PENGFEI WANG

Innovation, Status, and Networks

Innovation, Status, and Networks

Innovation, Status, and Networks

Innovatie, status, en netwerken

Thesis

to obtain the degree of Doctor from the
Erasmus University Rotterdam
by command of the
rector magnificus
Prof.dr. H.A.P. Pols

and in accordance with the decision of the Doctorate Board.

The public defense shall be held on

Thursday 01 September 2016 at 15:30 hrs
by

Pengfei Wang

Shandong, China

Erasmus University Rotterdam

Doctoral Committee

Promotor: Prof.dr. J.J.P. Jansen

Copromotor: Prof.dr. V.J.A. van de Vrande

Other members: Prof.dr. T.H. Reus
Prof.dr. K. Laursen
Prof.dr. G.M. Duijsters

Erasmus Research Institute of Management – ERIM
The joint research institute of the Rotterdam School of Management (RSM)
and the Erasmus School of Economics (ESE) at the Erasmus University Rotterdam
Internet: http://www.erim.eur.nl

ERIM Electronic Series Portal: http://hdl.handle.net/1765/1

ERIM PhD Series in Research in Management, 381
ERIM reference number: EPS-2016-381- S&E
ISBN 978-90-5892-453-7

Design: PanArt, www.panart.nl

This publication (cover and interior) is printed by Tuijtel on recycled paper, BalanceSilk®
The ink used is produced from renewable resources and alcohol free fountain solution.
Certifications for the paper and the printing production process: Recycle, EU Ecolabel, FSC®, ISO14001.
More info: www.tuijtel.com

PREFACE

There are a lot of people to whom I am greatly indebted for contributing in different ways to my PhD journey. First and foremost, I would like to express my deep gratitude to my promoter, Prof.dr. Justin Jansen, and my daily supervisor, Prof.dr. Vareska van de Vrande. I still remember the day that I first talked with them through Skype in 2010, which was my enrollment interview for the ERIM PhD program. Although I had cited their papers many times in my master thesis on open innovation, I did not know until they gave me an offer that Justin and Vareska were the very "Jansen" and "van de Vrande" that I already admired so much. I have to admit that I faced a great deal of uncertainty when choosing which offer to accept, because I had limited information about the world of academic research. Yet my final decision to come to RSM turns out to have been the right one, although I did not expect the magical Dutch weather. Justin and Vareska are not only the knowledgeable scholars that they appear to be in their published papers, they are also fairly generous in all aspects. This dissertation would not have been possible without countless discussions with them. I am very grateful to them for their openness and constant encouragement throughout the four years that have been the most important in my career.

I am also very fortunate to have worked with Michael Jensen from the University of Michigan. Although I only took a one-week lecture course that Michael delivered in ERIM, like many of my fellow students I was totally inspired by his introduction to network theory and the status model. I arranged to visit Michael because of his research status. Yet I realized afterwards that the quality of his research was actually much higher than his status that I observed. It was an amazing experience for me to visit Michael in Michigan, in 2014. We discussed our research projects while eating pizza, bibimbap, and hot dogs. Through collaborating with Michael, I came to understand that research is about more than just tables of correlations and regression.

I would also like to thank Jin Chen, my life-long mentor. Without his encouragement and recommendation, I would not have entered the academic world. Working with Jin from 2008 to 2011 really broadened my horizons. Jin always encouraged me to become an ambidextrous person, able to conduct rigorous research and solve practical problems for companies at the same time.

I warmly thank my friends at RSM with whom I share many good memories: Diana, Hendra, Hesam, Ilaria, Ivana, Jochem, Kevin, Kitty, Lameez, Lance, Maria Rita, Oli, Omar, Radina, Riccardo, Rick, Roxana, Ruxi, Saeed, Saeedeh, Sebastian, Shiko, Stefan, Ying, and many other individuals who made my time at RSM so enjoyable. Carolien and Patricia deserve special acknowledgement for their brilliant support on all kinds of administrative issues. I must also thank ERIM, Erasmus Trustfond, and CSC for their generous support.

I would like to express my deepest thanks to my family. My parents gave me endless and selfless support throughout my journey. As a child born at time when the very strict one-child policy was in force, I understand how much I mean to them. The distance of 8,900 km between Rotterdam and Shandong is not even comparable to the depth of their love and sacrifice.

I cannot thank enough my dear wife, Yuanyuan, who has followed me unconditionally and supported me from China to the world beyond. Having her alongside me has made PhD journey full of color and excitement. Qingqing, my dear princess, I am immensely proud of you.

Pengfei Wang

Rotterdam,
June, 2016

Table of Contents

Chapter 1. General Introduction 1

1.1 Research Topic: Innovation, Status, and Networks 1
1.2 Theoretical Background 5
1.2.1 Exploration and exploitation 5
1.2.2 Innovation theory 7
1.2.3 The status-based perspective 8
1.2.4 Network theory 9
1.3 Dissertation Overview 10
1.3.1 Study 1: Exploration, status, and firm growth 11
1.3.2 Study 2: A behavioral perspective on partner selection of strategic alliance 11
1.3.3 Study 3: Ambidextrous inventions, technological breakthroughs, and team composition 12
1.3.4 Study 4: Competition closure and the interaction between competition and collaboration networks 13

Chapter 2. Exploration, Status and Firm Growth 15

2.1 Introduction 16
2.2 Literature Review and Hypotheses 18
2.2.1 Exploration and growth 20
2.2.2 Exploration, technological status and growth 21
2.2.3 Exploration, status robustness, and growth 22
2.3 Methods 23
2.3.1 Data collection 23
2.3.2 Measurement 24
2.4 Analysis and Results 28
2.4.1 Robustness check 31
2.5 Discussion 37
2.5.1 Limitations and future research 39

Chapter 3. A Behavioral Perspective on the Selection of Partners in Strategic Alliances 43

3.1 Introduction 44
3.2 Literature Review and Hypotheses 46

3.2.1 Strategic orientation, behavioral homophily, and partner selection ... 46
3.2.2 Strategic orientation homophily and alliance scope ... 47
3.2.3 Strategic orientation homophily and status ... 48
3.3 Methods ... 49
3.3.1 Data collection ... 49
3.3.2 Variables ... 50
3.4 Analysis and Results ... 52
3.5 Discussion ... 58

Chapter 4. Ambidextrous Inventions, Technological Breakthroughs, and Team Composition ... 61

4.1 Introduction ... 62
4.2 Literature Review and Hypotheses ... 64
4.2.1 Ambidexterity of inventions and market value ... 66
4.2.2 Ambidexterity and breakthrough inventions ... 67
4.2.3 Team composition and ambidextrous inventions ... 69
4.3 Methods ... 71
4.3.1 Dependent variables ... 71
4.3.2 Independent variables ... 72
4.3.3 Control variables ... 73
4.4 Analysis and Results ... 74
4.4.1 Post-hoc analysis ... 80
4.5 Discussion ... 83
4.5.1 Limitations and directions for future research ... 84

Chapter 5. Competition Closure: Interaction between Competition and Collaboration Network ... 87

5.1 Introduction ... 88
5.2 Literature Review and Hypotheses ... 90
5.2.1 Collaboration networks: structural holes and network status ... 90
5.2.2 Collaboration networks: boundary conditions ... 92
5.2.3 The role of competition networks ... 93
5.2.4 Competition closure and performance ... 94
5.2.5 Competition closure and structural holes ... 96
5.2.6 Competition closure and network status ... 98
5.3 Methods ... 99

5.3.1 Dependent variables 100
5.3.2 Explanatory variables 101
5.3.3 Control variables 102
5.4 Analysis and Results 104
5.5 Discussion and Conclusion 113
5.5.1 Limitations and future research 115

Chapter 6. Conclusion and Discussion 119

6.1 Introduction 119
6.2 Summary of Main Findings 120
6.3 Implications for Theory 123
6.3.1 Implications for exploration, exploitation and innovation activities 123
6.3.2 Implications for status theory and research 124
6.3.3 Implications for network theory 126
6.4 Implications for Practice 127
6.4.1 Deceptive nature of status 127
6.4.2 Potential trap in strategic orientation 128
6.4.3 Managing inventions 128
6.4.4 Structuring competition networks 129

References 131

About the author 147

List of Tables

Table 1.1 Theoretical and methodological underpinnings of Study 1 11

Table 1.2 Theoretical and methodological underpinnings of Study 2 12

Table 1.3 Theoretical and methodological underpinnings of Study 3 13

Table 1.4 Theoretical and methodological underpinnings of Study 4 14

Table 1.5 Gaps addressed and intended contributions 14

Table 2.1 Descriptive statistics and correlations 29

Table 2.2 Fixed-effect panel estimation: firm growth $_{t+1}$ 33

Table 2.3 Fixed-effect panel estimation (robustness checks) 35

Table 3.1 Descriptive statistics and correlations 54

Table 3.2 Two-way clustering estimation on strategic alliance formation 55

Table 3.3 Effect of scope and status on the marginal effect of orientation dissimilarity 57

Table 4.1 Descriptive statistics and correlations 76

Table 4.2 Negative binomial regression on forward citations 77

Table 4.3 Logit estimation on breakthrough inventions 78

Table 4.4 Logit estimation on ambidextrous inventions 79

Table 4.5 Multinomial logit estimation with a comparison group of ambidextrous inventions 81

Table 5.1 Descriptive statistics and correlations 105

Table 5.2 Fixed-effect GLS models of venture capital firms' market share 106

Table 5.3 Probit estimation of the likelihood of an IPO being issued by a VC's portfolio companies 111

Table 5.4 Moderation effect of competition closure on the marginal effect of network status and structural holes 112

Table 6.1 Hypotheses in Study 1 120

Table 6.2 Hypotheses in Study 2 121

Table 6.3 Hypotheses in Study 3 122

Table 6.4 Hypotheses in Study 4 122

List of Figures

Figure 2.1 Effect of interaction of status and exploration on growth 32

Figure 2.2 Effect of interaction of status robustness and exploration on growth........................32

Figure 5.1 High versus low competition closure 96

Figure 5.2 Interaction between competition closure and structural holes.................................109

Figure 5.3 Interaction between competition closure and network status 109

Chapter 1. General Introduction

1.1 Research Topic: Innovation, Status, and Networks

With the rapid development and progress of technology, business, and society in the 21st century, firms are facing an extremely competitive and fast-changing environment. The update of smartphones is so fast that Apple, Samsung and Huawei may already release a new series of products before customers have got used to their old ones. Crowdfunding and online transactions have disrupted our existing financial, trade, and logistics systems. How to obtain and maintain competitive advantage in such dynamic environment has continuously attracted attention from both academic scholars and practitioners. It has been widely recognized that firms need to implement appropriate innovation strategies in order to create better products and services (Jansen, van den Bosch, and Volberda, 2006), and at the same time strive for a good position in external networks in order to take advantage of social capital and heterogeneous information (Burt, 1992; Podolny, 1993; Ahuja, 2000). In particular, it is essential for firms to make an appropriate choice internally between exploration and exploitation (Jansen et al., 2006; Lavie, Stettner, and Tushman, 2010) in order to ensure both short-term profitability and long-term renewal. Externally, obtaining a high status in inter-firm networks brings advantages to firms in the market for products (Podolny, Stuart, and Hannan, 1996; Malter, 2014), technologies (Podolny and Stuart, 1995; Stuart, 1998), and labor (Rider and Tan, 2015) because status signals the quality of firms' products or services, which can often be hard to observe (Podolny, 1993).

Even with decades of research on innovation (exploration and exploitation), status, and networks, many puzzles remain to be solved. First, limited attention has been paid to how a firm's strategic choice on exploration/exploitation interacts with network status to affect its performance and its propensity to behave in a certain way. Second, current studies have not provided enough insights on whether and how the degree of exploration or exploitation in an invention determines its value in the technology market, and how the composition of invention teams may affect whether inventions are arrived at through a process of exploration or exploitation. Finally, while existing research on networks concentrates mainly on collaboration networks, the effect of a firm's embeddedness in competition networks has been largely neglected. Therefore, to address those gaps, this dissertation tackles the overarching question:

How do innovation strategy (i.e. exploration and exploitation), status, and network structure collectively affect the performance and behavioral propensity of firms?

First of all, a closer investigation of the relationship between innovation, status, and performance is essential because it may help explain why certain prestigious companies have ceased to exist. The emergence of novel products and services has driven a large number of incumbent organizations to lose grounds, or even disappear, in quite a short space of time. For example, the telecom giants Nokia and Motorola very nearly lost their competitiveness in the age of the smartphone, and Kodak was very slow to make the switch from traditional film-based imaging to digital imaging (Wu, Wan, and Levinthal, 2014). Their slowness to react to changing markets is quite unexpected because those firms had possessed cutting-edge technologies, talented employees, and extremely high prestige and social impact. In the first study, I posit that exploration contributes less to the growth of high-status firms, which may lead such firms to form the illusion that exploration is not essential. This causes them to put less emphasis on creating exploratory innovations, and they become thus constrained by their existing competences. Thus, moving beyond previous research that highlights the contingency role of environmental conditions when explaining the importance of exploration (Jansen et al., 2006; Uotila et al., 2009), my first study emphasizes that the value of exploration may vary across firms. In particular, I introduce a status-based perspective (Podolny, 2005; Piazza and Castellucci, 2014) and investigate how a firm's technological status may affect the relationship between exploration and growth. I argue that status may be substitute for the effect of exploratory products or services on firm growth, so that, in firms with high status, exploration contributes less to growth.

Second, I highlight the exploration/exploitation framework as an important perspective for investigating partner selection for strategic alliances, whereas in current literature the emphasis is mainly on the performance implications of exploration/exploitation. How alliances are formed and evolve over time has attracted continuous attention from management scholars (Gulati, 1995; Sorenson and Stuart, 2008). Current studies have mainly identified organizational resources (Mowery, Oxley, and Silverman, 1998) and network structure (Podolny, 1994; Gulati and Garguilo, 1999) as being significant factors in alliance formation and partner selection, and have ignored the effect of a firm's strategic orientation in general (Lumpkin and Dess, 1996; Wiklund and Shepherd, 2003; Slater, Olson, and Hult, 2006), and exploration/exploitation in particular (March, 1991). Although research has long recognized that actors' behavioral characteristics determine the formation of (interpersonal) relationships and shape network positions (Mehra, Kilduff, and Brass, 2001; Sasovova et al., 2010), the effect of strategic orientation on organizations' partner selection has remained largely unexplored. To address this gap, I develop a contingency model to investigate how and under what conditions the strategic orientation (exploration-exploitation) of a firm and its potential partners affects the formation of strategic alliances. I posit that firms tend to select partners who have a similar strategic orientation with regard to exploration or exploitation, and that this is particularly true when firms have a high status and are seeking alliances with a broader scope.

Third, I emphasize that firms may obtain a competitive advantage in technology markets by creating ambidextrous inventions. I advance current knowledge on exploration and exploitation by examining how the degree of exploration (as opposed to exploitation) affects the value of an invention in the technology market, as well as how teams can be composed to generate high-impact inventions. It is very important to investigate the link between the exploitation and exploration of an invention and its technological value for two main reasons. First, although firm-level studies have shown the importance of balancing exploration and exploitation (Katila and Ahuja, 2002; He and Wong, 2004), a more salient question emerges: should firms realize that balance by generating inventions that are either *exploratory* or *exploitative* (Benner and Tushman, 2002), or should they combine the exploration and exploitation *within each invention*?

Although both approaches could lead to ambidexterity at the firm-level (Katila and Ahuja, 2002), they require totally different strategies. The first may require firms to employ a strategy of structural differentiation (Tushman and O'Reilly, 1996; Jansen, Tempelaar, van den Bosch, and Volberda, 2009; Fang, Lee, and Schilling, 2011), while the second demands ambidexterity at the invention-level. To answer this question, I investigate how the degree of exploration or exploitation within an invention affects its market value. The former strategy may be advisable when inventions that have either exploration- or exploitation-focus (Stettner or Lavie, 2014) are deemed to be of greater value, while the second may be better when ambidextrous inventions are given more credits in the technology market. Second, scholars have continued to search for a way to create valuable inventions or even technological breakthroughs, and here the emphasis is usually on the effect of knowledge components in an invention or the composition of invention teams (Singh, 2008; Singh and Fleming, 2010). Surprisingly, though, scholars have paid only limited attention to the degree of exploration/exploitation, which is one of the essential features of inventions (Rosenkopf and Nerkar, 2001; Benner and Tushman, 2002; Phelps, 2010). By emphasizing the importance of combining new and existing knowledge, this dissertation thus contributes to current literature on how to create impactful and breakthrough inventions.

Finally, in this dissertation, I aim to contribute to network research by shifting attention from collaboration networks to competition networks. Organization theorists have long recognized that the performance and behavioral propensity of firms are largely determined by their network positions (Granovetter, 1985; Burt, 1992; Podolny, 2005; Kilduff and Brass, 2010; Gulati, Lavie, and Madhavan, 2011). However, current studies have focused almost exclusively on the structure of collaboration networks, such as alliances between high-tech firms (Ahuja, 2000) and syndication in investments (Jensen, 2003; Podolny, 1994; Shipilov and Li, 2008), and have ignored the consequences of the embeddedness of firms within competition networks. Although recent studies have investigated how competition may affect the strategic judgment and choices of firms (Hsieh and Vermeulen, 2013; Skilton and Bernardes, 2014; Tsai, Su, and Chen, 2011), there is little work to be done on the implications of competition networks. Most importantly, although research on competitive dynamics implies that the competition relationship allocates market information and strategic attention (Chen, 1996; Tsai et al., 2011), which may then shape the outcomes of collaboration networks, little attention has been paid to how the interplay between collaboration and competition networks affects firm performance. Building on prior research on competitive dynamics (e.g. Chen, 1996) and network theory (Burt, 1992; Podolny, 2005), this study presents both theoretical development and empirical analysis on the performance implications of competition networks, and on their interaction with collaboration networks. Instead of concentrating on the effects of dyadic-level mutual rivalry (Gimeno and Woo, 1996; Ingram and Yue, 2008), I argue that it is important to focus on a firm's position within the competition network as a whole (Yu and Cannella, 2013), because competitors do not affect the performance of the firm independently (Skilton and Bernardes, 2014). That is, I argue that the performance of firms is shaped by the overall pattern of direct and indirect competition between interdependent competitors.

The contributions of the studies that make up this dissertation will become increasingly clear throughout the following chapters. I will use the remainder of this chapter to present a road map of my dissertation. First, I will provide an overview of relevant theory and research on exploration and exploitation, status, and networks that I will engage with throughout my dissertation. Second, I will present four empirical studies that bring together more detailed theoretical deduction and empirical examination. Finally, I will conclude with a general discussion of how these studies collectively contribute to our knowledge.

1.2 Theoretical Background

There are multiple streams of literature that provide insights into the research questions discussed above. In particular, this dissertation will draw mainly on exploration/exploitation literature, innovation theory, the status-based perspective on market competition, and network theory. Next, I provide a brief overview of each specific stream of research and discuss how they may contribute to building up my theoretical arguments and framework.

1.2.1 Exploration and exploitation

Since the seminal work by James March (1991), exploration and exploitation have attracted increasing interest and attention from scholars and practitioners (Lavie et al., 2010; Jansen et al., 2006; Tushman and O'Reilly, 1996; Levinthal and March, 1993). Exploration is characterized by activities such as "search, variation, risk-taking, experimentations, play, flexibility, discovery, and innovation", while exploitation involves activities such as "refinement, choice, production, efficiency, selection, implementation and execution" (March, 1991: 71). Firms may secure short-term profits (Auh and Menguc, 2005) by exploiting their existing products or services. However, over-exploitation also carries the risk of obsolescence (Sørensen and Stuart, 2000) because industry conditions change continuously and current competences inevitably become outdated (Jansen et al., 2006). Exploration, on the other hand, is important for firms to catch up with a shift in technological trajectory (Rosenkopf and Nerkar, 2001; Wu et al., 2014). At the same time, over-exploration may also be detrimental to firm performance because it may involve endless renewal (Wang and Li, 2008). To secure sustainable competitive advantage, firms need to manage the trade-off between exploration and exploitation (Gibson and Birkinshaw, 2004).

Even with decades of development, an important debate continues: continuity or orthogonality (Gupta, Smith, and Shalley, 2006). That is, should exploration and exploitation be viewed as two ends of a continuum (Lavie and Rosenkopf, 2006), or conceptualized as orthogonal variables (Katila and Ahuja, 2002; Jansen et al., 2006). In their discussion, Gupta et al. (2006) argue that different approaches may be appropriate, depending on the specific research context and level of analysis. When defining exploration and exploitation as learning (or strategic, behavioral) orientations of organizations, we should treat them as a continuum. That is, firms with a more exploratory orientation will be less exploitative. Yet, when exploration and exploitation refer to the number of local and global search outcomes, they should be treated as orthogonal constructs (Katila and Ahuja, 2002). An organization could, for example, have strong (or weak) capabilities in both exploration and exploitation at the same time. Following the arguments of Gupta et al. (2006), I treat exploration/exploitation as continuous or orthogonal, depending on the particular research context and question. When exploration and exploitation are analyzed in terms of a firm's exploratory or exploitative outputs (i.e. inventions, products, or services), I treat them as orthogonal because a firm could at the same time be generating both more exploratory innovations and more exploitative innovations than its competitors. When discussing exploration/exploitation as a strategic or behavioral orientation, I treat them as mutually exclusive, in the belief that when a firm increases its orientation (or attention, resources, and focus) on exploration, its emphasis on exploitation will inevitably decrease.

No matter how one conceptualizes exploration and exploitation, scholars agree that inherent tensions and conflicts emerge between them (Levinthal and March, 1993; Lavie and Rosenkopf, 2006; Andriopoulos and Lewis, 2009), which makes it more difficult to integrate them effectively. Exploration and exploitation compete for scarce resources, so that organizations have to make a conscious choice between exploration or exploitation activities in their resource allocations (Lavie et al., 2010). Moreover, exploration requires a totally different organizational structure (Jansen et al., 2006) and routine compared to exploitation, making it quite difficult for an organization to maintain both simultaneously. Quite often, organizations may not be able to develop both successfully at the same time, so their performance is found to be undermined when they both explore and exploit within same domains (Lavie et al., 2011; Stettner and Lavie, 2014).

Finally, organizations may conduct exploration and exploitation in various domains of their businesses. Organizations may explore new products (Jansen et al., 2006; Katila and Ahuja, 2002), explore their markets by entering foreign markets, expand their alliance portfolios by setting up alliances with new partners (Lavie and Rosenkopf, 2006), or build alliances that are more oriented toward R&D (Yang et al., 2010). In my dissertation, I focus on the exploration and exploitation involved in a firm’s internal knowledge generation, i.e. exploratory and exploitative innovations, (Katila and Ahuja, 2002; Benner and Tushman, 2002; Wang and Li, 2008; Phelps, 2010). Innovations may be either exploratory or exploitative (Jansen et al., 2006; Katila and Ahujia, 2002; Uotila et al., 2009), and involve new knowledge to different degrees (Benner and Tushman, 2002). Although exploration may lead to more new knowledge combinations (Fleming et al., 2007) which could increase the level of novelty, entering into novel domains may also bring potential uncertainty (Fleming, 2001) and illegitimacy (Zuckerman, 1999) for organizations.

1.2.2 Innovation theory

Ever since the fundamental contribution by Schumpeter (1934), innovation has been recognized by scholars as a vital engine of sustainable development for firms. By introducing innovative products and services, firms can either introduce technological breakthroughs to gain a first-mover advantage, or catch up with a paradigm shift and avoid becoming obsolete

(Wu et al., 2014). There is a widespread belief among innovation scholars that, in order to obtain and sustain a competitive advantage, high-tech firms need to create inventions with high impact (or that represent a technological breakthrough) in technology markets, although invention is only a part of the innovation process. As such, innovation researchers have long been interested in what determines the value of an invention (Fleming and Sorensen, 2001; Sorenson, Rivkin, and Fleming, 2006; Singh, 2008; Sorensen, Melero and Palomeras, 2014). Recent studies have found various factors to play an important role in determining the value of an invention or the likelihood of it becoming a technological breakthrough. These include collaboration networks (Singh, 2005; Singh, 2008), technological complexity (Fleming and Sorensen, 2001; Sorensen, Rivkin, and Fleming, 2006), backward science (Sorensen and Fleming, 2004; Fleming and Sorensen, 2004), specialists and generalists (Melero and Palomeras, 2014), and organization status (Podolny and Stuart, 1995). In this dissertation, I build on innovation theory and contribute to this stream by bringing up the notion of ambidextrous invention and examining what effect the exploration/exploitation associated with an invention has on its value in the technology market.

1.2.3 The status-based perspective

The status-based perspective assumes that the status of an organization signals the quality of its products or services, which is usually hard to observe (Podolny, 1993). Market actors rely on status as a reference for decision-making, especially when they experience altercentric uncertainty in evaluating the quality of particular firms. There is strong empirical evidence to suggest that high-status firms enjoy a number of advantages, such as lower transaction costs (Podolny, 1993), a greater likelihood of success (Higgins and Gulati, 2003; Stuart, Hoang, and Hybels, 1999), higher product prices (Benjamin and Podolny, 1999; Malter, 2014), and more opportunities for collaboration (Stuart, 1998; Ozmel, Reuer, and Gulati, 2013).

The status-based perspective is an important perspective to analyze the impact of exploratory and exploitative innovations, because the market for innovations is socially constructed (Gatignon and Robertson 1985; Rogers, 2003; Hsu and Ziedonis, 2013). What an innovation may contribute to the performance of a firm depends both on the quality of the innovation itself and the market identity of the firm. Previous studies have emphasized mainly that the value of exploratory and exploitative innovations depends on environmental contingencies (Jansen et al., 2006; Uotila et al., 2009), but have ignored the fact that the ultimate impact of innovations is contingent upon how high-tech firms are perceived by market audiences. As such, this dissertation stresses the social construction nature of innovation (Rogers, 2003), and identifies the technological status of high-tech firms (Podolny et al., 1996; Podolny and Stuart, 1995) as an important firm-level contingency for exploration and exploitation.

Status not only shapes the perception of external audiences, it also affects the self-cognition of firms (Bothner, Kim, and Smith, 2012; Marr and Thau, 2014). High-status firms may become over-confident, self-complacent, and distracted, leading to a deterioration in their performance (Bothner et al., 2012). High-status firms also react badly to status loss, and may experience worse performance after losing status (Marr and Thau, 2014). In addition, the greater visibility that comes with high status may mean that a firm is held more accountable by its stakeholders, and its status anxiety may thus be intensified (Jensen, 2006). In this dissertation, I also incorporate this aspect into the dissertation, and examine how status shapes a firm's behavioral propensity.

1.2.4 Network theory

How networks (e.g., strategic alliances) form and evolve over time has been of interest to management scholars for many years (Podolny, 1994; Gulati, 1995a; Gulati and Garguilo, 1999; Brass et al., 2004; Sorenson and Stuart, 2008; Ozmel et al., 2013), and has resulted in extensive analyses of which pairs of firms are more likely to form alliances than others, and why. Current studies have identified two important factors that account for firms' alliance formation and partner selection: organizational resources (Gulati, 1995b; Mowery et al., 1998; Das and Teng, 2000; Rothaermal and Boeker, 2008) and network structure (Podolny, 1994; Gulati, 1995; Gulati and Garguilo, 1999; Hallen, 2008). On the one hand, when firms are structurally close within a network, relationships are more likely to be formed. Prior ties, either direct or indirect (Gualti, 1995; Jensen, 2003; Hallen, 2008), could facilitate the formation of alliances between pairs of firms because prior interaction can enhance inter-firm trust, decrease information asymmetry and uncertainty (Podolny, 1994), and help with building interorganizational routines for future collaboration (Gulati, 1995). On the other hand, firms often form alliances in order to access partners' resources and knowledge (Grant and Baden-Fuller, 2004) or to learn from them (Gulati, 1995b; Dyer and Singh, 1998), which thus requires resource complementarity between the two parties (Rothaermel and Boeker, 2008). Extensive empirical evidence shows that alliance formation is dependent on prior networks and resources. However, current literature has ignored the effect of organizations' strategic orientation, a key focus of this dissertation.

In addition to network formation and evolution, network theorists have discussed at length the effect of different network positions (Granovetter, 1985; Burt, 1992; Podolny, 1993) on firm performance. For instance, it is well documented in the existing literature how brokerage positions may contribute to firms' market share (Shipilov, 2006; Zaheer and Bell, 2005), innovation outputs (Ahuja, 2000; Schilling and Phelps, 2007; Phelps, 2010), and their acquisition of status (Shipilov and Li, 2008). The literature also shows how network status shapes firms' alliance formation (Podolny, 1994; Ozmel, Reuer, and Gulati, 2013), product cost and price (Podolny, 1993; Benjamin and Podolny, 1999), bargaining power (Castelluci and Ertug, 2010), and market entry (Jensen, 2003). Network position exerts a significant influence over firm performance because it acts as both as a pipe and a prism for markets. On the one hand, network ties may be used to transfer information and resources, leading perhaps to uneven distribution across networks (Burt, 1992). Firms in a brokerage position may have unique and non-redundant information and resources to use. On the other hand, a firm's network position also serves as a signal for its quality, something that is often not easily discernible; this shapes the evaluation process of external audiences, and further influences their cost and price over market (Podolny, 1993; Rider and Tan, 2015). Yet, while current studies mainly explore collaboration networks such as alliances and syndication, we have limited knowledge of whether positions in competition networks (Tsai, Su, and Chen, 2011; Skilton and Bernardes, 2014) affect firm performance, and if so, how.

1.3 Dissertation Overview

With the aim of understanding the overarching research question on how innovations, status, and networks collectively affect the performance and behavioral propensity of firms, I will present four studies, conducted within two empirical contexts, namely the global semiconductor industry (SIC code 3674) and the venture capital industry in the U.S. The relevance of the theoretical perspectives used in the studies has been explained in the previous sections. In the tables below, I will summarize each study in terms of (a) its central topic, (b) outcome, (c) theoretical lenses employed, (d) research method, (e) unit of analysis, (f) sample, and (g) data source. In addition, I conclude with a table that presents an overview of the gaps in the literature and the main contributions.

1.3.1 Study 1: Exploration, status, and firm growth

The first study moves beyond the general notion that exploration is crucial to leverage new opportunities in high-tech industries, and argues that the value of exploration varies across firms. When examining the firm-level contingency model, the findings from the semiconductor industry support earlier research in that exploration contributes to a firm's growth. However, the results also show that the main effect of exploration on firm growth becomes weaker when a firm's technological status increases. In addition, status robustness also reduces the contribution of exploration to firm growth, which supports the assumption that stereotyping plays an important role when potential customers are evaluating the exploratory efforts of high-tech firms. Altogether, the status-based perspective suggests that status may substitute for exploration in predicting the growth of high-tech firms.

Table 1.1 Theoretical and methodological underpinnings of Study 1

Topic:	The moderation effect of status on exploration
Outcome:	Firm growth in product market
Theoretical lenses:	Exploration-exploitation
	Innovation theory
	Status-based perspective
Method:	Panel data analysis (GLS Fixed-effect)
Unit of analysis:	Firm
Sample:	807 firm-year observations of 159 semiconductor firms active between 1991 and 2002
Data sources:	Compustat; NBER USPTO; SDC Platinum

1.3.2 Study 2: A behavioral perspective on partner selection of strategic alliance

The second study applies the exploration/exploitation framework to analyze the selection of alliance partners. Although previous literature has discussed various factors that explain alliance partner selection, the effect of an organization's strategic orientation has been largely neglected. This study proposes an alternative explanation for partner selection: the homophily of strategic orientation, such that firms are more likely to form alliances with partners that have similar strategic orientations towards exploration/exploitation. In addition, the tendency to select partners on the basis of similar strategic orientation depends upon the status of the firm and the scope of the alliance. Empirical support for hypotheses is found from a choice–based matching sample from the semiconductor industry. Altogether, the results of this study provide several implications for research and practice.

Table 1.2 Theoretical and methodological underpinnings of Study 2

Topic:	Partner selection for strategic alliances
Outcome:	Likelihood of alliance formation between firms
Theoretical lenses:	Behavioral theory (exploration-exploitation)
	Network theory
	Status-based perspective
Method:	Choice-based matching
	Two-way clustered Logit regression
Unit of analysis:	Dyadic: pair of firms
Sample:	Strategic alliances between semiconductor firms, between 1991 and 2002
Data sources:	Compustat; NBER USPTO; SDC Platinum

1.3.3 Study 3: Ambidextrous inventions, technological breakthroughs, and team composition

While ambidexterity is widely accepted to be highly important for organizations, little work has been done to define ambidextrous inventions, or to investigate how ambidextrous inventions act in technology markets. Using patent data from the semiconductor industry over the period from 1991 to 2001, this study evaluates the value of inventions that involve different degrees of exploration. It finds that ambidextrous inventions that combine an organization's existing knowledge with new knowledge are of greater value. At the same time, ambidextrous inventions are also more likely to become technological breakthroughs.

Furthermore, this study investigates how to compose teams to create ambidextrous inventions. The results show that medium-sized teams and teams with a moderate level of invention experience are more likely to balance exploration and exploitation in their inventions. In the post-hoc analysis, I also discuss when invention teams would tend to create inventions that are either over-exploratory or over-exploitative.

Table 1.3 Theoretical and methodological underpinnings of Study 3

Topic:	Exploration and exploitation of inventions
Outcome:	The value of inventions in the technology market
Theoretical lenses:	Innovation theory
	Team theory
Method:	Patent analysis
	Logit and Multinomial regression
Unit of analysis:	Patent
Sample:	36,551 patents filed between 1991 and 2001
Data sources:	Compustat; NBER USPTO; Harvard Patent Network Dataverse

1.3.4 Study 4: Competition closure and the interaction between competition and collaboration networks

This study emphasizes that firms are embedded in both collaboration and competition networks simultaneously, and contends that the performance of a firm is determined by its positions in both networks. In particular, it argues that competition closure may undermine performance because it reduces the uniqueness of the capabilities that a firm may develop and increases the unpredictability of competitors' actions. Moreover, competition closure reduces the value of a firm's brokerage position in collaboration networks because it triggers information gathering by competitors. Finally, competition closure moves the attention of competitors away from a focal firm, which increases altercentric uncertainty and amplifies the value of its network status. Empirical evidence for hypotheses is found from the U.S. venture capital industry.

Table 1.4 Theoretical and methodological underpinnings of Study 4

Topic:	Competition and collaboration networks
Outcome:	Market performance
Theoretical lenses:	Network theory; Status-based perspective
Method:	Panel analysis; Network analysis
Unit of analysis:	Venture capital firm
Sample:	8,574 firm-year observations from 1997–2014
Data source:	ThomsonOne Private Equity

Table 1.5 concludes with the research gaps and the main contributions of each study in this dissertation.

Table 1.5 Gaps addressed and intended contributions

Study	Gaps in previous studies	Main contributions
Exploration, status, and firm growth	The contingent value of exploration. The role of status for innovation. The robustness of status	Emphasize that the value of exploration varies across firms. Highlight the socially constructed nature of the innovation market. Incorporate a status-based view into the analysis of exploration/exploitation
A behavioral perspective on partner selection for strategic alliances	The effect of strategic orientation on partner selection	Uncover the homophily of strategic orientations in the selection of alliance partners. Discuss the contingency roles of alliance- and firm- features
Ambidextrous inventions, technological breakthroughs, and team composition	The degree of exploration/exploitation when explaining the value of inventions. How teams are composed to create exploratory or exploitative inventions	Extend our knowledge of the impact of exploratory inventions in technology market. Provide practical implications on how to compose teams for different types of invention
Competition closure: Interaction between competition and collaboration networks	The importance of competition networks. The interaction of collaboration and competition networks	Advance our knowledge of the impact of competition networks. Show the interaction effect between competition and collaboration networks

Chapter 2. Exploration, Status and Firm Growth[1]

Abstract

What firms benefits more from exploration? We move beyond the general notion that exploration is crucial to leverage new opportunities in high-tech industries and argue that the technological status and status robustness of firms may reduce the impact of exploration on firm growth. In examining our firm-level contingency model, our findings from the semiconductor industry support earlier research in that exploration contributes to a firm's growth. Yet, we show that this main effect becomes weaker when a firm's technological status increases. In addition, we find that status robustness also reduces the contribution of exploration to firm growth, which supports our assumption that stereotyping plays an important role when potential customers are evaluating the exploratory activities of high-tech firms. Altogether, our status-based perspective suggests that status may substitute for exploration in predicting growth of high-tech firms. Important conceptual and managerial implications are discussed.

[1] This study is conducted in collaboration with Vareska van de Vrande and Justin Jansen

2.1 Introduction

What firms benefits more from exploration? Scholars have consistently argued that the ability to innovate is critical for high-tech firms. Firms need to search for and develop new competences in order to identify and leverage novel opportunities (Katila and Ahuja, 2002; Benner and Tushman, 2002; Uotila et al., 2009; Phelps, 2010; Wang et al., 2014). Such exploratory activities not only increase a firm's technological variety (Katila and Ahuja, 2002), they also help the firm to adapt to novel technologies (Sørensen and Stuart, 2000; Wu, Wan, and Levinthal, 2014). Since high-tech firms operate in an industry characterized by rapidly changing technologies, variations in customer preferences, and fluctuations in demand (Jansen et al., 2006; Zahra and Bogner, 2000), they need to move on from existing products and markets to create competitive advantage. While environmental conditions have often been highlighted in discussions of the importance of exploration, it remains unclear how and why high-tech firms may vary in terms of how much growth they generate when developing new products or entering into new markets (Lavie, Stettner, and Tushman, 2010). In order to understand this better, we introduce a status-based perspective (Podolny, 2005; Piazza and Castellucci, 2014), and explain how and why a firm's technological status may affect the exploration–growth relationship. By so doing, we contribute to earlier literature in at least two important ways.

First, we move beyond the dominant focus on environmental contingencies found in earlier research. Our study examines the contingency role of a firm's technological status in explaining potential benefits for growth that high-tech firms may derive from their exploratory activities. So far, scholars have mainly argued that exploration may be particularly important in highly dynamic environments. For instance, Jansen et al. (2006) and Uotila et al. (2009) have shown that environmental dynamism intensifies the contribution of exploration to a firm's financial performance. In dynamic environments, exploration may help firms to minimize potential threats of obsolescence and to capitalize on changing circumstances (Jansen et al., 2006; Raisch and Birkinshaw, 2008). Despite these insights into environmental factors, however, we argue that the ultimate impact of exploratory activities on firm growth varies across firms, and is contingent upon the way in which high-tech firms are perceived within the industry (Gatignon and Robertson 1985; Rogers, 2003; Hsu and Ziedonis, 2013). As such, our study identifies the technological status of high-tech firms (Podolny, Stuart, and Hannan, 1996; Podolny and Stuart, 1995) as a firm-level contingency because it may impact the way in which firms and their products are evaluated and adopted. Technological status refers to a firm's vertical position in the technological competition system (Podolny et al., 1996; Stuart, 1998) and provides a useful signal of its quality that is often difficult to observe (Podolny, 1993). Although previous studies have focused almost exclusively on the magnitude of status (see Piazza and Castellucci, 2014, for a review), recent studies have started to emphasize the importance of status robustness (Bothner, Smith, and White, 2010). In contrast to the magnitude of status that denotes the centrality of a firm's position within the network (Podolny, 2005; Jensen and Roy, 2008; Bonacich, 1987), robustness refers to the extent to which such a central position is potentially stable and durable (Bothner et al., 2010). We argue that both dimensions of status affect the extent to which potential customers evaluate and adopt new products, and therefore act as critical firm-level contingencies that shape the relationship between the exploration and sales growth of high-tech firms.

Second, although earlier research has suggested that status may bring firms various tangible and intangible advantages (Podolny, 2005; Piazza and Castellucci, 2014), we argue that a firm's technological status may actually reduce the impact of exploration on firm growth. Given that a firm's technological status signals the quality of its products or services (Podolny, 1993), most studies have highlighted advantages of having a higher status during transactions (Castellucci and Ertug, 2010; Benjamin and Podolny, 1999) or collaborations (Podolny, 1994; Stuart, 1998; Ozmel, Reuer, and Gulati, 2013). However, we contend that status also play a dominant role in how potential customers perceive the firm (Rindova, Pollock, and Hayward, 2009; Lynn, Podolny, and Tao, 2009), and may therefore shape the impact of a firm's exploration on its growth. From that, we build on recent debates about potential negative implications of status for high-status firms (Bothner et al., 2012; Marr and Thau, 2014) and suggest that it is important to consider status when seeking to understand the relationship between exploration and the growth of high-tech firms. Overall, our study contributes to research on organizational status by arguing that high status might not be directly harmful to the performance of high-tech firms, but rather may constrain the effectiveness of their exploratory activities to generate growth.

This paper examines how firms' technological status influences the effect of exploration on sales growth, using a sample of firms in the semiconductor industry, 1992–2002. We chose this industry because it presents an ideal context for investigating the role of exploration and technological status (Podolny et al., 1996; Stuart, 1998). We find that there is a direct connection between the amount of exploration that a firm conducts and its subsequent growth. However, the effect of exploration becomes weaker when firms have higher status or the status becomes more robust.

2.2 Literature Review and Hypotheses

Research has linked exploration to variation, risk-taking and discovery (March, 1991; Levinthal and March, 1993) that entails a shift away from an organization's current knowledge resources and skills (Lavie et al., 2010). Firms may explore in many different domains, such as extending their geographic scope or seeking out new partners (Lavie and Rosenkopf, 2006). In this paper, we focus on knowledge-based aspects of innovations (Katila and Ahuja, 2002) and define exploration as the extent to which a firm's innovation efforts are anchored in new knowledge (Benner and Tushman, 2002).

While exploration is generally considered to be essential for firm prosperity (Katila and Ahuja, 2002; Piao, 2010), scholars have identified a variety of conditions that may affect the importance of exploration for firm performance and survival. For instance, exploration is especially important for firms that operate within dynamic environments (Jansen et al., 2006; Lavie et al., 2010). Changes in technologies and customer demands may make current products or services obsolete and require new ones be developed (Sørensen and Stuart, 2000; Jansen et al., 2006). As such, high-tech firms need to move beyond their current portfolios of products and services and develop unfamiliar knowledge and opportunities.

Given the dominance of this type of external perspective in explaining why and under what conditions exploration may contribute to performance, firm-specific attributes have been largely ignored. Yet research in strategic management has long recognized that the pay-off of particular strategies depends on specific firm-level features (e.g., Shipilov, 2006). We identify the technological status of firms (Podolny et al., 1996; Podolny and Stuart, 1995) as one of the salient firm-level contingencies. We argue that status shapes the extent to which firms may benefit from their exploration and thus leverage novel opportunities for growth, because a firm with high technological status receives more technological deference from others. For instance, Intel Inc. has high technological status as it gets more deference from other semiconductor firms, and is located in a more central position within the semiconductor technology network. As a firm's technological status serves as an indicator of the quality of its products or services (Podolny, 1993; 2005), which reduces the information asymmetry and uncertainty for others, status is instrumental in helping people to form favorable perceptions of the firm, and may make other firms more willing to engage in transactions (Stuart, 1998; Castellucci and Ertug, 2010). For instance, firms with high status have been shown to have more opportunities to form strategic alliances (Stuart, 1998) and to generate inventions that become the foundation for subsequent innovations (Podolny and Stuart, 1995). Thus, we argue that the signaling effect of status affects the extent to which high-tech firms may have opportunities to exchange (Stuart, 1998; Podolny, 2005) and start selling new products to potential customers, and hence moderates the relationship between exploration and firm growth.

In addition to the contingency role of the magnitude of technological status, we investigate the status robustness (Bothner et al., 2010). Scholars have argued that the level of a firm's status is not a static attribute but rather evolves over time (Podolny and Phillips, 1996; Cowen, 2012). Because the status positions of some firms may be relatively stable while others are more vulnerable and fluctuate over time, scholars have argued that the concentration of a firm's dependency within a network should be investigated in order to capture the robustness of its status (White, 2002; Bothner et al., 2010). If a firm's status depends mainly on a limited set of connected partners, that status is considered to be relatively fragile (White, 2002), because it will be severely affected by partnership changes. Conversely, when a firm's status is dependent on a more even spread of partners, it is viewed as more robust, and would not be greatly affected when partnerships change. Regardless of the magnitude of status, status robustness has been shown to affect the behavior and performance of organizations (Bothner et al., 2010). For instance, looking at status robustness at various levels of analysis, Bothner et al. (2010) found that individuals are more likely to lose status when their status is fragile, industries in fragile positions will achieve less added value, and departments with fragile status will be rated less highly by their peers. Therefore, we argue that both the magnitude as well as the robustness (Bothner et al., 2010) of a firm's technological status should be taken into account in order to develop a thorough understanding of the contingency role of technological status.

2.2.1 Exploration and growth

High-tech firms experience frequent changes in technologies, variations in customer preferences, and fluctuations in product demand or supply of materials. They face strong environmental pressures that shorten product lifecycles and make current portfolios of products and services obsolete (Sørensen and Stuart 2000). As a consequence, high-tech firms need to keep abreast of emerging technologies in order to minimize threats of obsolescence and to pioneer technologies that will enable them to generate new options for growth (Wu et al., 2014). To do so, they need to experiment with novel approaches and to generate new sources of revenue by introducing new products and services (Jansen et al., 2006; Piao, 2010). Exploration of this kind enables high-tech firms to target premium markets and to create product niches that provide more lasting advantages for growth (Jansen et al., 2006; Levinthal and March, 1993).

Second, exploration may also increase a firm's technological variety and the diversity of its knowledge sources (Katila and Ahuja, 2002; Piao, 2010). It enhances the opportunity for high-tech firms to acquire and assimilate external information (Zahra and George, 2002). Such external information has not only been argued to be important for a firm's innovation, but also for predicting environmental changes (Cohen and Levinthal, 1990). It provides high-tech firms with a heightened capacity for industry foresight and enables them to sense and seize novel opportunities more effectively. Scholars have argued that a higher capacity to absorb external knowledge may help organizations to target their customers better and to seize emerging opportunities (Cohen and Levinthal, 1990).

In sum, exploration helps firms to align themselves better to changing market demand and to seize emerging opportunities, and this in turn will have a positive effect on firm growth. This is particularly important in fast-changing environments. Therefore, we hypothesize that:

Hypothesis 2.1: Exploration is positively related to the growth of high-tech firms.

2.2.2 *Exploration, technological status and growth*

Although the technological status of a firm can bring both tangible and intangible advantages (Stuart et al., 1999; Stuart, 1998; Podolny and Stuart, 1995), we argue that it may also undermine the benefits accruing from a firm's exploratory activities.

First, although learning from exploration may help organizations to identify novel opportunities to respond to emerging demands, the technological status of high-tech firms may offset such benefits. Firms with a high status are more likely to be more complacent in terms of their current behaviors and attitudes (Bothner et al., 2012), so that they are more confident in applying their own competences rather than relying on external resources (Gu and Lu, 2014). That is, even though exploration may help a firm to foresee and respond to external technological development, firms with higher technological status may become too complacent to actually seize emerging external opportunities. As such, they may be inclined to ignore the potential opportunities and benefits that may derive from exploratory activities, and the relationship between exploration and growth therefore becomes less strong.

Second, although exploration may help firms to respond to changes in technologies and customer demands, technological status may substitute for exploration in terms of the positive effect on firm growth. Scholars have argued that firm growth relies largely on the evaluations made by market stakeholders (e.g. potential customers and investors) (Lynn et al., 2009; Rindova et al., 2006) and their decisions to adopt new products and services. However, due to information asymmetry, in high-tech industries stakeholders often find it hard to evaluate new products accurately. Potential customers therefore tend to rely on alternative signals of quality and value, such as status, when making their decisions (Podolny, 1993; 1994). Stakeholders may first form their preference by referring to firms' standings (Jensen and Roy, 2008) because technological status signals its competences and quality in markets (Podolny and Stuart, 1995; Stuart, 1998), and is less difficult to observe (Podolny, 2005). Thus, a high-status firm may be thought by stakeholders to be more trustworthy, reliable, and competent (Stuart, 2000; Ozmel et al., 2013). Because their judgments are based more on a firm's status rather than on its exploratory activities, stakeholders may make decisions about potential transactions or investments with prestigious firms, with less regard to whether the firm is introducing new products or services. That is consistent with Giorgi and Weber's findings (2015) that when a security analyst has acquired status in the past, his or her current efforts become less effective in affecting others' judgments and decisions. Thus, we argue technological status may function as a substitute for exploration when evaluations are being made on whether to adopt new products or services, and it may therefore weaken the impact of exploration on firm growth.

On the contrary, when firms do not occupy a prominent position in terms of status, market stakeholders be very uncertain about the value of low-status firms' products or services (Ozmel et al., 2013; Stuart, 2000; Stuart, Hoang, and Hybels, 1999), because such firms will seem less appealing or credible when decisions are being. Stakeholders have to further refer to exploration within products (Hsu and Ziedonis, 2013) that may be a reflection of their value and quality, although this is harder to observe and evaluate. That is, when firms have low status, exploratory activities become more important for the decisions of potential customers and partners to make transactions. This is consistent with arguments made by Hsu and Ziedonis (2013) that knowledge stock is more important for start-ups that initially have little in the way of reputation, and vice versa. Thus, we contend that technological status weakens the value of exploration in terms of growth.

Hypothesis 2.2: *Technological status moderates the positive relationship between exploration and growth, such that the positive relationship between exploration and growth is weaker when status is higher*.

2.2.3 Exploration, status robustness, and growth

The robustness of status reflects the potential durability of a firm's status in competition networks (Bothner et al., 2010). A robust status, which is usually long-standing, acts as a legitimate and reliable signal in the minds of market stakeholders (Bothner et al., 2010), and also helps a firm to use its vertical status position to establish a market identity which is itself robust (Jensen, Kim, and Kim, 2011). As a consequence, potential customers may generate certain stereotypes about the competences and qualities of firms with a robust status. Stereotypes are beliefs about the characteristics, attributes, and behaviors of members of certain groups (Hilton and von Hippel, 1996), and act as a shorthand and blanket judgment containing evaluative components (Aaker, Vohs, and Mogilner, 2010). For instance, rich people (Fiske, Cuddy, Glich, and Xu, 2002) often are seen as competent due to stereotyping in people's minds. We argue that status robustness may be associated with stereotyping because firms with a robust status are likely to act in accordance with stakeholders' perceptions and expectations. If their status is less robust (Bothner et al., 2010), potential customers may not receive consistent signals, and may not therefore form a particular stereotype of a firm. As such, we argue that external stakeholders are more likely to form stereotypes of firms whose status is robust, and who have a relative robust market identity (Jensen, et al., 2011).

Since evaluations of the importance and value of new products are driven by stereotypes, we argue that a firm's exploratory activities become less important in generating growth when the status of a firm is more robust. That is, although high-tech firms may increase perceptions of quality and value by developing novel products and services, stakeholders are likely to be more indifferent to such changes because they rely largely on their stereotype that they have already formed. Therefore, exploration contributes less to firms with a more robust status. On the contrary, a fragile status (Bothner et al., 2010) may not be stable enough and sufficient for stakeholders to develop stereotypes (Hilton and von Hippel, 1996) or for a robust market identity to be established (Jensen et al., 2011). Where the status of a firm is fragile, stakeholders have no ready way of simplifying the process of judgment, so they are more likely to take notice of the efforts a firm is making to bring in new products and services. Therefore, we propose that exploratory activities become less effective in generating growth when status is robust.

Hypothesis 2.3: *Status robustness moderates the relationship between exploration and growth, such that the positive relationship between exploration and growth is weaker when status robustness is higher*.

2.3 Methods

2.3.1 Data collection

In order to empirically examine our hypotheses, we collected data from the semiconductor industry. We chose this setting because the dynamic and competitive conditions within the industry (Stuart, 1998; 2000) make innovation activities very important for firms' long-term survival. Moreover, this industry provides a suitable setting, because patent information is a good reflection of knowledge stock, creation and flow (Podolny et al., 1996; Stuart, 2000). The observation period is from 1991 to 2002.

We chose a sample of public firms in the semiconductor industry with SIC code 3674, drawn from Compustat. Public firms in the industry were selected to ensure the availability of key data. We matched those firms with patent information from NBER's USPTO dataset. At the time of data collection, the NBER patent dataset only included patents that were assigned before the year 2006. By scanning the dataset, we found that the number of patents included in the database decreases rapidly from the application year of 2002, which may be because many patents that were applied for after 2002 may still have been in progress. We therefore traced patents and innovation information up to 2002. Consistent with previous literature (Phelps, 2010), we used the application year rather than the year in which the patent was granted, because the interval between application and assignment is uncertain and the application year more accurately represents the time when the innovation was created. We had to drop some observations because of data availability for some measures. The final dataset used for the analyses in this paper included 807 observations for 159 firms.

2.3.2 Measurement

Dependent variable

Firm growth, was measured as the change of sales volume (Eisenhardt and Schoonhoven, 1990; Kim and Tsai, 2012; Li et al., 2013) for each firm from year t to $t+1$. In accordance with prior studies (Stuart, 2000; Podolny, Stuart and Hannan, 1996; Zheng, Singh, and Mitchell, 2014), we chose to measure performance as the accounting-based sales volume, because it is a good reflection of the size and the survival chance of the organization. Moreover, firm sales capture more accurately the response of consumers to the introduction of new products or services offered by the firm (Rubera and Droge, 2013). Finally, we focused on sales in the product market because status is the perceived quality of a producer's products relative to those of the producer's competitors (Podolny, 1993).

Explanatory variables

We captured *exploration* for each focal firm at time t. Following previous studies (Phelps, 2010; Katila and Ahuja, 2002), we used patent citation information to reflect the exploratory activities of high-tech firms, by measuring the extent to which a firm's innovation efforts were anchored in new knowledge (Benner and Tushman, 2002). Specifically, we categorized citations of current patents according to whether they were repeated or new. We analyzed all the backward citations of all the patents applied for, for each firm in each year, and checked whether these patents had been cited by the focal firm in the previous five years. If it had been cited, we consider it as a repeated citation. Otherwise, it was considered to be a new citation. For instance, for a citation in a current patent applied for by firm *i* in 1992, we checked whether it had been cited by firm *i* between 1987 and 1991. As a next step, the proportion of each patent that was based on repeated knowledge was calculated (Sørensen and Stuart, 2000). We subsequently categorized a patent as exploratory if less than 20 percent of its backward citations were repeated citations. Thus, our variable for exploratory activities is the number of patents for a firm in each year with less than 20 percent repeated citations, which is in line with Benner and Tushman (2002).

Overall, our measurement for exploration emphasizes the organizational boundary as a way to categorize the new and existing knowledge. It is consistent with the definition provided by Lavie et al. (2010: 114) that "exploration entails a shift ways from an organization's current knowledge base and skills", and the idea from Katila and Ahuja (2002: 1184) that "exploratory search behaviors involve a conscious effort to move away from current organizational routines and knowledge bases".

Technological status. We used patent citations to map the technological status of sample firms. First, we developed a network matrix, where each cell r_{ij} of the matrix includes the number of citations from firm *j* to firm *i*. Next, following previous studies (Podolny et al, 1996; Hallen, 2008; Ozmel et al., 2013), we used Bonacich's equation (Bonacich, 1987) to measure the power centrality. It suggests that a firm's technological status is dependent on the status of other firms from which it receives citations (Bothner et al., 2010). The measurement formula is:

$$S(\alpha, \beta) = \alpha \sum_{k=0}^{\infty} \beta^k R^{k+1} I$$

where α is a scaling factor that normalizes the measure, β is the weighting factor reflecting how much one firm's status depends on the status of its connecting firms, R is the matrix for the citations, and I is a column vector of ones. We used the standard formula in

UCINET 6 to measure technological status, which assigns β with the value of 0.995 of the reciprocal of R's largest eigenvalue. β has to be less than the reciprocal of the largest eigenvalue, otherwise the formula above is not convergent (Bothner et al., 2010). We employed a five-year window for each status measurement, consistent with prior studies (Podolny et al., 1996; Hallen, 2008).

Status robustness. The measurement for status robustness reflects the combination of the Herfindahl index and Bonacich's (1987) formula (Bothner et al., 2010). The Herfindahl index is usually used to calculate the concentration of firms in different domains (Van de Vrande, 2013), and ranges between 0 and 1. However, the original Herfindahl index cannot reflect the transitivity of status robustness. That is, a firm's status robustness may not only be related to the concentration of dependence, but also relies on the robustness of those dependents. Therefore, we map the robustness network and use the Bonacich (1987) formula, where each cell equals:

$$d_{ij}=\left[\frac{r(ij)}{\sum_{j=1}^{n} r(ij)}\right]^2$$

and a firm's status robustness is operationalized by the following formula:

$$R(\alpha,\beta) = -\alpha \sum_{k=0}^{\infty} \beta^k D^{k+1} I,$$

where D is the matrix of d_{ij}. Similar to the calculation above, β is set with the value of 0.995 of the reciprocal of R's largest eigenvalue, and the measure is operationalized in a five-year window.

Control variables

We also controlled for a set of factors that may affect firm growth. We included the *sales* in the previous year as an independent regressor in order to account for the persistence and patent dependence of firms' sales (Katila and Ahuja, 2002). Although we consider sales growth to be an appropriate indicator of a firm's performance in the market (Podolny et al., 1996), it is also a complicated concept that may be influenced by many other factors. By including past sales, we expect to control for some unobserved factors (Bothner et al., 2010).

Next, we controlled for the extent of a firm's *exploitation*. Although the main focus of our study is the relationship between exploration and firm growth, exploitation may also contribute to firm growth (Auh and Menguc, 2005). We therefore included exploitation as a control variable (Vagnani, 2012) by counting the number of patents that have more than 80 percent repeated citations (Benner and Tushman, 2002).

Furthermore, even though a firm's status may signal quality (Podolny, 1993; p.832), we also controlled for the *quality* of a firm's innovations in a more direct way. Previous studies (e.g. Castellucci and Ertug, 2010; Podolny, 1993) have used prior performance, age or product volumes to control for product quality, which we also included in our estimations as control variables. Following previous literature (Singh, 2008; Fleming, 2001), we used the amount of forward citations as an indicator of the quality of innovation. That is, the more citations a patent receives in a certain period, the better its quality. Because of the right-censored nature of this measurement (a patent applied for earlier in time is also more likely to receive more citations), we collected the number of forward citations for each patent over a fixed time period of five years. That is, for a patent applied in year *t-4*, we measured its quality as the number of forward citations it received from year *t-3* to year *t+1*. Based on this measurement, the quality of technological knowledge for a firm in year *t* equals to the sum of forward citations of patents that were applied from *t-4* through *t*. Thus, while the measure of status focused on their backward citations, we operationalized the quality of a firm's innovation with the forward citations of its patents. Because this variable is highly skewed, we log-transformed it before entering it into the analysis.

We also controlled for the *number of partners* because alliance partners may enhance a firm's sales by providing external resources and information. Alliance information was obtained through SDC Platinum. In line with prior studies, we included the number of partners (both non-equity and equity) that each firm has using a five-year time lag, i.e. between the year t-4 and t (Van de Vrande, 2013). We included *firm age* to account for the effect of obsolescence associated with aging (Sørensen and Stuart, 2000).

Because organizational slack and absorptive capacity may affect a firm's growth potential (George, 2005), we controlled for the amount of *cash flow* as a measure of financial slack for each firm, and *R&D expenditure* as an indicator of a firm's absorptive capacity (Cohen and Levinthal, 1990). However, those two terms are quite highly correlated with *sales*. Although the high correlations are intuitive, it may lead to potential multicollinearity issues. To account for this, we orthogonalized those terms (Ertug and Castellucci, 2014), which reduces their interdependencies while maintaining their individual effects. Finally, *year dummies* were included to control for systematic variation across periods (Podolny et al., 1996; Benner and Tushman, 2002).

2.4 Analysis and Results

To test our hypotheses, we estimated different panel models predicting the growth of sales using fixed-effects. A fixed-effects estimation was used for the following reasons. First, it eliminates all between-firm variation so that the coefficients reflect within-firm effects of technological knowledge and status on firm growth (Bothner et al., 2010). In this way, the results show how a firm's growth changes if its technological knowledge or status changes. Second, in a fixed-effect model, it is not necessary to make any assumptions about the distribution of firm-specific effects within the population, though standard random-effects assume that firm-specific effects are normally distributed in the population (Podolny, Stuart and Hannan, 1996).

Table 2.1 shows the descriptive statistics and correlations. As expected, status and quality are highly correlated, since status is a signal of quality (Podolny, 1993). That is, high-status firms are more likely to generate high-quality and impactful innovations. Consistent with previous studies (e.g. Pollock et al., 2015), the distribution of status is left-skewed because there are a small number of firms that occupy an extremely high position in the networks. By its nature, there are a fewer actors with very high status, and many actors with very low status. That is why status hierarchies are always depicted as pyramids. Similarly, exploration does not show a strictly normal distribution, either, which is also common when using patent stock as a measure (e.g. Aggarwal and Hsu, 2013). That means that, the majority of exploratory innovations in the semiconductor industry are developed by only a fewer innovative firms. However, the skewness of variables may potentially bias our estimation. In order to check the potential problem, we employed a test for non-normality in linear panel-data models (*xtsktest* in Stata), which allows us to identify departures away from gaussianity in both error components (i.e. firm-specific errors and the reminder errors) of a standard panel regression (Alejo et al., 2015). The results show that the null hypothesis of normality in firm-specific errors is not rejected at $p<0.1$ level; while we can only reject the normality in the reminder errors at $p<0.05$ level.[2] Thus, non-normality of

[2] The joint test of normality on firm-specific errors: $\chi^2=2.92$, prob> $\chi^2=0.232$; the joint test for normality on the reminder errors: $\chi^2=5.94$, prob> $\chi^2=0.051$.

Table 2.1 Descriptive statistics and correlations

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10
1. Firm growth $_{t+1}$	0.43	5.67										
2. Exploration $_t$	36.7	94.5	0.12									
3. Status $_t$	0.36	1.71	0.04	0.40								
4. Status robustness $_t$	-0.33	1.15	0.01	0.05	0.03							
5. Sale $_t$	3.61	31.8	0.14	0.08	0.03	0.03						
6. Partner number $_{t-4, t}$	16.5	44.9	0.05	0.72	0.36	0.04	0.09					
7. Quality $_t$	4.07	2.89	0.09	0.64	0.72	0.03	0.06	0.49				
8. R&D expenditure $_t$	0.26	1.64	-0.21	0.51	0.16	0.02	0.00	0.42	0.20			
9. Slack $_t$	1.25	12.7	-0.21	-0.44	-0.18	-0.02	-0.00	-0.43	-0.14	-0.00		
10. Age $_t$	9.89	10.1	-0.03	0.38	0.20	0.05	0.05	0.11	0.11	0.09	0.03	
11. Exploitation $_t$	10.5	62.0	0.00	0.40	0.66	0.02	0.02	0.22	0.28	0.05	0.00	0.15

Observation number = 807; $p<0.01$ if $|r|>0.09$

variables is not a major concern for regression. A variance inflation factors (VIF) test found that no VIF values were larger than 3.00, far below the critical value of 10, and the condition numbers were all less than 6.07, far below the conservative cutting point of 30. Thus, multicollinearity is not an issue, either. Table 2.2 provides the models used to test the hypotheses. The baseline Model 1 includes only control variables. Model 2 includes the independent variable *exploration*, which is used to test Hypothesis 2.1. The positive coefficient (β=2.486; s.e.=0.397) is significant ($p<0.01$), and stable throughout all models. Thus, our Hypothesis 2.1 that exploration contributes to firms' growth is supported.

Model 3 includes two moderators: status and robustness. Their main effects are insignificant, and also not stable across models. This may reflect the fact that technological status or robustness does not directly affect the growth of high-tech firms because their effects are non-linear (Bothner et al., 2012), or because their effects are contingent on the competition conditions of industries. Indeed, Podolny et al. (1996: 679) propose that when an industry is more crowded or competitive, status may have a negative or insignificant effect. Model 4 includes exploration, status, and robustness, together, where their main effects stay stable.

Next, Model 5 includes the interaction term of technological status and exploration (variables are standardized before calculating interaction terms) to test Hypothesis 2.2 that the positive relationship between exploration and growth is weaker when status is higher. The coefficient of the interaction between exploration and status is negative and significant (β= -0.312; s.e.=0.137; $p<0.05$), thereby supporting Hypothesis 2.2. Thus, technological status weakens the contribution of exploration to firm growth.

Model 6 tests Hypothesis 2.3 that the robustness of technological status also negatively moderates the relationship between knowledge and growth. It is supported because the negative coefficient (β= -2.070; s.e.=0.573) of interaction between exploration and status robustness is significant at the $p<0.01$ level. Finally, Model 7 provides a more conservative estimation, with all variables entered.

To show the nature of the two-way interaction effect, we present the results of Model 7 in Figures 2.1 and 2.2. As shown, although the growth in sales is positively linked to the amount of exploration for all firms, the impact is stronger for low-status firms or for firms whose status is more fragile.

2.4.1 Robustness check

In order to validate our findings, we conducted several robustness checks. First, we used an adapted measure for exploration. In the current analyses, exploration is measured as "the number of exploratory patents"; patents are categorized as exploratory if less than 20 percent of the backward citations are repeated citations (Sørensen and Stuart, 2000; Benner and Tushman, 2002). To check the robustness of our current operationalization, we also constructed a measure for exploration using the number of patents with less than 40 percent repeated citations. The estimation results remained similar across the alternative measures, as shown in Models 8 and 9 of Table 2.3.

Second, we controlled for exploitation by using the number of patent with more than 80 percent repeated backward citations. Although it is consistent with Benner and Tushman (2002), we have left out the patents with 20 to 80 percent repeated backward citations. That is, based on Benner and Tushman (2002) and our measurement above, such patents are neither exploratory nor exploitative. To ensure that our findings were robust and that we were covering all innovation outputs of firms, we also measured a firm's exploitation as patents that had more than 20 percent repeated citations. Again, as shown in Models 10 and 11, our findings remained stable when using this alternative measure.

Third, due to the high correlation between sales, slack and R&D intensity, we orthogonalized them before entering them into the model (Ertug and Castellucci, 2014). In order to ensure the reliability of the results, we re-ran the models by including the highly correlated but original scores. Using the original measures did not change the findings, as shown in Models 12 and 13.

Finally, the measurement of exploration emphasizes the knowledge novelty with regard to the focal firms (Katila and Ahuja, 2002; Benner and Tushman, 2002), regardless of the novelty to the whole industry. However, knowledge that is novel to the focal firms may not necessarily be novel to the whole market. In order to validate our findings, we re-ran the models, measuring exploration as knowledge that is novel to the whole industry (i.e. *pioneering technology*). Following Ahuja and Lampert (2001) and Quintana-Garcia and Benavides-Velasco (2008), who argued that only knowledge sources which are de novo are novel and exploratory to the whole industry (Ahuja and Lampert, 2001), we defined explorations as the patents that do not build on any established knowledge bases. In particular, we measured exploration as the number of patents in year *t-4* to *t* that do not cite any previous patents. The results were highly consistent with earlier findings. Moreover, we also tried the alternative measures for pioneering technology as the number of patents that cite only one (as well as two) previous patents. The results were similar, as shown in Models 14 and 15.

Figure 2.1 Effect of interaction of status and exploration on growth

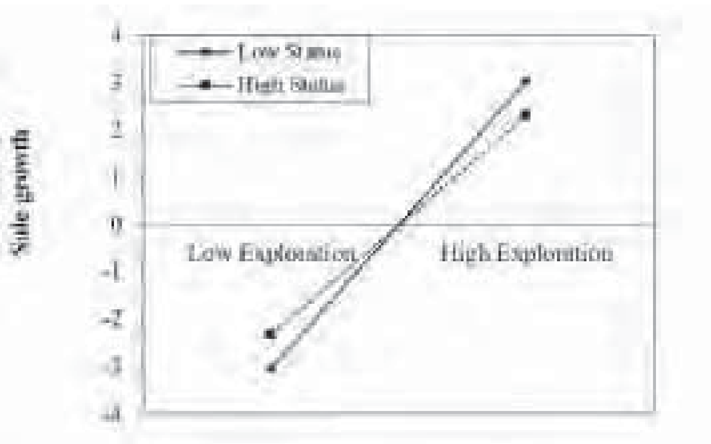


Figure 2.2 Effect of interaction of status robustness and exploration on growth

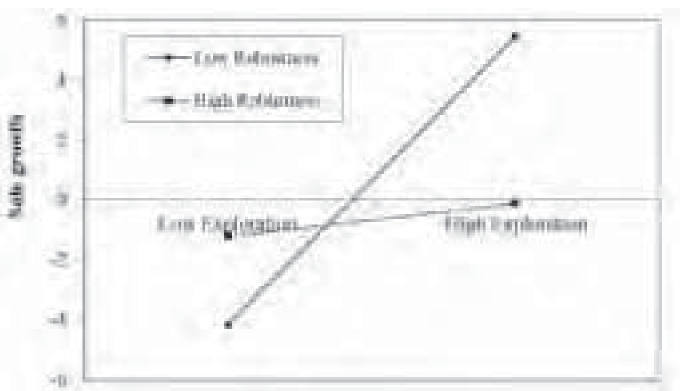


Table 2.2 Fixed-effect panel estimation: firm growth $_{t+1}$

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Robustness × Exploration						-2.070***	-2.056***
						(0.576)	(0.574)
Status × Exploration					-0.312**		-0.307**
					(0.137)		(0.136)
Status			-0.506*	-0.025	0.741	-0.046	0.708
			(0.305)	(0.307)	(0.455)	(0.304)	(0.451)
Robustness			-0.021	-0.014	-0.016	-0.602**	-0.599**
			(0.177)	(0.173)	(0.172)	(0.237)	(0.236)
Exploration		2.486***		2.478***	2.974***	2.470***	2.958***
		(0.397)		(0.412)	(0.465)	(0.408)	(0.461)
Exploitation	0.001	-0.002	0.007	-0.002	-0.002	-0.001	-0.001
	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Quality	0.174	0.064	0.171	0.064	0.067	0.100	0.104
	(0.261)	(0.254)	(0.261)	(0.255)	(0.254)	(0.253)	(0.252)
Sales	-0.316***	-0.361***	-0.325***	-0.361***	-0.364***	-0.382***	-0.384***
	(0.047)	(0.046)	(0.047)	(0.046)	(0.046)	(0.046)	(0.046)
Partner number	0.036***	0.025**	0.033***	0.025**	0.033***	0.039***	0.047***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)	(0.012)	(0.012)
R&D	-1.412***	-1.736***	-1.487***	-1.738***	-1.780***	-1.805***	-1.846***

	(0.145)	(0.149)	(0.151)	(0.153)	(0.154)	(0.153)	(0.154)
Slack	0.027	0.109***	0.047	0.109***	1.117***	1.116***	1.124***
	(0.029)	(0.031)	(0.032)	(0.032)	(0.033)	(0.032)	(0.032)
Age	2.223***	3.919***	2.629***	3.933***	4.117***	4.022***	4.202***
	(0.823)	(0.844)	(0.858)	(0.862)	(0.863)	(0.855)	(0.856)
Constant	-30.91***	-54.23***	-36.53**	-54.43***	-57.13***	-56.17***	-58.81***
	(11.308)	(11.595)	(11.796)	(11.859)	(11.879)	(11.758)	(11.778)
R-squared	0.271***	0.314***	0.274***	0.314***	0.319***	0.327***	0.333***
Year dummies	YES	YES	YES	YES	YES	YES	YES

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

Table 2.3 Fixed-effect panel estimation (robustness checks)

	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13	Model 14	Model 15
VARIABLES								
Robustness × Exploration		-2.602***		-2.123***		-2.056***		-1.843***
		(0.651)		(0.575)		(0.574)		(0.558)
Status × Exploration		-0.427***		-0.332**		-0.307**		-0.531***
		(0.140)		(0.137)		(0.136)		(0.127)
Status	-0.015	-0.849***	-0.015	-0.620***	-0.014	-0.599**	-0.033	-0.327*
	(0.172)	(0.269)	(0.173)	(0.236)	(0.173)	(0.236)	(0.173)	(0.190)
Robustness	0.069	1.082**	-0.200	0.491	-0.025	0.708	0.094	2.589***
	(0.312)	(0.456)	(0.287)	(0.418)	(0.307)	(0.451)	(0.270)	(0.656)
Exploration	2.930***	3.824***	2.307***	2.674***	2.478***	2.958***	1.753***	2.753***
	(0.473)	(0.538)	(0.462)	(0.491)	(0.412)	(0.461)	(0.404)	(0.448)
Exploitation	-0.004	-0.002	0.001	0.003	-0.002	-0.001	-0.000	0.000
	(0.004)	(0.004)	(0.003)	(0.003)	(0.005)	(0.005)	(0.001)	(0.001)
Quality	0.023**	0.049***	0.024**	0.046***	0.025**	0.047***	0.032***	0.046***
	(0.011)	(0.012)	(0.011)	(0.012)	(0.011)	(0.012)	(0.011)	(0.011)
Sales	-33.186***	-36.071***	-31.824***	-34.728***	-0.000	-0.000	-33.267***	-36.595***
	(4.656)	(4.606)	(4.664)	(4.648)	(0.000)	(0.000)	(4.753)	(4.762)

Partner number	-10.372***	-11.190***	-10.345***	-11.157***	-0.010***	-0.011***	-9.013***	-9.468***
	(0.960)	(0.957)	(0.961)	(0.967)	(0.001)	(0.001)	(0.962)	(0.945)
R&D	3.398***	3.932***	3.300***	3.867***	0.001***	0.001***	1.373	1.186
	(0.931)	(0.922)	(0.931)	(0.930)	(0.000)	(0.000)	(0.939)	(0.921)
Slack	0.055	0.079	0.047	0.075	0.064	0.104	-0.010	-0.056
	(0.258)	(0.253)	(0.255)	(0.252)	(0.255)	(0.252)	(0.257)	(0.252)
Age	4.110***	4.448***	4.056***	4.425***	3.933***	4.202***	2.494***	2.285***
	(0.863)	(0.851)	(0.863)	(0.858)	(0.862)	(0.856)	(0.872)	(0.854)
Constant	-59.699***	-65.307***	-59.091***	-65.130***	-52.304***	-56.536***	-37.250***	-34.772***
	(12.004)	(11.851)	(12.018)	(11.969)	(11.757)	(11.675)	(12.195)	(11.942)
R-squared	0.319	0.345	0.314	0.334	0.314	0.333	0.308	0.341
Year dummies	YES	YES	YES	YES	YES	YES	YES	YES

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

2.5 Discussion

Moving beyond the current literature that focuses on external contingencies when explaining the relationship between exploration and performance (Jansen et al., 2006; Uotila et al., 2009), this study investigates two firm-level moderators: technological status and status robustness. In line with prior studies (Katila and Ahuja, 2002; Jansen et al., 2006), our study shows that exploration is beneficial for the growth of high-tech firms. However, we contend that the signaling effect of technological status weakens the contribution of exploration, in such a way that exploration has less influence on the growth of prestigious firms. Our empirical results support this proposition by showing that the positive impact of exploration on a firm's sales growth becomes weaker when the status of the firm is higher and more robust.

This study therefore has important implications for the literature on exploration and status. First, our study highlights the contingent role of firm-specific attributes (i.e. status and robustness) in explaining the exploration–growth relationship, unlike previous studies which have focused mainly on external contingencies (Jansen et al., 2006; Uotila et al., 2009; Auh and Menguc, 2005). Nevertheless, there has been little research on firm-level characteristics that affect the extent to which firms can reap performance benefits from their exploratory activities, although a large body of studies have evidenced the pay-off of particular strategies is dependent on the characteristics of individual firms (e.g. Barnett, Greve, and Park, 1994; Shipilov, 2006). Our findings show that firm-level attributes indeed play an important role in explaining the benefits of exploration for firms, thereby stressing the need for future studies to include firm-level attributes when examining the benefits of exploration.

Second, this study highlights the socially constructed nature of innovation and success (Rindova et al., 2006; Rogers, 2003). As implied by our findings, the effect of exploration does not simply depend on its absolute value; it also relies on the technological status and robustness. That is, the novelty of a firm's new products and services is not the only reference point used by market stakeholders in their evaluations and decisions (Hsu and Ziedonis, 2013). Our findings suggest that, even in high-tech industries, stakeholders would tend to base their judgments largely on firm status, which indicates that the market is socially constructed (Rindova et al., 2006; Podolny and Stuart, 1995; Lynn et al., 2009). As a consequence, when analyzing the value of firms' innovation efforts, it becomes paramount to pay attention to decision-making processes of potential customers and the way they perceive organizations (Roger, 2003).

Third, our findings point to the potential limitations of status. Although scholars have often assumed status to have only positive implications (Podolny, 2005; Piazza and Castellucci, 2014), recent studies (Bothner et al., 2012; Marr and Thau, 2014) have started to suggest that status can also be a liability because it may bring complacency and distraction (Bothner et al., 2012). The findings in this paper suggest that having a high status impedes the growth potential of firms, indirectly. That is, exploration makes less of a contribution to the growth of high-status firms. Where this happens, it may also lead prestigious firms to the view that exploration is not essential, causing them to put less emphasis on the creation of exploratory innovations. In the short term, firms that engage in less exploration may not experience a loss of competitive advantage because their status will compensate for the lack of exploration. Yet when they gradually decrease their emphasis on bringing out new products, their status might also decline in the long run, because status is correlated with products and quality (Podolny, 1993; Podolny and Phillips, 1996). Consequently, their competitive advantage disappears when it is usually too late to recover. Our findings provide a warning to prestigious firms that relying on their status (or reputation, brand name) and failing to explore new competences and capabilities as happened with Nokia and Motorola, for example, may be fatal in the long run.

Our study also has distinguished between the magnitude and robustness of status (Bothner et al., 2010). The results of our analysis show that robustness negatively moderates the relationship between exploration and firm growth. It is consistent with the arguments that market stakeholders are likely to form stable stereotypes and perceptions of firms with a robust status, making them indifferent to changes in exploration within these firms. That is, when a firm already has a robust stereotype in the industry, it becomes more difficult to grow by trying to improve its products. Comparing the moderating effect of robustness (Hypothesis 3) to that of status (Hypothesis 2), we find that robustness exerts a significantly ($p<0.01$) stronger moderation effect than status, meaning that status robustness mitigates the value of exploration to an even greater extent than status magnitude. Thereby, this paper supports prior studies by showing the necessity and importance of considering robustness in analyses of status-based processes.

Finally, it is important to notice the difference between the vertical status robustness that we have discussed and the identity robustness of horizontal product categories (Zuckerman, 1999; 2000). The horizontal identity of a firm is robust when its product portfolio is concentrated rather than diversified, as this helps to reduce ambiguity and gives a firm greater legitimacy. Stakeholders may find it difficult to attach a clear identify to a firm when it has products across multiple categories. However, vertical status is robust when a firm has a wide span of relationships, but relying heavily on fewer partners within its network puts a firm in a more vulnerable position (Bothner et al., 2010).

2.5.1 Limitations and future research

Although our study has various implications for the current literature on exploration and status, we also recognize that it has some limitations that open up interesting avenues for future research. First, while we emphasize the importance of analyzing firm-level characteristics as boundary conditions for the value of exploration, we have focused only on the signaling effect of status and robustness. It is necessary to investigate further how other attributes may moderate the relationship between exploration and firm growth. For instance, will reputation have a similar effect to status? Although both reputation and status represent the prestige of a firm, scholars also recognize the differences between them (Podolny, 1993; Jensen and Roy, 2008).

Second, while we examine our hypotheses within the semiconductor industry in order to control for the heterogeneity of industries, this single-industry setting limits the generalizability of our findings to other sectors. It is uncertain whether technological status and exploration have significant effects in less dynamic industries. As prior research has shown that exploration has little effect on company performance in industries with a low intensity of R&D (Uotila et al., 2009), the moderating effect of status on the relationship between exploration and performance may very well be different from what we found in this study. Future research could shed more light how the interplay between exploration and status plays a role in explaining the growth of firms.

Third, it should be noted that status and quality interact closely with each other. Although the current study takes quality into account in explaining the relationship between status and the value of exploration, the actual interaction between quality and status is more complicated. As status is defined as the "perceived quality of a producer's products" (Podolny, 1993), status is also argued to "influence the quality at which the actor chooses to produce" (Benjamin and Podolny, 1999). Thus, although status and quality are clearly different concepts, they cannot be seen as truly independent. The relationship between them, however, is a dynamic one and difficult to capture, even with our longitudinal research design. Disentangling their unique effects could be one way of reaching a better understanding of the relationship between exploration and growth.

Fourth, in this paper we only analyze the status of firms in a technological network. Recent studies call for attention to be given to relational pluralism (Shipilov et al., 2014), which recognizes that firms are all residing in multiple networks simultaneously (Wang et al., 2014). Future studies could analyze the effect of other kinds of status, such as status in an inventor collaboration network or an alliance network. Will those types of network status show similar patterns of effects? And how will those different networks interact?

Fifth, although our study focuses on the moderation effect of status on the relationship between exploration and performance, we acknowledge that the relationship between status, performance and behaviors could be much more complicated than we have proposed here. For instance, scholars on status have also long recognized that performance is also an antecedent of status accumulation. The empirical results of Podolny and Phillips (1996) show that the prior performance of investment banks determines their current status. Besides, status may also affect firms' behavior with regard to innovation (e.g. exploration and exploitation). Phillips and Zuckerman (2001) find that low-status and high-status firms are more likely to adopt innovative practices than middle-status ones. Thus, we encourage future studies to adopt the dynamic perspective to make a comprehensive analysis of other relationships.

Finally, we note that although the direct effect of status on growth is positive, it is not significant. It means that firms with a high technological status do not necessarily expect higher growth. This seems consistent with Podolny et al. (1996), who argued that it is not possible to specify a direct relationship between status and growth. However, although the direct effect of status on growth is not the focus of this paper, it would be interesting for future studies to make a comprehensive analysis of this. For instance, how does competition crowding (Podolny et al., 1996) affect the relationship between status and growth? Will a firm with a higher status be less motivated to grow, as Bothner et al. (2012) have argued? These and other questions could be the focus of future research.

Chapter 3. A Behavioral Perspective on the Selection of Partners in Strategic Alliances[3]

Abstract

Although previous literature has discussed various factors that explain the selection of alliance partners, the effect of an organization's strategic orientation has been largely neglected. This study proposes an alternative explanation for partner selection: homophily of strategic orientation, such that firms are more likely to form alliance with potential partners that have a similar strategic orientation with regard to exploration and exploitation. We also argue that the propensity to select partners based on similarities in strategic orientation is contingent on the status of the firm and the scope of the alliance. A choice-based matching sample from the semiconductor industry provides empirical support for our hypotheses.

[3] This study is conducted in collaboration with Vareska van de Vrande and Justin Jansen

3.1 Introduction

How alliances form and evolve over time has attracted continuous attention from management scholars (Gulati, 1995; Sorenson and Stuart, 2008). Current studies have mainly identified organizational resources (Mowery, Oxley, and Silverman, 1998) and network structure (Podolny, 1994; Gulati and Garguilo, 1999) as being significant factors in alliance formation and partner selection, but ignored the effect of a firm's strategic orientation. Strategic orientation reflects the way that firms are organized and how they utilize resources and make decisions (Lumpkin and Dess, 1996; Wiklund and Shepherd, 2003; Slater, Olson, and Hult, 2006). Although research on individuals has long recognized that behavioral characteristics of actors affect their interpersonal relation formation and shape their network positions (Mehra, Kilduff, and Brass, 2001; Sasovova et al., 2010), the effect of strategic orientation on organizations' selection of partners remains largely unexplored. To address this gap, we develop a contingency model to investigate how and under what conditions the strategic orientation of a firm and its potential partners affects the likelihood of them forming a strategic alliance.

In particular, we adopt March's (1991) exploration/exploitation framework to examine the effect of a firm's strategic orientation (March, 1991; Uotila et al., 2009; Lavie, Stettner, and Tushman, 2010). For an organization, exploration denotes an orientation in which it shifts away from its current knowledge and skills to new ones, while exploitation is associated with further developing its existing expertise (March, 1991; Lavie et al., 2010). Building on the exploration/exploitation framework and homophily theory (McPherson, Smith-Lovin, and Cook, 2001; Chung, Singh, and Lee, 2000), we apply the notion of homophily to strategic orientation, and argue that firms with similar strategic orientations towards either exploration or exploitation are more likely to collaborate. This is not only because such firms have more similar organizational structures and routines, which helps to facilitate mutual understanding and cooperation, but also because they encounter fewer of the conflicts that can arise when trying to integrate and combine exploration and exploitation across organizational boundaries (March, 1991; Andriopoulos and Lewis, 2009; Stettner and Lavie, 2014).

Although homophily in strategic orientation alone would lead interorganizational networks to evolve into several isolated and dense clusters of similar firms, the reality suggests a relative balance between relations that connect together similar firms and those that link parties that appear less similar. Thus, in order to understand this heterogeneity, we identify various contingencies at both the alliance- and the firm-level that can counterbalance the effect of homophily. First, we identify alliance scope (Reuer, Zollo, and Singh, 2002) as an important contingency factor because it may escalate the complexity of the alliance (McCutchen, Swamidass, and Teng, 2008) when multiple and interdependent tasks are involved. Second, we examine whether the propensity to homophily varies across firms. We highlight the role of a firm's status because status may raise the firm's accountability (Jensen, 2006) and shape its preference for partners with a similar orientation.

To test our hypotheses, we draw on data relating to alliance formation in the semiconductor industry (Stuart, 1998). We chose this setting because the dynamic and competitive conditions in this industry increase the importance of exploration and exploitation for firms within it (Jansen, van den Bosch, and Volberda, 2006; Uotila et al., 2009). This study contributes to current literature in three main ways. First, we introduce a behavioral perspective to explain alliance partner selection. Our study moves beyond earlier literature that concentrated on prior networks and organizational resources (Gulati, 1995; Stuart, 1998; Jensen, 2003) to explain firms' selection of partners, and we emphasizes the role of organizations' strategic orientation. Second, although research on exploration and exploitation has been burgeoning, most studies have either focused on the performance implications of these two approaches (Lavie et al., 2011; Uotila et al., 2009), or have analyzed their organizational and external antecedents (Gibson and Birkinshaw, 2004; Jansen et al., 2006; Phelps, 2010). We demonstrate that exploration/exploitation also shapes how firms select their partners and form alliances. Third, although previous studies focus mainly on the contingency role of external market uncertainty in explaining homophily (Podolny, 1994; Collet and Philippe, 2014), we emphasize that the homophily tendency varies across alliances and firms.

3.2 Literature Review and Hypotheses

3.2.1 Strategic orientation, behavioral homophily, and partner selection

Firms may have different strategic orientations in terms of exploration or exploitation (Lavie et al., 2006; Uotila et al., 2009). Aligning with these strategic orientations requires firms to build and maintain different, and even incompatible, organizational routines (March, 1991; Andriopoulos and Lewis, 2009; Lavie et al., 2010). For example, since exploration entails non-local problem-solving, new knowledge search, or new market entry (Katila and Ahuja, 2002; Lavie et al., 2010), information processing may be more efficient under a decentralized decision-making structure (Jansen et al., 2006). In turn, exploitative firms usually build formalized structures (Jansen et al., 2006) and strong cultures (Sørensen, 2002; Andriopoulos and Lewis, 2009) to facilitate incremental improvements, and prompt the exploitation of existing capabilities.

Different organizational routines impede collaboration between exploratory and exploitative firms, because the firms may find it more difficult to understand and integrate their capabilities (Lane and Lubatkin, 1998; Chung et al., 2000). First, research on relative absorptive capacity suggests that interorganizational understanding and learning does not depend only on firms having an overlap in their knowledge (Zahra and George, 2002), but is also greatly affected by the similarity of their organizational routines (Lane and Lubatkin, 1998). Similar organizational routines are catalysts in helping partnering firms to cooperate more effectively with each other (Lorange and Roos, 1992). However, if firms have very different operational systems and organization structures, they may face greater difficulties in understanding one another and assimilating knowledge (Chung et al., 2000; Lane and Lubatkin, 1998). When the difficulties involved seem to be greater, firms may feel less inclined to collaborate with one another (Gulati, 1995; Mowery et al., 1998; Chung et al., 2000).

In addition, natural tensions and conflicts between exploration and exploitation also increase the difficulty of integration, and hence reduce the likelihood of collaboration between exploratory and exploitative firms. Firms make alliances in order to learn from partners or integrate their capabilities (Gulati, 1995; Das and Teng, 2000; Tiwana, 2008). However, the organizational routines needed for exploration and exploitation are not only different, but are also contradictory and incompatible (Lavie et al., 2011; Stettner and Lavie, 2014). For instance, although a strong organizational culture can prompt exploitation, it usually impedes a firm's ability to observe and respond to exploratory opportunities and challenging threats (Sørensen, 2002; Andriopoulos and Lewis, 2009). Thus, as a result of incompatible and conflicting routines, exploratory firms may find it difficult to integrate the capabilities of exploitative firms and vice versa, which consequently reduces their willingness to form an alliance.

Furthermore, exploratory and exploitative firms may have different criteria for evaluating the outcomes of alliances (Lavie et al., 2011). Exploratory firms may emphasize the novelty of project outcomes and intend to invest more time and effort into experimenting with emerging technologies and discovering novel product features, and they may expect their partners to do the same. In turn, exploitative firms may focus more on improving efficiency and refining existing products or services for current markets. Such disparities in objectives and expectations may lead the two parties to foresee conflicts in the collaboration and thus make them less willing to form an alliance (Chung et al., 2000). We therefore argue that:

Hypothesis 3.1: A pair of firms are more likely to form an alliance when they have similar strategic orientations, and less likely to do so when their orientations are dissimilar

3.2.2 Strategic orientation homophily and alliance scope

The scope of an alliance increases its complexity (McCutchen et al., 2008), because firms have to undertake multiple and interdependent tasks simultaneously. In order to manage such alliances successfully, alliance members not only need to distribute the various tasks appropriately so as to take advantage of the strengths of each firm, they also need to agree on the order of importance and priority for different tasks. Complex alliances with broader objectives increase the demand for inter-firm understanding and coordination (Reuer et al., 2002; Oxley and Sampson, 2004; Li et al., 2008). Greater complexity and coordination in alliances with a broader scope would make firms with a different orientation be viewed less favorably as potential partners; it would be seen as more challenging to reach an agreement with them on how to assign and prioritize the many tasks, with a greater likelihood of conflicts arising during this process.

Moreover, dealing with broad alliances requires both inter-firm and intra-firm integration. Broad alliances with multiple objectives require more business units (i.e., R&D, marketing, and manufacturing) to participate and collaborate. In the alliance, firms not only need to coordinate with their partners, they also need to ensure that their own participating units are well motivated and integrated. Thus, the coexistence of inter- and intra-firm integration makes it more difficult to successfully form and complete the alliance. In order to reduce the potential challenges associated with dealing with multiple tasks and goals, firms may tend to choose similar partners, where they have fewer concerns over inter-firm coordination and integration. By contrast, when the alliances are narrower and have fewer objectives, fewer business units within a firm may be involved; as less intra-firm integration is then required, it may give firms more leeway to select partners who differ from themselves. In sum, we argue that firms are more likely to choose partners with dissimilar strategic orientations when building narrower alliances with fewer objectives.

Hypothesis 3.2: When the scope of an alliance is broad, two firms with different strategic orientations will be less likely to form an alliance, and conversely when the scope is narrower they will be more likely to do so.

3.2.3 Strategic orientation homophily and status

Status refers to a firm's vertical position in a social system, which signals its hard–to–observe quality (Podolny, 1993). Status not only brings various opportunities and benefits (Podolny, 1994; Stuart, 1998; Ozmel et al., 2013), it also influences a firm's self-cognition and accountability to external audiences (Jensen, 2006; Phillips and Zuckerman, 2001). As firms' status increases, they become more concerned and anxious about status loss, because high-status firms are more susceptible to status loss. When they lose status, high-status firms will feel their identity to be threatened and will perform less well than low-status firms who suffer a comparable loss of status (Marr and Thau, 2014). As a result, high-status firms become more conservative (Phillips and Zuckerman, 2001), and tend to avoid activities that may negatively affect their status (Jensen, 2006).

Selecting strategic partners with dissimilar strategic orientation may threaten the current status of a high-status firm. When the firm does not have a good understanding of the capabilities of dissimilar partners and is not able to integrate them (Chung et al., 2000;

Lavie et al., 2011), the overall performance of the alliance will be badly affected (Stettner and Lavie, 2014), and both the status of the firm and its performance will suffer as a consequence (Podolny and Phillips, 1996; Marr and Thau, 2014). Thus, because of status anxiety (Jensen, 2006), high-status firms will be more likely to choose alliance partners with a similar strategic orientation, because engaging in an alliance with a dissimilar partner involves more uncertainty and risk.

In contrast, low-status firms are less concerned about status loss (Jensen, 2006). They have not accumulated much status to begin with, and therefore have less status to lose (Phillips and Zuckerman, 2001). These firms are more able to afford negative consequences, and more likely to maintain their performance even if their status is reduced (Marr and Thau, 2014). Low-status firms are therefore less conservative in their actions. Consequently, when selecting alliance partners, low-status firms are more likely to broaden their search, rather than limiting themselves to similar partners in their immediate vicinity. Therefore, we expect that, compared with high-status firms, low-status firms will show a lower propensity to form alliances with partners that have a similar strategic orientation.

Hypothesis 3.3: Firm with higher status will be more likely to build strategic alliances with firms that have a similar strategic orientation to their own, and firms with lower status will be less likely to do so.

3.3 Methods

3.3.1 Data collection

We collected data from the semiconductor industry to test our hypotheses, because the dynamic and competitive conditions within this industry increase the importance of the strategic orientation (exploration or exploitation) of firms (Jansen et al., 2006; Uotila et al., 2009). Moreover, this industry provides a suitable setting, because patent information is a good reflection of firms' knowledge creation, as well as their technological status (Stuart, 1998). Using Compustat, we chose all public firms in the semiconductor industry with SIC code 3674. We selected public firms as they tend to engage in more strategic alliance activity and to report this publicly, and that would therefore help to ensure the availability of key data. We matched those firms to patents from NBER's USPTO dataset, which includes patent information up to 2006. Thus, only firms who were involved in patenting activities were included for analysis because we used patent information to represent key variables (e.g., orientation and status). Consistent with previous literatures (Stuart, 1998; Phelps, 2010), we used the application year rather than the year in which the patent was granted, because the interval between application and assignment is uncertain and the application year represents more accurately the time at which the innovation is created. We then used strategic alliance data from SDC Platinum to see whether an alliance between a pair of sample firms existed in a particular year. The observation period for our dependent variable is from 1991 to 2002. All of the explanatory variables enter the estimations with values lagged one year with respect to the dependent variable (Shipilov et al., 2011).

3.3.2 Variables

Dependent variable

Likelihood of alliance formation. Our dependent variable is alliance formation between two firms, a dyadic-level binary variable with a value of 1 if the alliance is formed between them at time t+1, and 0 otherwise. We only analyzed intra-industry strategic alliances between firms in our sample. Although there are quite a small number of intra-industry alliances (Yang et al., 2010), such conservative restriction helps to rule out the heterogeneity across industries (Gulati, 1995). Moreover, firms within the same industry are also more comparable, because the emphasis on exploration or exploitation may differ across industries as a whole.

Independent variables

We measured a firm's strategic orientation as its relative exploration (March, 1991; Lavie, 2006). Following previous studies (Phelps, 2010; Katila and Ahuja, 2002), we used patent citations to reflect the exploratory activities of high-tech firms, using these to measure the extent to which a firm's efforts at innovation were anchored in new knowledge. Specifically, we categorized citations of current patents according to whether they were repeated or new. We analyzed all backward citations of all the patents applied for, for each firm in each year, and checked whether these citations had been cited by the focal firm in the previous five years. If it had been cited, we considered it to be a repeated citation. Otherwise, we regarded it as a new citation. As a next step, a firm's exploration was measured as the proportion of its all citations at time *t* that were based on new knowledge. Thus, exploration was measured here in a relative way (ranging from 0 to 1), reflecting the degree to which a firm has an emphasis on introducing new knowledge.

Orientation dissimilarity. Following previous literature (Shipilov et al., 2011), we calculated the dissimilarity between two firms in terms of orientation (i.e., exploration or exploitation) as:

$$Orientation\ dissimilarity_t = \frac{|exploration_{i,t} - exploration_{j,t}|}{|exploration_{i,t} + exploration_{j,t}|}$$

where $\text{exploration}_{i,t}$ and $\text{exploration}_{j,t}$ refer to firms *i* and *j*'s level of exploration at year *t*, respectively. Thus, it is a continuous variable that ranges from 0 to 1 where higher values indicate a greater dissimilarity between the firms' strategic orientations (exploration).

Alliance scope. The SDC database provides the objectives (service objectives) for alliances, such as research and development (R&D), manufacturing, licensing, and marketing. We counted the number of objectives for each alliance, as a reflection of its scope (McCutchen et al., 2008). We left out any alliances for which there was no service information. Most of the alliances had one or two objectives.

Status. We used patent citations to map the technological network of the sample firms. We developed a network matrix, where each cell r_{ij} of the matrix included the number of citations from firm *j* to firm *i,* over the past five years. Next, we used Bonacich's network centrality formula (Hallen, 2008) to measure the power centrality of each firm, as a proxy for their status.

Control variables

We included a set of control variables. First, we included *prior alliance*, to account for the tendency to repeat ties (Gulati, 1995), and if there had been a previous strategic alliance between two firms during the past five years, a value of 1 was assigned, and 0 if not. Second, we controlled for the effect of status homophily (Chung et al., 2000), where two firms are more likely to collaborate if they have similar social status. We also used Shipiliov et al.'s (2011) formula to calculate *status dissimilarity* between two firms.

Next, technological overlap (Mowery et al., 1998) was also included to reflect the relative importance of technological knowledge in the partners' knowledge portfolios. In particular, we entered two dummies, *citation*$_{i\text{–}j}$ and *citation*$_{j\text{–}i}$, to indicate whether firm i cited patents by firm j, and vice versa.

Geographical location was also taken into account, since proximity may strengthen the likelihood that firms will form a strategic alliance (Sorenson and Stuart, 2008). We created a dummy variable *co-location*, with the value of 1 if the two firms were from the same country, and 0 otherwise. An additional dummy variable was included to indicate whether the alliance was a *joint venture*. Furthermore, we included *R&D alliance* as a control variable. Following previous literature (Lavie and Rosenkopf, 2006), we categorized an alliance as R&D if it only had an R&D objective, and assigned it a value of 1; we assigned a value of 0 if it had no R&D objective, and 0.5 if it had multiple objectives, including R&D.

Finally, we also controlled for two industry-level factors. We included the overall exploration of the whole industry, *industry explorations*, measured as the size-weighted average of all firms' explorations at *t*. We also controlled for the degree of *market concentration* by calculating the Herfindahl index of firms' sales in the semiconductor industry. Higher values indicate that the market is more concentrated and oligopolistic, and lower values indicate a more equally distributed market.

3.4 Analysis and Results

This research design faces the potential problems of rare event and non-independence among observations. It may also lead to possible underestimation of standard errors for the firms that do not change between dyads (Jensen, 2003). The traditional techniques for autocorrelation correction of panel data, such as random or fixed effects methods, are not appropriate here (Hallen, 2008). Therefore, following previous studies, we used the choice-based sampling technique (Jensen, 2003; Sorenson and Stuart, 2008) to reduce the interdependence. For each non-zero dyad, we matched it with 10 random dyads in which there was no strategic alliance during the same time period. Different matching ratios (e.g. 1:5) provide consistent results (Sorenson and Stuart, 2008). Dropping the incomplete data, we ended up with 926 dyadic observations throughout our observation window, 71 of which were realized pairs of semiconductor firms involved in patenting activity. We estimated our models using a two-way clustering model (Kleinman, Stuart, and Tushman, 2013), which helps to reduce the interdependence problem by simultaneously clustering on both members of a dyad. As a robustness test, we also estimated alliance formation using a rare event logit model (Yang et al., 2010; Jensen, 2003) with one-way clustering, which provides consistent results.

Table 3.1 presents the descriptive statistics and correlations, while Table 3.2 presents the results of our analyses. Model 1 in Table 3.2 includes only the control variables, which mostly behave as expected. Model 2 includes the variable of orientation dissimilarity. The coefficient is significantly negative. Following Wiersema and Bowen (2009), we calculated its marginal effect, which is negative (-0.015) and significant (z-score = -2.45; $p<0.05$). Our Hypothesis 3.1 that two firms are more likely to form alliances when they have similar strategic orientations on exploration/exploitation, and less likely to do so when their orientations are dissimilar, is thus supported.

Model 3 includes the interaction between orientation dissimilarity and alliance scope. To limit the multicollinearity, all the variables were standardized prior to calculating the interaction term. The interaction is negative at the level of $p<0.05$, indicating that a broader alliance scope strengthens the negative effect of orientation dissimilarity on alliance formation. To interpret the moderation effect, we followed Wiersema and Bowen's (2009) procedure, and compared how the marginal effect of dissimilarity changes across different values of moderator (i.e. mean, mean-s.d., and mean+s.d.). As Table 3.3 shows, the relation between orientation dissimilarity and the possibility of alliance formation is more negative at higher values of scope, suggesting a generally negative moderation effect. At a low value of scope, the moderation effect seems sufficient to render the negative marginal effect of dissimilarity. That is, high values of alliance scope strengthen the impact that orientation dissimilarity has on the probability of alliance formation. Our Hypothesis 3.2 – that two firms with dissimilar strategic orientations become less likely to form an alliance when the alliance scope is broader, and more likely to do so when it is narrower – is thus supported. Finally, Model 4 includes the interaction term of orientation dissimilarity and status. The interaction term is significantly negative (with $p<0.01$). The marginal effects in Table 3.3 confirm the results. It means that high-status firms have a greater propensity to homophily. Our Hypothesis 3.3, stating that higher-status firms are less likely than lower-status firms to build strategic alliances with firms with a dissimilar strategic orientation, is hence supported.

Table 3.1 Descriptive statistics and correlations

Variables	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12
1. Alliance formation	0.08	0.27	1.00											
2. Orientation dissimilarity	0.58	0.38	–0.07	1.00										
3. R&D alliance	0.21	0.34	0.02	–0.08	1.00									
4. Status $_i$	0.22	0.37	0.01	–0.08	0.06	1.00								
5. Alliance scope	1.60	0.95	0.00	0.02	0.18	0.01	1.00							
6. Prior tie	0.02	0.15	0.09	–0.05	0.01	0.06	0.03	1.00						
7. Status dissimilarity	0.78	0.36	–0.02	0.09	–0.10	0.29	0.02	0.01	1.00					
8. Citation (j–i)	0.20	0.40	0.05	–0.27	0.05	0.33	0.01	0.09	–0.10	1.00				
9. Citation (i–j)	0.24	0.43	0.08	–0.25	0.02	0.37	–0.02	0.08	–0.10	0.63	1.00			
10. Co-location	0.83	0.38	–0.11	–0.13	0.03	0.08	0.12	0.01	–0.16	0.16	0.13	1.00		
11. Joint venture	0.23	0.42	–0.02	0.10	–0.22	–0.13	–0.11	–0.02	0.10	–0.05	–0.09	–0.07	1.00	
12. Market concentration	0.81	0.09	–0.02	0.02	0.07	–0.04	0.10	0.00	–0.37	0.08	0.02	0.34	–0.09	1.00
13. Industry exploration	0.48	0.38	–0.01	0.03	–0.01	–0.06	–0.03	–0.08	–0.37	0.03	0.04	0.17	–0.27	0.70

Coefficients greater than 0.08 in absolute value are significant at $p<0.01$

Table 3.2 Two-way clustering estimation on strategic alliance formation

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Orientation dissimilarity		–0.269**	–0.276**	–0.264**	–0.269**
		(0.127)	(0.119)	(0.114)	(0.109)
Orientation dissimilarity*Alliance scope			–0.376**		–0.382**
			(0.171)		(0.175)
Orientation dissimilarity*Status				–0.179***	–0.188***
				(0.067)	(0.064)
R&D alliance	0.050	0.030	0.030	0.039	0.032
	(0.086)	(0.086)	(0.090)	(0.090)	(0.091)
Alliance scope	0.040	0.056	–0.077	0.042	–0.089
	(0.075)	(0.076)	(0.069)	(0.073)	(0.071)
Status	–0.061	–0.057	–0.071	–0.132	–0.155
	(0.087)	(0.096)	(0.100)	(0.099)	(0.102)
Prior tie	1.263*	1.239*	1.146	1.298*	1.214*
	(0.736)	(0.735)	(0.792)	(0.687)	(0.734)
Status dissimilarity	–0.206	–0.124	–0.098	–0.137	–0.096
	(0.283)	(0.273)	(0.275)	(0.271)	(0.273)
Citation $_{j-i}$	0.114	–0.033	–0.057	–0.070	–0.097
	(0.507)	(0.496)	(0.516)	(0.476)	(0.493)
Citation $_{i-j}$	0.726*	0.678	0.690	0.654	0.679

	(0.429)	(0.460)	(0.471)	(0.471)	(0.469)
Co-location	–1.121***	–1.209***	–1.254***	–1.198***	–1.248***
	(0.419)	(0.426)	(0.423)	(0.418)	(0.414)
Joint venture	–0.118	–0.057	–0.242	–0.112	–0.337
	(0.271)	(0.295)	(0.339)	(0.303)	(0.380)
Market concentration	0.467	0.802	1.169	1.025	1.473
	(1.382)	(1.560)	(1.509)	(1.648)	(1.626)
Industry exploration	–0.043	0.001	–0.062	–0.034	–0.098
	(0.474)	(0.477)	(0.490)	(0.475)	(0.488)
Constant	–2.090***	–2.376**	–2.610**	–2.536**	–2.839**
	(1.035)	(1.178)	(1.135)	(1.248)	(1.232)
BIC	652.08	542.19	529.93	533.52	527.96
AIC	612.38	493.88	486.46	490.04	484.48
Pseudo R^2	0.047	0.054	0.065	0.058	0.069

Robust standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 3.3 Effect of scope and status on the marginal effect of orientation dissimilarity

Value of scope	Marginal effect	z-statistic	Value of Status	Marginal effect	z-statistic
Low	0.007	0.618	Low	-0.005	-0.56
Mean	-0.015**	-2.49	Mean	-0.015**	-2.47
High	-0.034***	-3.50	High	-0.022***	-4.56

*** p<0.01, ** p<0.05, * p<0.1; Computed at the mean of exploration dissimilarity

3.5 Discussion

Moving beyond prior studies that concentrate on network structure and resources when explaining firms' partner selection (Ozmel et al., 2013; Gulati, 1995), this paper emphasizes the role of an organization's strategic orientation. We apply March's (1991) exploration/exploitation framework, and argue that firms tend to form alliances with partners that have a similar strategic orientation with regard to exploration/exploitation. Supporting our hypotheses, evidence from the semiconductor industry shows that exploratory firms are more likely to form a strategic alliance with other exploratory firms, and exploitative firms likewise tend to partner with other exploitative firms. However, we find that this pattern of partner selection is contingent on the features of both the alliances and the firms. In particular, firms become more likely to ally themselves to partners with dissimilar strategic orientations when the scope of the alliance is narrower. Finally, the results demonstrate that high-status firms show a stronger tendency to seek out partners who are similar in terms of strategic orientation, either exploration or exploitation. Our findings provide important implications for current literature and practice.

First, this study extends research on the notion of homophily in alliance formation (Podolny, 1994; Collet and Philippe, 2014), and highlights the role of strategic orientation. Firms do not only flock together on the basis of status (Podolny, 1994; Chung et al., 2000), they also tend to cluster according to strategic orientation. This implies that a firm may have to lay more emphasis on either exploration or exploitation, if it expects to collaborate with partners with same type of orientation. However, the homophily tendency in strategic orientation may not be necessarily beneficial for firms because clustering by exploration or exploitation may lead respectively to either renewal or competence traps (Levinthal and March, 1993). If an exploitative firm, for instance, has only exploitative partners, it cannot access exploratory knowledge through interorganizational networks, and this may ultimately drive it to become trapped by existing competences. Conversely, when an exploratory firm forms alliances only with other exploratory firms, it may lack the exploitative capabilities needed to ensure short-term profitability. Thus, firms are advised to make alliances with firms with different strategic orientations, in order to balance exploration and exploitation at the inter-organizational level.

Second, although studies usually emphasize external uncertainty as a contingency for the homophily effect (Collet and Philippe, 2014), we highlight that the extent to which similar partners are selected does in fact vary across deals and firms. Firms tend to find partners with a similar orientation, especially for broader alliances. This implies that if an exploitative firm expects to collaborate with partners that have an exploratory focus, it is advisable to propose an alliance with a relatively narrow scope and fewer objectives. Otherwise, those potential partners may be more reluctant to agree to join them, because of the greater complexity and transaction costs associated with a broader alliance.

Third, high-status firms are more likely to cluster with others of the same orientation. High-status firms, which are usually large and well-established, may often be less exploratory and more exploitative, because organizational aging makes it more difficult for them to keep pace with a constant stream of new external developments (Sørensen and Stuart, 2000). Where this applies, they are much more likely to form alliances with exploitative partners. They may thus face a greater risk of ending up in competence traps (Levinthal and March, 1993). This may also help explain why prestigious companies (e.g., Nokia and Motorola) have lost ground. High-status firms are thus advised to ally with exploratory firms.

Although our study has multiple implications for research, we also recognize some limitations. First, while we examined our hypotheses within the semiconductor industry in order to control for the confounding effect of industry-related aspects, this single-industry setting may limit its generalizability. It is uncertain whether homophily in strategic orientation will still have similar effects in less dynamic industries. Scholars could also expand our research by investigating the formation of inter-industry alliances. We focused only on intra-industry alliances, because the overall emphasis on either exploration or exploitation may differ from one industry to the next, making it difficult to compare dyads.

Second, we only discussed how an exploration or exploitation orientation influences firms' selection of partners. It would be interesting to investigate how firms and partners co-evolve, after forming alliances. From an inter-organizational learning perspective, we might argue that the strategic orientation of a focal firm is likely to start converging with that of its partners. However, according to knowledge-accessing theory (Grant and Baden-Fuller, 2004), it is also possible that they may become divergent.

Finally, our study highlights that the strategic orientation of firms matters in terms of their propensity to form alliances. Although our exploration/exploitation framework reflects the essential strategic orientation of an organization, future studies might also analyze other types of orientation, such as entrepreneurial orientation (Lumpkin and Dess, 1996).

Chapter 4. Ambidextrous Inventions, Technological Breakthroughs, and Team Composition[4]

Abstract

While ambidexterity is widely accepted to be highly important for organizations, there has been very little investigation of how ambidextrous inventions are received in technology markets. Using patent data from the semiconductor industry from 1991 to 2001, this paper evaluates the value of inventions that involve with different degrees of exploration and exploitation. It finds that ambidextrous inventions that combine an organization's existing knowledge with new knowledge are of greater value than inventions that are either over-exploratory or over-exploitative. At the same time, ambidextrous inventions also have a higher likelihood of achieving a technological breakthrough. Furthermore, this study investigates how to compose teams to create ambidextrous inventions. Results show that medium-sized teams and teams with a medium level of invention experience are more likely to balance exploration and exploitation in their inventions. In the post-hoc analysis, we also discuss when invention teams would create inventions that are either over-exploratory or over-exploitative.

[4] This study is conducted in collaboration with Vareska van de Vrande and Justin Jansen

4.1 Introduction

Firms need to balance exploration and exploitation (Katila and Ahuja, 2002; He and Wong, 2004; Jansen, Van den Bosch, and Volberda, 2006; Wang and Li, 2008; Lavie, Stettner, and Tushman, 2010) in way that makes it possible for them to stay at the forefront of technological progresses (Wu, Wan, and Levinthal, 2014; Phelps, 2010) and at the same time to ensure short-term returns (March, 1991; March and Levinthal, 1993; Auh and Menguc, 2005). Yet, as firms strive to achieve this balance, a salient and important question emerges: should this be done by generating both exploratory and exploitative inventions (Benner and Tushman, 2002), or by combining exploration and exploitation within each invention. Although both approaches could lead to ambidexterity at the firm level (Katila and Ahuja, 2002), they require totally different strategies. The first may be realized through structural differentiation (Tushman and O'Reilly, 1996; Jansen et al., 2009; Fang, Lee, and Schilling, 2011), while the second demands ambidexterity at the invention level. To answer this question, therefore, it is necessary to investigate whether and how the degree of exploration (or exploitation)[5] within an invention affects its market value. Structural differentiation may be not advisable if over-exploration or over-exploitation in an invention impedes its market value.

The first goal of this paper is to emphasize the relationship between an invention's ambidexterity and its value in the technology market. To obtain and sustain competitive advantage, high-tech firms need to create inventions with high value in technology markets. What leads inventions to have value has been examined from various perspectives in the literature, and factors that have been considered include collaboration networks (Singh, 2005; Singh, 2008), technological complexity (Fleming and Sorenson, 2001; Sorenson, Rivkin, and Fleming, 2006), backward science (Sorenson and Fleming, 2004; Fleming and Sorenson, 2004), specialists and generalists (Melero and Palomeras, 2014), and organizational status (Podolny and Stuart, 1995). Yet, surprisingly, scholars have paid limited attention to the degree of exploration/exploitation, which is one of the essential features of any invention (Rosenkopf and Nerkar, 2001; Benner and Tushman, 2002; Phelps,

[5] An ambidextrous invention is defined as one that combines both exploration and exploitation. Here we consider the level of exploration and exploitation within an invention as being on a continuum between these two approaches (Lavie and Rosenkopf, 2006). When an invention is more exploratory, its level of exploitation is therefore lower.

2010). Exploration reflects the extent to which an invention goes beyond an organization's existing knowledge (Katila and Ahuja, 2002; Wanger al., 2014) to discover novel domains, while inventions that are exploitative draw on knowledge that is derived largely from current technologies (Lavie et al., 2010). Although exploration may lead knowledge to be combined in new ways that then increase its value (Fleming et al., 2007), an organization that enters new domains may also face uncertainty (Fleming, 2001) and have less credibility and legitimacy in those domains(Zuckerman, 1999). Thus, we expect that inventions will be more valuable when they combine exploration and exploitation (i.e., ambidextrous inventions).

This study also investigates how the ambidexterity of an invention affects the likelihood that it will become a technological breakthrough. Organizations not only want to ensure that all their inventions are of a good quality, but are also eager to create breakthrough inventions so that they can be at the forefront of technological advances (Trajtenberg, 1990; Ahuja and Lampert, 2001; Wu et al., 2014). Previous studies have discussed the antecedents of breakthrough inventions, and have analyzed team composition (Singh and Fleming, 2010; Singh, 2008), and the age and origin of knowledge components (Kelley, Ali, and Zahra, 2013; Phene, Fladmoe-Lindquist, and Marsh, 2006). However, we do not know whether combining exploration and exploitation within an invention (Katila and Ahuja, 2002; Benner and Tushman, 2002) can increase the possibility that it will achieve a breakthrough in technology markets, even though ambidexterity may increase the value of inventions on average.

Emphasizing the importance of ambidexterity for inventions, this study further investigates how the composition of invention teams affects their chances of creating ambidextrous inventions. Nowadays, many inventions are developed by a team of inventors (Wutchy, Jones, and Uzzi, 2007), and the composition of those teams can significantly affect the quality and market value of the inventions that they produce (Singh, 2005; Singh, 2008; Singh and Fleming, 2010; Gruner, Harhoff, and Hoisl, 2013). Existing literature have stored, for instance, that teams with more diverse knowledge and experience can produce inventions with high impact and will be likely to have fewer failures (Singh and Fleming, 2010), and that the presence of generalists in a team enhances the economic relevance of inventions (Melero and Palomeras, 2014). However, we have limited knowledge of how team composition determines the combination of exploration and exploitation. The tension between exploration and exploitation (March, 1991; Lavie et al., 2011) makes it difficult to balance these two approaches in an invention. A team should not only possess enough experience of using existing internal technologies, but should also have sufficient absorptive capacity (Cohen and Levinthal, 1990) to harness and use new external knowledge. More importantly, it should also have the capability to combine new and existing knowledge in an appropriate way. Thus, this study focuses on teams' abilities to access new and existing knowledge (Benner and Tushman, 2002; Wang et al., 2014) and to combine knowledge (Fleming, 2001), and discusses what effect team size and team experience have on the generation of ambidextrous inventions.

We test hypotheses in a sample of patents applied for by semiconductor firms between 1991 and 2001. By analyzing over 36,000 patents, this study finds that ambidextrous inventions have a market value that is about 5% higher than that of over-exploratory and over-exploitative inventions. Thus, it is advisable for a firm to encourage inventors to balance exploration and exploitation in each invention. Second, the results also indicate a positive relationship between ambidexterity and technological breakthrough. Ambidexterity increases by about 18% the possibility that an invention will become a breakthrough. Finally, we find that both team size and team invention experience have positive effects on the likelihood of the team creating ambidextrous inventions, with diminishing returns. In our post-hoc analysis, we find that although larger teams with more experience can reduce the risk of over-exploration in inventions, they are also more likely to come up with inventions that are over-exploitative.

4.2 Literature Review and Hypotheses

Exploration refers to activities that take a firm some distance from its existing business, and that involve more variation, risk-taking and discovery; exploitation, on the other hand, involves searching locally within the firm's existing domains and improving products through refinement or incremental changes (March, 1991; Lavie et al., 2010). Organizations may engage in exploitation and exploitation by different means – for example, by extending their geographic scope and looking for new partnerships (Lavie and Rosenkopf, 2006; Stettner and Lavie, 2014). When looking at exploration and exploitation within high-tech industries, scholars lay particular stress on the importance of technological knowledge generation (Sorenson and Stuart, 2000; Ahuja and Lampert, 2001; Rosenkopf and Nerkar, 2001), which reflects the extent to which a firm combines new[6] and existing knowledge in its overall innovations (Katila and Ahuja, 2002; Benner and Tushman, 2002; Wang and Li, 2008; Phelps, 2010; Wang et al., 2014).

Previous studies reveal that, although exploration contributes to firm performance in general, an extremely high level of exploration may become harmful (Katila and Ahuja, 2002; Ahuja and Lampert, 2001; Wang and Li, 2008). Exploration brings firms distinctive new knowledge and variations, which are necessary for them to find optimal solutions to technological problems. However, very high levels of exploration can also create greater instability and unreliability, which makes productions less efficient (Katila and Ahuja, 2002). Thus, it is advisable for organizations to balance exploratory and exploitative inventions and pursue ambidexterity (He and Wong, 2004; Hess and Rothaermel, 2011; Jansen, Cao, and Simsek, 2012).

However, even when they understand the importance of doing this, firms might still feel ambivalent and uncertain about how to implement a strategy of ambidexterity, because there are different ways of balancing exploratory and exploitative inventions. First, firms can use structural differentiation in their invention activities (Jansen et al., 2009; Tushman and O'Reilly, 1996). That is, they may assign separate teams to exploratory and exploitative inventions (Benner and Tushman, 2002). Exploitative teams focus on refining current technologies, while exploratory teams discover novel knowledge through riskier experimentation (Lavie et al., 2010). By developing both exploratory and exploitation inventions, firms become ambidextrous at the organization-level (Fang et al., 2011). Alternatively, organizations can require all teams to combine current technologies with new knowledge in the development process, so that every invention will be more ambidextrous.

It seems that both approaches are feasible for ensuring the balance of exploration and exploitation at the firm level (Katila and Ahuja, 2002). However, they may result in different returns at the invention level if the value of an invention is closely related to its

[6] New knowledge in this paper refers to knowledge that is new to the organization. That is, we emphasize the organizational boundaries for the definition of new knowledge (Katila and Ahuja, 2002; Benner and Tushman, 2002), whereas other studies used the age of knowledge as another dimension of newness (Nerkar, 2003; Kelly et al., 2013)

degree of exploration/exploitation (ambidexterity). In other words, if ambidextrous inventions are more valuable than non-ambidextrous ones, the first approach may limit the value of inventions. On the other hand, if balancing exploration and exploitation within a technological invention is likely to have an adverse effect on how it performs in the market, structural differentiation may be a better approach (Lavie et al., 2011; Stettner and Lavie, 2014).

4.2.1 Ambidexterity of inventions and market value

Invention is the process of recombining knowledge in order to find solutions to technological problems (Henderson and Clark, 1990; Kogut and Zander, 1992; Fleming, 2001; Fleming, Mingo, and Chen, 2007; Katila and Ahuja, 2002; Nelson and Winter, 1982). Organizations often tend to confine their search for knowledge to the technological domains with which they are already familiar, and hence invent by recombining current knowledge (Sorenson and Stuart, 2000). Yet, even though inventors may continually exploit an organization's existing knowledge in depth (Katila and Ahuja, 2002), the extra value that existing knowledge can bring to the market becomes gradually exhausted, because there is a limit to the number of ways in which existing knowledge can be usefully combined (Fleming, 2001). Moreover, a change in the competitive environment or technology trajectory may also mean that a firm's existing knowledge becomes outdated (Sorenson and Stuart, 2000; Jansen et al., 2006; Wu et al., 2014). Inventions that do not match current market needs will not be given a rough ride (Sorenson and Stuart, 2000). Thus, inventions that employ only existing internal knowledge have their limitations, making it necessary to include new knowledge.

The introduction of new knowledge keeps inventions away from the problem of local search (Nelson and Winter, 1982; Wang et al., 2014). Inventions that combine new knowledge with existing knowledge are likely to bring novel and distinctive combinations to the market. New combinations open up previously unexplored technological opportunities and potential (Fleming, 2001; Fleming et al., 2007), which may attract more firms or inventors to follow. In addition, new knowledge also increases technological variation (Baum and Singh, 1994), which is valuable for finding better solutions to technological problems (Katila and Ahuja, 2002). Thus, inventions that draw on new knowledge are more likely to be of greater value than those that only recombine existing knowledge.

However, when the proportion of new knowledge within an invention becomes extremely high, the added value normally associated with exploration may be eroded. First, although new knowledge increases variation and diversity, it also brings uncertainty (Katila and Ahuja, 2002). A firm is usually more familiar with knowledge that it already has and uncertain about how to best apply new external knowledge, and this means that it cannot ensure the quality of inventions that build largely on new knowledge. Second, inventions that involve a high degree of new knowledge are not capitalizing on a firm's existing knowledge (Sorenson and Stuart, 2000). Existing knowledge is usually a firm's current expertise and the source of core competence (Kogut and Zander, 1992; Grant, 1996). An invention that does not rely on any existing knowledge makes no use of the firm's advantage and core competence, and is thus unlikely to be competitive in the market. At the same time, the inclusion of much external knowledge in an invention means that a firm is entering an area where other firms are superior, thus decreasing the likelihood that the invention will be especially valuable.

Finally, we contend that the value of an invention is also socially constructed (Podolny and Stuart, 1995). The influence of an invention is determined not only by the nature of the knowledge involved (Fleming, 2001), but also by the characteristics of firms that develop it (Podolny and Stuart, 1995). Audiences tend to place firms into different classes or categories, based on their main activities (Zuckerman, 1999). They will perceive firms as more credible and legitimate if the inventions they produce are consistent with their established expertise. Yet, when a firm invents in a completely new domain with completely novel knowledge, its legitimacy and credibility may be questioned (Zuckerman, 1999). That is, audiences might be less likely to accept a firm's inventions when they build on extremely new knowledge. Therefore, we hypothesize that:

> *Hypothesis 4.1: Ambidextrous inventions are of greater value, such that an invention's value is curvilinearly related to the degree of exploration*.

4.2.2 Ambidexterity and breakthrough inventions

Following previous studies, we define breakthrough inventions as those inventions that serve as the basis for many subsequent technological developments (Trajtenberg, 1990; Phene et al., 2006; Singh and Fleming, 2010). Technological breakthroughs bring a unique competitive advantage and economic value, as they create new technological trajectories and paradigms (Ahuja and Lampert, 2001; Kelley et al., 2013). For instance, digital photography, which was so different from the previous silver halide film technology, represented a major breakthrough and opened the way for a whole series of new related technologies (Wu et al., 2014).

To create a completely new technology, inventions cannot simply build on the existing knowledge within the organization, which still exploits the potential of an existing technology. New knowledge is necessary to create an entirely breakthrough inventions (Singh and Fleming, 2010; Kelly et al., 2013). New knowledge usually comes from a trajectory that is different from current ones. Thus, when new knowledge and existing knowledge are combined, a link is made between different technological trajectories, which is then more likely to result in a breakthrough in technology (Wu et al., 2014).

However, when an invention incorporates too much new knowledge, it may be less likely to become a breakthrough. First, incorporating too much new knowledge decreases the possibility of creating an entirely new technology. Let us suppose that existing knowledge is located on trajectory *I* and new knowledge comes from trajectory *II*. When an invention builds only on existing knowledge, it exploits trajectory *I*, without creating a new trajectory. However, when an invention only combines new knowledge, it exploits trajectory *II*. Thus, a new trajectory may be more likely to occur when inventions combine both new and existing knowledge at the same time. Second, new knowledge is also associated with uncertainty and unfamiliarity (Fleming, 2001; Katila and Ahuja, 2002). The creation of breakthrough inventions requires sufficient capabilities to combine different trajectories (Fleming, 2001). However, incorporating a large amount of new knowledge increases the difficulty for organizations and teams to make an appropriate combination of knowledge components because they are unfamiliar with the new knowledge and how different elements of that knowledge may relate to one another (Fleming and Sorenson, 2001). Thus, they are less capable of coming up with a significant new development.

> *Hypothesis 4.2*: *Ambidextrous inventions are more likely to be breakthroughs, such that the possibility that an invention will be a breakthrough is curvilinearly related to the relative degree of exploration*.

4.2.3 Team composition and ambidextrous inventions

The practical issue for firms is how to facilitate the creation of ambidextrous inventions if these are valuable. Inventions are often generated by teams (Paulus, 2000; Singh and Fleming, 2010; Wutchy et al., 2007; Melero and Palomeras, 2014). Thus, it is necessary to discuss the influence of team composition on the degree of ambidexterity within an invention. Two aspects are particularly important here: the access to new and existing knowledge; and the capability of team members to combine those two types of knowledge.

Size of invention team

Teams with more members are likely to possess a greater amount of knowledge. The scope of each inventor's knowledge is limited (Singh and Fleming, 2010), but the scopes of different inventors do not completely overlap, even within a same firm. As the size of the invention team increases, the scope and diversity of knowledge becomes greater (Liu, 2014). Similarly, the scope of external networks (Singh and Fleming, 2010) may increase with team size, such that larger teams have more opportunities to learn from external sources (Almeida, Dokko, and Rosenkopf, 2003). Teams with more members are thus likely to access both more internal knowledge and more external new knowledge.

Larger teams also perform better when combining new and existing knowledge. First, using the new knowledge requires sufficient absorptive capacity (Zahra and George, 2002; Lane, Koka, Pathak, 2006), where larger teams often have advantages (Almeida et al., 2003). Second, processing different pieces of knowledge simultaneously adds to the complexity and difficulty, because inventors may be unfamiliar with the interdependency between existing and new components (Fleming and Sorenson, 2001). If so, invention teams may have to devote considerable time and effort to iterative processes of trial-and-error (Singh and Fleming, 2010; Nelson and Winter, 1982), in order to come up with a good invention. Teams with more members have an advantage in that they can sort through and select information collaboratively, enabling them to speed up the process and find the best solutions more quickly.

However, if the team becomes too large, size can become a disadvantage rather than an advantage. First, the internal knowledge scope of the various team members becomes highly overlapped. That is, the additional members may only contribute a limited amount of extra knowledge. Second, although larger teams may also have more access to external new knowledge, it becomes more difficult for all of the members to digest and utilize the increased amount of knowledge. Thus, the marginal value of external knowledge will diminish. Third, larger teams tend to create knowledge that is more socially embedded within firms (Hoetker and Agarwal, 2007), with the result that the exploitation of existing knowledge is given greater emphasis and they may do little exploration. Finally, the cost of coordination (Taylor and Greve, 2006) increases with the size of team, making it more difficult for a larger team to combine new and existing knowledge. Intra-team conflicts and free-riding (Jehn and Mannix, 2001) may increase with team size, which also impairs team members' efficiency and effectiveness in collaborating and combining knowledge. Therefore, we hypothesize that:

Hypothesis 4.3: The likelihood of creating ambidextrous inventions is curvilinearly related to the size of the invention team.

Invention Experiences

Team experience reflects the current knowledge stock of team members. With more invention experience, an invention team possesses more existing knowledge within a firm, and this knowledge can be used for developing inventions. Moreover, the amount of new knowledge that inventors or teams can absorb, digest and utilize is contingent on their current experience or knowledge (Lane et al., 2006; Zahra and George, 2002; Cohen and Levinthal, 1990). Thus, teams with more experience and knowledge are able to better understand external knowledge. Conversely, it becomes quite difficult for a team with no experience to incorporate new knowledge into their inventions (Cohen and Levithal, 1990), as they do not have a sufficient level of experience and knowledge that enable them to absorb and make sense of new knowledge. Finally, experience also provides teams with the ability to combine different areas of knowledge. Inventions combine different knowledge components (Fleming, 2001), a process which requires investors to have sufficient expertise and experience, as they have to deal with complicated issues such as technological interdependence and complexity (Fleming and Sorenson, 2001).

However, experience may also increase inertia for teams (Hannan and Freeman, 1984). With excessive experience, teams may well find themselves trapped by existing technologies, making it difficult or sometimes impossible for them to take on board new knowledge. In this case, their current knowledge and experience will only act as a basis for recombination, rather than for absorption of external knowledge (Zahra and George, 2002; Cohen and Levinthal, 1990). And without incorporating sufficient new knowledge, teams cannot create ambidextrous inventions. Thus, we hypothesize that:

> *Hypothesis 4.4: The likelihood of creating ambidextrous inventions is curvilinearly related to the average level of experience within an invention team*.

4.3 Methods

We tested our theoretical hypotheses in the semiconductor industry. The dynamic and competitive nature makes exploratory and exploitative inventions essential for firms in this industry (Wang et al., 2014; Jansen et al., 2006). Also, within the industry, patenting is considered to be a good indicator of a firm's invention activities (Podolny and Stuart, 1995; Sorenson and Stuart, 2000). Finally, focusing on one industry helps to control for the confounding effects of industry-level factors.

We used the Compustat database, which includes basic information such as sales and R&D expenditure, to track all firms in the semiconductor industry (SIC: 3674, semiconductors and related devices) from 1991 to 2001. From the USPTO database, which contains key information on patents, we identified all the patents that were applied for by those firms, and we excluded any firms that did not apply for any patents during the observation periods. We then added information about the inventors and invention teams for each patent in our sample, using Harvard Patent Network Dataverse (Lai et al., 2013). Excluding patents with missing data, we ended up with a dataset of 36,551 patents from 161 firms over the period from 1991 to 2001.

4.3.1 Dependent variables

Value of inventions. The dependent variable, the value of inventions in the technology market, was measured as the number of forward citations that a patent receives till 2006. Forward citations are considered a good indicator of a patent's value and quality (Singh, 2008; Nerkar, 2003; Fleming, 2001; Rosenkopf and Nerkar, 2001) because it reflects the recognition and impact that a patent has had in the technology market.

Breakthrough inventions. Following prior studies (Ahuja and Lampert, 2001), inventions were categorized as breakthrough inventions if they have a very strong influence on subsequent technological developments (Kelly et al., 2013; Phene et al., 2006). Thus, we measured this using a dummy variable that was set to 1 if a patent was in the top 5% in terms of forward citations till 2006 (Singh and Fleming, 2010) of all the patents applied for during the same year.

Ambidextrous inventions. To test the effect of team composition on the likelihood that a team will create an ambidextrous invention, we constructed a dummy variable, *ambidextrous invention*. It was assigned a value of 1 if the degree of exploration (which is explained below) ranged from 0.4 to 0.6. That is, an invention was considered as more ambidextrous when the number of repeated citations was closer to the number of new citations (Benner and Tushman, 2002). We also tried different ranges such as 0.35 to 0.65, and the results were similar.

4.3.2 Independent variables

Degree of exploration. We followed previous studies (Phelps, 2010; Katila and Ahuja, 2002) and used information on backward citation of patents to measure exploration by calculating the extent to which an invention includes new knowledge (Benner and Tushman, 2002). We first categorized the citations of a patent according to whether they were repeated or new. We analyzed all the backward citations for each patent applied for by each firm in each year, and checked whether that same citation had been used by the firm in previous applications during the past five years. If it had been cited, it was considered to a repeated citation. Otherwise, it was a new citation. For instance, for a citation in a patent applied for by firm i in 1992, we checked whether it had been cited by firm i between 1987 and 1991. We then divided the number of new backward citations by the number of total backward citations for each patent in order to determine the degree of exploration within each invention. Thus, the degree of exploration in an invention is a continuous variable, ranging from 0 to 1. An invention is more exploratory (hence less exploitative), when its value is closer to 1.

Such an operationalization assumes that all existing knowledge in an invention has no exploratory value, while all new knowledge has a full value of exploration. In order to validate our operationalization with the extreme value assignment of 0 and 1 to existing and new citations (Katila and Ahuja, 2002), we also submitted it to a sensitivity test, in which we assigned new citations a value of 0.9 (or 0.8), and repeated citations a value of 0.1 (or 0.2), and the results were robust.

Team size. We used *number of inventors* for each patent to measure the size of invention teams (Liu, 2014). The Harvard Patent Network (Lai et al., 2013) provides detailed information about inventors for each patent.

Invention experience. We first identified inventors for each patent, and we then counted the number of patents that each had applied for prior to the year of application for the focal patent. Invention experience was measured as the average number of patents that inventors had applied for before the focal patent (Singh and Fleming, 2010).

4.3.3 Control variables

Number of citations. We controlled for the *number of backward citations* of each patent, to reflect the amount of knowledge it was building upon, as this is suggested to influence an invention's value and the likelihood of it being a breakthrough (Kelly et al., 2013; Gruber et al., 2013).

Number of classes was included in all the models. When a patent spans a greater number of classes, it may attract more attention and have more impact in the market. Similarly, we also included *number of claims* (Singh and Fleming, 2010; Gruber et al., 2013), which reflects the scope and complexity of a patent.

Recency of knowledge was controlled for (Nerkar, 2003; Kelly et al., 2013) by calculating the average of patent number of all backward citations (Sorenson and Fleming, 2004). The larger the number, the more recent knowledge the focal patent was building on. That is because USPTO assigns the patent numbers sequentially. When a patent builds on more recent knowledge, it might open more technological potentials (Nerkar, 2003).

Value of backward knowledge. The value of an invention might also be influenced by the value of knowledge that it built on. Thus, we controlled for this possibility by measuring the average number of forward citations that a patent's backward citations received up to 2006.

We controlled for *firm sales* and *firm R&D* (Singh, 2008). Inventions by a larger firm or a more innovative firm might be more likely to attract attention (Podolny and Stuart, 1995). F*irm age* was controlled for because aging organizations tend to invest less in exploration (Sorenson and Stuart, 2000).

Firm status reflects the social position of a patenting firm in technological networks (Podolny and Stuart, 1995), which may help its patents be more widely diffused and received. It is measured as the Bonacich network centrality (Bonacich, 1987; Podolny, Stuart, and Hannan, 1996) in the citation network of those firms.

4.4 Analysis and Results

As the dependent variable for Hypothesis 4.1 is a count variable, representing the number of citations, we employed a negative binomial regression (Sorenson and Fleming, 2004; Fleming et al., 2007). Patents applied early on in our time frame are more likely to collect forward citations because they have existed for longer than more recent patents. Thus, to exclude the influence of year, we incorporated the fixed effect of application year within estimation (Singh, 2008). There may also be certain technology-level factors that we did not control for in the models, so we also clustered the data by USPTO technological class (Singh, 2008). For those hypotheses with dichotomous dependent variables, we used logit regression (Singh and Fleming, 2010). Descriptive statistics and correlations are provided in Table 4.1. The mean of ambidextrous invention is 0.10, which means that about 10% of all inventions are recognized as ambidextrous.

The regression results are shown in Tables 4.2, 4.3 and 4.4. Model 1 includes only control variables and provides the results of the baseline estimation, which confirms the findings of previous studies (e.g., Podolny and Stuart, 1995; Nerker, 2003). Hypothesis 4.1 is tested in Model 2 by including the variables that represent the degree of exploration. The linear and squared terms are significantly positive (β= 0.186, s.e.=0.091) at $p<0.1$ and negative (β= -0.211, s.e.=0.055) at $p<0.001$ respectively. Thus, Hypothesis 4.1, that the degree of exploration contributes to the value of an invention, with diminishing returns, is supported. More precisely, when the degree of exploration exceeds the turning point of 0.44, the value of an invention decreases. It means that, in order to achieve more value, inventions should combine existing and new knowledge, rather than focusing on one type or the other. In Model 3, we also used the dummy variable of ambidextrous inventions for estimation. The positive coefficient ((β= 0.049, s.e.=0.018) is significant at $p<0.01$. This further supports Hypothesis 4.1. As to effect size, ambidextrous inventions have 5% greater value than other inventions.

The testing of Hypothesis 4.2 on breakthrough inventions is shown in Table 4.3. The linear and squared terms of the degree of exploration in Model 5 are significantly positive (β=0.734, s.e.=0.314) at $p<0.05$ and negative (β= -0.805, s.e.=0.267) at $p<0.001$ respectively. Thus, the likelihood of an invention becoming a breakthrough is curvilinearly related to the degree of exploration within an invention, which supports Hypothesis 4.2. In particular, the turning point is 0.46, which means that an invention is most likely to be a breakthrough when 46% of the knowledge used is new knowledge. We also test Hypothesis 2 by using the dummy variable of ambidextrous invention in Model 6. The positive coefficient of 0.155 (s.e.=0.077) is significant at $p<0.05$ which further supports our arguments that ambidextrous inventions are more likely to become breakthroughs than inventions that are either over-exploratory or over-exploitative.

We tested the effect of team composition on ambidextrous inventions and reported results in Table 4.4. Model 7 provides the baseline results with only control variables. Hypothesis 4.3 is tested in Model 8 by adding team size. The linear term is positive (β=0.134, s.e.=0.030and significant at $p<0.001$, while the squared term is negative (β= -0.011, s.e.=0.005) and significant at $p<0.1$. Thus, Hypothesis 4.3 is supported. The turning point of 6 means that an invention team of 6 inventors would be most likely to generate ambidextrous inventions.

Hypothesis 4.4 is tested in Model 9. Both the linear (β= 0.006, s.e.=0.001) and square (β= -0.029, s.e.=0.006) terms are significant at $p<0.001$. Thus Hypothesis 4.4 is supported. Although the turning point of 103 is positioned well within our data range, it greatly exceeds the mean. That means that team experience only decreases the likelihood of the ambidexterity of inventions when it reaches the extreme. The findings are further confirmed by the full Model 10.

Table 4.1 Descriptive statistics and correlations

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Citations	11.6	17.6														
2 Degree of exploration	0.66	0.35	-0.01													
3 Ambidextrous inventions	0.10	0.31	0.02	-0.16												
4 Team size	2.19	1.39	0.05	-0.05	0.03											
5 Team experience	19.0	35.7	-0.03	-0.34	0.03	-0.03										
6 No. of backward citations	12.5	16.6	0.01	-0.30	0.02	0.08	0.11									
7 No. of claims	20.4	13.8	0.05	-0.05	0.03	0.03	0.07	0.11								
8 No. of tech class	1.77	0.80	0.07	0.01	0.01	0.03	0.00	0.02	0.02							
9 Value of citations	37.6	31.0	0.31	-0.31	0.06	0.06	0.07	0.18	0.04	0.03						
10 Recency of citations/10^5	54.2	3.89	-0.25	0.03	0.06	0.05	0.08	-0.04	0.10	-0.01	-0.14					
11 Firm age	16.7	10.3	-0.07	-0.07	0.03	-0.01	0.07	-0.03	0.02	-0.01	-0.05	0.10				
12 Firm status	4.62	5.54	0.05	-0.33	0.04	-0.08	0.25	0.18	0.17	0.02	0.13	-0.06	0.22			
13 Firm sales/10^4	1.16	2.63	-0.08	0.03	0.03	0.04	-0.05	-0.07	-0.05	0.03	-0.08	0.19	-0.06	-0.08		
14 Firm R&D/10^3	1.02	1.49	-0.13	0.05	0.03	0.05	-0.09	-0.09	-0.04	0.03	-0.11	0.30	0.14	-0.10	0.83	
15 Breakthrough inventions	0.05	0.22	0.064	-0.06	0.02	0.03	0.04	0.05	0.07	0.03	0.19	-0.00	-0.03	0.06	-0.02	-0.04

Significant at $p<0.01$ level, for all $|r|>0.02$.

Table 4.2 Negative binomial regression on forward citations

	Model 1	Model 2	Model 3
Constant	1.619***	1.637***	1.632***
	(0.233)	(0.230)	(0.021)
No. of backward citations	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)
No. of claims	0.008***	0.008***	0.008***
	(0.001)	(0.001)	(0.001)
No. of tech class	0.055*	0.054*	0.054*
	(0.025)	(0.025)	(0.025)
Value of backward citations	0.011***	0.011***	0.011***
	(0.002)	(0.002)	(0.002)
Recency of citations/10^5	0.021***	0.021***	0.020***
	(0.004)	(0.005)	(0.004)
Firm age	-0.002	-0.002	-0.002
	(0.002)	(0.002)	(0.002)
Firm status	0.004	0.004	0.004
	(0.004)	(0.004)	(0.004)
Firm sales/10^4	0.023**	0.022**	0.023**
	(0.009)	(0.008)	(0.008)
Firm R&D/10^3	-0.058***	-0.057***	-0.057***
	(0.011)	(0.010)	(0.011)
Degree of exploration		0.186*	
		(0.091)	
Degree of exploration -squared		-0.211***	
		(0.055)	
Ambidextrous inventions			0.049**
			(0.018)
Chi2	110,42	111,26	126,76
Log Likelihood	-119,414	-119,402	-119,409
Year Dummies	Yes	Yes	Yes
Clustered by technology class	Yes	Yes	Yes

*: p<0.1; **: p<0.01; ***: p<0.001

Table 4.3 Logit estimation on breakthrough inventions

	Model 4	Model 5	Model 6
Constant	-6.554***	-6.526***	-6.499***
	(0.791)	(0.834)	(0.804)
No. of backward citations	0.003*	0.003*	0.003*
	(0.002)	(0.002)	(0.002)
No. of claims	0.013***	0.012***	0.013***
	(0.001)	(0.001)	(0.001)
No. of tech class	0.146*	0.145*	0.146*
	(0.086)	(0.085)	(0.086)
Value of backward citations	0.015***	0.015***	0.015***
	(0.003)	(0.003)	(0.003)
Recency of citations/10^5	0.053**	0.053**	0.052**
	(0.017)	(0.019)	(0.017)
Firm age	-0.011*	-0.011*	-0.011*
	(0.006)	(0.007)	(0.006)
Firm status	0.038**	0.036**	0.038**
	(0.015)	(0.014)	(0.015)
Firm sales/10^4	0.073***	0.069***	0.072***
	(0.022)	(0.021)	(0.021)
Firm R&D/10^3	-0.205***	0.206***	-0.203***
	(0.036)	(0.035)	(0.036)
Degree of exploration		0.734*	
		(0.314)	
Degree of exploration -squared		-0.805**	
		(0.267)	
Ambidextrous inventions			0.155*
			(0.077)
Chi2	1,315	1,329	1,310
Log Likelihood	-6,588	-6,582	-6,586
Year Dummies	Yes	Yes	Yes
Clustered by technology class	Yes	Yes	Yes

p<0.05; **: p<0.01; ***: p<0.001

Table 4.4 Logit estimation on ambidextrous inventions

	Model 7	Model 8	Model 9	Model 10
Constant	-6.207***	-6.350***	-6.286***	-6.419***
	(0.460)	(0.455)	(0.464)	(0.603)
No. of backward	0.000	0.000	0.000	-0.000
citations	(0.001)	(0.001)	(0.001)	(0.001)
No. of claims	0.003*	0.003*	0.003*	0.003*
	(0.002)	(0.002)	(0.002)	(0.002)
No. of tech class	0.013	0.010	0.013	0.010
	(0.029)	(0.028)	(0.027)	(0.024)
Value of backward	0.006***	0.006***	0.006***	0.006***
citations	(0.001)	(0.001)	(0.001)	(0.001)
Recency of	0.057***	0.056***	0.058***	0.057***
citations/10^5	(0.010)	(0.010)	(0.010)	(0.012)
Firm age	0.009***	0.010***	0.009***	0.009***
	(0.002)	(0.002)	(0.002)	(0.004)
Firm status	0.020***	0.022***	0.017***	0.018***
	(0.005)	(0.005)	(0.006)	(0.006)
Firm sales/10^4	0.042	0.042	0034	0.035
	(0.036)	(0.034)	(0.036)	(0.027)
Firm R&D/10^3	-0033	-0.035	-0.000	-0.000
	(0.064)	(0.061)	(0.000)	(0.000)
Team size		0.134***		0.126***
		(0.030)		(0.037)
Team size squared		-0.011**		-0.010*
		(0.005)		(0.005)
Team experience			0.006***	0.006**
			(0.001)	(0.002)
Team experience			-0.029***	-0.028**
squared/10^3			(0.006)	(0.010)
Chi2	249.65	294.17	423.35	372.24
Log Likelihood	-11,974	-11,961	-11,957	--11,945
Year Dummies	Yes	Yes	Yes	Yes
Clustered by technology class	Yes	Yes	Yes	Yes

*: p<0.05; **: p<0.01; ***: p<0.001

4.4.1 *Post-hoc analysis*

The estimation results in Table 4.4 suggest that team size and experience significantly affect the team's likelihood of creating ambidextrous inventions. Although an invention is ambidextrous when it balances new and repeated knowledge (Benner and Tushman, 2002; Katila and Ahuja, 2002), non-ambidextrous inventions could be either over-exploratory or over-exploitative (Wang and Li, 2008). Thus, we distinguished between non-ambidextrous inventions that were exploratory (with more than 60 percent of new citations) and those that were exploitative (with less than 40 percent of new citations), and did a post-hoc analysis to see whether team composition has different effects on over-exploratory and over-exploitation inventions. We employed multinomial models, using ambidextrous inventions as the baseline group. Results are presented in Table 4.5.

The results show that team size decreases the log odds of being over-exploratory inventions (versus ambidextrous inventions), while it has no significant effect on the likelihood difference between over-exploitative and ambidextrous inventions (Model 14). It means that a larger team size reduces the risk of creating over-exploratory inventions, but has no significant impact on the likelihood of creating inventions with over-exploitation.

Team experience decreases the log odds of being exploratory inventions (versus ambidextrous inventions); and it increases the log odds of being exploitative (Model 16). It means that having a greater level of experience within the team may reduce the risk of creating over-exploratory inventions, but may increase the danger of over-exploitation.

Table 4.5 Multinomial logit estimation with a comparison group of ambidextrous inventions

VARIABLES	Model 11 Exploitation	Model 12 Exploration	Model 13 Exploitation	Model 14 Exploration	Model 15 Exploitation	Model 16 Exploration	Model 17 Exploitation	Model 18 Exploration
Constant	9.188***	3.789***	9.166***	3.845***	9.261***	3.748***	9.237***	3.803***
	(0.715)	(0.532)	(0.713)	(0.524)	(0.699)	(0.509)	(0.696)	(0.503)
No. of backward citations	0.010***	-0.018***	0.010***	-0.018***	0.010***	-0.017***	0.010***	-0.017***
	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)
No. of claims	-0.010***	0.003**	-0.011***	0.003**	-0.010***	0.003**	-0.010***	0.004*
	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
No. of tech class	-0.060**	0.026	-0.061**	0.030	-0.060**	0.030	-0.061**	0.033
	(0.027)	(0.033)	(0.027)	(0.033)	(0.028)	(0.030)	(0.028)	(0.030)
Value of backward citations	0.006***	-0.020***	0.006***	-0.019***	0.006***	-0.019***	0.006***	-0.019***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Recency of citations/10^5	-0.019***	0.005	-0.019***	0.007	-0.019***	0.058	-0.019***	0.076
	(0.001)	-0.009	(0.001)	(0.009)	(0.001)	(0.088)	(0.001)	(0.088)
Firm age	-0.002	-0.009	-0.002	-0.009	-0.003	-0.008	-0.003	-0.008
	(0.004)	(0.006)	(0.004)	(0.006)	(0.004)	(0.005)	(0.004)	(0.005)
Firm status	0.047***	-0.061***	0.047***	-0.063***	0.039***	-0.051***	0.039***	-0.054***

	(0.005)	(0.010)	(0.005)	(0.010)	(0.006)	(0.009)	(0.006)	(0.009)
Firm sales/10^4	0.002	-0.056*	0.002	-0.055*	-0.009	-0.036	-0.010	-0.036
	(0.017)	(0.038)	(0.017)	(0.032)	(0.017)	(0.0031)	(0.017)	(0.030)
Firm R&D/10^3	-0.070**	0.076	-0.072**	0.077	-0.033	0.020	-0.036	0.021
	(0.028)	(0.068)	(0.028)	(0.067)	(0.028)	(0.060)	(0.0028)	(0.059)
Team size			0.020	-0.076***			0.022	-0.078***
			(0.017)	(0.017)			(0.016)	(0.017)
Team experience					0.004***	-0.011***	0.004***	-0.011***
					(0.001)	(0.001)	(0.001)	(0.001)
Log Likelihood	2,039	2,039	-26,269	-26,269	-25,889	-25,889	-25,837	-25,837
Chi2	-26,320	-26,320	2,148	2,148	3,892	3,892	4,100	4,100
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustered by technological class	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	36,551	36,551	36,551	36,551	36,551	36,551	36,551	36,551

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4.5 Discussion

This study suggests that in order to provide better recommendations on what strategies firms should adopt, ambidexterity needs to be discussed at the level of inventions. Using patent data from the semiconductor industry, we find that ambidextrous inventions have a higher average value than inventions that heavily concentrate exploitation and exploration, and are more likely to offer breakthrough technologies. Thus, we conclude that firms should emphasize ambidexterity in each of their inventions if they want to perform better in technology markets. Our results also show that teams with a medium-level size and a medium-level experience are more likely to create ambidextrous inventions.

First, we highlight the importance of pursuing ambidexterity at the invention level. It is widely accepted that firms should balance exploration and exploitation (Katila and Ahuja, 2002; He and Wong, 2004; Jansen et al., 2006; Lavie et al., 2010), but the important question left unanswered is how that balance should be achieved. In general, there are two different ways: structurally differentiating the two types of inventions (Benner and Tushman, 2002; Jansen et al., 2009; Fang et al., 2011), and balancing exploration and exploitation within each invention. The findings of this paper suggest that the strategy of structural differentiation may not be the best approach because inventions with either over-exploration or over-exploitation are found to be less valuable than ambidextrous inventions. That is, although it is possible for a firm to realize ambidexterity at the firm level by assigning separate teams whose remit is either exploration or exploitation (Benner and Tushman, 2002; Jansen et al., 2009), the value of the individual inventions in the market may be low. Thus, to ensure the value of individual inventions, firms are advised to combine new and existing knowledge at the invention level.

Second, this study highlights the relationship between ambidextrous inventions and technological breakthroughs (Singh and Fleming, 2010). A technological breakthrough creates a new trajectory (Wu et al., 2014), which helps firms build a unique competitive advantage (Ahuja and Lampert, 2001). However, insufficient attention has been paid in the literature to how to combine internal and external knowledge in order to build breakthrough inventions (Phene et al., 2006; Kelley et al., 2013). This study shows that the introduction of new external knowledge is a necessary condition for making a breakthrough. Still, having too much new knowledge could be a liability and reduce the likelihood of a breakthrough.

Third, this study highlights the effect of team composition on the creation of ambidextrous inventions. Current studies on exploration and exploitation for the most part emphasize the role of top management teams (Beckman, 2006; Lubatkin et al., 2006), but pay limited attention to the composition of frontline teams. The analysis in this study not only confirms the relationship between team composition and invention ambidexterity, but also provides practical suggestions on how to compose a team to create ambidextrous inventions. That is, firms are advised to build invention teams with moderate size and experience, in order to generate ambidextrous inventions.

Fourth, this study also discusses when investment teams would tend to create inventions that are either over-exploratory or over-exploitative (Wang and Li, 2008), although neither type of invention is ambidextrous. Although team size and experience have positive effects on the likelihood of the team creating ambidextrous inventions, we find that they have different effects on the likelihood of creating over-exploratory and over-exploitative inventions. For instance, although invention experience may help teams reduce the risk of over-exploration in their inventions, experience at the same time increases the likelihood of creating over-exploitative inventions.

Finally, this study provides empirical foundations for future research on firm-level exploration and exploitation. Although in previous studies exploration has been widely considered to be the extent to which a firm introduces new knowledge into its innovations (Katila and Ahuja, 2002; Benner and Tushman, 2002; Phelps, 2010; Wang and Li, 2008), to our best knowledge there has been no direct empirical evidence of how introducing new knowledge affects the value of an invention, The findings of this paper confirm that analyzing whether inventions include existing internal knowledge and new external knowledge provides a useful way of evaluating firm-level exploration and exploitation (e.g. Benner and Tushman, 2002).

4.5.1 Limitations and directions for future research

Although we provide contributions to research on inventions and technological breakthroughs, our study is not without limitations. First, although we define the exploration of inventions in terms of the proportion of knowledge that did not previously exist within an organization, following the logic of previous studies (Benner and Tushman, 2002; Katila and Ahuja, 2002), we also recognize that exploration is multidimensional (Rosenkopf and McGrath, 2011). That is, an invention may explore in other domains, such as technological classes (Fleming, 2001). Thus, we see potential for future research to examine our hypotheses with other aspects of exploration of inventions, and investigate different mechanisms by which they add value.

Second, we propose that an ambidextrous invention has greater value in technology markets than either over-exploratory or over-exploitative inventions, but we do not discuss the synergy between inventions. Although the individual value of over-exploratory or over-exploitative inventions is lower, it is still possible for them to create larger benefits if there are synergies between them and they complement each other well. Thus, in order to validate the main proposition in this study that ambidextrous inventions are more valuable, future studies should consider synergy between inventions.

Third, this study also opens up opportunities for discussing the balance between exploration and exploitation. Although scholars mainly agree on the benefits of ambidexterity (Lavie et al., 2010; Jansen et al., 2006; He and Wong, 2004; Katila and Ahuja, 2002; March, 1991), recent studies have also challenged this notion by showing that balancing exploration and exploitation within the same domain might impede performance (Stettner and Lavie, 2014; Lavie et al., 2011), That is because the tension and conflicts between them may outweigh the benefits of the synergy. The findings in this paper that ambidextrous inventions outperform the other two types of invention suggest that the value of ambidexterity within one domain is still open to debate. Scholars may investigate the heterogeneity of contexts, which may account for the mixed findings.

Fourth, future studies may explore further other demographic aspects of invention teams (Taylor and Greve, 2006). For instance, this study only discusses experience of applying a patent; other types of experience such as invention experience in different technological classes (Singh and Fleming, 2010; Merelo and Palomeras, 2014) should also be discussed.

Fifth, it is also important to investigate how firm-level factors moderate the value of ambidextrous (as opposed to over-exploratory and over-exploitative) inventions in technology markets. In particular, are over-exploratory inventions by a prestigious firm more attractive to the market because of the signaling effect of prestige (Podolny and Stuart, 1995)? Or are they less favored and seen as less legitimate, because they do not match the firm's expertise (Zuckerman, 1999)?

Finally, we conducted our empirical tests within one industry, which undoubtedly brings issues of generalizability. The semiconductor industry is particularly dynamic, which makes exploration more essential (Jansen et al., 2006). However, in more static industries, exploration may exert a much weaker or even negligible effect on the value of inventions. Thus, it would be interesting to analyze how industry-specific features might moderate our findings in this study.

Chapter 5. Competition Closure: Interaction between Competition and Collaboration Network[7]

Abstract

While most network research focuses on inter-firm collaboration, we have largely ignored firms' competition relationships. This paper emphasizes that firms are embedded in both collaboration and competition networks simultaneously, and contends that the performance of a firm is determined by its position in both networks. In particular, we argue that competition closure may undermine performance because a firm is less able to develop unique capabilities and it makes the actions of competitors more unpredictable. Moreover, we posit that competition closure reduces the value of a firm's brokerage position in collaboration networks because it triggers information gathering among competitors. Finally, we argue that competition closure directs the attention of competitors away from a focal firm, which increases altercentric uncertainty and amplifies the value of its network status. We find empirical evidence for our hypotheses from the U.S. venture capital industry.

[7] This study is conducted in collaboration with Justin Jansen

5.1 Introduction

It has long been recognized by scholars that network positions play an important role in the performance and behaviors of firms (Brass, Galaskiewicz, Greve, and Tsai, 2004; Burt, 1992; Granovetter, 1985; Gulati, Lavie, and Madhavan, 2011; Kilduff and Brass, 2010; Podolny, 2005). Existing studies, for instance, have provided useful insights into how brokerage positions may help to build market share (Shipilov, 2006; Zaheer and Bell, 2005), engage in more innovation activities (Ahuja, 2000; Schilling and Phelps, 2007), and gain status (Shipilov and Li, 2008). Others have also shown how network status affects the formation of alliances (Ozmel, Reuer, and Gulati, 2013; Podolny, 1994), product cost and price (Benjamin and Podolny, 1999; Podolny, 1993), bargaining power (Castelluci and Ertug, 2010), and market entry (Jensen, 2003). However, these studies have focused almost exclusively on the structure of collaboration networks such as alliances between high-tech firms (Ahuja, 2000) and syndication in investments (Jensen, 2003; Podolny, 1994; Shipilov and Li, 2008), and have ignored the consequences of firms' embeddedness in competition networks. Although recent studies have started to investigate how competition may affect the strategic judgment and choices of firms (Hsieh and Vermeulen, 2013; Skilton and Bernardes, 2014; Tsai, Su, and Chen, 2011), the implications of competition networks for a firm's performance remain to be explored.

More importantly, although research on competitive dynamics implies that a competition relationship can allocate market information and strategic attention (Chen, 1996; Tsai et al., 2011), which may affect the outcomes of collaboration networks, little attention has been given to how the interplay of collaboration and competition networks shapes firm performance. Building on prior research on competitive dynamics (e.g. Chen, 1996) and network theory (Burt, 1992; Podolny, 2005), this study provides both theoretical development and empirical analysis of the performance implications of competition networks, and also how they interact with collaboration networks. However, instead of concentrating on the effect of dyadic-level mutual rivalry (Gimeno and Woo, 1996; Ingram and Yue, 2008), we argue that it is important to focus on a firm's position in the competition network as a whole (Yu and Cannella, 2013), because competitors do not affect the performance of a firm independently (Skilton and Bernardes, 2014). That is, we argue that the performance of a firm is in fact shaped by the overall pattern of direct and indirect ties between interdependent competitors.

First, in focusing on competition networks, we introduce the notion of competition closure, which – like network closure in collaboration (Coleman, 1988; Schilling and Phelps, 2007) – is defined as the extent to which the direct competitors of a focal firm are in competition with one another. A competition relationship exists between two firms when they operate in the same markets (Haveman and Nonnemaker, 2000; Hiseh and Vermeulen, 2013; Ingram and Yue, 2008). Thus, a firm that operates in a sparse competition network usually encounters different competitors across markets, while high competition closure means that a firm has the same set of competitors in multiple markets. We contend that competition closure undermines the performance of a firm for two reasons: it not only increases the unpredictability of competitors' actions, which then limits the firm's ability to navigate and control competitive environments (Baum and Wally, 2003; Tsai et al., 2011), but it also undermines the uniqueness of capabilities that it may develop in different markets, thus eroding its competitive advantage (Barney, 1991).

Second, we emphasize that competition closure shapes the outcomes of collaboration networks. Although scholars have long suggested that the value of social capital is contingent upon competitive conditions (Burt, 1997), very few studies have looked at the interplay between competition and collaboration networks. Rather, there has been an implicit assumption that that collaboration networks are the dominant determinants of information exchange between firms (Uzzi, 1996). Network theorists share the basic assumption that collaboration between firms acts as a pipe for the transfer of information and knowledge (Burt, 1992; Inkpen and Tsang, 2005; Mowery, Oxley, and Silverman, 1996; Shipilov, 2006; Uzzi, 1996). However, firms may also gather market information and competitive intelligence by analyzing competitors within competition networks (Chen, 1996; Ghoshal and Westney, 1991; Porter, 1980; Tsai et al., 2011; Zajac and Bazerman, 1991). We argue therefore that rivalry in competition networks also shapes the distribution of market information among firms (Tsai et al., 2011) and may reduce the benefits to be derived from structural holes in collaboration networks. At the same time, a firm's position in collaboration networks also acts as a prism (Podolny, 2001) that signals actors' quality that is hard to observe (Podolny, 1993). Although network status may bring various advantages to the firm in factor and product markets by signaling a certain level of quality (Benjamin and Podolny, 1999; Malter, 2014; Rider and Tan, 2015), we argue that the value of status in collaboration networks is contingent upon competition networks as well. It has been recognized that market actors tend to rely on status for decisions only when there is uncertainty about the quality of particular firms (Dimov and Milanov, 2010; Podolny, 2001), but they have focused mostly on the uncertainty derived from market conditions (Collet and Philippe, 2014; Podolny, 1994) and ignored the uncertainty that may come from conditions that vary across firms' competitive networks. We employ the attention-based view (Ocasio, 1997), and argue that competition closure may alter the amount of attention that market actors pay to a firm, thus affecting the degree of altercentric uncertainty for the firm (the uncertainty that others face when evaluating the quality of a firm) and the value of its network status.

We tested our hypotheses with data on the venture capital (VC) firms in the U.S. This setting is particularly suitable because syndication plays an essential role for both the behavior (Dimov and Milanov, 2010; Guler and Guillén, 2010; Podonly, 2001; Sorenson and Stuart, 2008) and performance (Hochberg, Ljungqvist, and Lu, 2007) of VC firms. Moreover, multi-market competition between VC firms for investment opportunities and fundraising may also affect the quality of VCs' investments and hence their performance (Gompers and Lerner, 2001; Hochberg et al., 2007). Thus, both competition and collaboration network structures affect the performance of VC firms.

5.2 Literature Review and Hypotheses

5.2.1 Collaboration networks: structural holes and network status

Scholars have widely assumed that firms may collaborate in order to acquire complementary resources (Gulati, 1995; Mowery, Oxley, and Silverman, 1998), to spread uncertainty and risk (Dimov and Milanov, 2010; Podolny, 1994), or to benefit from status leakage from high-status partners (Podolny and Phillips, 1996; Stuart, Hoang, and Hybels, 1999). Collectively, such inter-firm ties form a collaboration network, within which each individual firm occupies a distinct structural position. Firm performance (Ahuja, 2000; Shipilov, 2006) and behavior (Guler and Guillén, 2010; Jensen, 2003; Shipilov, Li, and Greve, 2011) are found to be largely determined by the firm's network positions (Brass et al. 2004; Gulati et al., 2011; Kilduff and Brass, 2010), because inter-firm collaboration not only acts as a conduit for transferring valuable information (Burt, 1992; Inkpen and Tsang, 2005; Uzzi, 1996), but also signals the quality of focal firms (Podolny, 2001). Network scholars have been focusing on structural holes (Burt, 1992) when analyzing the role of networks in information-sharing, and on network status when investigating the signaling role of networks (Podolny, 2005).

Firms have structural holes in their collaboration network when they are connected to other firms that are not directly connected (Burt, 1992; Jensen, 2008). Structural holes may improve organizational outcomes because they provide benefits in terms of information and control (Burt, 1997). When a firm has structural holes in its collaboration network, the information and knowledge of its partners are less likely to overlap because there is no direct linkage between the partners (Mowery et al., 1996). In addition, structural holes may also enable firms to control the exchange of information within collaboration networks, and collect scarcity rents from them. In that sense, a firm with structural holes could act as a broker and play off its unconnected partners (Zaheer and Soda, 2009). Extensive evidence of the effect of structural holes has been found in various contexts such as high-tech industries (Ahuja, 2000; Schilling and Phelps, 2007) and investment banking markets (Jensen, 2008; Shipilov, 2006; Shipilov and Li, 2008).

Network status refers to a firm's vertical position in a particular hierarchical system (Jensen, Kim, Kim, 2011; Jensen and Roy, 2008), and is usually operationalized as the centrality of a firm's position in the collaboration network (Bonacich, 1987; Hallen, 2008; Ozmel et al., 2013; Podolny, 1993). Status provides an indicator of quality (Piazza and Castellucci, 2014; Podolny, 2005) and affects whether firms have opportunities to make transactions and exchanges, and if so, when and to what extent (Stuart, 1998). When market actors face a high degree of uncertainty (Podolny, 2001) and have difficulty assessing and judging a firm's qualities, they tend to refer to the status of a firm to help them reach their decision. Existing research has provided many insights into the value of network status in both product markets (Malter, 2014; Benjamin and Podolny, 1999; Podolny, 1993; Podolny et al., 1996) and labor markets (Bidwell et al., 2015; Rider and Tan, 2015).

5.2.2 Collaboration networks: boundary conditions

Despite the inherent benefits that firms may derive from their status in collaboration networks and from the structural holes in those networks, some important boundary conditions have been identified. For instance, Podolny and Baron (1997) focus on network context and found that, although a brokerage position may facilitate job mobility for individuals in task-advice networks, it has a negative effect on mobility in buy-in networks. Shipilov (2006) further emphasizes the contingency role of specification in understanding the value of structural holes because firms can only exploit their brokerage advantage when they have either a broad or a deep understanding of their partners' businesses.

Scholars have also argued that the effect of status is shaped by altercentric uncertainty (Podolny, 2001). Only when people are uncertain about whether they can accurately evaluate the quality of a particular firm will they refer to its status for their decision. For instance, Podolny (1994) shows that when altercentric uncertainty in markets increases, leading investors tend to select partners on the basis of their status, choosing those whose status is very similar to their own. Furthermore, Collet and Philippe (2014) make a distinction between upward and downward market uncertainty, and argued that the effect of status intensifies in downward markets compared to upward markets. However, focusing on market-derived uncertainty assumes that all firms in the same markets face similar levels of altercentric uncertainty. In fact, such uncertainty will usually be more firm-specific, and will vary considerably from firm to firm (Stuart, 2000; Stuart et al., 1999).

Building on this contingency perspective, we argue that competition networks shape the value of collaboration network resources (i.e., structural holes and network status) because they impact the way in which focal firms may be able to leverage informational and signaling benefits from their collaboration networks. Because of this, we suggest that the interplay between competition and collaboration networks needs to be taken into account. For instance, emphasizing the effect of competition on collaboration networks, Burt (1997) has shown that the information and control benefits of bridging structural holes are especially valuable to managers with fewer immediate competitors. However, our understanding of the implications of competition networks in general, and of their role in explaining the outcomes of collaboration networks in particular, remains far from complete.

5.2.3 The role of competition networks

While economists focus on industry attributes such as entry barriers and bargaining power when investigating competition (Porter, 1985), management scholars have investigated how the features of organizational resources may lead to advantages over competitors (Barney, 1991; Lavie, 2006). Research into competitive dynamics and inter-firm rivalry (Baum and Korn, 1999; Chen, 1996; Gimeno and Woo, 1996; Yu and Cannella, 2013) in particular, has claimed that competitive relationships can exist at the dyadic level when a pair of firms seek out limited resources or target similar markets (Chen and Miller, 2012; Gimeno, 2004). That is, a firm may experience varied competitive pressures from different competitors in the same industry (Barnett, 1997), because the level of competition or rivalry may be determined by the extent to which they operate in the same markets (Baum and Korn, 1996; Chen, 1996; Ingram and Yue, 2008). Mutual competition drives firms to pay more attention to each other and to collect relevant market information about each other's activities. This may include information such as pricing strategies (Chen, 1996), new product development, and new market entries (MacMillan, McCaffery, and Van Wijk, 1985; Greve and Taylor, 2000; Hsieh and Vermeulen, 2013; Skilton and Bernardes, 2014).

Consistent with previous studies (Haveman and Nonnomaker, 2000; Hsieh and Vermeulen, 2013; Ingram and Yue, 2008; Skilton and Bernades, 2014), we consider rivalry or competition between two firms to be present when they operate in the same market. This type of rivalry between firms at the dyadic level collectively forms the competition network (Hsieh and Vermeulen, 2013; Tsai et al., 2011) that characterizes the overall competition structure within markets. The position of a firm in the competition network may not only determine the overall intensity of competition that it faces, but may also affect what information it gathers in markets and how much attention it receives from other market actors. We argue that such roles of competition networks may determine the performance of firms, in both direct and indirect ways. However, there is very little research in the competition and network literature that systematically explores how different positions in competition networks may affect the performance of firms.

5.2.4 Competition closure and performance

We argue that competition closure may undermine the performance of firms for two main reasons.

First, a firm obtains competitive advantage when it is able to build and apply unique capabilities that are difficult for its competitors to imitate (Barney, 1991). However, competition closure may make those capabilities less unique. Scholars have argued that the extent to which firms compete may explain how organizations develop their capabilities (Greve and Taylor, 2000; Huygens et al., 2001). A firm may acquire certain capabilities through learning from and imitating its competitors in a particular market. For instance, when competitors successfully introduce new and effective organizational practices, a firm could imitate or adopt those practices (Burns and Wholey, 1993; Garcia-Pont and Nohria, 2000), or it may choose to implement an improved version. When competitors introduce innovative products, a firm is usually forced to upgrade its innovation capabilities in order to catch up (Greve and Taylor, 2000; Pouder and John, 1996). During this process, the firm could acquire capabilities by competing with particular competitors in a market. Those capabilities could be transferred and applied to compete with other competitors in other markets (Kostova, 1999), and may contribute to the competitive advantage of the firm if the capabilities are unique and are not easily acquired by competitors in those markets (Barney, 1991).

However, we argue that such capabilities are less likely to be unique when competition closure is high. High competition closure means that there is intense competition among the direct competitors of a focal firm. Heightened competition between direct competitors may also drive them to learn from each other (Greve and Taylor, 2000; Pouder and John, 1996), so that the particular capabilities become more widely shared among firms in the market. A firm is unlikely to be able to obtain a competitive advantage if capabilities that were once unique are shared more widely by its various market competitors (Barney, 1991). As shown in Figure 5.1a, firm A competes with firms B, C, and D, who are also competing with one another. Where there is high competition closure of this kind, although firm A may acquire a certain capability through its competition with firm B and apply it to the competition with firms C and D in another market, the capability is less likely to be unique in that market because firms C and D may also develop similar capabilities through competing with (and learning from) firm B. Thus, it is less possible for a firm to build competitive advantage when it faces high competition closure. Conversely, when there is a lower level of competitive closure in which a firm's direct competitors do not compete intensely, the firm is more likely to build unique capabilities. The capabilities that it develops through competing with particular competitors in one market (e.g. U.S,) are usually not possessed by competitors in other markets (e.g. China) because they have no direct contact with those competitors in the first market. Thus, a firm may utilize such capabilities to gain a competitive advantage over competitors in other markets (e.g. China) where those capabilities are not widely or evenly distributed. Thus, firms with low competition closure are more likely to outperform competitors because of the distinct capabilities they have developed through competing with different competitors in different markets. As shown in Figure 5.1b, firm A faces low competition closure such that its competitors have no contact with each other. The capabilities that firm A acquires through competing with firm B could be transferred and applied to its competition with firms C and D. Firms C and D are less likely to obtain the same capabilities because, without direct contact with firm B, they are less likely to learn from or imitate it. Similarly, in order to compete with firm B, firm A may also apply the capabilities that it acquires by imitating firms C and D. Thus, firm A is more likely to perform best because it can apply capabilities which are not evenly distributed across markets and competitors (Barney, 1991).

Second, a firm's performance also depends on the extent to what it is able to navigate and control competitive environments (Keats and Hitt, 1988; Tsai et al., 2011). Competition closure may increase the uncertainty and complexity of competitive environments by making the actions of competitors more unpredictable. Firms' actions are largely shaped by the moves of their competitors (Chen, 1996; Chen and MacMillan, 1992; Gimeno, 2004; Hsieh and Vermeulen, 2013). For instance, firms may form alliances as a response to alliance formation by their competitors (Gimeno, 2004). When the competitors of a firm are not competing with one another (low competition closure), their actions are less difficult to predict because those competitors only refer to the actions (for example, alliance formation) of the firm. When a firm faces increased competition closure in that its direct competitors have more mutual contact, their actions become more complex to predict because they will also be affected by those of the other firms. In Figure 5.1a, firm B may pursue strategic actions in response to competitive moves by firms A, C, and D, which makes it quite difficult for firm A to foresee. This type of high competition closure may increase market uncertainty and transaction costs (Dess and Beard, 1984; Tsai et al., 2011) and makes the competitive environment more difficult for the firm to anticipate. In this more difficult competitive environment, acquiring a competitive advantage may present more problems for a firm (Baum and Wally, 2003; Keats and Hitt, 1988; Tsai et al., 2011), firms with high competition closure are hence likely to perform less well. Altogether, we argue that,

Hypothesis 5.1: Competition closure is negatively related to firm performance.

Figure 5.1 High versus low competition closure

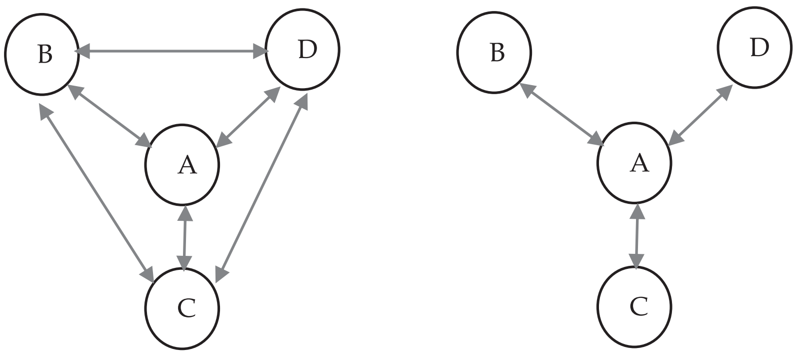


Figure 5. 1a. High closure **Figure 5.1b. Low closure**

5.2.5 Competition closure and structural holes

Scholars have consistently argued that brokerage positions may contribute to the performance of firms (Shipilov and Li, 2008; Shipilov, 2006) because they provide firms with useful and irredundant information (Burt, 2008; Reagans and Zuckerman, 2008) and the opportunity to generate scarcity rents from unconnected partners (Zaheer and Soda, 2009). However, information may not only be accumulated through inter-firm relationships, a high degree of inter-firm rivalry may also lead firms to gather information about their competitors (Baum and Korn, 1999; Chen, 1996; Skilton and Bernardes, 2014; Tsai et al., 2011). Because most firms are embedded in both competition and collaboration networks, we argue that it is important to consider the interplay between them in order to better understand the effect of structural holes in collaboration networks.

First, competition closure enhances mutual information gathering among competitors and reduces the extent to which firms may benefit from information advantages derived from structural holes in collaboration networks. When firms compete, they tend to pay attention to one another (Chen, 1996; Haveman and Nonnemaker, 2000; Porter, 1980; Tsai et al., 2011) by collecting and analyzing competitive intelligence relating to their direct competitors. For instance, a firm is more likely to sense emerging opportunities when its competitors enter new markets (Haveman and Nonnemaker, 2000; Skilton and Bernerdes, 2014) or introduce new products (Greve and Taylor, 2000; Hsieh and Vermeulen, 2013). Market information becomes more transparent and widely held by market actors (Li, Poppo, and Zhou. 2008). Mutual competition may also drive direct competitors to act in similar ways (Korn and Baum, 1999; Skilton and Bernerdes, 2014), makes the information in inter-firm networks overlap and become redundant, and reduces the variety of information that a firm is exposed to (Burt, 1992; 1997). Although structural holes in collaboration networks may present a firm with a brokerage position and give it an information advantage in collaboration networks (Burt, 1992; 1997), the impact of these advantages in terms of enhancing firm performance is weakened when the firm faces high competition closure and direct competitors who are also competing with each other.

Second, competition closure may also intensify potential opportunistic behavior by its competitors. As stated above, competition closure increases the unpredictability of competitors' actions and the uncertainty of competitive environments. Even with information advantages from its collaboration networks, a firm that faces competition closure is less likely to reap the associated benefits (Baum and Wally, 2003; Dess and Beard, 1984). The firm may become more concerned about the potential opportunism of market actors, and this may lead it to act in a more cautious and conservative way (Gulati, 1995; Podolny, 1994). Under such conditions, the relationship between structural holes and the performance of a firm is weakened because the firm will be less willing to leverage information and control benefits. That is, when experiencing a higher level of competition closure, the firm may be reluctant to take full advantage of the information it has collected through collaboration networks, and this consequently undermines the potential value of structural holes.

In sum, we argue that competition closure increases information exchange, similarity of knowledge, and potential opportunism by competitors, which further reduces the value of structural holes in collaboration networks for firm performance.

Hypothesis 5.2: Competition closure and structural holes interact in such way that the positive effect of structural holes on firm performance becomes weaker when the firm faces greater competition closure.

5.2.6 Competition closure and network status

Although we argued that high-status firms perform better because of inherent advantages (Podolny et al., 1996), the underlying assumption is that market actors are uncertain about the quality and competences of a firm (Malter, 2014; Podolny, 1994). Thus, the value of status in collaboration networks is contingent upon the uncertainty that other market actors face when judging firms (Podolny, 2001; Simcoe and Waguespack, 2011; Stuart et al., 1999). We argue that competition closure may increase the uncertainty that competitors face when assessing a firm, and that it will therefore help that firm to leverage the benefits of having a high status in collaboration networks, and to improve performance.

Inter-firm competition shapes the uncertainty felt by others about the focal firm. It also affects the amount of attention that firms pay to their counterparts (Ocasio, 1997; Tsai et al., 2011). When competition closure of a firm is low, the direct competitors may devote most of their attention (Ocasio, 1997) to that firm, so that they gather more competitor intelligence about its activities (Chen, 1996; Haveman and Nonnemaker, 2000). Those competitors may thus have more accurate market information about the firm (Tsai et al., 2011). If so, they face less information asymmetry and uncertainty in evaluating that firm, and hence rely less on the firm's status in making their judgment and decisions, which consequently reduces the value of status for the firm (Podolny, 2005).

In contrast, when competition closure increases, there are more rivalries between the firm's direct competitors. Those competitors start to conduct mutual competition analysis, so that they have to pay more attention to each another (Hansen and Hass, 2008; Ocasio, 2011), and hence pay less attention to the firm. Their information on the firm will thus be reduced. For instance, because they are giving less attention to the firm, competitors may not notice when the firm enters a new market or develops a new product (Haveman and Nonnemaker, 2000; Hsieh and Vermeulen, 2013; Skilton and Bernerdes, 2014). If so, the information asymmetry and altercentric uncertainty that competitors face when evaluating that firm will increase, and they will then be more likely to use the firm's status as an indicator of quality when making their decisions. Thus, when competition closure is high, status exerts a stronger effect such that high-status firms will have more opportunities to exploit promising business opportunities (Jensen, 2003; Ozmel et al., 2013), acquire better resources at a lower cost (Podolny, 1993l; Rider and Tan, 2015), and consequently outperform other firms (Podolny et al., 1996). In sum, we argue that competition closure may strengthen the value of network status for a firm's performance because it reduces the attention paid to the firm by competitors, which then increases the altercentric uncertainty surrounding that firm.

Hypothesis 5.3: Competition closure interacts with network status in such way that the positive effect of network status on a firm's performance becomes stronger when the firm faces greater competition closure.

5.3 Methods

We tested our hypotheses using data from VC firms in the U.S. between 1997 and 2014. VC firms often collaborate in syndication, where several VC firms co-invest in a same target company (Lerner, 1994). The primary reason behind syndication is to diversify the high risk of venture capital investments and to leverage skills and expertise of investors (Brander, Amit, and Antweiler, 2002; Sorenson and Stuart, 2008). Various studies have documented how the network structure of VC industry shapes the business activities and performance of VC firms (Dimov and Milanov, 2010; Guler and Guillén, 2010; Podolny, 2001; Sorenson and Stuart, 2001). Importantly, competition is also very intensive (Hochberg et al., 2007) because VC firms compete with one another in terms of both fundraising (Gompers and Lerner, 1999) and chasing promising deals. Although competition and collaboration among VC firms are usually local, VC firms also frequently invest in target firms that are outside their geographic regions and domain specializations (Guler and Guillén, 2010; Kogut, Urso, and Walker, 2007; Sorenson and Stuart, 2008). Thus, VC firms compete in multiple markets, which provides an excellent context in which to assess multi-market contacts and competition networks (Baum and Korn, 1999; Gimeno and Woo, 1999).

We acquired information about VC investments from ThomsonOne's private equity database (formerly VentureXpert). This private database includes extensive information about VC investments, especially those taking place in the U.S. Although all types of investors (such as corporate venture capital, business angels, and bank-affiliated investors) are included, we followed earlier research and restricted our data collection to private VC firms (Sorenson and Stuart, 2008), because the other types of investors may have different goals and subsequent behaviors. VC firms which only make periodic investments are also excluded because their identity may not be meaningfully confined to the venture capital community (Podolny, 2001). Thus, we used conservative selection thresholds under which a VC firm was included in the dataset when it had made at least three investments in a particular year t.

5.3.1 Dependent variables

We used two variables to construct VC firm performance: market share and investment performance. First, we used market share at year t+1 as an indicator of market performance (Shipilov, 2006; Zaheer and Bell, 2005). We treated each investment deal done by a firm as one share of the market, and calculated the total market volume as the number of deals completed by the firm during that time period. Thus, we calculated the market share for VC firm i at time t+1 by dividing the number of firm i's investment deals by the total market volume. With this operationalization, we assumed that if collaboration and competition networks do indeed have an effect on VC markets, they should affect the investment opportunities for VC firms, which would then be reflected in their market share (Shipilov, 2006). We did not use the capital value share of VC firms because deal value and amounts are often undisclosed.

We also used successful exits of VC firms' portfolio companies as an indicator of the VC firms' investment performance. Thus, a VC firm was treated as a high-performer if its portfolio companies had successfully conducted an initial public offering (IPO) during that time period (Corwin and Schultz, 2005; Gulati and Higgins, 2003; Stuart et al., 1999). We built a dichotomous variable, IPO, which equals to 1 if firm i had portfolio companies that had conducted an IPO at time t+1, and 0, otherwise. By so doing, we assumed that the information advantage and signaling effect of VC firms' network positions should make it more likely that portfolio firms might conduct an IPO (Gulati and Higgins, 2003). We treated IPO as a successful exit because IPOs generate approximately four times greater returns on average (Guler, 2007; Pollock et al., 2015) than private sales to other companies—the other form of successful VC exit from an investment. We used a dichotomous variable, rather than the actual number of IPOs, because a counting variable in this setting would be largely zero-inflated.

5.3.2 Explanatory variables

Structural holes. Based upon the syndication among VC firms, we constructed the collaboration network in each year t. That is, for each year, the cell connecting i and j contains the number of investments that VC firms co-invested in during that particular year. To construct the measure for structural holes, we used a two-step approach. First, we used the indicator of constraint defined by Burt (1992) to capture the extent of connectedness among a focal firm's partners. Second, to arrive at a measure of structural holes, we then subtracted the constraint from 1. Larger values indicate greater non-redundancy or more structural holes in the collaboration network.

Network status. Following previous studies (Podolny, 2001; Hallen, 2008; Shipilov and Li, 2008; Ozmel et al., 2013), we used Bonacich's equation (Bonacich, 1987) to measure the network status. The measurement formula is:

$$S(\alpha, \beta) = \alpha \sum_{k=0}^{\infty} \beta^k R^{k+1} I$$

where α is a scaling factor that normalizes the measure, β is the weighting factor reflecting how much a firm's status depends on the status of its connecting firms, R is the matrix for collaboration network, and I is a column vector of ones. We used the standard formula in UCINET 6 to measure status, which assigned β with the value of 0.995 of the reciprocal of R's largest eigenvalue (β has to be less than the reciprocal of the largest eigenvalue, otherwise, the formula above is not convergent) (Bothner, Smith, and White, 2010). We normalized the measure to the range between 0 and 1 in order to make them comparable (Dimov and Milanov, 2010; Jensen, 2008).

Competition closure. Competition networks are measured from the networks of inter-firm rivalry (Skilton and Bernardes, 2014; Tsai et al., 2011). We firstly constructed competition networks, within which the cell connecting i and j contains an index that defines firm i's direct market engagement with firm j (Chen, 1996) in year t:

$$Z_{ijt} = \sum_{k=1}^{n} \left(\frac{P_{jkt}}{P_{jt}}\right) * \left(\frac{P_{ikt}}{P_{kt}}\right)$$

Where P_{ikt} refers to the number of deals invested by firm i in market k at year t; P_{jkt} refers to the number of deals invested by firm j in market k at t; P_{jt} is the total deals invested by firm j at t; and P_{kt} is the total number of deals in market k. Z_{ijt} is determined by two factors: the strategic importance of market k for firm j, and the market power of firm i on market k, at time t. Z_{ijt} becomes greater when firm i is a powerful VC firm in the markets that are essential for j (Tsai et al., 2011). We focused on firms' competition contacts in geographic markets (Hsieh and Vermeulen, 2013; Haveman and Nonnemaker, 2000), and categorized the VC firms' markets (k) in terms of US geographic states. That is, a competition relationship existed between two firms in a market if they both had investment deals in that state (k) at year t. Based on the network filled with Z_{ijt}, we then measured competition closure as the network constraint as defined by Burt (1992), which reflects the extent to which the direct competitors of a focal firm are also competing with one another.

5.3.3 Control variables

To account for other factors that may affect VC firm performance, we controlled for a set of variables that include both firm and industry features. Because VC firms may learn from their previous experiences, we controlled for the number of deals made by a VC firm in year t, which reflects the firm's past experience of investments. Controlling for past experiences also helps to disentangle the effects of the network from the volume of activities in which a VC firm has undertaken (Podolny, 2001).

Successful experience of a firm was captured as the number of IPOs that each VC firm had had in its portfolio from 1985 up to year t. Past success appears to be important for VC firms' future performance. However, firms with more past success may also be more and complacent (Bothner et al., 2012) and are more likely to underperform.

As Shipilov (2006) indicated, the level of specialization may affect the amount of profit that a firm is able to reap from the information advantage it derives from its brokerage. As such, we controlled for specialization as the Herfindahl index of firm i's industry concentration at t:

$$\text{Specialization(it)} = \sum_{c=1}^{n} \left(\frac{N_{ict}}{N_{it}}\right)$$

Where N_{ict} refers to the number of deals invested in by firm i in industry c at year t; N_{it} refers to the number of all deals invested in by firm i at t; and c is the one-digit industry code assigned by ThomsonOne.

Egocentric uncertainty. We controlled for a firm's acceptance of egocentric uncertainty, the uncertainty that the firm faces about the prospects of investments (Podolny, 2001), by the financing rounds at year t (Podolny, 2001; Sorenson and Stuart, 2008). VC investments are staged (Gompers and Lerner, 2001; Sahlman, 1990), and the uncertainty and risk involved in the investment decrease with each round of financing. As portfolio companies grow, they start to produce viable products or even to become profitable. It becomes less risky for VC firms to finance those companies. We calculated the proportion of investments in the first round made by each firm i in year t.

We also controlled for industry heat, because VC firms focusing on 'hot' industries may face more and better investment opportunities (Sorenson and Stuart, 2008). We firstly identified the industry focus for each VC firm in each year, defining this as the industry (identified by a one-digit SIC code) that a VC firm had invested in most during year t. Industry heat then is measured as the proportion of venture-based firms that went public in that industry.

Market size is also controlled for. The market for VC fluctuates largely over time (Gompers and Lerner, 2001). As market size increases, the overall competitive pressure in the market is lessened, giving VC firms more space and flexibility to make investments. We capture market size as the total number of deals in total at time t.

We also controlled for the age of the VC firm in order to account for differences in firms' propensity to increase performance and take risks (Guler and Guillén, 2010), and used year dummies to control for the effect of time variances.

5.4 Analysis and Results

We employed GLS regressions to estimate the market share of VC firms, because pooling repeated observations for the same VC firms is likely to violate the assumption behind OLS estimation that observations in sample are independent and to result in autocorrelation issues. A fixed–effect estimation was used for the following reasons. First, it eliminates all between-firm variation so that the coefficients reflect within-firm effects of the competition and collaboration network on the performance of focal firms (Bothner et al., 2010). That is, the absorption of between-firm variance gives us confidence that the changes in the value of independent variables at year t are temporally followed by a change in the dependent variable at t+1 (Podolny, 2001). Second, it is not necessary for fixed effects to make strict assumptions about the distribution of firm-specific effects within the population, because the standard random effects assume that firm-specific effects are normally distributed in the population (Podolny et al., 1996). However, fixed-effect estimation automatically leaves out the time-invariant variables, such as firms' location, which might also influence firms' performance (Gompers and Lerner, 2001). Thus, to account for variances in firms' geographic locations, we clustered the standard error by the states in which their headquarters are based (non-US VC firms are all clustered within one group). In a robustness test, we estimated with random-effect settings (Shipilov, 2006), which allows us to include those time-invariant variables, and we found quite a similar pattern of results to those reported with fixed-effect settings. Because our second dependent variable, IPO, is dichotomous, we employed probit regressions for our panel data (Corwin and Schultz, 2005) in order to estimate the likelihood of VC firms having companies within their portfolio that would issue an IPO. A logit regression was also conducted to validate main results.

Descriptive statistics and correlations are presented in Table 1 for all variables except year dummies. As Table 1 shows, the positions of firms in collaboration and competition networks do not exhibit the same patterns, because structural holes and competition closure are not highly correlated.

Table 5.1 Descriptive statistics and correlations

	Mean	S.D	1	2	3	4	5	6	7	8	9	10	11
1. Market share/10^{-4}	16.28	19.9											
2. Competition closure	0.02	0.30	–0.14										
3. Egocentric uncertainty	0.23	0.22	0.00	0.09									
4. Structural holes	0.61	0.27	0.41	–0.31	–0.24								
5. Network status	0.06	0.11	0.71	–0.17	–0.10	0.41							
6. Industry heat	0.31	0.14	0.08	–0.05	0.07	0.08	0.06						
7. Specialization	0.47	0.22	–0.16	0.04	–0.04	–0.16	–0.14	0.12					
8. Successful experiences	4.26	10.39	0.49	–0.14	–0.13	0.29	0.04	0.05	–0.09				
9. Past experiences	12.58	14.49	0.79	–0.19	–0.05	0.48	0.76	0.12	–0.23	0.55			
10. Market size/10^{3}	7.82	2.62	–0.17	–0.16	0.08	0.09	–0.05	0.11	–0.17	0.00	0.10		
11. Firm age	11.53	10.59	0.29	–0.07	–0.17	0.18	0.27	0.03	–0.09	0.48	0.31	–0.09	
12. IPO	0.12	0.32	0.29	–0.07	–0.00	0.18	0.28	0.06	–0.15	0.12	0.27	–0.09	0.11

n=8,574; $p<0.01$ if $|r|>0.04$

Table 5.2 Fixed-effect GLS models of venture capital firms' market share

VARIABLES	Raw Model 1	Raw Model 2	Raw Model 3	Raw Model 4	Raw Model 5	Orthog Model 6	Orthog Model 7
Competition closure × network status				7.10*	7.56*	1.92*	2.04*
				(4.21)	(4.27)	(1.14)	(1.16)
Competition closure × structural holes			–0.35***		–0.52**		–0.52**
			(0.13)		(0.22)		(0.22)
Competition closure		–0.50***	–1.00***	3.31	2.82	–0.77***	–1.50***
		(0.17)	(0.32)	(2.15)	(1.92)	(0.19)	(0.39)
Structural holes	1.09***	1.02***	1.02***	0.81***	0.79***	0.81***	0.80***
	(0.24)	(0.23)	(0.21)	(0.15)	(0.15)	(0.15)	(0.15)
Network status	3.10***	3.10***	3.09***	6.24***	6.44***	3.82***	3.86***
	(0.49)	(0.49)	(0.49)	(1.84)	(1.86)	(0.62)	(0.62)
Egocentric uncertainty	1.99***	1.99***	1.99***	2.06***	2.06***	2.06***	2.06***
	(0.26)	(0.26)	(0.25)	(0.29)	(0.29)	(0.29)	(0.29)
Industry heat	2.26**	2.23**	2.22**	2.49**	2.49**	2.49**	2.49**
	(0.98)	(0.97)	(0.97)	(0.97)	(0.96)	(0.97)	(0.97)
Specialization	–1.11*	–1.00	–0.95	–0.82	–0.75	–0.82	–0.74
	(0.62)	(0.63)	(0.62)	(0.55)	(0.53)	(0.55)	(0.53)
Successful experiences	–0.42***	–0.42***	–0.42***	–0.35***	–0.35***	–0.35***	–0.34***
	(0.04)	(0.04)	(0.04)	(0.08)	(0.08)	(0.08)	(0.08)
Past experiences	0.37***	0.37***	0.37***	0.41***	0.41***	0.41***	0.41***

	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)
Market size	–0.00***	–0.00***	–0.00***	–0.00***	–0.00***	–0.00***	–0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Firm age	–0.65***	–0.65***	–0.66***	–0.59***	–0.59***	–0.59***	–0.59***
	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)
Constant	31.13***	31.39***	31.59***	28.97***	29.10***	27.91***	27.97***
	(2.41)	(2.46)	(2.52)	(1.03)	(1.04)	(1.13)	(1.11)
Observations	8,574	8,574	8,574	8,574	8,574	8,574	8,574
R-squared	0.33	0.33	0.33	0.34	0.34	0.34	0.34
Location clustered	YES	YES	YES	YES	YES	YES	YES
Year dummies	YES	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2 presents the main results of estimation regarding the market share of VC firms. Model 1 only includes control variables. Most control variables show the effects that we had expected. For instance, both network status and structural holes have positive effects on market share. Industry heat and past experiences are found to positively affect the market share of VC firms. Firm age is found to be negatively associated with market share, which may reflect the fact that older firms often lack momentum and face the risk of obsolescence (Sorensen and Stuart, 2000). Yet it is interesting to see that successful experience (as expressed in the number of IPOs) can also impede performance. It is possible that successful firms, which may become more complacent, lack the motivation to expand their market (Bothner et al., 2012).

In Model 2, we enter competition closure. The main effect is negative and significant (β = –0.50, with $p<0.01$). However, although this is confirmed by Model 3, the results in Models 4 and 5 do not provide consistent patterns, which leads us to be cautious about interpreting the results regarding Hypothesis 5.1. The inconsistent patterns result from the inclusion of interaction term of network status and competition closure. The correlations of competition closure (r=0.65) and network status (r=0.58) with their interaction term are quite high, although those two variables are relatively correlated (r=–0.17). Thus, the results in Models 4 and 5 may be biased, due to the potential issues of multicollinearity between the interaction term and the two variables. To further examine the results, we followed previous studies (Ertug and Castellucci, 2013; Hiatt, Sine and Tolbert, 2009) and orthogonalized those three terms using orthog command in Stata 13. By doing so, we removed the effect of the two variables from their interaction term. We repeated the original estimations as shown in Models 4 and 5 with orthogonalized terms as shown in Models 6 and 7. The main effects of competition closure are negative and significant (β= –0.77, with $p<0.01$ in Model 6; β= –1.50 with $p<0.01$ in Model 7), which is consistent with our results in Models 1 to 3. Thus, we conclude that Hypothesis 5.1 is supported.

Model 3 includes the interaction between competition closure and structural holes. The main effect of structural holes is significant and positive (β=1.02, with $p<0.01$), while the interaction is negative (β= –0.35, with $p<0.01$). It is also confirmed by the full Models 5 and 7. Thus, the results provide support for Hypothesis 5.2.

Model 4 includes the interaction of competition closure and network status. The main effect of network status stays positive (β=6.24, with $p<0.05$) and the interaction term is also positive (β=7.10, with $p<0.1$), albeit marginally significant. However, the magnitude of the main effect of network status becomes much bigger (from β=3.09 in Model 3 to β=6.24 in Model 4), which may also be explained by problems of multicollinearity due to the entry of the interaction term, as discussed above. Thus, we also referred to results in Model 6 that were estimated with orthogonalized terms. This model provides similar patterns, as the interaction term stays positive (β=1.92, with $p<0.1$). And at the same time, the magnitude of network status is more consistent with that found in Models 1 to 3. The results are further confirmed in Models 5 and 7. Hypothesis 5.3 is thus supported.

Figure 5.2 Interaction between competition closure and structural holes

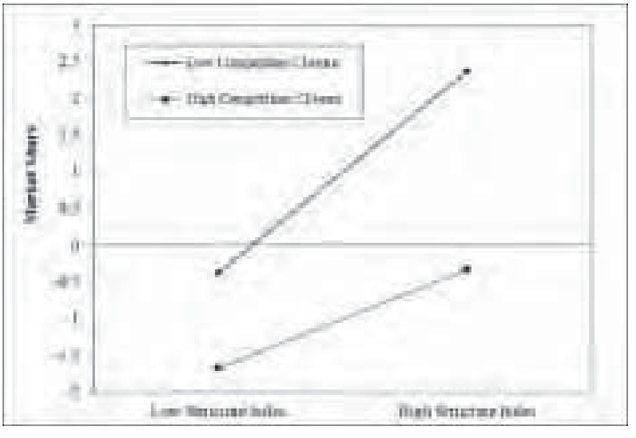
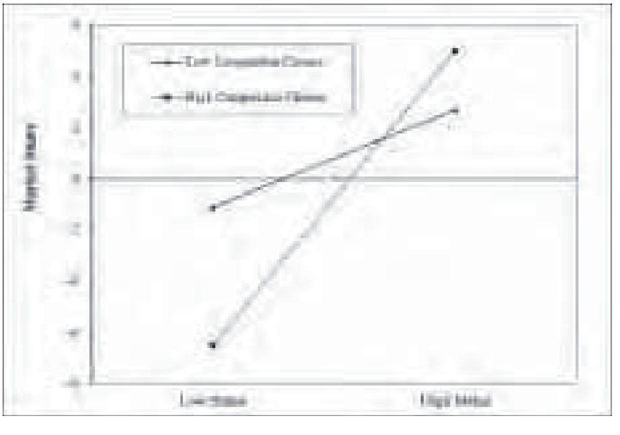


Figure 5.3 Interaction between competition closure and network status



To help us interpret the interaction effects, we illustrated the results in Figures 5.2 and 5.3. Figure 5.2 adopts the results from Model 3, and shows that, although in general firms with more structural holes have a higher market share, the effect of structural holes on performance becomes weaker when competition closure is higher. With the results from Model 6, Figure 5.3 indicates that, in general, network status in collaboration networks is beneficial, and it brings more benefits for firms with a higher level of competition closure.

Applying the same settings, we estimated the likelihood of an IPO being issued by a VC's portfolio companies. Models 8–14 employed probit estimation. As shown in Model 8, both network status and structural holes in syndication networks exert positive effects. The coefficient of competition closure on IPO likelihood is negative (with $p<0.01$, in Model 9), and stable across models, consistent with Hypothesis 5.1. The interaction between competition closure and structural holes on IPO likelihood is negative (with $p<0.01$, in Model 10). Competition closure also strengthens the value of network status, because the interaction between them is positive (with $p<0.1$, in Model 11). Those results are all confirmed by the full Model 12 and the orthogonalized operationalization, as shown in Model 13 and Model 14. In Model 15, we re-estimated the full model with logit regression and gained similar results.

To better interpret the moderation effect on the likelihood of IPOs, we followed Wiersema and Bowen's (2009) procedure and compared how the marginal effect of network status and structural holes changes across different values of moderator (i.e., mean, mean–s.d., and mean+s.d.), with the results of logit regression in Model 15. As Table 4 shows, the relationship between network status and IPO likelihood is stronger at higher values of competition closure, suggestive of a generally positive moderation effect. That is, high values of competition closure strengthen the impact of network status on investment performance, which is consistent with Hypothesis 2. As to the marginal effect of structural holes, although it is more positive at low values of competition closure than at high values, it is less positive at low values of competition closure than at medium values. This means that, although competition closure negatively moderates the effect of structural holes, the moderation effect may be curvilinear, rather than simply linear.

Table 5.3 Probit estimation of the likelihood of an IPO being issued by a VC's portfolio companies

VARIABLES	**Raw** Model 8	**Raw** Model 9	**Raw** Model 10	**Raw** Model 11	**Raw** Model 12	**Orthog** Model 13	**Orthog** Model 14	**Orthog** Model 15
Competition closure × network status				0.24*	0.36**	0.06*	0.10**	0.15**
				(0.14)	(0.15)	(0.04)	(0.04)	(0.07)
Competition closure × structural holes			–0.20***		–0.22***		–0.22***	-0.49***
			(0.05)		(0.05)		(0.05)	(0.09)
Competition closure		–0.28***	–0.46***	–0.17*	–0.31***	–0.30***	–0.50***	-1.13***
		(0.07)	(0.09)	(0.10)	(0.11)	(0.07)	(0.09)	(0.19)
Structural holes	0.30***	0.26***	0.23***	0.24***	0.21***	0.24***	0.21***	0.42***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.08)
Network status	0.08**	0.07**	0.07*	0.18**	0.22***	0.10**	0.10**	0.20***
	(0.04)	(0.04)	(0.04)	(0.07)	(0.07)	(0.04)	(0.04)	(0.07)
Egocentric uncertainty	–0.22***	–0.22***	–0.22***	–0.21***	–0.21***	–0.21***	–0.21***	-0.35***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.09)
Industry heat	0.18	0.17	0.15	0.16	0.14	0.16	0.14	0.32
	(0.18)	(0.18)	(0.18)	(0.18)	(0.18)	(0.18)	(0.18)	(0.32)
Specialization	–0.17	–0.18	–0.19	–0.17	–0.18	–0.17	–0.18	-0.20
	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.25)
Successful experiences	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.03***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Past experiences	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Market size	–0.00***	–0.00***	–0.00***	–0.00***	–0.00***	–0.00***	–0.00***	-0.00***

	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Firm age	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	2.76***	2.94***	3.02***	2.82***	2.85***	2.79***	2.80***	5.99***
	(0.30)	(0.31)	(0.31)	(0.32)	(0.31)	(0.32)	(0.32)	(0.71)
Wald Chi2	1,313	1,321	1,316	1,322	1,317	1,322	1,317	1,165
Log Likelihood	–1,849	–1,840	–1,832	–1,838	–1,829	–1,838	–1,829	-1,814
Observations	8,523	8,523	8,523	8,523	8,523	8,523	8,523	8,523
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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

Table 5.4 Moderation effect of competition closure on the marginal effect of network status and structural holes

Network Status			Structural Holes		
Value of closure	Marginal effect [a]	z-statistic	Value of closure	Marginal effect	z-statistic
Low	0.02	0.36	Low	0.70***	8.45
Mean	0.42**	2.36	Mean	1.04***	5.55
High	2.36**	2.55	High	-0.22	-0.22

*** p<0.01, ** p<0.05, * p<0.1

[a] Computed at the mean of network status and structural holes; marginal effects are all enlarged by 10^3, for interpretation.

5.5 Discussion and Conclusion

Moving beyond previous research on the collaboration networks, our study has highlighted the importance of taking into account a firm's competition networks when explaining performance. A firm's position in competition networks not only affects its ability to build unique capabilities and to compete successfully, but also shapes the benefits that it can derive from collaboration networks. Combining research on social network and competitive dynamics, we introduced the notion of competition closure and argued that it plays an important role in determining firm performance. We find that competition closure directly impedes firm performance. Moreover, competition closure reduces the performance benefits of structural holes in collaboration networks, but it amplifies the effect of network status. Our findings provide implications for current research and practice.

First of all, our findings highlight the significant role of competitive rivalry in distributing market information, directing strategic attention, and shaping the acquisition of unique capabilities. Literature on inter-firm relations and networks has largely emphasized the benefits and opportunities that stem from collaboration networks, as collaborative relationships may enable a firm to gain valuable information and resources (Ahuja, 2000; Brass et al., 2004; Podolny, 1994; Shipilov and Li, 2008). Our results imply that mutual competition acts as an alternative mechanism to collaboration in markets in facilitating the distribution of important market information. Competition also triggers firms to gather information about each other (Chen, 1996; Tsai et al., 2011), such as recruitment activity, pricing, market entry and innovation strategies (Greve and Taylor, 2000; Gimono and Woo, 1999; Hsieh and Vermeulen, 2013). The research on inter-firm networks has underestimated the importance of this activity so far (Gulati et al., 2011). To better understand and explain the performance and behavior of firms, future research needs to explore the position of firms in both collaboration and competition networks.

Second, the significant main effect of competition closure on firm performance implies that a firm may outperform others by purposely designing its competition networks. In addition to shaping strategic choices such as market entry (e.g., Hsieh and Vermeulen, 2013; Skilton and Bernardes, 2014), the specific position of a firm in competition networks (competition closure) is also found to affect its market performance. This implies that a firm may significantly increase its performance if it can structure its competition networks more appropriately. In particular, a firm is likely to enjoy a competitive advantage when it reduces competition closure. This helps to increase the uniqueness of its capabilities and limit the unpredictability of competitors' actions. Competition closure is reduced when a firm competes with different competitors in different markets. It thus seems advisable for firms to enter market niches where its competitors in other markets are as yet not competing. However, most studies have shown that firms have a tendency to enter markets by following their competitors (Haveman and Nonnemaker, 2000). Thus, our study suggests that, in terms of which markets a firm enters, it may pay the firm not to follow the herd (Hsieh and Vermeulen, 2013) but to seek out different markets from those of its existing competitors.

Third, the interaction effect of competition closure and structural holes implies that competition and collaboration networks may interact collectively, rather than work independently, to affect the performance of firms. Organizations are embedded simultaneously within collaboration networks (Burt, 1992; Jensen, 2003; Podolny, 2005; Shipilov, 2006) and competition networks (Skilton and Bernardes, 2014; Tsai et al., 2011), and their positions in both networks are not highly correlated. That is, where a firm has many structural holes in its collaboration networks, this does not necessarily mean that it will occupy a similar brokerage position in its competition networks. However, our findings that competition closure decreases the performance benefits of structural holes imply that competition networks act as an alternative mechanism for distributing information. Thus, it means that it is not always beneficial for a firm to strive for brokerage positions in collaboration networks, particularly when high competition closure causes information to become widely available in markets. However, it is worth noting that, although competition does indeed trigger information-gathering by firms, information obtained in this way may be more costly and complex to acquire than that which is obtained through collaboration (Uzzi, 1996), and competitors usually tend not to disclose such information. By contrast, collaboration increases the level of trust between partner firms (Gulati, 1995; Inkpen and Tsang, 2005), and the sense that they can rely on one another. This may then facilitate more sharing of internal information, including some tacit knowledge (Uzzi, 1997), in a more active way.

Fourth, our results have implications for understanding the contingent value of network status. Our findings on the interaction between network status and competition closure imply that altercentric uncertainty varies across firms, which challenges the assumption in previous studies that all firms in the same market face a similar level of uncertainty (Podolny, 1994). The attention-based view (Ocasio, 2011) that we used to predict the uncertainty of alters also adds another perspective to the current literature on status, in which uncertainty is usually linked to market turbulence (Collet and Philippe, 2014).

Finally, our findings also imply that competition closure is not necessarily either beneficial or harmful for collaboration networks. Although competition closure limits the value of structural holes, it strengthens the effect of network status on firm performance. In order to amplify the value of its collaboration network resources, a firm needs to make a cautious evaluation of its structural holes and network status when designing competition strategies. When its competitive advantage originates from structural holes, the firm might be advised to aim for low competition closure by competing with different competitors in different markets. Conversely, if network status plays a major part in a firm's competitive advantage, high competition closure may be preferable.

5.5.1 Limitations and future research

Although our study provides multiple implications for research on inter-firm relationships and networks, we also recognize some limitations that open up interesting avenues for future research. First, our single-industry setting may limit the generalizability of our findings to other sectors. Prior research has shown that network status exerts a weaker effect on the performance and behavioral patterns of organizations in industries with a low level of market uncertainty (Podolny, 1994). Future research should shed more light on such industry-specific characteristics. Our empirical context is also limited to the U.S. market, so future studies should be expanded to cover different institutional contexts. Likewise, although the VC data from ThomsonOne has been widely used in previous studies (e.g., Guler and Guillén, 2010; Sorenson and Stuart, 2008), it is also recognized to have certain limitations. Thus, it is also necessary to replicate our estimations with more comprehensive data.

Second, following previous studies (Haveman and Nonnemaker, 2000; Hsieh and Vermeulen, 2013), we defined firms as competing with each other if they share the same geographic market. Other ways of categorizing markets are, however, possible. For instance, VC firms may be categorized by the size of fund that they manage or by the industry that they focus on (Ingram and Yue, 2008). Although we expect that our findings will still hold when markets are operationalized in other ways, the effect sizes may be different. Thus, we encourage other researchers to explore competition networks in other dimensions and to make comparisons with the geographic markets categorization used in this study.

Third, we used both market share and the IPO likelihood of portfolio companies as indicators of VC firms' market and investment performance. Yet we also recognize that firm performance is multifaceted. It would be important for future studies to explore how the effect of competition closure and the interplay between competition and collaboration work in other dimensions of performance, such as capital value share (Shipilov, 2006), profits, returns, and innovation. It would also be interesting to explore whether and how they exert different effects on different dimensions of performance.

Fourth, in this study we make a distinction between firms' collaboration networks and their competition networks. We focus on the closure in competition networks, but future studies may discuss other attributes of those networks, such as competition status. In our view, it may be hard to distinguish competition status from network status. Theoretically, both of them indicate an actor's quality in relation to peers in markets, so they may be highly correlated in empirical terms. However, it is possible that actors may have high competition status and low network status, if they are powerful in the market but reluctant to collaborate with their peers. Thus, we encourage future studies to investigate this area in more depth.

Fifth, it would also be interesting to investigate the different boundary conditions for the effect of competition and collaboration networks (Burt, 1997). We have primarily discussed the interplay between competition and collaboration, building on the assumption that competition and collaboration network structures are equally important. However, more studies are needed to compare the influences of competition and collaboration networks. According to social embeddedness perspective, for instance, we might expect that, although both types of network are important and effective for information exchange, collaboration networks may have stronger effect because they facilitate the transfer of more tacit and implicit knowledge (Granovetter, 1985; Uzzi, 1996) than competition networks.

Finally, although we make a distinction between competition and collaboration networks and discuss their interaction, it is also intuitive that they could be interrelated. A firm's competition position may affect its propensity to collaborate, and lead to different patterns of collaboration (Gimeno, 2004; Khanna, Gulati, and Nohria, 1998). At the same time, collaboration positions may also reshape competitive pressures (Gnyawali, He, and Madhavan, 2006; Silverman and Baum, 2002). Thus, we encourage future studies to investigate the causal relationship between competition and collaboration networks.

Chapter 6. Conclusion and Discussion

6.1 Introduction

In this dissertation, I highlight how obtaining and maintaining competitive advantage requires firms both to implement appropriate innovation strategies (i.e., exploration/exploitation) and to acquire status in their external networks. In particular, I combine three research streams: innovation (exploration/exploitation), status, and networks, with the aim of shedding light on how they collectively affect firm performance and behavior. I firstly describe how, although exploration is generally beneficial for high-tech firms, its value varies across firms and is contingent on status and the robustness of that status. Secondly, I emphasize exploration/exploitation as an important angle from which to investigate the pattern of alliance partner selection. I highlight the fact that firms tend to select partners who have similar orientation to themselves in terms of exploration/exploitation. Thirdly, I examine the market value of inventions with different degrees of exploration and exploration. And finally, I draw attention to competition networks. Altogether, this dissertation shows that there is a significant interacting between innovation, status, and networks, and contributes to our knowledge in each area of research.

In this chapter, I firstly provide a brief summary of the main findings of each study. Second, I discuss how my findings contribute to current theory on innovation (exploration and exploitation), status, and networks. Finally, I conclude with discussion of the practical implications of my dissertation for managers.

6.2 Summary of Main Findings

The first key finding is that the competitive advantage of firms in high-tech industries is collectively determined by innovation strategy, status, and networks. In particular, Study 1 shows that status reduces the value of exploratory innovations, such that exploration contributes less to the growth of high-status firms and firms with robust status. Building on the literature on performance implications of exploration (Jansen et al., 2006; He and Wong, 2004) and the status-based perspective (Bothner et al., 2010; Podolny, 1993), Study 1 develops a contingency model to investigate the relationship between exploration and firm growth. Consistent with prior studies, results show that exploration contributes to firms within highly dynamic industries (Jansen et al., 2006; Uotila, 2009). However, the effect of exploration varies according to firms' technological status and status robustness. More specially, exploration contributes less to high-status firms and firms whose status is robust. Table 6.1 summarizes the results of Study 1.

Table 6.1 Hypotheses in Study 1

Hypotheses	Result
Hypothesis 2.1: Exploration is positively related to the growth of high-tech firms.	Supported
Hypothesis 2.2: Technological status moderates the positive relationship between exploration and growth, such that the positive relationship between exploration and growth is weaker when status is higher.	Supported
Hypothesis 2.3: Status robustness moderates the relationship between exploration and growth, such that the positive relationship between exploration and growth is weaker when status robustness is higher.	Supported

Second, results in Study 2 show that partner selection and relationship formation in networks is affected to a significant extent by a firm's strategic orientation with regard to exploration/exploitation. Evidence from the semiconductor industry shows that exploratory firms are more likely to form a strategic alliance with exploratory firms, and that exploitative firms with exploitative firms. Moreover, this pattern of partner selection is contingent on particular aspects of both the alliance and the firms. In particular, firms are more likely to form alliances with partners of a different strategic orientation when the scope of the alliance is narrower. Finally, the results also demonstrated that high-status firms have a stronger tendency to find partners who are similar in terms of their strategic orientation towards exploration/exploitation. Table 6.2 summarizes the results of Study 2.

Table 6.2 Hypotheses in Study 2

Hypotheses	**Result**
Hypothesis 3.1: A pair of firms are more likely to form an alliance when they have similar strategic orientations, and less likely to do so when their orientations are dissimilar.	Supported
Hypothesis 3.2: When the scope of an alliance is broad, two firms with different strategic orientations will be less likely to form an alliance, and conversely when the scope is narrower they will be more likely to do so.	Supported
Hypothesis 3.3: Firm with higher status will be more likely to build strategic alliances with firms that have a similar strategic orientation to their own, and firms with lower status will be less likely to do so.	Supported

Third, it is also apparent that the competitive advantage of firms in technology markets is dependent on the creation of ambidextrous inventions. By conducting patent-level analysis, Study 3 finds that ambidextrous inventions are typically of greater value than either over-exploitative or over-exploratory inventions, and that they are more likely to become breakthrough technologies. The study also investigates how to compose invention teams to generate ambidextrous inventions. Results shows that teams with medium size and experience are more likely to generate ambidextrous inventions. Table 6.3 summarizes the results of Study 3.

Table 6.3 Hypotheses in Study 3

Hypotheses	**Result**
Hypothesis 4.1: Ambidextrous inventions are of greater value, such that an invention's value is curvilinearly related to the relative degree of exploration.	Supported
Hypothesis 4.2: Ambidextrous inventions are more likely to be breakthrough, such that an invention's possibility of becoming breakthrough is curvilinearly related to the relative degree of exploration.	Supported
Hypothesis 4.3: The likelihood of creating ambidextrous inventions is curvilinearly related to the size of invention team.	Supported
Hypothesis 4.4: The likelihood of creating ambidextrous inventions is curvilinearly related to the average experience of invention team.	Supported

Finally, the competitive advantage of firms is collectively determined by collaboration and competition networks. The empirical evidence from the VC industry in Study 4 shows the importance of a firm's position in its competition networks. In particular, firms with higher competition closure are found to perform worse than those with lower competition closure. In addition, the results show that competition closure negatively moderates the value of structural holes, while it positively moderates the effect of network status. Table 6.4 summarizes the results of Study 4.

Table 6.4 Hypotheses in Study 4

Hypotheses	**Result**
Hypothesis 5.1: Competition closure is negatively related to firm performance	Supported
Hypothesis 5.2: Competition closure and structural holes interact in such way that the positive effect of structural hole on performance becomes weaker when it has larger competition closure.	Supported
Hypothesis 5.3: Competition closure interaction with network status in such way that the positive effect of network status on performance becomes stronger when it has larger competition closure.	Supported

6.3 Implications for Theory

In addition to the findings of each study outlined above, this dissertation leads to a number of interesting insights to existing literature In the following section, I will provide an overview of the theoretical implications of my dissertation.

6.3.1 Implications for exploration, exploitation, and innovation activities

This dissertation provides some important implications for the literature on exploration/exploitation, in that it both highlights the contingent value of exploration and exploitation and emphasizes their value in technology markets.

The contingent value of exploration and exploitation. My dissertation emphasizes the status-based perspective as an important angle to evaluate the effect of exploration and exploitation. The studies in this dissertation show that status has a significant moderation effect on the effect of exploration (exploitation) on firm performance and partner selection. On the one hand, they show that the contribution that exploration makes to growth varies across firms according to their particular status, and how robust that status is. In particular, exploration contributes more to firms with low or unstable status. On the other hand, the studies illustrate how, although firms generally take account of strategic orientation with regard to exploration or exploitation when selecting partners for a strategic alliance, their propensity to do this also depends on their network status. Specially, high-status firms are found to have a stronger tendency to select partners with similar orientation towards exploration or exploitation. This therefore emphasizes the importance of the status-based perspective when analyzing the effects of exploration and exploitation.

More generally, these findings suggest that the effects of exploration or exploitation depend on firm-specific features. It has been widely recognized that the value of exploration/exploitation is dependent on a variety of factors, but most of the current literature focuses exclusively on external factors such as environmental dynamism and competitiveness (Jansen et al., 2006; Uotila et al., 2009), and firm-level contingencies are left largely unexplored. My focus on firm status hence opens the way for further discussion of firm-level characteristics as boundary conditions for the effects of exploration and exploitation. Thus, in future studies, scholars could investigate further the contingency role of other firm-level attributes. For instance, will reputation exert a similar effect to status?

Although both reputation and status represent a firm's prestige, scholars also recognize that there are differences between them (Podolny, 1993; Jensen and Roy, 2008).

The value of exploration and exploitation in technology markets. My dissertation shifts research attention on exploration and exploitation away from product markets towards technology markets. Most current studies investigate how organization-level exploration and exploitation affects firm performance in product markets (Jansen et al., 2006) or financial markets (Uotila et al., 2009). The studies which form the focus of this dissertation involve an analysis at the invention level, and investigate whether and how the degree of exploration or exploitation within an invention affects its value in technology markets (as reflected in forward citations).

The findings provide are important for the debate on how to balance exploration and exploitation. There are generally two different ways of doing this: differentiating exploration and exploitation structurally (Benner and Tushman, 2002; Jansen et al., 2009; Fang et al., 2011), or balancing exploration and exploitation within each invention. My findings suggest that the strategy of structural differentiation may not be the best approach, because inventions of either over-exploration or over-exploitation are found to be of lower value than ambidextrous innovations. That is, while it is possible for a firm to achieve a balance at the firm level (Benner and Tushman, 2002; Jansen et al., 2009) by assigning separate teams to focus on exploration and exploitation, the value of each individual invention in technology markets is then lower. Thus, in order to increase the value of inventions, firms should combine new and existing knowledge within each invention. Ambidextrous inventions are not only of greater value, but are also more likely to become breakthroughs.

6.3.2 Implications for status theory and research

My dissertation also has implications for status research. First, my findings point to the potential limitations of status, which have only been addressed to a very limited extent (Bothner et al., 2012; Marr and Thau, 2014). The findings suggest that having a high status *indirectly* impedes the growth potential of firms. That is, exploration contributes less to the growth of high-status firms. In such cases, prestigious firms may then start to regard exploration as not essential, causing them to put less emphasis on the creation of exploratory innovations. In the short term, firms that engage in less exploration may not experience a loss of competitive advantage, because their status may compensate for the lack of exploration. However, when firms gradually decrease their emphasis on introducing new products, their status may also decline in the long run, because status is correlated with products and quality (Podolny, 1993; Podolny and Phillips, 1996). At the point when a firm's competitive advantage is lost, it is usually too late to recover. The findings of this study hence provide a warning to prestigious firms that basing a competitive strategy predominantly on status (or reputation, brand name) and failing to explore new competences and capabilities may be fatal in the long run.

In addition, my findings imply that firms with high status are more likely to form clusters based on strategic orientation in exploration or exploitation. High-status firms, which are usually large and well-established, may often be less exploratory and more exploitative, because organizational aging makes it more difficult for them to keep pace with a constant stream of new external development (Sørensen and Stuart, 2000). If so, high-status firms are much more likely to form alliances with exploitative partners. They may thus face a greater risk of ending up in competence traps (Levinthal and March, 1993) because they cannot access exploratory knowledge through inter-organizational networks. This may also help explain the relative demise of prestigious companies such as Nokia and Motorola. High-status firms are thus advised to make alliances with exploratory firms, rather than being driven by the force of homophily in strategic orientation.

Furthermore, my dissertation distinguishes between the magnitude and robustness of status (Bothner et al., 2010). The results of Study 1 show that robustness negatively moderates the relationship between exploration and firm growth. This is consistent with arguments that market stakeholders are likely to form stable perceptions of firms that have a robust status, so that they are then indifferent to changes in the level of exploration taking place within those firms'. That is, when a firm already has a robust identity (status) in the industry, it becomes more difficult to grow through product improvement. When we compare the moderating effect of robustness with that of status, we find that robustness exerts a significantly ($p<0.01$) stronger moderation effect than status, meaning that status robustness mitigates the value of exploration to a much greater extent than the magnitude of status does. Thereby, this study implies the necessity to consider robustness when analyzing status-based processes.

Finally, the results regarding the interaction of network status and competition closure imply that altercentric uncertainty varies across firms, which challenges the assumption in previous studies that all firms in the same market face a similar level of uncertainty (Podolny, 1994). The basic premise for the status-based model is that market audiences face uncertainty when evaluating the quality of firms. However, scholars usually attribute that uncertainty to market turbulence (Podolny, 1994; Collect and Philippe, 2014). The findings in Study 4 imply that uncertainty varies across firms, and is related to the amount of attention that audiences (Ocasio, 2011) pay to particular firms.

6.3.3 Implications for network theory

This dissertation provides implications for network theory in that it emphasizes the effect of strategic orientation and highlights the interplay between competition and collaboration networks.

Strategic orientation and partner selection. The results of these studies have some significant implications for research on partner selection in strategic alliances. While most studies focus on the importance of organizational resources or network structure for understanding patterns of partner selection, my dissertation highlights the role of strategic orientation. The findings imply that firms tend to cluster by strategic orientation. However, this is not necessarily beneficial, because clustering by exploration and exploitation may lead respectively to either renewal or competence traps (Levinthal and March, 1993). If an exploitative firm, for instance, has only exploitative partners, it cannot access exploratory knowledge through inter-organizational networks, and this may ultimately drive it to fail.

Although my dissertation only discusses patterns of alliance formation, it is necessary to investigate how the exploration or exploitation of firms and partners co-evolve, after alliances have been formed. That is, if an exploratory firm builds an alliance with exploitative or exploratory partners, how does the level of exploration of that firm then change over time? From an inter-organizational learning perspective we may propose a convergent track, where the firm becomes more exploitative as it learns from exploitative partners. However, following knowledge-accessing logic (Grant and Baden-Fuller, 2004; Mowery et al., 1996), it is also possible that the tracks of a firm and its partners will diverge.

Interplay between competition and collaboration networks. My dissertation highlights the role of competition networks. Prior studies on inter-firm networks have largely emphasized the benefits and opportunities that can stem from collaboration networks because collaborative ties may be conducive to valuable information and resources (Ahuja, 2000; Brass et al., 2004; Podolny, 1994; Shipilov and Li, 2008). Our findings suggest that mutual competition serves as an alternative mechanism to collaboration in markets in terms of distributing important market information. Competition also triggers firms to gather information about one another (Chen, 1996; Tsai et al., 2011) such as recruitment activities, pricing, market entry and innovation strategies (Greve and Taylor, 2000; Gimono and Woo, 1999; Hsieh and Vermeulen, 2013) – and this has so far been underestimated in research on inter-firm networks (Gulati et al., 2011). Thus, a key contribution of this dissertation is to shift the attention of network researchers from collaboration to competition networks.

In addition, I highlight the interplay between collaboration and competition networks. The findings that competition closure decreases the performance benefits of structural holes imply that competition networks act as an alternative mechanism for information distribution, and this is in addition to the part that collaborative relationships play in transferring information. Thus, it means that it is not always beneficial for a firm to try to achieve a brokerage position in collaboration networks, particularly when high competition closure causes information to become widely available in markets.

6.4 Implications for Practice

In addition to the theoretical implications for academic scholars, my dissertation also provides some important insights for practitioners on how to manage exploration, status and networks.

6.4.1 Deceptive nature of status

First of all, my dissertation warns managers of high-status firms against ignoring the importance of innovation in general, and of exploration in particular. The findings imply that high-status firms may be more likely to be under the illusion that exploration is not essential, which causes them to put less emphasis on creating exploratory innovations. This is a dangerous notion because neglecting to explore new capabilities may be fatal in the long run. High-status firms usually have an advantage when promoting products in the market or when recruiting employees, just because of their prestige, reputation or brand name. Yet, in the past, many prestigious firms have been found to become obsolete or have been driven out of markets. The findings of this dissertation point to the need for managers of high-status firms to keep up with technological progress, and seek out an adequate level of novel knowledge, even if exploration contributes less to overall performance in high-status firms than in low-status firms.

6.4.2 Potential trap in strategic orientation

My dissertation highlights the fact that it may be problematic for firms to cluster with similar partners. The findings show that firms with similar strategic orientations tend to cluster together. That is, exploratory firms are more likely to ally with other exploratory ones, and exploitative firms with other exploitative ones. However, this tendency is not necessarily beneficial for a firm's sustainable competitive advantage. It drives firms to have partners who have the same kind of orientation as they have. When this happens, exploitative firms may become polarized in exploitation, because they only seek out exploitative partners through inter-firm networks. Focusing too heavily on exploitation may lead to a competence trap, while a similar undue emphasis on exploration may cause firms to be trapped by renewal (Levinthal and March, 1993). Both types of trap are harmful for firms. Thus, managers need to purposely build strategic alliances with firms of a different strategic orientation in order to balance exploration and exploitation at the inter-organizational level.

6.4.3 Managing inventions

This dissertation provides important implications for managers about how to generate valuable and even breakthrough inventions. The results show that patents that achieve a balance between new and existing knowledge (i.e., ambidextrous inventions) are of greater value in technology markets, and also are more likely to become breakthroughs. It is important to remember that exploration in an invention refers to the extent to which it incorporates knowledge that did not previously exist within the firm. Thus, managers may encourage invention teams to combine existing knowledge with knowledge that is new to the firm, rather than focusing exclusively on one or the other.

This dissertation also provides valuable insights into how to organize invention teams in order to build ambidextrous inventions. Managers may organize invention teams with medium size (about 6 people) and a medium level of team experience in order to generate inventions that draw on a better combination of new and existing knowledge, and which are more likely to become technological breakthroughs.

6.4.4 Structuring competition networks

Finally, this dissertation implies that managers may build competitive advantage by deliberately structuring their competition networks in a certain way. The findings show that occupying a specific position in a competition network (competition closure) affects the firm's performance. Thus, a firm may significantly increase its performance if it can appropriately structure its competition networks. In particular, a firm is likely to enjoy a competitive advantage when it reduces its competition closure. This helps to ensure that the capabilities it develops are unique and to limit the unpredictability of competitors' actions. Since there is a lower level of competition closure when a firm competes with different competitors in different markets, it is advisable for a firm to enter those markets where its competitors from other markets do not operate. However, most studies have shown that firms have a tendency to enter markets by following their competitors. Thus, our study suggests that firms can achieve a better pay-off from market entry if they can steer clear of the herding instinct.

In addition, when structuring competition networks, managers also need to consider their current positions in collaboration networks. Although competition closure limits the value of structural holes, it strengthens the effect of network status on firm performance. In order to increase the value of its collaboration network resources, a firm needs to make a cautious evaluation of its structural holes and network status when designing competition strategies. When its competitive advantage originates mainly from structural holes, it is encouraged to compete with different competitors in different markets. Conversely, if network status plays a major part in its competitive advantage, high competition closure may be preferable.

References

Aaker, J., Vohs, K. D., and Mogilner, C. 2010. Nonprofits are seen as warm and for-profits as competent: Firm stereotypes matter. *Journal of Consumer Research*, *37*(2), 224-237.

Aggarwal, V. A., and Hsu, D. H. 2013. Entrepreneurial exits and innovation. *Management Science*, *60*(4), 867-887.

Ahuja, G. 2000. Collaboration networks, structural holes, and innovation: A longitudinal study. *Administrative science quarterly*, *45*(3), 425–455.

Ahuja, G., and Lampert, M. C. 2001. Entrepreneurship in the large corporation: A longitudinal study of how established firms create breakthrough inventions. *Strategic Management Journal*, *22*(6-7), 521-543.

Alejo, J., Galvao, A., Montes-Rojas, G., and Sosa-Escudero, W. 2015. Tests for normality in linear panel-data models. *Stata Journal*, *15*(3), 822-832.

Almeida, P., Dokko, G., and Rosenkopf, L. 2003. Startup size and the mechanisms of external learning: increasing opportunity and decreasing ability?. *Research Policy*, 32(2), 301-315.

Andriopoulos, C., and Lewis, M. W. 2009. Exploitation–exploration tensions and organizational ambidexterity: Managing paradoxes of innovation. *Organization Science*, 20(4), 696–717.

Auh, S., and Menguc, B. 2005. Balancing exploration and exploitation: The moderating role of competitive intensity. *Journal of Business Research*, *58*(12), 1652-1661.

Barnett, W. P. 1997. The dynamics of competitive intensity. *Administrative Science Quarterly*, 42, 128–160.

Barnett, W. P., Greve, H. R., and Park, D. Y. 1994. An evolutionary model of organizational performance. *Strategic Management Journal*, *15*(S1), 11-28.

Baum, J. A., and Korn, H. J. 1996. Competitive dynamics of inter-firm rivalry.*Academy of Management Journal*, *39*(2), 255–291.

Baum, J. A., and Korn, H. J. 1999. Dynamics of dyadic competitive interaction. *Strategic Management Journal*, *20*(3), 251–278.

Baum, J. A., and Singh, J. V. 1994. Organizational niches and the dynamics of organizational mortality. *American Journal of Sociology*, 346-380.

Beckman, C. M. 2006. The influence of founding team company affiliations on firm behavior. *Academy of Management Journal,* 49(4), 741-758.

Benjamin, B. A., and Podolny, J. M. 1999. Status, quality, and social order in the California wine industry. *Administrative Science Quarterly*, *44*(3), 563–589.

Benner, M. J., and Tushman, M. 2002. Process management and technological innovation: A longitudinal study of the photography and paint industries. *Administrative Science Quarterly*, *47*(4), 676-707.

Bidwell, M., Won, S., Barbulescu, R., and Mollick, E. 2014. I used to work at Goldman Sachs! How firms benefit from organizational status in the market for human capital. *Strategic Management Journal*, 36(8), 1164-1173.

Bonacich, P. 1987. Power and centrality: A family of measures. *American Journal of Sociology*, 1170-1182.

Bothner, M. S., Kang, J. H., and Stuart, T. E. 2007. Competitive crowding and risk taking in a tournament: Evidence from NASCAR racing.*Administrative Science Quarterly*, *52*(2), 208–247.

Bothner, M. S., Kim, Y. K., and Smith, E. B. 2012. How does status affect performance? Status as an asset vs. status as a liability in the PGA and NASCAR. *Organization Science*, *23*(2), 416-433.

Bothner, M. S., Smith, E. B., and White, H. C. 2010. A Model of Robust Positions in Social Networks1. *American Journal of Sociology*, *116*(3), 943–92.

Brander, J. A., Amit, R., and Antweiler, W. 2002. Venture-Capital Syndication: Improved Venture Selection vs. The Value-Added Hypothesis.*Journal of Economics & Management Strategy*, *11*(3), 423–452.

Brass, D. J., Galaskiewicz, J., Greve, H. R., and Tsai, W. 2004. Taking stock of networks and organizations: A multilevel perspective. *Academy of Management Journal*, *47*(6), 795–817.

Burt, R. S. 1992. *Structural holes: The social structure of competition*. Harvard university press.

Burt, R. S. 1997. The contingent value of social capital. *Administrative Science Quarterly*, 339–365.

Burt, R. S. 2008. Information and structural holes: comment on Reagans and Zuckerman. *Industrial and Corporate Change*, *17*(5), 953–969.

Castellucci, F., and Ertug, G. 2010. What's in it for them? Advantages of higher–status partners in exchange relationships. *Academy of Management Journal*, *53*(1), 149–166.

Chen, M. J. 1996. Competitor analysis and inter-firm rivalry: Toward a theoretical integration. *Academy of Management Review*, *21*(1), 100–134.

Chen, M. J., and MacMillan, I. C. 1992. Nonresponse and delayed response to competitive moves: The roles of competitor dependence and action irreversibility. *Academy of Management Journal*, *35*(3), 539–570.

Chen, M. J., and Miller, D. 2012. Competitive dynamics: Themes, trends, and a prospective research platform. *The Academy of Management Annals*,*6*(1), 135–210.

Chung, S. A., Singh, H., and Lee, K. 2000. Complementarity, status similarity and social capital as drivers of alliance formation. *Strategic Management Journal*, *21*(1), 1–22.

Cohen, W. M., and Levinthal, D. A. 1990. Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly*, 128-152.

Coleman, J. S. 1988. Social capital in the creation of human capital. *American Journal of Sociology*, 95–120.

Collet, F., and Philippe, D. 2014. From Hot Cakes to Cold Feet: A Contingent Perspective on the Relationship between Market Uncertainty and Status Homophily in the Formation of Alliances. *Journal of Management Studies*,*51*(3), 406–432.

Corwin, S. A., and Schultz, P. 2005. The role of IPO underwriting syndicates: Pricing, information production, and underwriter competition. *The Journal of Finance*, *60*(1), 443–486.

Cowen, A. P. 2012. An Expanded Model of Status Dynamics: The Effects of Status Transfer and Inter-firm Coordination. *Academy of Management Journal*, *55*(5), 1169–1186.

Das, T. K., and Teng, B. S. 2000. A resource–based theory of strategic alliances. *Journal of Management,* 26(1), 31–61.

Dess, G. G., and Beard, D. W. 1984. Dimensions of organizational task environments. *Administrative Science Quarterly*, 52–73.

Dimov, D., and Milanov, H. 2010. The interplay of need and opportunity in venture capital investment syndication. *Journal of Business Venturing*, *25*(4), 331–348.

Eisenhardt, K. M., and Schoonhoven, C. B. 1990. Organizational growth: Linking founding team, strategy, environment, and growth among US semiconductor ventures, 1978-1988. *Administrative science quarterly*, 504-529.

Ertug, G., & Castellucci, F. 2013. Getting What You Need: How Reputation and Status Affect Team Performance, Hiring, and Salaries in the NBA.*Academy of Management Journal*, *56*(2), 407–431.

Fang, C., Lee, J., and Schilling, M. A. 2011. Balancing exploration and exploitation through structural design: The isolation of subgroups and organizational learning. *Organization Science*, 21(3), 625-642.

Fiske, S. T., Cuddy, A. J., Glick, P., and Xu, J. 2002. A model of (often mixed) stereotype content: competence and warmth respectively follow from perceived status and competition. *Journal of Personality and Social Psychology*, *82*(6), 878.

Fleming, L. 2001. Recombinant uncertainty in technological search. *Management Science*, *47*(1), 117-132.

Fleming, L., and Sorenson, O. 2001. Technology as a complex adaptive system: evidence from patent data. *Research Policy*, 30(7), 1019-1039.

Fleming, L., and Sorenson, O. 2004. Science as a map in technological search. *Strategic Management Journal*, 25(8-9), 909-928.

Fleming, L., Mingo, S., and Chen, D. 2007. Collaborative brokerage, generative creativity, and creative success. *Administrative Science Quarterly*, 52(3), 443-475.

Fragale, A. R., Overbeck, J. R., and Neale, M. A. 2011. Resources versus respect: Social judgments based on targets' power and status positions.*Journal of Experimental Social Psychology*, 47(4), 767-775.

Gande, A., Puri, M., Saunders, A., and Walter, I. 1997. Bank underwriting of debt securities: Modern evidence. *Review of Financial Studies*, *10*(4), 1175–1202.

Garcia-Pont, C., and Nohria, N. 2002. Local versus global mimetism: The dynamics of alliance formation in the automobile industry. *Strategic Management Journal*, 23: 307–321.

Gatignon, H., and Robertson, T. S. 1985. A propositional inventory for new diffusion research. *Journal of consumer research*, 849-867.

George, G. 2005. Slack resources and the performance of privately held firms. *Academy of Management Journal*, *48*(4), 661-676.

Ghoshal, S., and Westney, D. E. 1991. Organizing competitor analysis systems. *Strategic Management Journal*, *12*(1), 17–31.

Gibson, C. B., and Birkinshaw, J. 2004. The antecedents, consequences, and mediating role of organizational ambidexterity. *Academy of Management Journal*, 47(2), 209–226.

Gimeno, J. 2004. Competition within and between networks: The contingent effect of competitive embeddedness on alliance formation. *Academy of Management Journal*, *47*(6), 820–842.

Gimeno, J., and Woo, C. Y. 1996. Hypercompetition in a multimarket environment: The role of strategic similarity and multimarket contact in competitive de–escalation. *Organization Science*, *7*(3), 322–341.

Gimeno, J., and Woo, C. Y. 1999. Multimarket contact, economies of scope, and firm performance. *Academy of Management Journal*, *42*(3), 239–259.

Giorgi, S., and Weber, K. 2015. Marks of Distinction Framing and Audience Appreciation in the Context of Investment Advice. *Administrative Science Quarterly*, Forthcoming.

Gnyawali, D. R., He, J., & Madhavan, R. 2006. Impact of co–opetition on firm competitive behavior: An empirical examination. *Journal of Management*, *32*(4), 507–530.

Gompers, P. A., and Lerner, J. 1999a. *What drives venture capital fundraising?* (No. w6906. National bureau of economic research.

Gompers, P., and Lerner, J. 1999b. An analysis of compensation in the US venture capital partnership. *Journal of Financial Economics*, *51*(1), 3–44.

Gompers, P., and Lerner, J. 2001. The venture capital revolution. *Journal of Economic Perspectives*, 145–168.

Granovetter, M. 1985. Economic action and social structure: the problem of embeddedness. *American Journal of Sociology*, 481–510.

Granovetter, M. S. 1973. The strength of weak ties. *American Journal of Sociology*, 1360–1380.

Grant, R. M. 1996. Toward a Knowledge-Based Theory of the firm. *Strategic Management Journal,* 17(S2), 109-122.

Grant, R. M., and Baden-Fuller, C. 2004. A knowledge accessing theory of strategic alliances. *Journal of Management Studies*, 41(1), 61–84.

Greve, H. R., and Taylor, A. 2000. Innovations as catalysts for organizational change: Shifts in organizational cognition and search. *Administrative Science Quarterly*, *45:* 54–80.

Gu, Q., and Lu, X. 2014. Unraveling the mechanisms of reputation and alliance formation: A study of venture capital syndication in China. *Strategic Management Journal*, *35*(5), 739-750.

Gulati, R. 1995. Social structure and alliance formation patterns: A longitudinal analysis. *Administrative Science Quarterly*, 619–652.

Gulati, R., and Gargiulo, M. 1999. Where do interorganizational networks come from? . *American Journal of Sociology*, *104*(5), 1439–1493.

Gulati, R., and Higgins, M. C. 2003. Which ties matter when? The contingent effects of interorganizational partnerships on IPO success. *Strategic Management Journal*, *24*(2), 127–144.

Gulati, R., Lavie, D., and Madhavan, R. R. 2011. How do networks matter? The performance effects of interorganizational networks. *Research in Organizational Behavior*, *31*, 207–224.

Guler, I., and Guillén, M. F. 2010. Home country networks and foreign expansion: Evidence from the venture capital industry. *Academy of Management Journal*, *53*(2), 390–410.

Gupta, A. K., Smith, K. G., and Shalley, C. E. 2006. The interplay between exploration and exploitation. *Academy of management journal*, 49(4), 693-706.

Hallen, B. L. 2008. The causes and consequences of the initial network positions of new organizations: From whom do entrepreneurs receive investments?. *Administrative Science Quarterly*, *53*(4), 685-718.

Hannan, M. T., and Freeman, J. 1984. Structural inertia and organizational change. *American Sociological Review*, 149-164.

Hansen, M. T., and Haas, M. R. 2001. Competing for attention in knowledge markets: Electronic document dissemination in a management consulting company. *Administrative Science Quarterly*, *46*(1), 1–28.

Haveman, H. A., and Nonnemaker, L. 2000. Competition in multiple geographic markets: The impact on growth and market entry. *Administrative Science Quarterly*, *45:* 232–267.

He, Z. L., and Wong, P. K. 2004. Exploration vs. exploitation: An empirical test of the ambidexterity hypothesis. *Organization Science*, 15(4), 481-494.

Henderson, R. M., and Clark, K. B. 1990. Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms. *Administrative Science Quarterly*, 9-30.

Henderson, R., and Mitchell, W. 1997. The interactions of organizational and competitive influences on strategy and performance. *Strategic Management Journal*, *18*(s 1), 5–14.

Hess, A. M., and Rothaermel, F. T. 2011. When are assets complementary? Star scientists, strategic alliances, and innovation in the pharmaceutical industry. *Strategic Management Journal*, 32(8), 895-909.

Hiatt, S. R., Sine, W. D., and Tolbert, P. S. 2009. From Pabst to Pepsi: The deinstitutionalization of social practices and the creation of entrepreneurial opportunities. *Administrative Science Quarterly*, *54*(4), 635–667.

Hilton, J. L., and Von Hippel, W. 1996. Stereotypes. *Annual Review of Psychology*, *47*(1), 237-271.

Hochberg, Y. V., Ljungqvist, A., and Lu, Y. 2007. Whom you know matters: Venture capital networks and investment performance. *The Journal of Finance*, *62*(1), 251–301.

Hoetker, G., & Agarwal, R. (2007). Death hurts, but it isn't fatal: The postexit diffusion of knowledge created by innovative companies. *Academy of Management Journal*, *50*(2), 446-467.

Hsieh, K. Y., amd Vermeulen, F. 2013. The structure of competition: How competition between one's rivals influences imitative market entry. *Organization Science*, *25*(1), 299-319.

Hsu, D. H. 2004. What do entrepreneurs pay for venture capital affiliation?. *The Journal of Finance*, *59*(4), 1805–1844.

Hsu, D. H., and Ziedonis, R. H. 2013. Resources as dual sources of advantage: Implications for valuing entrepreneurial-firm patents. *Strategic Management Journal*, *34*(7), 761–781.

Huygens, M., Van Den Bosch, F. A., Volberda, H. W., and Baden-Fuller, C. 2001. Co-Evolution of Firm Capabilities and Industry Competition: Investigating the Music Industry, 1877-1997. *Organization Studies*, *22*(6), 971-1011.

Inkpen, A. C., and Tsang, E. W. 2005. Social capital, networks, and knowledge transfer. *Academy of Management Review*, *30*(1), 146–165.

Jansen, J. J., Simsek, Z., and Cao, Q. 2012. Ambidexterity and performance in multiunit contexts: Cross-level moderating effects of structural and resource attributes. *Strategic Management Journal*, 33(11), 1286-1303.

Jansen, J. J., Tempelaar, M. P., Van den Bosch, F. A., and Volberda, H. W. 2009. Structural differentiation and ambidexterity: The mediating role of integration mechanisms. *Organization Science,* 20(4), 797-811.

Jansen, J. J., Van Den Bosch, F. A., and Volberda, H. W. 2006. Exploratory innovation, exploitative innovation, and performance: Effects of organizational antecedents and environmental moderators. *Management Science*, 52(11), 1661-1674.

Jehn, K. A., and Mannix, E. A. 2001. The dynamic nature of conflict: A longitudinal study of intragroup conflict and group performance. *Academy of Management Journal*, 44(2), 238-251.

Jensen, M. 2003. The role of network resources in market entry: commercial banks' entry into investment banking, 1991–1997. *Administrative Science Quarterly*, *48*(3), 466–497.

Jensen, M. 2008. The use of relational discrimination to manage market entry: When do social status and structural holes work against you?. *Academy of Management Journal*, *51*(4), 723–743.

Jensen, M. 2006. Should we stay or should we go? Accountability, status anxiety, and client defections. *Administrative Science Quarterly*, 51(1), 97–128.

Jensen, M., and Roy, A. 2008. Staging exchange partner choices: When do status and reputation matter?. *Academy of Management Journal*, *51*(3), 495–516.

Jensen, M., Kim, B. K., and Kim, H. 2011. The importance of status in markets: A market identity perspective. *Status in management and organizations*, 87–117.

Katila, R., and Ahuja, G. 2002. Something old, something new: A longitudinal study of search behavior and new product introduction. *Academy of Management Journal*, *45*(6), 1183–1194.

Keats, B. W., and Hitt, M. A. 1988. A causal model of linkages among environmental dimensions, macro organizational characteristics, and performance. *Academy of Mmanagement Journal*, *31*(3), 570–598.

Kelley, D. J., Ali, A., and Zahra, S. A. 2013. Where Do Breakthroughs Come From? Characteristics of High-Potential Inventions. *Journal of Product Innovation Management*, 30(6), 1212-1226.

Khanna, T., Gulati, R., and Nohria, N. 1998. The dynamics of learning alliances: Competition, cooperation, and relative scope. *Strategic Management Journal*, *19*(3), 193–210.

Kilduff, M., and Brass, D. J. 2010. Organizational social network research: Core ideas and key debates. *The Academy of Management Annals*, *4*(1), 317–357.

Kim, K. H., and Tsai, W. 2012. Social comparison among competing firms. *Strategic Management Journal*, *33*(2), 115-136.

Kleinbaum, A. M., Stuart, T. E., and Tushman, M. L. 2013. Discretion within constraint: Homophily and structure in a formal organization. *Organization Science*, 24(5), 1316–1336.

Kogut, B., and Zander, U. 1992. Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science*, 3(3), 383-397.

Kogut, B., Urso, P., and Walker, G. 2007. Emergent properties of a new financial market: American venture capital syndication, 1960–2005.*Management Science*, *53*(7), 1181–1198.

Korn, H. J., and Baum, J. A. 1999. Chance, imitative, and strategic antecedents to multimarket contact. *Academy of Management Journal*, *42*(2), 171–193.

Lane, P. J., and Lubatkin, M. 1998. Relative absorptive capacity and interorganizational learning. *Strategic Management Journal*, 19(5), 461-477.

Lane, P. J., and Lubatkin, M. 1998. Relative absorptive capacity and interorganizational learning. *Strategic Management Journal*, 19(5), 461–477.

Lane, P. J., Koka, B. R., and Pathak, S. 2006. The reification of absorptive capacity: a critical review and rejuvenation of the construct. *Academy of Management Review,* 31(4), 833-863.

Lavie, D. 2006. The competitive advantage of interconnected firms: An extension of the resource–based view. *Academy of Management Review*,*31*(3), 638–658.

Lavie, D., and Rosenkopf, L. 2006. Balancing exploration and exploitation in alliance formation. *Academy of Management Journal*, *49*(4), 797-818.

Lavie, D., Kang, J., and Rosenkopf, L. 2011. Balance within and across domains: the performance implications of exploration and exploitation in alliances. *Organization Science*, 22(6), 1517-1538.

Lavie, D., Stettner, U., and Tushman, M. L. 2010. Exploration and exploitation within and across organizations. *The Academy of Management Annals*, *4*(1), 109-155.

Lee, J. J. 2010. Heterogeneity, brokerage, and innovative performance: Endogenous formation of collaborative inventor networks. *Organization Science*, *21*(4), 804–822.

Lerner, J. 1994. The syndication of venture capital investments. *Financial Management*, 16–27.

Levinthal, D. A., and March, J. G. 1993. The myopia of learning. *Strategic Management Journal*, *14*(S2), 95-112.

Li, D., Eden, L., Hitt, M. A and Ireland, R. D. 2008. Friends, acquaintances, or strangers? Partner selection in R&D alliances. *Academy of Management Journal*, 51(2), 315–334.

Li, H., Zhang, Y., Li, Y., Zhou, L. A., and Zhang, W. 2012. Returnees versus locals: who perform better in china's technology entrepreneurship?. *Strategic Entrepreneurship Journal*, *6*(3), 257-272.

Li, J. J., Poppo, L., and Zhou, K. Z. 2008. Do managerial ties in China always produce value? Competition, uncertainty, and domestic vs. foreign firms. *Strategic Management Journal*, *29*(4), 383–400.

Liu, K. 2014. Human capital, social collaboration, and patent renewal within US pharmaceutical firms. *Journal of Management*, *40*(2), 616-636.

Lorange, P. J. and Ross. J. 1992. *Strategic Alliances*. Blackwell, Cambridge, MA.

Lubatkin, M. H., Simsek, Z., Ling, Y., and Veiga, J. F. 2006. Ambidexterity and performance in small-to medium-sized firms: The pivotal role of top management team behavioral integration. *Journal of Management*, 32(5), 646-672.

Lumpkin, G. T., and Dess, G. G. 1996. Clarifying the entrepreneurial orientation construct and linking it to performance. *Academy of Management Review*, 21(1), 135–172.

Lynn, F. B., Podolny, J. M., and Tao, L. 2009. A Sociological (De) Construction of the Relationship between Status and Quality. *American Journal of Sociology*, *115*(3), 755–804.

MacMillan, I., McCaffery, M. L., and Van Wijk, G. 1985. Competitors' responses to easily imitated new products — Exploring commercial banking product introductions. *Strategic Management Journal*, *6*(1), 75–86.

Malter, D. 2014. On the Causality and Cause of Returns to Organizational Status Evidence from the Grands Crus Classés of the Médoc. *Administrative Science Quarterly*, *59*(2), 271–300.

March, J. G. 1991. Exploration and exploitation in organizational learning. *Organization Science*, *2*(1), 71-87.

Marr, J. C., and Thau, S. 2014. Falling from Great (and Not-So-Great) Heights: How Initial Status Position Influences Performance after Status Loss. *Academy of Management Journal*, 57(1), 223-248.

McCutchen, W. W., Swamidass, P. M., and Teng, B. S. 2008. Strategic alliance termination and performance: The role of task complexity, nationality, and experience. *The Journal of High Technology Management Research*, 18(2), 191–202.

McPherson, M., Smith–Lovin, L., and Cook, J. M. 2001. Birds of a feather: Homophily in social networks. *Annual Review of Sociology*, 27, 415–444.

Mehra, A., Kilduff, M., and Brass, D. J. 2001. The social networks of high and low self–monitors: Implications for workplace performance. *Administrative Science Quarterly*, 46(1), 121–146.

Melero, E., and Palomeras, N. 2015. The Renaissance Man is not dead! The role of generalists in teams of inventors. *Research Policy*, 44(1), 154-167.

Merton, R. K. 1968. The Matthew effect in science. *Science*, *159*(3810), 56–63.

Mowery, D. C., Oxley, J. E., and Silverman, B. S. 1996. Strategic alliances and inter-firm knowledge transfer. *Strategic Management Journal*, *17*(S2), 77–91.

Mowery, D. C., Oxley, J. E., and Silverman, B. S. 1998. Technological overlap and inter-firm cooperation: implications for the resource–based view of the firm. *Research Policy*, *27*(5), 507–523.

Nelson, R. R., and Winter, S. G. 1982. *An evolutionary theory of economic change*. Harvard University Press.

Nerkar, A. 2003. Old is gold? The value of temporal exploration in the creation of new knowledge. *Management Science*, 49(2), 211-229.

Ocasio, W. 1997. Towards an attention–based view of the firm. *Strategic Management Journal*, *18*(6), 187–206.

Ocasio, W. 2011. Attention to attention. *Organization Science*, *22*(5), 1286–1296.

Ouchi, W. G. 1980. Markets, bureaucracies, and clans. *Administrative Science Quarterly*, 129–141.

Oxley, J. E., and Sampson, R. C. 2004. The scope and governance of international R&D alliances. *Strategic Management Journal*, 25(8-9), 723–749.

Ozmel, U., Reuer, J., and Gulati, R. 2013. Signals across Multiple Networks: How Venture Capital and Alliance Networks Affect Interorganizational Collaboration. *Academy of Management Journal*, 56(3), 852–866

Paulus, P. 2000. Groups, Teams, and Creativity: The Creative Potential of Idea-generating Groups. *Applied psychology*, 49(2), 237-262.

Penrose, E. T. 1995. *The Theory of the Growth of the Firm*. Oxford university press.

Peteraf, M. A. 1993. The cornerstones of competitive advantage: a resource-based view. *Strategic Management Journal*, *14*(3), 179–191.

Phelps, C. C. 2010. A 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., and Marsh, L. 2006. Breakthrough innovations in the US biotechnology industry: the effects of technological space and geographic origin. *Strategic Management Journal*, 27(4), 369-388.

Phillips, D. J., and Zuckerman, E. W. 2001. Middle-Status Conformity: Theoretical Restatement and Empirical Demonstration in Two Markets1. *American Journal of Sociology*, *107*(2), 379-429.

Piao, M. 2010. Thriving in the new: Implication of exploration on organizational longevity. *Journal of Management*, *36*(6), 1529-1554.

Piazza, A., and Castellucci, F. 2014. Status in organization and management theory. *Journal of Management*, *40*(1), 287–315.

Podolny, J. M. 1993. A status–based model of market competition. *American Journal of Sociology*, 829–872.

Podolny, J. M. 1994. Market uncertainty and the social character of economic exchange. *Administrative Science Quarterly*, 458-483.

Podolny, J. M. 2001. Networks as the Pipes and Prisms of the Market1.*American Journal of Sociology*, *107*(1), 33–60.

Podolny, J. M. 2005. *Status signals: A sociological study of market competition*. Princeton University Press.

Podolny, J. M., and Baron, J. N. 1997. Resources and relationships: Social networks and mobility in the workplace. *American Sociological Review*, 673–693.

Podolny, J. M., and Phillips, D. J. 1996. The dynamics of organizational status. *Industrial and Corporate Change*, *5*(2), 453–471.

Podolny, J. M., and Stuart, T. E. 1995. A role–based ecology of technological change. *American Journal of Sociology*, 1224–1260.

Podolny, J. M., Stuart, T. E., and Hannan, M. T. 1996. Networks, knowledge, and niches: Competition in the worldwide semiconductor industry, 1984–1991. *American Journal of Sociology*, 659–689.

Pollock, T. G., Lee, P. M., Jin, K., and Lashley, K. 2015. (Un) Tangled Exploring the Asymmetric Coevolution of New Venture Capital Firms' Reputation and Status. *Administrative Science Quarterly*, *60*(3), 482-517.

Porter, M. E. 1980. Competitive strategy–techniques for analysis industries and competitors. *New York: The Free Press*.

Porter, M. E. 1985. *Competitive advantage: Creating and sustaining superior performance*. Simon and Schuster.

Pouder, R., and John, C. H. S. 1996. Hot spots and blind spots: geographical clusters of firms and innovation. *Academy of Management Review*, *21*: 1192–1225.

Quintana-García, C., and Benavides-Velasco, C. A. 2008. Innovative competence, exploration and exploitation: The influence of technological diversification. *Research Policy*, *37*(3), 492-507.

Raisch, S., and Birkinshaw, J. 2008. Organizational ambidexterity: Antecedents, outcomes, and moderators. *Journal of Management*, 34(3), 375-409.

Reagans, R. E., and Zuckerman, E. W. 2008. Why knowledge does not equal power: the network redundancy trade–off. *Industrial and Corporate Change*, *17*(5), 903–944.

Reuer, J. J., Zollo, M., and Singh, H. 2002. Post-formation dynamics in strategic alliances. *Strategic Management Journal*, 23(2), 135–151.

Rider, C. I., and Tan, D. 2015. Labor market advantages of organizational status: A study of lateral partner hiring by large US law firms. *Organization Science, 26(2):* 356–372.

Rindova, V. P., Pollock, T. G., and Hayward, M. L. 2006. Celebrity firms: The social construction of market popularity. *Academy of Management Review*, *31*(1), 50-71.

Robert Baum, J., and Wally, S. 2003. Strategic decision speed and firm performance. *Strategic Management Journal*, *24*(11), 1107–1129.

Rogers, E. M. 2003. *Diffusion of Innovations*. Simon and Schuster.

Lai R., D'Amour, A., Yu, A., Sun, Y., and Fleming L. 2013) "Disambiguation and Co-authorship Networks of the U.S. Patent Inventor Database (1975 - 2010)", http://hdl.handle.net/1902.1/15705 UNF:5:RqsI3LsQEYLHkkg5jG/jRg== the Harvard Dataverse Network [Distributor] V5 [Version]

Rosenkopf, L., and McGrath, P. 2011. Advancing the conceptualization and operationalization of novelty in organizational research. *Organization Science,* 22(5), 1297-1311.

Rosenkopf, L., and Nerkar, A. 2001. Beyond local search: boundary-spanning, exploration, and impact in the optical disk industry. *Strategic Management Journal*, 22(4), 287-306.

Rubera, G., and Droge, C. 2013. Technology versus Design Innovation's Effects on Sales and Tobin's Q: The Moderating Role of Branding Strategy. *Journal of Product Innovation Management*, *30*(3), 448-464.

Sahlman, W. A. 1990. The structure and governance of venture–capital organizations. *Journal of Financial Economics*, *27*(2), 473–521.

Sasovova, Z., Mehra, A., Borgatti, S. P., and Schippers, M. C. 2010. Network churn: The effects of self–monitoring personality on brokerage dynamics. *Administrative Science Quarterly*, 55(4), 639–670.

Schilling, M. A., and Phelps, C. C. 2007. Inter-firm collaboration networks: The impact of large–scale network structure on firm innovation. *Management Science*, *53*(7), 1113–1126.

Schumpeter, J. A. 1934. *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle*. Transaction publishers.

Shipilov, A. V. 2006. Network strategies and performance of Canadian investment banks. *Academy of Management Journal*, *49*(3), 590-604.

Shipilov, A. V., and Li, S. X. 2008. Can you have your cake and eat it too? Structural holes' influence on status accumulation and market performance in collaborative networks. *Administrative Science Quarterly*, *53*(1), 73–108.

Shipilov, A. V., Li, S. X., and Greve, H. R. 2011. The prince and the pauper: Search and brokerage in the initiation of status–heterophilous ties. *Organization Science*, *22*(6), 1418–1434.

Shipilov, A., Gulati, R., Kilduff, M., Li, S., and Tsai, W. 2014. Relational pluralism within and between organizations. *Academy of Management Journal*, 57(2), 449–459.

Silverman, B. S., and Baum, J. A. 2002. Alliance–based competitive dynamics. *Academy of Management Journal*, *45*(4), 791–806.

Simcoe, T. S., and Waguespack, D. M. 2011. Status, quality, and attention: What's in a (missing) name?. *Management Science*, *57*(2), 274–290.

Singh, J. 2005. Collaborative networks as determinants of knowledge diffusion patterns. *Management Science*, 51(5), 756-770.

Singh, J. 2008. Distributed R&D, cross-regional knowledge integration and quality of innovative output. *Research Policy*, *37*(1), 77-96.

Singh, J., and Fleming, L. 2010. Lone inventors as sources of breakthroughs: Myth or reality?. *Management Science*, 56(1), 41-56.

Skilton, P. F., and Bernardes, E. 2014. Competition network structure and product market entry. *Strategic Management Journal*.

Slater, S. F., Olson, E. M., and Hult, G. T. M. 2006. The moderating influence of strategic orientation on the strategy formation capability–performance relationship. *Strategic Management Journal*, 27(12), 1221–1231

Sørensen, J. B. 2002. The strength of corporate culture and the reliability of firm performance. *Administrative Science Quarterly*, 47(1), 70–91.

Sørensen, J. B., and Stuart, T. E. 2000. Aging, obsolescence, and organizational innovation. *Administrative Science Quarterly*, *45*(1), 81–112.

Sorenson, O., and Fleming, L. 2004. Science and the diffusion of knowledge. *Research Policy*, 33(10), 1615-1634.

Sorenson, O., and Stuart, T. E. 2001. Syndication networks and the spatial distribution of venture capital investments1. *American Journal of Sociology*, *106*(6), 1546–1588.

Sorenson, O., and Stuart, T. E. 2008. Bringing the context back in: Settings and the search for syndicate partners in venture capital investment networks. *Administrative Science Quarterly*, *53*(2), 266–294.

Sorenson, O., Rivkin, J. W., and Fleming, L. 2006. Complexity, networks and knowledge flow. *Research Policy*, 35(7), 994-1017.

Staw, C. J. N. B. M., and Nemeth, C. J. 1989. The tradeoff of social control and innovation in group and organizations. *Advances in experimental social psychology*, 22, 175-210.

Stettner, U., and Lavie, D. 2014. Ambidexterity under scrutiny: Exploration and exploitation via internal organization, alliances, and acquisitions. *Strategic Management Journal,* 35(13), 1903–1929.

Stuart, T. E. 1998. Network positions and propensities to collaborate: An investigation of strategic alliance formation in a high-technology industry. *Administrative Science Quarterly*, 668-698.

Stuart, T. E. 2000. Interorganizational alliances and the performance of firms: A study of growth and innovation rates in a high–technology industry. *Strategic Management Journal*, *21*(8), 791–811.

Stuart, T. E., Hoang, H., and Hybels, R. C. 1999. Interorganizational endorsements and the performance of entrepreneurial ventures. *Administrative Science Quarterly*, *44*(2), 315–349.

Taylor, A., and Greve, H. R. 2006. Superman or the fantastic four? Knowledge combination and experience in innovative teams. *Academy of Management Journal*, *49*(4), 723-740.

Tiwana, A. 2008. Do bridging ties complement strong ties? An empirical examination of alliance ambidexterity. *Strategic Management Journal*, 29(3), 251–272.

Trajtenberg, M. 1990. A penny for your quotes: patent citations and the value of innovations. *The Rand Journal of Economics*, 172-187.

Tsai, W., Su, K. H., and Chen, M. J. 2011. Seeing through the eyes of a rival: Competitor acumen based on rival–centric perceptions. *Academy of Management Journal*, *54*(4), 761–778.

Tushman, M. L., and Reilly, O., Charles III, A. 1996. Organizations: Managing evolutionary. *California Management Review*, 38, 4.

Uotila, J., Maula, M., Keil, T., and Zahra, S. A. 2009. Exploration, exploitation, and financial performance: analysis of S&P 500 corporations. *Strategic Management Journal*, *30*(2), 221-231.

Uzzi, B. 1996. The sources and consequences of embeddedness for the economic performance of organizations: The network effect. *American Sociological Review*, 674–698.

Vagnani, G. 2012) Exploration and Long-Run Organizational Performance: The Moderating Role of Technological Interdependence. *Journal of Management*, 0149206312466146.

Van de Vrande, V. 2013. Balancing your technology-sourcing portfolio: How sourcing mode diversity enhances innovative performance. *Strategic Management Journal*, *34*(5), 610-621.

Wang, C., Rodan, S., Fruin, M., and Xu, X. 2014. Knowledge Networks, Collaboration Networks, and Exploratory Innovation. *Academy of Management Journal*, *57*(2), 484-514.

Wang, H., and Li, J. 2008. Untangling the effects of overexploration and overexploitation on organizational performance: The moderating role of environmental dynamism. *Journal of Management*, 34(5), 925-951

Wernerfelt, B. 1984. A resource-based view of the firm. *Strategic Management Journal*, *5*(2), 171–180.

White, H. C. 2002. *Markets from networks: Socioeconomic models of production*. Princeton University Press.

Wiersema, M. F., and Bowen, H. P. 2009. The use of limited dependent variable techniques in strategy research: Issues and methods. *Strategic Management Journal*, 30(6), 679-692.

Wiklund, J., and Shepherd, D. 2003) Knowledge-based resources, entrepreneurial orientation, and the performance of small and medium-sized businesses. *Strategic Management Journal*, 24(13), 1307–1314.

Wu, B., Wan, Z., and Levinthal, D. A. 2014. Complementary assets as pipes and prisms: Innovation incentives and trajectory choices. *Strategic Management Journal*.

Wuchty, S., Jones, B. F., and Uzzi, B. 2007. The increasing dominance of teams in production of knowledge. *Science*, 316(5827), 1036-1039.

Yang, H., Lin, Z. J., and Lin, Y. L. 2010. A multilevel framework of firm boundaries: firm characteristics, dyadic differences, and network attributes. *Strategic Management Journal*, 31(3), 237–261.

Yu, T., and Cannella, A. A. 2013. A comprehensive review of multimarket competition research. *Journal of Management*, *39*(1), 76-109.

Zaheer, A., and Bell, G. G. 2005. Benefiting from network position: firm capabilities, structural holes, and performance. *Strategic Management Journal*, *26*(9), 809–825.

Zaheer, A., and Soda, G. 2009. Network evolution: The origins of structural holes. *Administrative Science Quarterly*, *54*(1), 1–31.

Zahra, S. A., and Bogner, W. C. 2000. Technology strategy and software new ventures' performance: Exploring the moderating effect of the competitive environment. *Journal of Business Venturing*, *15*(2), 135-173.

Zahra, S. A., and George, G. 2002. Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review*, *27*(2), 185-203.

Zaiac, E. I., and Bazerman, M. H. 1991. Blind spots in industry and competitor analysis: Implications of inter-firm (mis) perceptions for strategic decisions. *Academy of Management Review*, *16*(1), 37–56.

Zheng, W., Singh, K., and Mitchell, W. 2014. Buffering and enabling: The impact of interlocking political ties on firm survival and sales growth. *Strategic Management Journal*, DOI: 10.1002/smj.2301.

Zuckerman, E. W. 1999. The categorical imperative: Securities analysts and the illegitimacy discount. *American Journal of Sociology*, 104(5), 1398-1438.

Zuckerman, E. W. 2000. Focusing the corporate product: Securities analysts and de-diversification. *Administrative Science Quarterly*, *45*(3), 591-619.

Summary

To obtain and maintain competitive advantage, firms need to implement appropriate innovation strategies (i.e. exploration or exploitation) and acquire status in external networks. In this dissertation, I investigate how innovation strategy, status, and network structure jointly affect the performance and behavioral propensity of firms. In particular, I combine theories on exploration and exploitation, innovation, networks, and the status-based perspective to investigate (1) how exploration interacts with status to affect the performance of high-tech firms; (2) how exploration and exploitation shape partner selection for strategic alliance; (3) how the exploration or exploitation of an invention determines its value in technology markets, and what effect team characteristics have on that value; and (4) how competition networks affect firm performance directly, and how collaboration and competition networks interplay.

The findings from the four empirical studies show that status is an important factor in terms of how exploration and exploitation affect a firm's performance and its propensity to act in certain ways. Hence, scholars should place more emphasis on the status-based approach as it is more likely to lead to a better understanding of the effects of particular strategic choices. The message for practice is that high-status firms should be wary of the signaling effect of status, and should never underrate the importance of quality and novelty.

Analysis at the invention level shows that the balance between exploration and exploitation in an invention determines its value in technology markets and the likelihood that it will become a technological breakthrough. Moreover, some important practical insights are also provided into how to compose an appropriate team to generate such inventions.

Finally, my dissertation also contributes to network theory by drawing attention to competition networks, whose effects haven't been given sufficient consideration. For managers, it suggests that, in order to create competitive advantage, firms should focus on their positions in both collaboration and competition networks.

Summary (Dutch)

Voor het behalen en behouden van concurrentievoordeel moeten bedrijven geschikte exploratieve of exploitatieve innovatiestrategieën implementeren en status verwerven in externe netwerken. In deze dissertatie onderzoek ik hoe innovatiestrategie, status en netwerkstructuur een gezamenlijk effect hebben op de prestaties en het intentioneel gedrag van bedrijven. In het bijzonder combineer ik theorieën over exploratie en exploitatie, innovatie, netwerken en het status-gebaseerde perspectief om te onderzoeken (1) hoe exploratie in interactie met status een effect heeft op de prestaties van hightech bedrijven; (2) hoe exploratie en exploitatie vorm geven aan de selectie van strategische alliantiepartners; (3) hoe de exploratie of exploitatie van een uitvinding de waarde ervan bepaalt in technologiemarkten en welk effect teameigenschappen hebben op die waarde; en (4) hoe concurrentienetwerken bedrijfsprestaties direct beïnvloeden en hoe samenwerkings- en concurrentienetwerken interacteren.

De bevindingen van de vier empirische studies tonen aan dat status een belangrijke factor is in termen van hoe exploratie en exploitatie invloed hebben op zowel bedrijfsprestaties als bedrijfsintenties om op bepaalde manieren actie te ondernemen. Wetenschappers zouden daarom meer nadruk moeten leggen op de status-gebaseerde benadering om zodoende een beter inzicht te krijgen in de effecten van bepaalde strategische keuzes. De boodschap voor de praktijk is dat bedrijven met een hoge status waakzaam moeten zijn voor de signaaleffecten van status en nooit het belang van kwaliteit en noviteit zouden moeten onderschatten. Analyse op uitvindingniveau laat zien dat de balans tussen exploratie en exploitatie in een uitvinding bepaalt wat de waarde van deze is in technologiemarkten en met welke waarschijnlijkheid de uitvinding een technologische doorbraak zal worden. Daarnaast worden enkele belangrijke praktische inzichten gegeven in hoe een geschikt team samen te stellen voor het genereren van dergelijke uitvindingen. Tot slot draagt mijn dissertatie bij aan netwerktheorie door aandacht te besteden aan concurrentienetwerken, waarvan de effecten nog zijn onderbelicht. Een belangrijke managementimplicatie is dat gefocust moet worden op de positie van een bedrijf in zowel samenwerkings- als concurrentienetwerken om concurrentievoordeel te behalen.

About the author

Pengfei Wang (1985) obtained his master degree in Entrepreneurship and Innovation in 2011 and bachelor degree in Management Science from School of Management and Chu Kochen Honors College in 2008, Zhejiang University, China. In 2011, he started his PhD at the Department of Strategy and Entrepreneurship, Rotterdam School of Management (RSM), working together with Prof. Justin Jansen and Asso. Prof. Vareska van de Vrande. As part of his PhD trajectory, he also spent three months as a visiting scholar at the Ross School of Business, University of Michigan, Ann Arbor.

Pengfei's general research interests center around innovation, entrepreneurship, networks, and status. In particular, he investigates how exploration/exploitation, status and network interact in multiple contexts. He has expertise in qualitative research methods including network analysis and multi-level analysis. His studies have been published in the *Journal of International Management* and under review with top-tier journals.

Pengfei is currently working as a post-doctor researcher at RSM, with the support of NWO VIDI grant.

Portfolio

Working papers

Dissertation-based papers:

Exploration, status and growth (with Justin Jansen, Vareska van de Vrande)

A behavioral perspective on the selection of partners in strategic alliances. (with Justin Jansen, Vareska van de Vrande)

Ambidextrous inventions, technological breakthroughs, and team composition. (with Justin Jansen, Vareska van de Vrande)

Competition closure: Interaction between competition and collaboration networks (with Justin Jansen)

Other working papers:

Not in the same boat: how status inconsistency affects research performance of business schools. (with Michael Jensen)

Crystallizing status: Corporate divestiture as a strategic response to status inconsistency. (with Michael Jensen)

Formation of distant ties: Distinction between social and relational dimensions

The transfer of status across systems: The role of audience overlap

Foreignness and syndication: Venture capital investments in emerging and developed markets

Research visit

From 2014.09 to 2014.11, research visit to the Ross School of Business, University of Michigan Ann Arbor, invited by Michael Jensen, collaborating on the project of status inconsistency

Teaching & supervising activities

Strategic business plan, RSM bachelor program, 2011-2012

Research methodology, RSM bachelor thesis, 2012-2014

Corporate spin-offs and venturing, RSM master thesis, 2013-2015

Corporate venturing, RSM master electives, 2014-2015

Venture capital investment, RSM master thesis 2015-2016

Conference attended

Wang, P., Van de Vrande, V., & Jansen, J.J.P. Exploration, status, and growth

Academy of Management Meeting 2015, Vancouver

Wang, P., Van de Vrande, V., & Jansen, J.J.P. Ambidextrous inventions, technological breakthroughs, and invention teams

Academy of Management Meeting 2015, Vancouver

Wang, P. Multi-level status: Organization's and unit's status on units' performance

Academy of Management Meeting 2014, Philadelphia.

Wang, P. Why Firm Differs in R&D Expenditure?

Academy of Management Meeting 2013, Orlando.
SIER PhD Workshop, 2013, Switzerland

Wang, P., Van de Vrande, V., & Jansen, J.J.P. Knowledge Accessing: Partners' impact on Firms' Exploration.

SEI Phd Consortium 2013, Imperial Business School
SMS Lake Geneva special conference 2013, Lausanne
Open and User Innovation Workshop 2012, HBS

PhD course

Publishing strategy
English
Advanced topics of research in strategy
Topics in philosophy of science
Research methodology and measurements
Eden doctoral seminar on strategic management
Advanced survey methods
Social networks and market competition
Strategic entrepreneurship
Open innovation and open business models

Language skills and certificates

STATA
MS ACCESS
TOFEL
GMAT
Cambridge English Proficiency

The ERIM PhD Series

The ERIM PhD Series contains PhD dissertations in the field of Research in Management defended at Erasmus University Rotterdam and supervised by senior researchers affiliated to the Erasmus Research Institute of Management (ERIM). All dissertations in the ERIM PhD Series are available in full text through the ERIM Electronic Series Portal: http://repub.eur.nl/pub. ERIM is the joint research institute of the Rotterdam School of Management (RSM) and the Erasmus School of Economics at the Erasmus University Rotterdam (EUR).

Dissertations in the last five years

Abbink, E.J., *Crew Management in Passenger Rail Transport*, Promotors: Prof. L.G. Kroon & Prof. A.P.M. Wagelmans, EPS-2014-325-LIS, http://repub.eur.nl/pub/76927

Acar, O.A., *Crowdsourcing for Innovation: Unpacking Motivational, Knowledge and Relational Mechanisms of Innovative Behavior in Crowdsourcing Platforms*, Promotor: Prof. J.C.M. van den Ende, EPS-2014-321-LIS, http://repub.eur.nl/pub/76076

Akin Ates, M., *Purchasing and Supply Management at the Purchase Category Level: strategy, structure and performance*, Promotors: Prof. J.Y.F. Wynstra & Dr E.M. van Raaij, EPS-2014-300-LIS, http://repub.eur.nl/pub/50283

Akpinar, E., *Consumer Information Sharing*, Promotor: Prof. A. Smidts, EPS-2013-297-MKT, http://repub.eur.nl/pub/50140

Alexander, L., *People, Politics, and Innovation: A Process Perspective*, Promotors: Prof. H.G. Barkema & Prof. D.L. van Knippenberg, EPS-2014-331-S&E, http://repub.eur.nl/pub/77209

Almeida e Santos Nogueira, R.J. de, *Conditional Density Models Integrating Fuzzy and Probabilistic Representations of Uncertainty*, Promotors: Prof. U. Kaymak & Prof. J.M.C. Sousa, EPS-2014-310-LIS, http://repub.eur.nl/pub/51560

Bannouh, K., *Measuring and Forecasting Financial Market Volatility using High-frequency Data*, Promotor: Prof. D.J.C. van Dijk, EPS-2013-273-F&A, http://repub.eur.nl/pub/38240

Ben-Menahem, S.M., *Strategic Timing and Proactiveness of Organizations*, Promotors: Prof. H.W. Volberda & Prof. F.A.J. van den Bosch, EPS-2013-278-S&E, http://repub.eur.nl/pub/39128

Benning, T.M., *A Consumer Perspective on Flexibility in Health Care: Priority Access Pricing and Customized Care*, Promotor: Prof. B.G.C. Dellaert, EPS-2011-241-MKT, http://repub.eur.nl/pub/23670

Benschop, N, *Biases in Project Escalation: Names, frames & construal levels*, Promotors: Prof. K.I.M. Rhode, Prof. H.R. Commandeur, Prof. M.Keil & Dr A.L.P. Nuijten, EPS-2015-375-S&E, hdl.handle.net/1765/79408

Berg, W.E. van den, *Understanding Salesforce Behavior using Genetic Association Studies*, Promotor: Prof. W.J.M.I. Verbeke, EPS-2014-311-MKT, http://repub.eur.nl/pub/51440

Betancourt, N.E., *Typical Atypicality: Formal and Informal Institutional Conformity, Deviance, and Dynamics*, Promotor: Prof. B. Krug, EPS-2012-262-ORG, http://repub.eur.nl/pub/32345

Bliek, R. de, *Empirical Studies on the Economic Impact of Trust*, Promotor: Prof. J. Veenman & Prof. Ph.H.B.F. Franses, EPS-2015-324-ORG, http://repub.eur.nl/pub/78159

Blitz, D.C., *Benchmarking Benchmarks*, Promotors: Prof. A.G.Z. Kemna & Prof. W.F.C. Verschoor, EPS-2011-225-F&A, http://repub.eur.nl/pub/22624

Boons, M., *Working Together Alone in the Online Crowd: The Effects of Social Motivationsand Individual Knowledge Backgrounds on the Participation and Performance of Members of Online Crowdsourcing Platforms*, Promotors: Prof. H.G. Barkema & Dr D.A. Stam, EPS-2014-306-S&E, http://repub.eur.nl/pub/50711

Brazys, J., *Aggregated Marcoeconomic News and Price Discovery*, Promotor: Prof. W.F.C. Verschoor, EPS-2015-351-F&A, http://repub.eur.nl/pub/78243

Burger, M.J., *Structure and Cooptition in Urban Networks*, Promotors: Prof. G.A. van der Knaap & Prof. H.R. Commandeur, EPS-2011-243-ORG, http://repub.eur.nl/pub/26178

Byington, E., *Exploring Coworker Relationships: Antecedents and Dimensions of Interpersonal Fit,Coworker Satisfaction, and Relational Models*, Promotor: Prof. D.L. van Knippenberg, EPS-2013-292-ORG, http://repub.eur.nl/pub/41508

Camacho, N.M., *Health and Marketing: Essays on Physician and Patient Decision-Making*, Promotor: Prof. S. Stremersch, EPS-2011-237-MKT, http://repub.eur.nl/pub/23604

Cancurtaran, P., *Essays on Accelerated Product Development*, Promotors: Prof. F. Langerak & Prof.G.H. van Bruggen, EPS-2014-317-MKT, http://repub.eur.nl/pub/76074

Caron, E.A.M., *Explanation of Exceptional Values in Multi-dimensional Business Databases*, Promotors: Prof. H.A.M. Daniels & Prof. G.W.J. Hendrikse, EPS-2013-296-LIS, http://repub.eur.nl/pub/50005

Carvalho, L. de, *Knowledge Locations in Cities: Emergence and Development Dynamics*, Promotor: Prof. L. Berg, EPS-2013-274-S&E, http://repub.eur.nl/pub/38449

Consiglio, I., *Others: Essays on Interpersonal and Consumer Behavior*, Promotor: Prof. S.M.J. van Osselaer, EPS-2016-366-MKT, http://repub.eur.nl/pub/79820

Cox, R.H.G.M., *To Own, To Finance, and To Insure - Residential Real Estate Revealed*, Promotor: Prof. D. Brounen, EPS-2013-290-F&A, http://repub.eur.nl/pub/40964

Deichmann, D., *Idea Management: Perspectives from Leadership, Learning, and Network Theory*, Promotor: Prof. J.C.M. van den Ende, EPS-2012-255-ORG, http://repub.eur.nl/pub/31174

Deng, W., *Social Capital and Diversification of Cooperatives*, Promotor: Prof. G.W.J. Hendrikse, EPS-2015-341-ORG, http://repub.eur.nl/pub/77449

Desmet, P.T.M., *In Money we Trust? Trust Repair and the Psychology of Financial Compensations*, Promotor: Prof. D. de Cremer, EPS-2011-232-ORG, http://repub.eur.nl/pub/23268

Dollevoet, T.A.B., *Delay Management and Dispatching in Railways*, Promotor: Prof. A.P.M. Wagelmans, EPS-2013-272-LIS, http://repub.eur.nl/pub/38241

Doorn, S. van, *Managing Entrepreneurial Orientation*, Promotors: Prof. J.J.P. Jansen, Prof. F.A.J. van den Bosch, & Prof. H.W. Volberda, EPS-2012-258-STR, http://repub.eur.nl/pub/32166

Douwens-Zonneveld, M.G., *Animal Spirits and Extreme Confidence: No Guts, No Glory?* Promotor: Prof. W.F.C. Verschoor, EPS-2012-257-F&A, http://repub.eur.nl/pub/31914

Duca, E., *The Impact of Investor Demand on Security Offerings*, Promotor: Prof. A. de Jong, EPS-2011-240-F&A, http://repub.eur.nl/pub/26041

Duyvesteyn, J.G. *Empirical Studies on Sovereign Fixed Income Markets,* Promotors: Prof. P.Verwijmeren & Prof. M.P.E. Martens, EPS-2015-361-F&A, hdl.handle.net/1765/79033

Duursema, H., *Strategic Leadership: Moving Beyond the Leader-Follower Dyad*, Promotor: Prof. R.J.M. van Tulder, EPS-2013-279-ORG, http://repub.eur.nl/pub/39129

Eck, N.J. van, *Methodological Advances in Bibliometric Mapping of Science*, Promotor: Prof. R. Dekker, EPS-2011-247-LIS, http://repub.eur.nl/pub/26509

Elemes, A, *Studies on Determinants and Consequences of Financial Reporting Quality,* Promotor: Prof. E.Peek, EPS-2015-354-F&A, http://hdl.handle.net/1765/79037

Ellen, S. ter, *Measurement, Dynamics, and Implications of Heterogeneous Beliefs in Financial Markets*, Promotor: Prof. W.F.C. Verschoor, EPS-2015-343-F&A, http://repub.eur.nl/pub/78191

Erlemann, C., *Gender and Leadership Aspiration: The Impact of the Organizational Environment*, Promotor: Prof. D.L. van Knippenberg, EPS-2016-376-ORG, http://repub.eur.nl/pub/79409

Eskenazi, P.I., *The Accountable Animal*, Promotor: Prof. F.G.H. Hartmann, EPS-2015-355-F&A, http://repub.eur.nl/pub/78300

Essen, M. van, *An Institution-Based View of Ownership*, Promotors: Prof. J. van Oosterhout & Prof. G.M.H. Mertens, EPS-2011-226-ORG, http://repub.eur.nl/pub/22643

Evangelidis, I., *Preference Construction under Prominence*, Promotor: Prof. S.M.J. van Osselaer, EPS-2015-340-MKT, http://repub.eur.nl/pub/78202

Faber, N., *Structuring Warehouse Management*, Promotors: Prof. MB.M. de Koster & Prof. Ale Smidts, EPS-2015-336-LIS, http://repub.eur.nl/pub/78603

Fernald, K., *The Waves of Biotechnological Innovation in Medicine: Interfirm Cooperation Effects and a Venture Capital Perspective,* Promotors: Prof. E.Claassen, Prof. H.P.G. Pennings & Prof. H.R. Commandeur, EPS-2015-371-S&E, http://hdl.handle.net/1765/79120

Fourne, S.P., *Managing Organizational Tensions: A Multi-Level Perspective on Exploration, Exploitation and Ambidexterity*, Promotors: Prof. J.J.P. Jansen & Prof. S.J. Magala, EPS-2014-318-S&E, http://repub.eur.nl/pub/76075

Gharehgozli, A.H., *Developing New Methods for Efficient Container Stacking Operations*, Promotor: Prof. M.B.M. de Koster, EPS-2012-269-LIS, http://repub.eur.nl/pub/37779

Gils, S. van, *Morality in Interactions: On the Display of Moral Behavior by Leaders and Employees*, Promotor: Prof. D.L. van Knippenberg, EPS-2012-270-ORG, http://repub.eur.nl/pub/38027

Ginkel-Bieshaar, M.N.G. van, *The Impact of Abstract versus Concrete Product Communications on Consumer Decision-making Processes*, Promotor: Prof. B.G.C. Dellaert, EPS-2012-256-MKT, http://repub.eur.nl/pub/31913

Gkougkousi, X., *Empirical Studies in Financial Accounting*, Promotors: Prof. G.M.H. Mertens & Prof. E. Peek, EPS-2012-264-F&A, http://repub.eur.nl/pub/37170

Glorie, K.M., *Clearing Barter Exchange Markets: Kidney Exchange and Beyond*, Promotors: Prof. A.P.M. Wagelmans & Prof. J.J. van de Klundert, EPS-2014-329-LIS, http://repub.eur.nl/pub/77183

Hekimoglu, M., *Spare Parts Management of Aging Capital Products,* Promotor: Prof. R. Dekker, EPS-2015-368-LIS, http://hdl.handle.net/1765/79092

Heij, C.V., *Innovating beyond Technology. Studies on how management innovation, co-creation and business model innovation contribute to firm's (innovation) performance*, Promotors: Prof. F.A.J. van den Bosch & Prof. H.W. Volberda, EPS-2012-370-STR, http://repub.eur.nl/pub/78651

Heyde Fernandes, D. von der, *The Functions and Dysfunctions of Reminders*, Promotor: Prof. S.M.J. van Osselaer, EPS-2013-295-MKT, http://repub.eur.nl/pub/41514

Heyden, M.L.M., *Essays on Upper Echelons & Strategic Renewal: A Multilevel Contingency Approach*, Promotors: Prof. F.A.J. van den Bosch & Prof. H.W. Volberda, EPS-2012-259-STR, http://repub.eur.nl/pub/32167

Hoever, I.J., *Diversity and Creativity*, Promotor: Prof. D.L. van Knippenberg, EPS-2012-267-ORG, http://repub.eur.nl/pub/37392

Hogenboom, A.C., *Sentiment Analysis of Text Guided by Semantics and Structure,* Promotors: Prof. U. Kaymak & Prof. F.M.G. de Jong, EPS-2015-369-LIS, http://hdl.handle.net/1765/79034

Hogenboom, F.P., *Automated Detection of Financial Events in News Text*, Promotors: Prof. U. Kaymak & Prof. F.M.G. de Jong, EPS-2014-326-LIS, http://repub.eur.nl/pub/77237

Hollen, R.M.A.*, Exploratory Studies into Strategies to Enhance Innovation-Driven International Competitiveness in a Port Context: Toward Ambidextrous Ports,* Promotors: Prof. F.A.J. Van Den Bosch & Prof. H.W.Volberda, EPS-2015-372-S&E, hdl.handle.net/1765/78881

Hoogendoorn, B., *Social Entrepreneurship in the Modern Economy: Warm Glow, Cold Feet*, Promotors: Prof. H.P.G. Pennings & Prof. A.R. Thurik, EPS-2011-246-STR, http://repub.eur.nl/pub/26447

Hoogervorst, N., *On The Psychology of Displaying Ethical Leadership: A Behavioral Ethics Approach*, Promotors: Prof. D. de Cremer & Dr M. van Dijke, EPS-2011-244-ORG, http://repub.eur.nl/pub/26228

Hout, D.H. van, *Measuring Meaningful Differences: Sensory Testing Based Decision Making in an Industrial Context; Applications of Signal Detection Theory and Thurstonian Modelling*, Promotors: Prof. P.J.F. Groenen & Prof. G.B. Dijksterhuis, EPS-2014-304-MKT, http://repub.eur.nl/pub/50387

Houwelingen, G.G. van, *Something To Rely On*, Promotors: Prof. D. de Cremer & Prof. M.H. van Dijke, EPS-2014-335-ORG, http://repub.eur.nl/pub/77320

Hurk, E. van der, *Passengers, Information, and Disruptions*, Promotors: Prof. L.G. Kroon & Prof. P.H.M. Vervest, EPS-2015-345-LIS, http://repub.eur.nl/pub/78275

Hytonen, K.A., *Context Effects in Valuation, Judgment and Choice: A Neuroscientific Approach*, Promotor: Prof. A. Smidts, EPS-2011-252-MKT, http://repub.eur.nl/pub/30668

Iseger, P. den, *Fourier and Laplace Transform Inversion with Applications in Finance*, Promotor: Prof. R. Dekker, EPS-2014-322-LIS, http://repub.eur.nl/pub/76954

Jaarsveld, W.L. van, *Maintenance Centered Service Parts Inventory Control*, Promotor: Prof. R. Dekker, EPS-2013-288-LIS, http://repub.eur.nl/pub/39933

Jalil, M.N., *Customer Information Driven After Sales Service Management: Lessons from Spare Parts Logistics*, Promotor: Prof. L.G. Kroon, EPS-2011-222-LIS, http://repub.eur.nl/pub/22156

Kappe, E.R., *The Effectiveness of Pharmaceutical Marketing*, Promotor: Prof. S. Stremersch, EPS-2011-239-MKT, http://repub.eur.nl/pub/23610

Karreman, B., *Financial Services and Emerging Markets*, Promotors: Prof. G.A. van der Knaap & Prof. H.P.G. Pennings, EPS-2011-223-ORG, http://repub.eur.nl/pub/22280

Khanagha, S., *Dynamic Capabilities for Managing Emerging Technologies*, Promotor: Prof. H.W. Volberda, EPS-2014-339-S&E, http://repub.eur.nl/pub/77319

Kil, J., *Acquisitions Through a Behavioral and Real Options Lens*, Promotor: Prof. H.T.J. Smit, EPS-2013-298-F&A, http://repub.eur.nl/pub/50142

Klooster, E. van ’t, *Travel to Learn: the Influence of Cultural Distance on Competence Development in Educational Travel*, Promotors: Prof. F.M. Go & Prof. P.J. van Baalen, EPS-2014-312-MKT, http://repub.eur.nl/pub/51462

Koendjbiharie, S.R., *The Information-Based View on Business Network Performance: Revealing the Performance of Interorganizational Networks*, Promotors: Prof. H.W.G.M. van Heck & Prof. P.H.M. Vervest, EPS-2014-315-LIS, http://repub.eur.nl/pub/51751

Koning, M., *The Financial Reporting Environment: The Role of the Media, Regulators and Auditors*, Promotors: Prof. G.M.H. Mertens & Prof. P.G.J. Roosenboom, EPS-2014-330-F&A, http://repub.eur.nl/pub/77154

Konter, D.J., *Crossing Borders with HRM: An Inquiry of the Influence of Contextual Differences in the Adoption and Effectiveness of HRM*, Promotors: Prof. J. Paauwe & Dr L.H. Hoeksema, EPS-2014-305-ORG, http://repub.eur.nl/pub/50388

Korkmaz, E., *Bridging Models and Business: Understanding Heterogeneity in Hidden Drivers of Customer Purchase Behavior*, Promotors: Prof. S.L. van de Velde & Prof. D. Fok, EPS-2014-316-LIS, http://repub.eur.nl/pub/76008

Kroezen, J.J., *The Renewal of Mature Industries: An Examination of the Revival of the Dutch Beer Brewing Industry*, Promotor: Prof. P.P.M.A.R. Heugens, EPS-2014-333-S&E, http://repub.eur.nl/pub/77042

Kysucky, V., *Access to Finance in a Cros-Country Context*, Promotor: Prof.dr. L. Norden, EPS-2015-350-F&A, http://repub.eur.nl/pub/78225

Lam, K.Y., *Reliability and Rankings*, Promotor: Prof. Ph.H.B.F. Franses, EPS-2011-230-MKT, http://repub.eur.nl/pub/22977

Lander, M.W., *Profits or Professionalism? On Designing Professional Service Firms*, Promotors: Prof. J. van Oosterhout & Prof. P.P.M.A.R. Heugens, EPS-2012-253-ORG, http://repub.eur.nl/pub/30682

Langhe, B. de, *Contingencies: Learning Numerical and Emotional Associations in an Uncertain World*, Promotors: Prof. B. Wierenga & Prof. S.M.J. van Osselaer, EPS-2011-236-MKT, http://repub.eur.nl/pub/23504

Lee, C.I.S.G, *Big Data in Management Research: Exploring New Avenues*, Promotors: Prof. S.J. Magala & Dr W.A. Felps, EPS-2016-365-ORG, http://repub.eur.nl/pub/79818

Legault-Tremblay, P.O., Corporate Governance During Market Transition: Heterogeneous responses to Institution Tensions in China, Promotor: Prof. B. Krug, EPS-2015-362-ORG, http://repub.eur.nl/pub/78649

Lenoir, A.S. *Are You Talking to Me? Addressing Consumers in a Globalised World,* Promotors: Prof. S. Puntoni & Prof. S.M.J. van Osselaer, EPS-2015-363-MKT, http://hdl.handle.net/1765/79036

Leunissen, J.M., *All Apologies: On the Willingness of Perpetrators to Apologize*, Promotors: Prof. D. de Cremer & Dr. M. van Dijke, EPS-2014-301-ORG, http://repub.eur.nl/pub/50318

Li, D., *Supply Chain Contracting for After-sales Service and Product Support*, Promotor: Prof. M.B.M. de Koster, EPS-2015-347-LIS, http://repub.eur.nl/pub/78526

Li, Z., *Irrationality: What, Why and How*, Promotor(s): Prof. H. Bleichrodt, Prof. P.P. Wakker, & Prof. K.I.M. Rohde, EPS-2014-338-MKT, http://repub.eur.nl/pub/77205

Liang, Q.X., *Governance, CEO Identity, and Quality Provision of Farmer Cooperatives*, Promotor: Prof. G.W.J. Hendrikse, EPS-2013-281-ORG, http://repub.eur.nl/pub/39253

Liket, K., *Why 'Doing Good' is not Good Enough: Essays on Social Impact Measurement*, Promotors: Prof. H.R. Commandeur & Dr K.E.H. Maas, EPS-2014-307-STR, http://repub.eur.nl/pub/51130

Loos, M.J.H.M. van der, *Molecular Genetics and Hormones: New Frontiers in Entrepreneurship Research*, Promotors: Prof. A.R. Thurik, Prof. P.J.F. Groenen, & Prof. A. Hofman, EPS-2013-287-S&E, http://repub.eur.nl/pub/40081

Lovric, M., *Behavioral Finance and Agent-Based Artificial Markets*, Promotors: Prof. J. Spronk & Prof. U. Kaymak, EPS-2011-229-F&A, http://repub.eur.nl/pub/22814

Lu, Y., *Data-Driven Decision Making in Auction Markets*, Promotors: Prof. H.W.G.M. van Heck & Prof. W. Ketter, EPS-2014-314-LIS, http://repub.eur.nl/pub/51543

Ma, Y., *The Use of Advanced Transportation Monitoring Data for Official Statistics,* Promotors: Prof. L.G. Kroon and Dr Jan van Dalen, EPS-2016-391-LIS, hdl.handle.net/1765/80174

Manders, B., *Implementation and Impact of ISO 9001*, Promotor: Prof. K. Blind, EPS-2014-337-LIS, http://repub.eur.nl/pub/77412

Markwat, T.D., *Extreme Dependence in Asset Markets Around the Globe*, Promotor: Prof. D.J.C. van Dijk, EPS-2011-227-F&A, http://repub.eur.nl/pub/22744

Mees, H., *Changing Fortunes: How China's Boom Caused the Financial Crisis*, Promotor: Prof. Ph.H.B.F. Franses, EPS-2012-266-MKT, http://repub.eur.nl/pub/34930

Mell, J.N., *Connecting Minds: On The Role of Metaknowledge in Knowledge Coordination*, Promotor: Prof. D.L. van Knippenberg, EPS-2015-359-ORG, http://hdl.handle.net/1765/78951

Meuer, J., *Configurations of Inter-firm Relations in Management Innovation: A Study in China's Biopharmaceutical Industry*, Promotor: Prof. B. Krug, EPS-2011-228-ORG, http://repub.eur.nl/pub/22745

Micheli, M.R., *Business Model Innovation: A Journey across Managers' Attention and Inter-Organizational Networks*, Promotor: Prof. J.J.P. Jansen, EPS-2015-344-S&E, http://repub.eur.nl/pub/78241

Mihalache, O.R., *Stimulating Firm Innovativeness: Probing the Interrelations between Managerial and Organizational Determinants*, Promotors: Prof. J.J.P. Jansen, Prof. F.A.J. van den Bosch, & Prof. H.W. Volberda, EPS-2012-260-S&E, http://repub.eur.nl/pub/32343

Milea, V., *News Analytics for Financial Decision Support*, Promotor: Prof. U. Kaymak, EPS-2013-275-LIS, http://repub.eur.nl/pub/38673

Naumovska, I., *Socially Situated Financial Markets: A Neo-Behavioral Perspective on Firms, Investors and Practices*, Promotors: Prof. P.P.M.A.R. Heugens & Prof. A. de Jong, EPS-2014-319-S&E, http://repub.eur.nl/pub/76084

Nielsen, L.K., *Rolling Stock Rescheduling in Passenger Railways: Applications in short term planning and in disruption management*, Promotor: Prof. L.G. Kroon, EPS-2011-224-LIS, http://repub.eur.nl/pub/22444

Nuijten, A.L.P., *Deaf Effect for Risk Warnings: A Causal Examination applied to Information Systems Projects*, Promotors: Prof. G.J. van der Pijl, Prof. H.R. Commandeur & Prof. M. Keil, EPS-2012-263-S&E, http://repub.eur.nl/pub/34928

Oord, J.A. van, *Essays on Momentum Strategies in Finance,* Promotor: Prof. H.K. van Dijk, EPS-2016-380-F&A, hdl.handle.net/1765/80036

Osadchiy, S.E., *The Dynamics of Formal Organization: Essays on bureaucracy and formal rules*, Promotor: Prof. P.P.M.A.R. Heugens, EPS-2011-231-ORG, http://repub.eur.nl/pub/23250

Ozdemir, M.N., *Project-level Governance, Monetary Incentives, and Performance in Strategic R&D Alliances*, Promotor: Prof. J.C.M. van den Ende, EPS-2011-235-LIS, http://repub.eur.nl/pub/23550

Peers, Y., *Econometric Advances in Diffusion Models*, Promotor: Prof. Ph.H.B.F. Franses, EPS-2011-251-MKT, http://repub.eur.nl/pub/30586

Peters, M., *Machine Learning Algorithms for Smart Electricity Markets*, Promotor: Prof. W. Ketter, EPS-2014-332-LIS, http://repub.eur.nl/pub/77413

Porck, J., *No Team is an Island: An Integrative View of Strategic Consensus between Groups*, Promotors: Prof. P.J.F. Groenen & Prof. D.L. van Knippenberg, EPS-2013-299-ORG, http://repub.eur.nl/pub/50141

Porras Prado, M., *The Long and Short Side of Real Estate, Real Estate Stocks, and Equity*, Promotor: Prof. M.J.C.M. Verbeek, EPS-2012-254-F&A, http://repub.eur.nl/pub/30848

Poruthiyil, P.V., *Steering Through: How organizations negotiate permanent uncertainty and unresolvable choices*, Promotors: Prof. P.P.M.A.R. Heugens & Prof. S.J. Magala, EPS-2011-245-ORG, http://repub.eur.nl/pub/26392

Pourakbar, M., *End-of-Life Inventory Decisions of Service Parts*, Promotor: Prof. R. Dekker, EPS-2011-249-LIS, http://repub.eur.nl/pub/30584

Pronker, E.S., *Innovation Paradox in Vaccine Target Selection*, Promotors: Prof. H.J.H.M. Claassen & Prof. H.R. Commandeur, EPS-2013-282-S&E, http://repub.eur.nl/pub/39654

Protzner, S. *Mind the gap between demand and supply: A behavioral perspective on demand forecasting,* Promotors: Prof. S.L. van de Velde & Dr L. Rook, EPS-2015-364-LIS, *http*://repub.eur.nl/pub/79355

Pruijssers, J.K., *An Organizational Perspective on Auditor Conduct*, Promotors: Prof. J. van Oosterhout & Prof. P.P.M.A.R. Heugens, EPS-2015-342-S&E, http://repub.eur.nl/pub/78192

Retel Helmrich, M.J., *Green Lot-Sizing*, Promotor: Prof. A.P.M. Wagelmans, EPS-2013-291-LIS, http://repub.eur.nl/pub/41330

Rietdijk, W.J.R. *The Use of Cognitive Factors for Explaining Entrepreneurship,* Promotors: Prof. A.R. Thurik & Prof. I.H.A. Franken, EPS-2015-356-S&E, http://repub.eur.nl/pub/79817

Rietveld, N., *Essays on the Intersection of Economics and Biology*, Promotors: Prof. A.R. Thurik, Prof. Ph.D. Koellinger, Prof. P.J.F. Groenen, & Prof. A. Hofman, EPS-2014-320-S&E, http://repub.eur.nl/pub/76907

Rijsenbilt, J.A., *CEO Narcissism: Measurement and Impact*, Promotors: Prof. A.G.Z. Kemna & Prof. H.R. Commandeur, EPS-2011-238-STR, http://repub.eur.nl/pub/23554

Rösch, D. *Market Efficiency and Liquidity,* Promotor: Prof. M.A. van Dijk, EPS-2015-353-F&A, http://hdl.handle.net/1765/79121

Roza-van Vuren, M.W., *The Relationship between Offshoring Strategies and Firm Performance: Impact of innovation, absorptive capacity and firm size*, Promotors: Prof. H.W. Volberda & Prof. F.A.J. van den Bosch, EPS-2011-214-STR, http://repub.eur.nl/pub/22155

Rubbaniy, G., *Investment Behaviour of Institutional Investors*, Promotor: Prof. W.F.C. Verschoor, EPS-2013-284-F&A, http://repub.eur.nl/pub/40068

Schoonees, P. *Methods for Modelling Response Styles*, Promotor: Prof.dr P.J.F. Groenen, EPS-2015-348-MKT, http://repub.eur.nl/pub/79327

Schouten, M.E., *The Ups and Downs of Hierarchy: the causes and consequences of hierarchy struggles and positional loss*, Promotors; Prof. D.L. van Knippenberg & Dr L.L. Greer, EPS-2016-386-ORG, http://repub.eur.nl/pub/80059

Shahzad, K., *Credit Rating Agencies, Financial Regulations and the Capital Markets*, Promotor: Prof. G.M.H. Mertens, EPS-2013-283-F&A, http://repub.eur.nl/pub/39655

Sousa, M.J.C. de, *Servant Leadership to the Test: New Perspectives and Insights*, Promotors: Prof. D.L. van Knippenberg & Dr D. van Dierendonck, EPS-2014-313-ORG, http://repub.eur.nl/pub/51537

Spliet, R., *Vehicle Routing with Uncertain Demand*, Promotor: Prof. R. Dekker, EPS-2013-293-LIS, http://repub.eur.nl/pub/41513

Staadt, J.L., *Leading Public Housing Organisation in a Problematic Situation: A Critical Soft Systems Methodology Approach*, Promotor: Prof. S.J. Magala, EPS-2014-308-ORG, http://repub.eur.nl/pub/50712

Stallen, M., *Social Context Effects on Decision-Making: A Neurobiological Approach*, Promotor: Prof. A. Smidts, EPS-2013-285-MKT, http://repub.eur.nl/pub/39931

Tarakci, M., *Behavioral Strategy: Strategic Consensus, Power and Networks*, Promotor: Prof. D.L. van Knippenberg & Prof. P.J.F. Groenen, EPS-2013-280-ORG, http://repub.eur.nl/pub/39130

Teixeira de Vasconcelos, M., *Agency Costs, Firm Value, and Corporate Investment*, Promotor: Prof. P.G.J. Roosenboom, EPS-2012-265-F&A, http://repub.eur.nl/pub/37265

Troster, C., *Nationality Heterogeneity and Interpersonal Relationships at Work*, Promotor: Prof. D.L. van Knippenberg, EPS-2011-233-ORG, http://repub.eur.nl/pub/23298

Tsekouras, D., *No Pain No Gain: The Beneficial Role of Consumer Effort in Decision-Making*, Promotor: Prof. B.G.C. Dellaert, EPS-2012-268-MKT, http://repub.eur.nl/pub/37542

Tuijl, E. van, *Upgrading across Organisational and Geographical Configurations*, Promotor: Prof. L. van den Berg, EPS-2015-349-S&E, http://repub.eur.nl/pub/78224

Tuncdogan, A., *Decision Making and Behavioral Strategy: The Role of Regulatory Focus in Corporate Innovation Processes*, Promotors: Prof. F.A.J. van den Bosch, Prof. H.W. Volberda, & Prof. T.J.M. Mom, EPS-2014-334-S&E, http://repub.eur.nl/pub/76978

Uijl, S. den, *The Emergence of De-facto Standards*, Promotor: Prof. K. Blind, EPS-2014-328-LIS, http://repub.eur.nl/pub/77382

Vagias, D., *Liquidity, Investors and International Capital Markets*, Promotor: Prof. M.A. van Dijk, EPS-2013-294-F&A, http://repub.eur.nl/pub/41511

Veelenturf, L.P., *Disruption Management in Passenger Railways: Models for Timetable, Rolling Stock and Crew Rescheduling*, Promotor: Prof. L.G. Kroon, EPS-2014-327-LIS, http://repub.eur.nl/pub/77155

Venus, M., *Demystifying Visionary Leadership: In search of the essence of effective vision communication*, Promotor: Prof. D.L. van Knippenberg, EPS-2013-289-ORG, http://repub.eur.nl/pub/40079

Vermeer, W., *Propagation in Networks:The impact of information processing at the actor level on system-wide propagation dynamics,* Promotor: Prof. P.H.M.Vervest, EPS-2015-373-LIS, http://repub.eur.nl/pub/79325

Versluis, I., *Prevention of the Portion Size Effect*, Promotors: Prof. Ph.H.B.F. Franses & Dr E.K. Papies, EPS-2016-382-MKT, http://repub.eur.nl/pub/79880

Visser, V.A., *Leader Affect and Leadership Effectiveness: How leader affective displays influence follower outcomes*, Promotor: Prof. D.L. van Knippenberg, EPS-2013-286-ORG, http://repub.eur.nl/pub/40076

Vlam, A.J., *Customer First? The Relationship between Advisors and Consumers of Financial Products*, Promotor: Prof. Ph.H.B.F. Franses, EPS-2011-250-MKT, http://repub.eur.nl/pub/30585

Vries, J. de, *Behavioral Operations in Logistics,* Promotors: Prof. M.B.M de Koster & Prof. D.A. Stam, EPS-2015-374-LIS, http://repub.eur.nl/pub/79705

Waltman, L., *Computational and Game-Theoretic Approaches for Modeling Bounded Rationality*, Promotors: Prof. R. Dekker & Prof. U. Kaymak, EPS-2011-248-LIS, http://repub.eur.nl/pub/26564

Wang, T., *Essays in Banking and Corporate Finance*, Promotors: Prof. L. Norden & Prof. P.G.J. Roosenboom, EPS-2015-352-F&A, http://repub.eur.nl/pub/78301

Wang, Y., *Information Content of Mutual Fund Portfolio Disclosure*, Promotor: Prof. M.J.C.M. Verbeek, EPS-2011-242-F&A, http://repub.eur.nl/pub/26066

Wang, Y., *Corporate Reputation Management: Reaching Out to Financial Stakeholders*, Promotor: Prof. C.B.M. van Riel, EPS-2013-271-ORG, http://repub.eur.nl/pub/38675

Weenen, T.C., *On the Origin and Development of the Medical Nutrition Industry*, Promotors: Prof. H.R. Commandeur & Prof. H.J.H.M. Claassen, EPS-2014-309-S&E, http://repub.eur.nl/pub/51134

Wolfswinkel, M., *Corporate Governance, Firm Risk and Shareholder Value*, Promotor: Prof. A. de Jong, EPS-2013-277-F&A, http://repub.eur.nl/pub/39127

Yang, S., *Information Aggregation Efficiency of Prediction Markets*, Promotor: Prof. H.W.G.M. van Heck, EPS-2014-323-LIS, http://repub.eur.nl/pub/77184

Zaerpour, N., *Efficient Management of Compact Storage Systems*, Promotor: Prof. M.B.M. de Koster, EPS-2013-276-LIS, http://repub.eur.nl/pub/38766

Zhang, D., *Essays in Executive Compensation*, Promotor: Prof. I. Dittmann, EPS-2012-261-F&A, http://repub.eur.nl/pub/32344

Zwan, P.W. van der, *The Entrepreneurial Process: An International Analysis of Entry and Exit*, Promotors: Prof. A.R. Thurik & Prof. P.J.F. Groenen, EPS-2011-234-ORG, http://repub.eur.nl/pub/23422

To obtain and maintain competitive advantage, firms need to implement appropriate innovation strategies (i.e. exploration or exploitation) and acquire status in external networks. In this dissertation, I investigate how innovation strategy, status, and network structure jointly affect the performance and behavior of firms. In particular, I combine theories on exploration and exploitation, innovation, networks, and the status-based perspective to investigate (1) how exploration interacts with status to affect the performance of high-tech firms; (2) how exploration and exploitation shape partner selection for strategic alliance; (3) how the exploration or exploitation of an invention determines its value in technology markets, and what effect team characteristics have on that value; and (4) how competition networks affect firm performance directly, and how collaboration and competition networks interplay.

The findings from the four empirical studies show that status is an important factor in terms of how exploration and exploitation affect a firm's performance and its propensity to act in certain ways. Hence, scholars should place more emphasis on the status-based approach as it is more likely to lead to a better understanding of the effects of particular strategic choices. Analysis at the invention level shows that the balance between exploration and exploitation in an invention determines its value in technology markets and the likelihood that it will become a technological breakthrough. Finally, my dissertation also contributes to network theory by drawing attention to competition networks, whose effects haven't been given sufficient consideration.

ERIM

The Erasmus Research Institute of Management (ERIM) is the Research School (Onderzoek school) in the field of management of the Erasmus University Rotterdam. The founding participants of ERIM are the Rotterdam School of Management (RSM), and the Erasmus School of Economics (ESE). ERIM was founded in 1999 and is officially accredited by the Royal Netherlands Academy of Arts and Sciences (KNAW). The research under taken by ERIM is focused on the management of the firm in its environment, its intra- and interfirm relations, and its business processes in their interdependent connections.

The objective of ERIM is to carry out first rate research in management, and to offer an advanced doctoral programme in Research in Management. Within ERIM, over three hundred senior researchers and PhD candidates are active in the different research programmes. From a variety of academic backgrounds and expertises, the ERIM community is united in striving for excellence and working at the fore front of creating new business knowledge.

ERIM

ERIM PhD Series
Research in Management

Erasmus University Rotterdam (EUR)
Erasmus Research Institute of Management
Mandeville (T) Building
Burgemeester Oudlaan 50
3062 PA Rotterdam, The Netherlands

P.O. Box 1738
3000 DR Rotterdam, The Netherlands
T +31 10 408 1182
E info@erim.eur.nl
W www.erim.eur.nl