketplaces and Supply Chain Management
2. Thomas Basbøll
*LIKENESS
A Philosophical Investigation*
3. Morten Knudsen
*Beslutningens vaklen
En systemteoretisk analyse af moderniseringen af et amtskommunalt sundhedsvæsen 1980-2000*
4. Lars Bo Jeppesen
*Organizing Consumer Innovation
A product development strategy that is based on online communities and allows some firms to benefit from a distributed process of innovation by consumers*
5. Barbara Dragsted
*SEGMENTATION IN TRANSLATION AND TRANSLATION MEMORY SYSTEMS
An empirical investigation of cognitive segmentation and effects of integrating a TM system into the translation process*
6. Jeanet Hardis
*Sociale partnerskaber
Et socialkonstruktivistisk casestudie af partnerskabsaktørers virkelighedsopfattelse mellem identitet og legitimitet*
7. Henriette Hallberg Thygesen
System Dynamics in Action
8. Carsten Mejer Plath
Strategisk Økonomistyring
9. Annemette Kjærgaard
Knowledge Management as Internal Corporate Venturing
10. Knut Arne Hovdal
*De professionelle i endring
Norsk ph.d., ej til salg gennem Samfundslitteratur*
11. Søren Jeppesen
*Environmental Practices and Greening Strategies in Small Manufacturing Enterprises in South Africa
– A Critical Realist Approach*
12. Lars Frode Frederiksen
*Industriel forskningsledelse
– på sporet af mønstre og samarbejde i danske forskningsintensive virksomheder*
13. Martin Jes Iversen
*The Governance of GN Great Nordic
– in an age of strategic and structural transitions 1939-1988*
14. Lars Pynt Andersen
*The Rhetorical Strategies of Danish TV Advertising
A study of the first fifteen years with special emphasis on genre and irony*
15. Jakob Rasmussen
Business Perspectives on E-learning
16. Sof Thrane
*The Social and Economic Dynamics of Networks
– a Weberian Analysis of Three Formalised Horizontal Networks*
17. Lene Nielsen
Engaging Personas and Narrative Scenarios – a study on how a user-centered approach influenced the perception of the design process in the e-business group at AstraZeneca
18. S.J Valstad
*Organisationsidentitet
Norsk ph.d., ej til salg gennem Samfundslitteratur*

19. Thomas Lyse Hansen
Six Essays on Pricing and Weather risk in Energy Markets
20. Sabine Madsen
Emerging Methods – An Interpretive Study of ISD Methods in Practice
21. Evis Sinani
The Impact of Foreign Direct Investment on Efficiency, Productivity Growth and Trade: An Empirical Investigation
22. Bent Meier Sørensen
Making Events Work Or, How to Multiply Your Crisis
23. Pernille Schnoor
*Brand Ethos
Om troværdige brand- og virksomhedsidentiteter i et retorisk og diskursteoretisk perspektiv*
24. Sidsel Fabech
*Von welchem Österreich ist hier die Rede?
Diskursive forhandlinger og magtkampe mellem rivaliserende nationale identitetskonstruktioner i østrigske pressediskurser*
25. Klavs Odgaard Christensen
*Sprogpolitik og identitetsdannelse i flersprogede forbundsstater
Et komparativt studie af Schweiz og Canada*
26. Dana B. Minbaeva
Human Resource Practices and Knowledge Transfer in Multinational Corporations
27. Holger Højlund
*Markedets politiske fornuft
Et studie af velfærdens organisering i perioden 1990-2003*
28. Christine Mølgaard Frandsen
*A.s erfaring
Om mellemværendets praktik i en transformation af mennesket og subjektiviteten*
29. Sine Nørholm Just
The Constitution of Meaning – A Meaningful Constitution? Legitimacy, identity, and public opinion in the debate on the future of Europe
- 2005**
1. Claus J. Varnes
Managing product innovation through rules – The role of formal and structured methods in product development
2. Helle Hedegaard Hein
Mellem konflikt og konsensus – Dialogudvikling på hospitalsklinikker
3. Axel Rosenø
Customer Value Driven Product Innovation – A Study of Market Learning in New Product Development
4. Søren Buhl Pedersen
*Making space
An outline of place branding*
5. Camilla Funck Ellehave
*Differences that Matter
An analysis of practices of gender and organizing in contemporary workplaces*
6. Rigmor Madeleine Lond
Styring af kommunale forvaltninger
7. Mette Aagaard Andreassen
Supply Chain versus Supply Chain Benchmarking as a Means to Managing Supply Chains
8. Caroline Aggestam-Pontoppidan
*From an idea to a standard
The UN and the global governance of accountants' competence*
9. Norsk ph.d.
10. Vivienne Heng Ker-ni
An Experimental Field Study on the

- Effectiveness of Grocer Media Advertising*
Measuring Ad Recall and Recognition, Purchase Intentions and Short-Term Sales
11. Allan Mortensen
Essays on the Pricing of Corporate Bonds and Credit Derivatives
12. Remo Stefano Chiari
Figure che fanno conoscere
Itinerario sull'idea del valore cognitivo e espressivo della metafora e di altri tropi da Aristotele e da Vico fino al cognitivismo contemporaneo
13. Anders McIlquham-Schmidt
Strategic Planning and Corporate Performance
An integrative research review and a meta-analysis of the strategic planning and corporate performance literature from 1956 to 2003
14. Jens Geersbro
The TDF – PMI Case
Making Sense of the Dynamics of Business Relationships and Networks
15. Mette Andersen
Corporate Social Responsibility in Global Supply Chains
Understanding the uniqueness of firm behaviour
16. Eva Boxenbaum
Institutional Genesis: Micro – Dynamic Foundations of Institutional Change
17. Peter Lund-Thomsen
Capacity Development, Environmental Justice NGOs, and Governance: The Case of South Africa
18. Signe Jarlov
Konstruktioner af offentlig ledelse
19. Lars Stæhr Jensen
Vocabulary Knowledge and Listening Comprehension in English as a Foreign Language
- An empirical study employing data elicited from Danish EFL learners*
20. Christian Nielsen
Essays on Business Reporting
Production and consumption of strategic information in the market for information
21. Marianne Thejls Fischer
Egos and Ethics of Management Consultants
22. Annie Bekke Kjær
Performance management i Process-innovation
– belyst i et social-konstruktivistisk perspektiv
23. Suzanne Dee Pedersen
GENTAGELSENS METAMORFOSE
Om organisering af den kreative gøren i den kunstneriske arbejdspraksis
24. Benedikte Dorte Rosenbrink
Revenue Management
Økonomiske, konkurrencemæssige & organisatoriske konsekvenser
25. Thomas Riise Johansen
Written Accounts and Verbal Accounts
The Danish Case of Accounting and Accountability to Employees
26. Ann Fogelgren-Pedersen
The Mobile Internet: Pioneering Users' Adoption Decisions
27. Birgitte Rasmussen
Ledelse i fællesskab – de tillidsvalgtes fornyende rolle
28. Gitte Thit Nielsen
Remerger
– skabende ledelseskrafter i fusion og opkøb
29. Carmine Gioia
A MICROECONOMETRIC ANALYSIS OF MERGERS AND ACQUISITIONS

30. Ole Hinz
Den effektive forandringsleder: pilot, pædagog eller politiker?
Et studie i arbejdslederens meningstilskrivninger i forbindelse med vellykket gennemførelse af ledelsesinitierede forandringsprojekter
31. Kjell-Åge Gotvassli
Et praksisbasert perspektiv på dynamiske læringsnettverk i toppidretten
Norsk ph.d., ej til salg gennem Samfundslitteratur
32. Henriette Langstrup Nielsen
Linking Healthcare
An inquiry into the changing performances of web-based technology for asthma monitoring
33. Karin Tweddell Levinsen
Virtuel Uddannelsespraksis
Master i IKT og Læring – et casestudie i hvordan proaktiv proceshåndtering kan forbedre praksis i virtuelle læringsmiljøer
34. Anika Liversage
Finding a Path
Labour Market Life Stories of Immigrant Professionals
35. Kasper Elmquist Jørgensen
Studier i samspillet mellem stat og erhvervsliv i Danmark under 1. verdenskrig
36. Finn Janning
A DIFFERENT STORY
Seduction, Conquest and Discovery
37. Patricia Ann Plackett
Strategic Management of the Radical Innovation Process
Leveraging Social Capital for Market Uncertainty Management
- 2006**
1. Christian Vintergaard
Early Phases of Corporate Venturing
2. Niels Rom-Poulsen
Essays in Computational Finance
3. Tina Brandt Husman
Organisational Capabilities, Competitive Advantage & Project-Based Organisations
The Case of Advertising and Creative Good Production
4. Mette Rosenkrands Johansen
Practice at the top
– how top managers mobilise and use non-financial performance measures
5. Eva Parum
Corporate governance som strategisk kommunikations- og ledelsesværktøj
6. Susan Aagaard Petersen
Culture's Influence on Performance Management: The Case of a Danish Company in China
7. Thomas Nicolai Pedersen
The Discursive Constitution of Organizational Governance – Between unity and differentiation
The Case of the governance of environmental risks by World Bank environmental staff
8. Cynthia Selin
Volatile Visions: Transactions in Anticipatory Knowledge
9. Jesper Banghøj
Financial Accounting Information and Compensation in Danish Companies
10. Mikkel Lucas Overby
Strategic Alliances in Emerging High-Tech Markets: What's the Difference and does it Matter?
11. Tine Aage
External Information Acquisition of Industrial Districts and the Impact of Different Knowledge Creation Dimensions

- A case study of the Fashion and Design Branch of the Industrial District of Montebelluna, NE Italy*
12. Mikkel Flyverbom
*Making the Global Information Society Governable
On the Governmentality of Multi-Stakeholder Networks*
 13. Anette Grønning
*Personen bag
Tilstedevær i e-mail som interaktionsform mellem kunde og medarbejder i dansk forsikringskontekst*
 14. Jørn Helder
*One Company – One Language?
The NN-case*
 15. Lars Bjerregaard Mikkelsen
*Differing perceptions of customer value
Development and application of a tool for mapping perceptions of customer value at both ends of customer-supplier dyads in industrial markets*
 16. Lise Granerud
*Exploring Learning
Technological learning within small manufacturers in South Africa*
 17. Esben Rahbek Pedersen
*Between Hopes and Realities:
Reflections on the Promises and Practices of Corporate Social Responsibility (CSR)*
 18. Ramona Samson
*The Cultural Integration Model and European Transformation.
The Case of Romania*
- 2007**
1. Jakob Vestergaard
*Discipline in The Global Economy
Panopticism and the Post-Washington Consensus*
 2. Heidi Lund Hansen
*Spaces for learning and working
A qualitative study of change of work, management, vehicles of power and social practices in open offices*
 3. Sudhanshu Rai
*Exploring the internal dynamics of software development teams during user analysis
A tension enabled Institutionalization Model; "Where process becomes the objective"*
 4. Norsk ph.d.
Ej til salg gennem Samfundslitteratur
 5. Serden Ozcan
*EXPLORING HETEROGENEITY IN ORGANIZATIONAL ACTIONS AND OUTCOMES
A Behavioural Perspective*
 6. Kim Sundtoft Hald
*Inter-organizational Performance Measurement and Management in Action
– An Ethnography on the Construction of Management, Identity and Relationships*
 7. Tobias Lindeberg
*Evaluative Technologies
Quality and the Multiplicity of Performance*
 8. Merete Wedell-Wedellsborg
*Den globale soldat
Identitetsdannelse og identitetsledelse i multinationale militære organisationer*
 9. Lars Frederiksen
*Open Innovation Business Models
Innovation in firm-hosted online user communities and inter-firm project ventures in the music industry
– A collection of essays*
 10. Jonas Gabrielsen
Retorisk toposlære – fra statisk 'sted' til persuasiv aktivitet

11. Christian Moldt-Jørgensen
Fra meningsløs til meningsfuld evaluering.
Anvendelsen af studentertilfredsheds-målinger på de korte og mellemlange videregående uddannelser set fra et psykodynamisk systemperspektiv
12. Ping Gao
Extending the application of actor-network theory
Cases of innovation in the telecommunications industry
13. Peter Mejlby
Frihed og fængsel, en del af den samme drøm?
Et phronetisk baseret casestudie af frigørelsens og kontrollens sam-eksistens i værdibaseret ledelse!
14. Kristina Birch
Statistical Modelling in Marketing
15. Signe Poulsen
Sense and sensibility:
The language of emotional appeals in insurance marketing
16. Anders Bjerre Trolle
Essays on derivatives pricing and dynamic asset allocation
17. Peter Feldhütter
Empirical Studies of Bond and Credit Markets
18. Jens Henrik Eggert Christensen
Default and Recovery Risk Modeling and Estimation
19. Maria Theresa Larsen
Academic Enterprise: A New Mission for Universities or a Contradiction in Terms?
Four papers on the long-term implications of increasing industry involvement and commercialization in academia
20. Morten Wellendorf
Postimplementering af teknologi i den offentlige forvaltning
Analyser af en organisations kontinuerlige arbejde med informations-teknologi
21. Ekaterina Mhaanna
Concept Relations for Terminological Process Analysis
22. Stefan Ring Thorbjørnsen
Forsvaret i forandring
Et studie i officerers kapabiliteter under påvirkning af omverdenens forandringspres mod øget styring og læring
23. Christa Breum Amhøj
Det selvskabte medlemskab om managementstaten, dens styringsteknologier og indbyggere
24. Karoline Bromose
Between Technological Turbulence and Operational Stability
– An empirical case study of corporate venturing in TDC
25. Susanne Justesen
Navigating the Paradoxes of Diversity in Innovation Practice
– A Longitudinal study of six very different innovation processes – in practice
26. Luise Noring Henler
Conceptualising successful supply chain partnerships
– Viewing supply chain partnerships from an organisational culture perspective
27. Mark Mau
Kampen om telefonen
Det danske telefonvæsen under den tyske besættelse 1940-45
28. Jakob Halskov
The semiautomatic expansion of existing terminological ontologies using knowledge patterns discovered

- on the WWW – an implementation and evaluation*
29. Gergana Koleva
European Policy Instruments Beyond Networks and Structure: The Innovative Medicines Initiative
 30. Christian Geisler Asmussen
Global Strategy and International Diversity: A Double-Edged Sword?
 31. Christina Holm-Petersen
*Stolthed og fordom
Kultur- og identitetsarbejde ved skabelsen af en ny sengeafdeling gennem fusion*
 32. Hans Peter Olsen
*Hybrid Governance of Standardized States
Causes and Contours of the Global Regulation of Government Auditing*
 33. Lars Bøge Sørensen
Risk Management in the Supply Chain
 34. Peter Aagaard
*Det unikkes dynamikker
De institutionelle mulighedsbetingelser bag den individuelle udforskning i professionelt og frivilligt arbejde*
 35. Yun Mi Antorini
*Brand Community Innovation
An Intrinsic Case Study of the Adult Fans of LEGO Community*
 36. Joachim Lynggaard Boll
*Labor Related Corporate Social Performance in Denmark
Organizational and Institutional Perspectives*
- 2008**
1. Frederik Christian Vinten
Essays on Private Equity
 2. Jesper Clement
Visual Influence of Packaging Design on In-Store Buying Decisions
 3. Marius Brostrøm Kousgaard
*Tid til kvalitetsmåling?
– Studier af indrulleringsprocesser i forbindelse med introduktionen af kliniske kvalitetsdatabaser i speciallægepraksissektoren*
 4. Irene Skovgaard Smith
*Management Consulting in Action
Value creation and ambiguity in client-consultant relations*
 5. Anders Rom
*Management accounting and integrated information systems
How to exploit the potential for management accounting of information technology*
 6. Marina Candi
Aesthetic Design as an Element of Service Innovation in New Technology-based Firms
 7. Morten Schnack
*Teknologi og tværfaglighed
– en analyse af diskussionen omkring indførelse af EPJ på en hospitalsafdeling*
 8. Helene Balslev Clausen
Juntos pero no revueltos – un estudio sobre emigrantes norteamericanos en un pueblo mexicano
 9. Lise Justesen
*Kunsten at skrive revisionsrapporter.
En beretning om forvaltningsrevisions beretninger*
 10. Michael E. Hansen
The politics of corporate responsibility: CSR and the governance of child labor and core labor rights in the 1990s
 11. Anne Roepstorff
Holdning for handling – en etnologisk undersøgelse af Virksomheders Sociale Ansvar/CSR

12. Claus Bajlum
Essays on Credit Risk and Credit Derivatives
13. Anders Bojesen
The Performative Power of Competence – an Inquiry into Subjectivity and Social Technologies at Work
14. Satu Reijonen
*Green and Fragile
A Study on Markets and the Natural Environment*
15. Ilduara Busta
*Corporate Governance in Banking
A European Study*
16. Kristian Anders Hvass
*A Boolean Analysis Predicting Industry Change: Innovation, Imitation & Business Models
The Winning Hybrid: A case study of isomorphism in the airline industry*
17. Trine Paludan
*De uvidende og de udviklingsparate
Identitet som mulighed og restriktion blandt fabriksarbejdere på det aftayloriserede fabriksgulv*
18. Kristian Jakobsen
Foreign market entry in transition economies: Entry timing and mode choice
19. Jakob Elming
Syntactic reordering in statistical machine translation
20. Lars Brømsøe Termansen
*Regional Computable General Equilibrium Models for Denmark
Three papers laying the foundation for regional CGE models with agglomeration characteristics*
21. Mia Reinholt
The Motivational Foundations of Knowledge Sharing
22. Frederikke Krogh-Meibom
*The Co-Evolution of Institutions and Technology
– A Neo-Institutional Understanding of Change Processes within the Business Press – the Case Study of Financial Times*
23. Peter D. Ørberg Jensen
OFFSHORING OF ADVANCED AND HIGH-VALUE TECHNICAL SERVICES: ANTECEDENTS, PROCESS DYNAMICS AND FIRMLEVEL IMPACTS
24. Pham Thi Song Hanh
Functional Upgrading, Relational Capability and Export Performance of Vietnamese Wood Furniture Producers
25. Mads Vangkilde
*Why wait?
An Exploration of first-mover advantages among Danish e-grocers through a resource perspective*
26. Hubert Buch-Hansen
*Rethinking the History of European Level Merger Control
A Critical Political Economy Perspective*
- 2009**
1. Vivian Lindhardsen
From Independent Ratings to Communal Ratings: A Study of CWA Raters' Decision-Making Behaviours
2. Guðrið Weihe
Public-Private Partnerships: Meaning and Practice
3. Chris Nøkkentved
*Enabling Supply Networks with Collaborative Information Infrastructures
An Empirical Investigation of Business Model Innovation in Supplier Relationship Management*
4. Sara Louise Muhr
Wound, Interrupted – On the Vulnerability of Diversity Management

5. Christine Sestoft
Forbrugeradfærd i et Stats- og Livsformsteoretisk perspektiv
6. Michael Pedersen
Tune in, Breakdown, and Reboot: On the production of the stress-fit self-managing employee
7. Salla Lutz
Position and Reposition in Networks – Exemplified by the Transformation of the Danish Pine Furniture Manufacturers
8. Jens Forssbæk
Essays on market discipline in commercial and central banking
9. Tine Murphy
Sense from Silence – A Basis for Organised Action
How do Sensemaking Processes with Minimal Sharing Relate to the Reproduction of Organised Action?
10. Sara Malou Strandvad
Inspirations for a new sociology of art: A sociomaterial study of development processes in the Danish film industry
11. Nicolaas Mouton
On the evolution of social scientific metaphors: A cognitive-historical enquiry into the divergent trajectories of the idea that collective entities – states and societies, cities and corporations – are biological organisms.
12. Lars Andreas Knutsen
Mobile Data Services: Shaping of user engagements
13. Nikolaos Theodoros Korfiatis
Information Exchange and Behavior
A Multi-method Inquiry on Online Communities
14. Jens Albæk
Forestillinger om kvalitet og tværfaglighed på sygehuse
– skabelse af forestillinger i læge- og plejegrupperne angående relevans af nye idéer om kvalitetsudvikling gennem tolkningsprocesser
15. Maja Lotz
The Business of Co-Creation – and the Co-Creation of Business
16. Gitte P. Jakobsen
Narrative Construction of Leader Identity in a Leader Development Program Context
17. Dorte Hermansen
“Living the brand” som en brandorienteret dialogisk praxis: Om udvikling af medarbejdernes brandorienterede dømmekraft
18. Aseem Kinra
Supply Chain (logistics) Environmental Complexity
19. Michael Nørager
How to manage SMEs through the transformation from non innovative to innovative?
20. Kristin Wallevik
Corporate Governance in Family Firms
The Norwegian Maritime Sector
21. Bo Hansen Hansen
Beyond the Process
Enriching Software Process Improvement with Knowledge Management
22. Annemette Skot-Hansen
Franske adjektivisk afledte adverbier, der tager præpositionssyntagmer indledt med præpositionen à som argumenter
En valensgrammatisk undersøgelse
23. Line Gry Knudsen
Collaborative R&D Capabilities
In Search of Micro-Foundations

24. Christian Scheuer
*Employers meet employees
Essays on sorting and globalization*
25. Rasmus Johnsen
*The Great Health of Melancholy
A Study of the Pathologies of Perfor-
mativity*
26. Ha Thi Van Pham
*Internationalization, Competitiveness
Enhancement and Export Performance
of Emerging Market Firms:
Evidence from Vietnam*
27. Henriette Balieu
*Kontrolbegrebets betydning for kausa-
tivalternationen i spansk
En kognitiv-typologisk analyse*
- 2010**
1. Yen Tran
*Organizing Innovation in Turbulent
Fashion Market
Four papers on how fashion firms crea-
te and appropriate innovation value*
2. Anders Raastrup Kristensen
*Metaphysical Labour
Flexibility, Performance and Commit-
ment in Work-Life Management*
3. Margrét Sigrún Sigurdardóttir
*Dependently independent
Co-existence of institutional logics in
the recorded music industry*
4. Ásta Dis Óladóttir
*Internationalization from a small do-
mestic base:
An empirical analysis of Economics and
Management*
5. Christine Secher
*E-deltagelse i praksis – politikernes og
forvaltningens medkonstruktion og
konsekvenserne heraf*
6. Marianne Stang Våland
*What we talk about when we talk
about space:*
7. Rex Degnegaard
*Strategic Change Management
Change Management Challenges in
the Danish Police Reform*
8. Ulrik Schultz Brix
*Værdi i rekruttering – den sikre beslut-
ning
En pragmatisk analyse af perception
og synliggørelse af værdi i rekrutte-
rings- og udvælgelsesarbejdet*
9. Jan Ole Similä
*Kontraktsledelse
Relasjonen mellom virksomhetsledelse
og kontraktshåndtering, belyst via fire
norske virksomheter*
10. Susanne Boch Waldorff
*Emerging Organizations: In between
local translation, institutional logics
and discourse*
11. Brian Kane
*Performance Talk
Next Generation Management of
Organizational Performance*
12. Lars Ohnemus
*Brand Thrust: Strategic Branding and
Shareholder Value
An Empirical Reconciliation of two
Critical Concepts*
13. Jesper Schlamovitz
*Håndtering af usikkerhed i film- og
byggeprojekter*
14. Tommy Moesby-Jensen
*Det faktiske livs forbindtlighed
Førsokratisk informeret, ny-aristotelisk
ἦθος-tænkning hos Martin Heidegger*
15. Christian Fich
*Two Nations Divided by Common
Values
French National Habitus and the
Rejection of American Power*

16. Peter Beyer
Processer, sammenhængskraft og fleksibilitet
Et empirisk casestudie af omstillingsforløb i fire virksomheder
17. Adam Buchhorn
Markets of Good Intentions
Constructing and Organizing Biogas Markets Amid Fragility and Controversy
18. Cecilie K. Moesby-Jensen
Social læring og fælles praksis
Et mixed method studie, der belyser læringskonsekvenser af et lederkursus for et praksisfællesskab af offentlige mellemledere
19. Heidi Boye
Fødevarer og sundhed i senmodernismen
– En indsigt i hyggefænomenet og de relaterede fødevarerpraksisser
20. Kristine Munkgård Pedersen
Flygtige forbindelser og midlertidige mobiliseringer
Om kulturel produktion på Roskilde Festival
21. Oliver Jacob Weber
Causes of Intercompany Harmony in Business Markets – An Empirical Investigation from a Dyad Perspective
22. Susanne Ekman
Authority and Autonomy
Paradoxes of Modern Knowledge Work
23. Anette Frey Larsen
Kvalitetsledelse på danske hospitaler
– Ledelsernes indflydelse på introduktion og vedligeholdelse af kvalitetsstrategier i det danske sundhedsvæsen
24. Toyoko Sato
Performativity and Discourse: Japanese Advertisements on the Aesthetic Education of Desire
25. Kenneth Brinch Jensen
Identifying the Last Planner System
Lean management in the construction industry
26. Javier Busquets
Orchestrating Network Behavior for Innovation
27. Luke Patey
The Power of Resistance: India's National Oil Company and International Activism in Sudan
28. Mette Vedel
Value Creation in Triadic Business Relationships. Interaction, Interconnection and Position
29. Kristian Tørning
Knowledge Management Systems in Practice – A Work Place Study
30. Qingxin Shi
An Empirical Study of Thinking Aloud Usability Testing from a Cultural Perspective
31. Tanja Juul Christiansen
Corporate blogging: Medarbejderes kommunikative handlekraft
32. Malgorzata Ciesielska
Hybrid Organisations. A study of the Open Source – business setting
33. Jens Dick-Nielsen
Three Essays on Corporate Bond Market Liquidity
34. Sabrina Speiermann
Modstandens Politik
Kampagnestyling i Velfærdsstaten. En diskussion af trafikcampagners styringspotentiale
35. Julie Uldam
Fickle Commitment. Fostering political engagement in 'the flighty world of online activism'

36. Annegrete Juul Nielsen
Traveling technologies and transformations in health care
37. Athur Mühlen-Schulte
*Organising Development
Power and Organisational Reform in the United Nations Development Programme*
38. Louise Rygaard Jonas
*Branding på butiksgulvet
Et case-studie af kultur- og identitetsarbejdet i Kvickly*
- 2011**
1. Stefan Fraenkel
*Key Success Factors for Sales Force Readiness during New Product Launch
A Study of Product Launches in the Swedish Pharmaceutical Industry*
2. Christian Plesner Rossing
International Transfer Pricing in Theory and Practice
3. Tobias Dam Hede
Samtalekunst og ledelsesdisciplin – en analyse af coachingsdiskursens genealogi og governmentality
4. Kim Pettersson
Essays on Audit Quality, Auditor Choice, and Equity Valuation
5. Henrik Merkelsen
The expert-lay controversy in risk research and management. Effects of institutional distances. Studies of risk definitions, perceptions, management and communication
6. Simon S. Torp
Employee Stock Ownership: Effect on Strategic Management and Performance
7. Mie Harder
Internal Antecedents of Management Innovation
8. Ole Helby Petersen
Public-Private Partnerships: Policy and Regulation – With Comparative and Multi-level Case Studies from Denmark and Ireland
9. Morten Krogh Petersen
'Good' Outcomes. Handling Multiplicity in Government Communication
10. Kristian Tangsgaard Hvelplund
Allocation of cognitive resources in translation - an eye-tracking and key-logging study
11. Moshe Yonatany
The Internationalization Process of Digital Service Providers
12. Anne Vestergaard
*Distance and Suffering
Humanitarian Discourse in the age of Mediatization*
13. Thorsten Mikkelsen
Personlighedens indflydelse på forretningsrelationer
14. Jane Thostrup Jagd
Hvorfor fortsætter fusionsbølgen udover "the tipping point"? – en empirisk analyse af information og kognitioner om fusioner
15. Gregory Gimpel
Value-driven Adoption and Consumption of Technology: Understanding Technology Decision Making
16. Thomas Stengade Sønderkov
*Den nye mulighed
Social innovation i en forretningsmæssig kontekst*
17. Jeppe Christoffersen
Donor supported strategic alliances in developing countries
18. Vibeke Vad Baunsgaard
Dominant Ideological Modes of Rationality: Cross functional

- integration in the process of product innovation*
19. Throstur Olaf Sigurjonsson
Governance Failure and Iceland's Financial Collapse
 20. Allan Sall Tang Andersen
Essays on the modeling of risks in interest-rate and inflation markets
 21. Heidi Tscherning
Mobile Devices in Social Contexts
 22. Birgitte Gorm Hansen
Adapting in the Knowledge Economy Lateral Strategies for Scientists and Those Who Study Them
 23. Kristina Vaarst Andersen
Optimal Levels of Embeddedness The Contingent Value of Networked Collaboration
 24. Justine Grønbæk Pors
Noisy Management A History of Danish School Governing from 1970-2010
 25. Stefan Linder
Micro-foundations of Strategic Entrepreneurship Essays on Autonomous Strategic Action
 26. Xin Li
Toward an Integrative Framework of National Competitiveness An application to China
 27. Rune Thorbjørn Clausen
Værdifuld arkitektur Et eksplorativt studie af bygningers rolle i virksomheders værdiskabelse
 28. Monica Viken
Markedsundersøkelser som bevis i varemerke- og markedsføringsrett
 29. Christian Wymann
Tattooing The Economic and Artistic Constitution of a Social Phenomenon
 30. Sanne Frandsen
Productive Incoherence A Case Study of Branding and Identity Struggles in a Low-Prestige Organization
 31. Mads Stenbo Nielsen
Essays on Correlation Modelling
 32. Ivan Häuser
Følelse og sprog Etablering af en ekspressiv kategori, eksemplificeret på russisk
 33. Sebastian Schwenen
Security of Supply in Electricity Markets
- 2012**
1. Peter Holm Andreasen
The Dynamics of Procurement Management - A Complexity Approach
 2. Martin Haulrich
Data-Driven Bitext Dependency Parsing and Alignment
 3. Line Kirkegaard
Konsulenten i den anden nat En undersøgelse af det intense arbejdsliv
 4. Tonny Stenheim
Decision usefulness of goodwill under IFRS
 5. Morten Lind Larsen
Produktiviteten, vækst og velfærd Industrirådet og efterkrigstidens Danmark 1945 - 1958
 6. Petter Berg
Cartel Damages and Cost Asymmetries
 7. Lynn Kahle
Experiential Discourse in Marketing A methodical inquiry into practice and theory
 8. Anne Roelsgaard Obling
Management of Emotions in Accelerated Medical Relationships

9. Thomas Frandsen
Managing Modularity of Service Processes Architecture
10. Carina Christine Skovmøller
*CSR som noget særligt
Et casestudie om styring og menings-
skabelse i relation til CSR ud fra en
intern optik*
11. Michael Tell
*Fradragsbeskæring af selskabers
finansieringsudgifter
En skatteretlig analyse af SEL §§ 11,
11B og 11C*
12. Morten Holm
*Customer Profitability Measurement
Models
Their Merits and Sophistication
across Contexts*
13. Katja Joo Dyppel
*Beskatning af derivater
En analyse af dansk skatteret*
14. Esben Anton Schultz
*Essays in Labor Economics
Evidence from Danish Micro Data*
15. Carina Risvig Hansen
*"Contracts not covered, or not fully
covered, by the Public Sector Directive"*
16. Anja Svejgaard Pors
*Iværksættelse af kommunikation
- patientfigurer i hospitalets strategiske
kommunikation*
17. Frans Bévort
*Making sense of management with
logics
An ethnographic study of accountants
who become managers*
18. René Kallestrup
*The Dynamics of Bank and Sovereign
Credit Risk*
19. Brett Crawford
*Revisiting the Phenomenon of Interests
in Organizational Institutionalism
The Case of U.S. Chambers of
Commerce*
20. Mario Daniele Amore
Essays on Empirical Corporate Finance
21. Arne Stjernholm Madsen
*The evolution of innovation strategy
Studied in the context of medical
device activities at the pharmaceutical
company Novo Nordisk A/S in the
period 1980-2008*
22. Jacob Holm Hansen
*Is Social Integration Necessary for
Corporate Branding?
A study of corporate branding
strategies at Novo Nordisk*
23. Stuart Webber
*Corporate Profit Shifting and the
Multinational Enterprise*
24. Helene Ratner
*Promises of Reflexivity
Managing and Researching
Inclusive Schools*
25. Therese Strand
*The Owners and the Power: Insights
from Annual General Meetings*
26. Robert Gavin Strand
*In Praise of Corporate Social
Responsibility Bureaucracy*
27. Nina Sormunen
*Auditor's going-concern reporting
Reporting decision and content of the
report*
28. John Bang Mathiasen
*Learning within a product development
working practice:
- an understanding anchored
in pragmatism*
29. Philip Holst Riis
*Understanding Role-Oriented Enterprise
Systems: From Vendors to Customers*
30. Marie Lisa Dacanay
*Social Enterprises and the Poor
Enhancing Social Entrepreneurship and
Stakeholder Theory*

31. Fumiko Kano Glückstad
Bridging Remote Cultures: Cross-lingual concept mapping based on the information receiver's prior-knowledge
32. Henrik Barslund Fosse
Empirical Essays in International Trade
33. Peter Alexander Albrecht
*Foundational hybridity and its reproduction
Security sector reform in Sierra Leone*
34. Maja Rosenstock
*CSR - hvor svært kan det være?
Kulturanalytisk casestudie om udfordringer og dilemmaer med at forankre Coops CSR-strategi*
35. Jeanette Rasmussen
*Tweens, medier og forbrug
Et studie af 10-12 årige danske børns brug af internettet, opfattelse og forståelse af markedsføring og forbrug*
36. Ib Tunby Gulbrandsen
*'This page is not intended for a US Audience'
A five-act spectacle on online communication, collaboration & organization.*
37. Kasper Aalling Teilmann
Interactive Approaches to Rural Development
38. Mette Mogensen
*The Organization(s) of Well-being and Productivity
(Re)assembling work in the Danish Post*
39. Søren Friis Møller
*From Disinterestedness to Engagement
Towards Relational Leadership In the Cultural Sector*
40. Nico Peter Berhausen
Management Control, Innovation and Strategic Objectives – Interactions and Convergence in Product Development Networks
41. Balder Onarheim
*Creativity under Constraints
Creativity as Balancing 'Constrainedness'*
42. Haoyong Zhou
Essays on Family Firms
43. Elisabeth Naima Mikkelsen
*Making sense of organisational conflict
An empirical study of enacted sense-making in everyday conflict at work*
- 2013**
1. Jacob Lyngsie
Entrepreneurship in an Organizational Context
2. Signe Groth-Brodersen
*Fra ledelse til selvet
En socialpsykologisk analyse af forholdet imellem selvledelse, ledelse og stress i det moderne arbejdsliv*
3. Nis Høyrup Christensen
Shaping Markets: A Neoinstitutional Analysis of the Emerging Organizational Field of Renewable Energy in China
4. Christian Edelvold Berg
*As a matter of size
THE IMPORTANCE OF CRITICAL MASS AND THE CONSEQUENCES OF SCARCITY FOR TELEVISION MARKETS*
5. Christine D. Isakson
*Coworker Influence and Labor Mobility
Essays on Turnover, Entrepreneurship and Location Choice in the Danish Maritime Industry*
6. Niels Joseph Jerne Lennon
*Accounting Qualities in Practice
Rhizomatic stories of representational faithfulness, decision making and control*
7. Shannon O'Donnell
*Making Ensemble Possible
How special groups organize for collaborative creativity in conditions of spatial variability and distance*

8. Robert W. D. Veitch
Access Decisions in a Partly-Digital World
Comparing Digital Piracy and Legal Modes for Film and Music
9. Marie Mathiesen
Making Strategy Work
An Organizational Ethnography
10. Arisa Shollo
The role of business intelligence in organizational decision-making
11. Mia Kaspersen
The construction of social and environmental reporting
12. Marcus Møller Larsen
The organizational design of offshoring
13. Mette Ohm Rørdam
EU Law on Food Naming
The prohibition against misleading names in an internal market context
14. Hans Peter Rasmussen
GIV EN GED!
Kan giver-idealtyper forklare støtte til velgørenhed og understøtte relationsopbygning?
15. Ruben Schachtenhaufen
Fonetisk reduktion i dansk
16. Peter Koerver Schmidt
Dansk CFC-beskatning
I et internationalt og komparativt perspektiv
17. Morten Froholdt
Strategi i den offentlige sektor
En kortlægning af styringsmæssig kontekst, strategisk tilgang, samt anvendte redskaber og teknologier for udvalgte danske statslige styrelser
18. Annette Camilla Sjørup
Cognitive effort in metaphor translation
An eye-tracking and key-logging study
19. Tamara Stucchi
The Internationalization of Emerging Market Firms: A Context-Specific Study
20. Thomas Lopdrup-Hjorth
"Let's Go Outside": The Value of Co-Creation
21. Ana Alačovska
Genre and Autonomy in Cultural Production
The case of travel guidebook production
22. Marius Gudmand-Høyer
Stemningssindssygdommens historie i det 19. århundrede
Omtydningen af melankolien og manien som bipolære stemningslidelser i dansk sammenhæng under hensyn til dannelsen af det moderne følelseslivs relative autonomi.
En problematiserings- og erfarings-analytisk undersøgelse
23. Lichen Alex Yu
Fabricating an S&OP Process
Circulating References and Matters of Concern
24. Esben Alfort
The Expression of a Need
Understanding search
25. Trine Pallesen
Assembling Markets for Wind Power
An Inquiry into the Making of Market Devices
26. Anders Koed Madsen
Web-Visions
Repurposing digital traces to organize social attention
27. Lærke Højgaard Christiansen
BREWING ORGANIZATIONAL RESPONSES TO INSTITUTIONAL LOGICS
28. Tommy Kjær Lassen
EGENTLIG SELVLEDELSE
En ledelsesfilosofisk afhandling om selvedelsens paradoksale dynamik og eksistentielle engagement

29. Morten Rossing
Local Adaption and Meaning Creation in Performance Appraisal
30. Søren Obed Madsen
*Lederen som oversætter
Et oversættelsesteoretisk perspektiv på strategisk arbejde*
31. Thomas Høgenhaven
*Open Government Communities
Does Design Affect Participation?*
32. Kirstine Zinck Pedersen
*Failsafe Organizing?
A Pragmatic Stance on Patient Safety*
33. Anne Petersen
*Hverdagslogikker i psykiatrisk arbejde
En institutionsetnografisk undersøgelse af hverdagen i psykiatriske organisationer*
34. Didde Maria Humle
Fortællinger om arbejde
35. Mark Holst-Mikkelsen
*Strategieksekvering i praksis
– barrierer og muligheder!*
36. Malek Maalouf
*Sustaining lean
Strategies for dealing with organizational paradoxes*
37. Nicolaj Tofte Brenneche
*Systemic Innovation In The Making
The Social Productivity of
Cartographic Crisis and Transitions
in the Case of SEEIT*
38. Morten Gylling
*The Structure of Discourse
A Corpus-Based Cross-Linguistic Study*
39. Binzhang YANG
*Urban Green Spaces for Quality Life
- Case Study: the landscape
architecture for people in Copenhagen*
40. Michael Friis Pedersen
*Finance and Organization:
The Implications for Whole Farm
Risk Management*
41. Even Fallan
*Issues on supply and demand for
environmental accounting information*
42. Ather Nawaz
*Website user experience
A cross-cultural study of the relation
between users' cognitive style, context
of use, and information architecture
of local websites*
43. Karin Beukel
*The Determinants for Creating
Valuable Inventions*
44. Arjan Markus
*External Knowledge Sourcing
and Firm Innovation
Essays on the Micro-Foundations
of Firms' Search for Innovation*
- 2014**
1. Solon Moreira
*Four Essays on Technology Licensing
and Firm Innovation*

TITLER I ATV PH.D.-SERIEN

1992

1. Niels Kornum
Servicesamkørsel – organisation, økonomi og planlægningsmetode

1995

2. Verner Worm
*Nordiske virksomheder i Kina
Kulturspecifikke interaktionsrelationer ved nordiske virksomhedsetableringer i Kina*

1999

3. Mogens Bjerre
*Key Account Management of Complex Strategic Relationships
An Empirical Study of the Fast Moving Consumer Goods Industry*

2000

4. Lotte Darsø
*Innovation in the Making
Interaction Research with heterogeneous Groups of Knowledge Workers creating new Knowledge and new Leads*

2001

5. Peter Hobolt Jensen
*Managing Strategic Design Identities
The case of the Lego Developer Network*

2002

6. Peter Lohmann
The Deleuzian Other of Organizational Change – Moving Perspectives of the Human
7. Anne Marie Jess Hansen
To lead from a distance: The dynamic interplay between strategy and strategizing – A case study of the strategic management process

2003

8. Lotte Henriksen
*Videndeling
– om organisatoriske og ledelsesmæssige udfordringer ved videndeling i praksis*
9. Niels Christian Nickelsen
Arrangements of Knowing: Coordinating Procedures Tools and Bodies in Industrial Production – a case study of the collective making of new products

2005

10. Carsten Ørts Hansen
Konstruktion af ledelsesteknologier og effektivitet

TITLER I DBA PH.D.-SERIEN

2007

1. Peter Kastrup-Misir
Endeavoring to Understand Market Orientation – and the concomitant co-mutation of the researched, the researcher, the research itself and the truth

2009

1. Torkild Leo Thellefsen
*Fundamental Signs and Significance effects
A Semeiotic outline of Fundamental Signs, Significance-effects, Knowledge Profiling and their use in Knowledge Organization and Branding*
2. Daniel Ronzani
When Bits Learn to Walk Don't Make Them Trip. Technological Innovation and the Role of Regulation by Law in Information Systems Research: the Case of Radio Frequency Identification (RFID)

2010

1. Alexander Carnera
*Magten over livet og livet som magt
Studier i den biopolitiske ambivalens*