January 2015

Founders' Credentials and Performance of Startups

Siva Ramakrishna Devarakonda Venkata Naga
Purdue University

Graduate School Form 30
Updated 1/15/2015

PURDUE UNIVERSITY
GRADUATE SCHOOL
Thesis/Dissertation Acceptance

This is to certify that the thesis/dissertation prepared

By Siva Ramakrishna Devarakonda Venkata Naga

Entitled

FOUNDERS' CREDENTIALS AND PERFORMANCE OF STARTUPS

For the degree of Doctor of Philosophy

Is approved by the final examining committee:

Thomas H. Brush
Co-chair

Jeffrey J. Reuer
Co-chair

Umit Ozmel

Alfonso Gambardella

To the best of my knowledge and as understood by the student in the Thesis/Dissertation Agreement, Publication Delay, and Certification Disclaimer (Graduate School Form 32), this thesis/dissertation adheres to the provisions of Purdue University's "Policy of Integrity in Research" and the use of copyright material.

Approved by Major Professor(s): Thomas H. Brush and Jeffrey J. Reuer

Approved by: Mark Bagnoli 7/28/2015

Head of the Departmental Graduate Program Date

FOUNDERS' CREDENTIALS AND PERFORMANCE OF STARTUPS

A Dissertation

Submitted to the Faculty

of

Purdue University

by

Siva Ramakrishna Devarakonda Venkata Naga

In Partial Fulfillment of the

Requirements for the Degree

of

Doctor of Philosophy

August 2015

Purdue University

West Lafayette, Indiana

This dissertation is dedicated to my grandfathers, parents, Guru, and my brother.

ACKNOWLEDGEMENTS

I would like to thank a number of people who helped me achieve this milestone. First and foremost, I would like to thank my advisor and committee co-chair, Jeffrey Reuer. He has been a great mentor, and has provided very systematic and high-quality guidance and training that are going to be highly invaluable to me in my academic career. I am deeply thankful to him for investing his time and energy in me and this dissertation.

I am very thankful to my committee co-chair, Thomas Brush for providing very valuable suggestions in this dissertation. I deeply thank him for his exceptional seminars on corporate strategy and innovation, and for inspiring me to develop strong conceptual understanding of strategy research. I thank Umit Ozmel for the feedback and support at important stages of this dissertation. I also thank my external committee member Alfonso Gambardella for his valuable suggestions in this dissertation.

I would also like to thank Timothy Folta for his significant and thought-provoking seminars during the first two years of my doctoral training. Doctoral program colleagues Goran Calic and Wonsang Ryu have been an invaluable company, and provided a very active environment to build my research and learning skills. I also thank Kelly Felty and others in the Krannert Doctoral Program Office.

My mother has always encouraged me to aim high and strive for excellence in all my endeavors. My father has been my role model for hard work, dedication, and sincerity. Both my grandfathers stimulated interest in intellectual pursuits. My Guru has been a constant source of inspiration and comfort. My brother has always been a great friend for me. I dedicate this dissertation to these six individuals.

I got married in my third year of PhD; I thank my wife and in-laws for their support. Last, but not the least, I would like to acknowledge my two nieces, sister, brother-in-law, Sudha, Prashanth, Kirti, Nitya, Aditya, and Harsha for easing research pressure.

TABLE OF CONTENTS

Page

Page

Page

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Devarakonda Venkata Naga, Siva Ramakrishna. Ph.D., Purdue University, August 2015. Founders' Credentials and the Performance of Startups. Major Professors: Thomas H. Brush and Jeffrey J. Reuer.

In this dissertation, I unpack startup founders' characteristics and investigate their impact on the performance of young high-tech startups. I distinguish specific aspects of founders that convey their unobservable quality and human capital, and advance new arguments that deepen our understanding about founders' role in shaping the prospects and performance of young high-tech startups. In particular, I examine founders' distinct technical and entrepreneurial credentials that have the effect of facilitating important milestones for startups, such as strategic alliances and initial public offering, which ensure startups' growth and survival. Further, I also investigate the contingent effects of these credentials of startup founders on the degree of uncertainty that prevails for potential alliances partners and investors about startups' underlying quality. In three essays that comprise this dissertation, I find evidence that startup founders' scientific and entrepreneurial credentials promote favorable cooperative commercialization agreements for startups with alliances partners and accelerate their initial public offerings. I also find evidence that these distinct credentials of founders are more useful when there is higher uncertainty about startups' quality. These findings have important implications for research in strategy and entrepreneurship about the significance and enduring impact of startups'

founding teams on startups' growth and performance. The arguments and evidence also provide many practical implications for high-tech entrepreneurs and resource providers.

In the first study, I propose three distinct credentials of startup founders and explore their impact on startups' alliance formation in the context of market for ideas and technologies. In particular, I unpack three distinct credentials of startup founders -- scientific stars, employees of prominent incumbents, and successful founders, and show that they influence the formation of cooperative commercialization agreements for startups. Further, I develop the argument that the impact of founders' credentials is contingent on other signals that can effectively convey the underlying quality of startups' quality to potential collaborators and mitigate uncertainty. I find evidence that a startup's published patent application diminishes the positive effect of founders' credentials on formation of cooperative agreements with incumbents.

In the second study, I examine an underexplored dimension of alliance contracting, in particular the payment structures that parties negotiate for their high-tech partnerships, and develop hypotheses about the remedial role of startup founders' credentials in obtaining favorable payment structures for startups within collaborative commercialization with incumbents. Specifically, I show that founders' scientific and entrepreneurial credentials positively shape the proportion of upfront payments that startups can obtain from their licensees, rather than deferred and contingent payments that routinely feature in these transactions. More importantly, I provide evidence for the intuitive notion that scientific and entrepreneurial credentials would complement each other. Finally, I also

suggest that the positive effects of these two distinct founders' credentials on the proportion of upfront payments will vary based upon startups' venture development stages.

In the final study, I develop hypotheses about the role of founders' credentials on startups' rate of going public. I propose that startup founders' scientific and entrepreneurial credentials play a pivotal role in positively influencing the startup's ability to go public. Specifically, I suggest that startups that have a scientific star or a founder with prior IPO experience on their founding team are able to go public faster. I also suggest that the effects of founders' scientific and entrepreneurial credentials are contingent on other potential means through which startups can credibly convey their overall quality and prospects. In particular, given the fact that high-tech startups are usually backed by venture capitalists and the quality of their VC affiliations produce information on startups' quality and prospects, I suggest that prominent VC affiliations moderate the effects of founders' credentials on startup's rate of going public.

CHAPTER 1. INTRODUCTION

In this dissertation, I unpack startup founders' characteristics and investigate their impact on the performance of young high-tech startups. I distinguish specific aspects of founders that convey their unobservable quality and human capital, and advance new arguments that deepen our understanding about founders' role in shaping the prospects and performance of young high-tech startups. In particular, I examine founders' distinct technical and entrepreneurial credentials that have the effect of facilitating important milestones for startups, such as strategic alliances and initial public offering, which ensure startups' growth and survival. Further, I also investigate the contingent effects of these credentials of startup founders on the degree of uncertainty that prevails for potential alliances partners and investors about startups' underlying quality. In three essays that comprise this dissertation, I find evidence that startup founders' scientific and entrepreneurial credentials promote favorable cooperative commercialization agreements for startups with alliances partners and accelerate their initial public offerings. I also find evidence that these distinct credentials of founders are more useful when there is higher uncertainty about startups' quality. These findings have important implications for research in strategy and entrepreneurship about the significance and enduring impact of startups' founding teams on startups' growth and performance. The arguments and evidence also provide many practical implications for high-tech entrepreneurs and resource providers.

1.1 Theoretical Background and Positioning

Startups are subject to a high degree of uncertainty about their prospects and are liable to suffer failure on account of their lack of resources (e.g., Stinchcombe, 1965; Freeman et al., 1983; Singh et al., 1986; Bruderl and Rudolf, 1990). In particular, when startups are in their early stages of founding they face a severe shortage of resources such as financial capital, man-power, and relationships with potential suppliers and customers (e.g., Penrose, 1959; Stinchcombe, 1965; Hannan and Freeman, 1984), which affects their prospects for growth and survival. Given that startups face resource constraints, the question arises as to how startups can yet overcome their susceptibility to failure, and rather achieve growth.

Prior research emphasizes that startup founders can play a highly significant role in shaping growth opportunities for startups (e.g., Eisenhardt and Schoonhoven, 1990; Cooper et al., 1994; Gimeno et al., 1994). Specifically, startup founders' knowledge, skills, experience, know-how and expertise are part of startups' initial endowments, and critically determine the performance and survival of startups (e.g., Cooper et al., 1994). Founders' expertise and know-how widen the strategic scope for startups and influence the subsequent development of startups (e.g., Boeker, 1989). In its initial stages, a startup's distinctive tangible and intangible capabilities and its capacity to obtain superior performance largely correlates with the skills and competence of its founding team members (e.g., Eisenhardt and Schoonhoven, 1990; Gimeno et al., 1994; Colombo and Grilli, 2005). In particular, startup founders' industry specific know-how and

entrepreneurial know-how and experience are positively related to performance and survival of startups (e.g., Cooper et al., 1994).

While the above ideas broadly suggests that founders contribute their know-how and expertise to their startups and have a strong bearing on the performance of startups, a separate body of research also strongly suggests that startups largely rely on strategic alliances and outside investors to access complementary resources and capital to promote startups' growth and performance (e.g., Pisano, 1989; Gulati, 1998; Stuart et al., 1999; Ahuja, 2000; Baum et al., 2000; Baum and Silverman, 2004). Whereas previous research on startup founders is largely focused on their impact of startup performance, there is very limited research and evidence (e.g., Eisenhardt and Schoonhoven, 1996) about how founders contribute to startups' strategic alliance partnerships and financing strategies. Given the significance of founders in shaping startups' strategic growth and development, there is a need for understanding how and to what extent founders affect outcomes for startups in the alliance and capital market context.

To begin with, startups' ability to access complementary resources and capital through strategic alliances and capital markets is very limited for several reasons. First startups usually lack track records (e.g., Stuart et al., 1999; Baum et al., 2000) that can credibly provide information to potential collaborators about startups' proprietary ideas and innovations. Collaborative partnerships between startups and incumbents may fail to occur because incumbents find it costly to assess startups' underlying resources before making commitments to develop startups' ideas and technologies (e.g., Stigler, 1961; Rangan, 2000; Rothaermel and Deeds, 2004). Likewise, potential investors may be wary

about the prospects of startups' resources in the absence of credible information (e.g., Amit et al., 1990; Hsu, 2006). Such information costs arise in part because early stage startups wish to avoid disclosing proprietary information that might be misappropriated (Arrow, 1962), and they have incentives to overstate their ideas, other intangible resources, and their prospects (e.g., Gulati, 1999, Hsu, 2006). In effect, information asymmetries surrounding the prospects of early stage startups and innovators' proposals (e.g., Mody, 1993; Pisano, 1997; Lerner and Merges, 1998) escalates the risk of adverse selection for outsiders, and the classical 'lemons' problem ensues for potential alliance partners and investors (e.g., Akerlof, 1970).

While startups' generally poor information conditions create frictions and diminish opportunities for startups to attract potential alliance partners and financing from outside investors (e.g., Shane and Stuart, 2002; Hsu and Ziedonis, 2013), startups can overcome informational frictions by taking actions that credibly convey information about their quality, and yet are costly for other startups to imitate (Spence, 1973). For instance, startups can reduce uncertainty about their quality and produce information on their underlying asset quality and prospects by obtaining the affiliation of prominent outsiders such as VCs who are actively involved in financing high-risk startup activity (e.g., Megginson and Weiss, 1991; Stuart, Hoang, and Hybels, 1999). However, startups also have to incur significant cost to gain the endorsement of prominent VCs as they have to offer equity to the VCs, agree to stringent control and monitoring (e.g., Hsu, 2004).

Similarly, startups can partner with prominent alliance partners to enhance their performance (e.g., Baum et al., 2000) and signal their quality to outsiders (e.g., Stuart et

al., 1999). However, partnering with prominent partners may not be easy for startups, particularly those with radical innovations, because prominent partners are likely to be very selective in their choice of partners (e.g., Li et al., 2008; Ozmel et al., 2013). As a consequence, startups may incur loss of time while establishing alliances with prominent partners, or contract with them on less attractive terms (e.g., Danzon et al., 2005). Additionally, while startups can rely on the quality of their resource base and patent stocks to obtain resources from outsiders (e.g., Wagner and Cockburn, 2010; Hsu and Ziedonis, 2013), assembling these firm-level resources may take considerable time and resources, and may also not credibly reduce uncertainty for outside investors about the potential market prospects of startups' technologies (e.g., Long, 2002; Gans et al., 2008).

Given these strategic considerations for startups, I depart from previous research about the impact of startup founders on startups' performance, and rather advance the idea that startup founders' distinctive human capital has a much broader role for startups in the context of startups' strategic alliance and financing strategies. To being with, I argue that while a founder's human capital is private information, potential collaborators and investors in alliance and capital markets can learn about founders' human capital by evaluating their career track records and accomplishments. Noting that human capital and know-how are distributed heterogeneously among individuals (e.g., Haltiwanger and Waldman, 1985; Teece, 2003), and a few are more sophisticated in their ability to combine knowledge and create novel ideas, I further suggest that some startup founders are likely to have attained superior quality know-how and expertise that is costly-to-imitate for others (Spence 1973, 2002).

To set up the above argument, I build upon ideas expounded in the economics of information concerning the risk of adverse selection and its remedies (e.g., Akerlof, 1970; Spence, 1973) and suggest that founders' superior credentials serve as credible signals for the quality of their unobservable human capital and know-how. These credentials can therefore function as effective means for outsiders to reduce their risk of adverse selection while making decisions on resource commitments to startups. Inasmuch as there is uncertainty about startups' underlying quality and the prospects of their innovations, outsiders can rather evaluate startup founders' credentials and track records to draw credible inferences about startups' quality. Accordingly, founders' distinct credentials that relate to their unobservable industry-specific competence, as well as their unobservable entrepreneurial and management competence, can function as credible signals for outsiders. It is to be noted here that while the quality of founders' technical and scientific credentials establish their industry-specific experience and competence, founders' entrepreneurial accomplishments and credentials attest to their entrepreneurial and management competence.

1.2 Evidence from Three Studies

The first essay, presented in chapter 2, proposes three distinct credentials of startup founders and explores their impact on startups' alliance formation in the context of market for ideas and technologies. Early stage startups typically try to obtain resources from external agents (e.g., Stuart et al., 1999; Shane and Cable, 2002) and are devoid of track records (e.g., Shane and Stuart, 2002) that enhance their visibility and establish credibility to resource providers. Potential investors and collaborators face difficulties locating and

selecting early startups lacking credible track records (e.g., Baum and Silverman, 2004). In this regard, I unpack three distinct credentials of startup founders -- scientific stars, employees of prominent incumbents, and successful founders -- that are costly for other founders to attain and which enable transactions with firms by reducing their costs of search and selection. Further, I develop the argument that the impact of founders' credentials is contingent on other signals that can effectively convey the underlying quality of startups' quality to potential collaborators and mitigate uncertainty. I find evidence that a startup's published patent application diminishes the positive effect of founders' credentials on formation of cooperative agreements with incumbents. The main theoretical contribution is that startup founders' credentials serve as signals of their unobservable human capital and play an influential role in shaping early stage commercialization opportunities for startups by signaling the value of their latent ideas and technologies. The evidence therefore shows the relevance of founder effects in promoting cooperative commercialization, particularly in the earliest stages of the firm's technological development when uncertainty is substantial.

This paper complements research on market for ideas and collaborative R&D partnerships (e.g., Stuart, 1998; Gulati. 1999) and contributes broadly to research on alliances and partner selection (Li et al., 2008; Rothaermel and Boeker, 2008; Diestre and Rajagopalan, 2012), by suggesting that founders' credentials play an important role in addressing information asymmetries and reducing risks of adverse selection faced by incumbent firms and enabling transactions with upstream suppliers of technologies. Founders' credentials therefore can foster the division of innovative labor and cooperative commercialization opportunities for startups.

This study also contributes to research on founding teams in enhancing performance and growth prospects of entrepreneurial firms. Prior streams of research examined the effects of founders' human capital and networks on performance of entrepreneurial ventures (Eisenhardt and Schoonhoven, 1990; Gimeno et al., 1997; Baum et al., 2000; Colombo and Grili, 2005; Delmar and Shane, 2006; Eesley and Roberts, 2012) and alliance formation (e.g., Eisenhardt and Schoonhoven, 1996; Stuart et al., 2007; Hallen, 2008; Luo et al., 2009), and this study complements prior research by arguing a signaling role for founders' unobservable human capital (e.g, Mincer, 1958; Coff, 1997). Specifically, this paper explicates three distinct credentials of founders and shows that they address information asymmetries and the risk of adverse selection surrounding an early stage startup's ideas and technologies.

The second essay, appearing in Chapter 3, examines an underexplored dimension of alliance contracting, in particular the payment structures that parties negotiate for their high-tech partnerships, and develops hypotheses about the remedial role of startup founders' credentials in obtaining favorable payment structures for startups during collaborative commercialization with incumbents. Specifically, I investigate two distinct credentials of startup founders and argue that they play an instrumental role in positively shaping the proportion of upfront payments that startups can obtain from their licensees, rather than deferred and contingent payments that routinely feature in these transactions. Finally, because high-tech startups are usually venture backed (e.g., Sahlman, 1990; Gompers and Lerner, 2001) and startups' venture activity produces information on startups' progress, I also suggest that the positive effects of these two distinct founders' credentials on the proportion of upfront payments that startups receive will vary based upon

startups' venture activity. In particular, I suggest that the positive effect of founders' technical credentials on upfront proportion will be prominent for a startup in early stages of venture rounds, while the positive effect of founders' entrepreneurial credentials in the form of prior IPOs will be more pronounced during later stages of venture development.

At a broad level, essay 2 contributes to literature in strategy and entrepreneurship by examining the signaling role of founders' credentials in enhancing the value attained from their ideas and innovative capabilities from cooperative commercialization arrangements. Specifically, it investigates an underexplored aspect of startup performance – payment structures in cooperative agreements – and contributes to the research on market for ideas and collaborative R&D partnerships by suggesting that founders' credentials play an important role in reducing risks of adverse selection for prospective partners and shaping favorable compensation structures for startups. Importantly, it shows how founders' technical and entrepreneurial credentials are distinctive yet complement one another.

By showing how founders' credentials shape payment structures and the allocation of risk in partnerships involving startups, this study contributes to an emerging stream of work on the design of alliances which has so far emphasized contract complexity and specific provisions geared to partners' control and coordination concerns (e.g., Luo, 2002; Anderson and Dekker, 2005; Hagedoorn and Hesen, 2007; Mesquita and Brush, 2008; Hoetker & Mellewigt, 2009; Li, Poppo, and Zhou, 2010). I present alliance payment structures as an additional means by which incumbent firms and startups allocate risk between them, and the evidence indicates that founders' credentials can enable startups to bear less risk when they engage in cooperative commercialization transactions with incumbents.

The paper also advances research in strategy and entrepreneurship by showing the importance of founder effects and the value of credentialing mechanisms in strategic alliances. Prior research has examined the roles of inter-organizational relationships (e.g., Gulati, 1999, Ozmel et al., 2013), affiliations with prominent venture capitalists (e.g., Hsu, 2006), technological track records (e.g., Stuart, 1998; Rothaermel and Boeker, 2008), and experience of top management team members (e.g., Eisenhardt and Schoonhoven, 1996) in facilitating collaborations for startups. It therefore complements this research by showing how founders' credentials shape payment structures and the allocation of risk in partnerships involving startups.

In Essay 3, presented in Chapter 4, I develop hypotheses about the role of founders' credentials and track records on startups' rate of going public. I propose two distinct credentials of startup founders and suggest that they play a pivotal role in positively influencing the startup's ability to go public. Specifically, I suggest that startups that have a scientific star or a founder with prior IPO experience on their founding team are able to go public faster. I also suggest that the effects of founders' scientific and entrepreneurial credentials are contingent on other potential means through which startups can credibly convey their overall quality and prospects. Notably, given the fact that high-tech startups are generally backed by venture capitalists (VCs) (e.g., Sahlman, 1990; Gompers and Lerner, 2001) and the quality of their VC affiliations produce information on the startups' quality, I suggest that prominent VC affiliations moderate the effects of founders' credentials on startup's rate of going public.

At a broad level, Essay 3 contributes to research in strategy and entrepreneurship on startups' IPO timing decisions and IPO performance. Prior research has investigated the role of startups' interorganizational relationships and endorsements (e.g., Stuart et al., 1999; Chang, 2004) and the top management team's experience (e.g., Beckman and Burton, 2008) and prestige (e.g., Certo et al., 2001) on the IPO timing and performance of startups. I complement this stream of research by showing how specific aspects of founders' credentials that are indicative of their scientific and entrepreneurial accomplishments are likely to have a strong bearing on startups' IPOs.

Second, I complement prior research by showing the contingency between startup founders' scientific and entrepreneurial accomplishments and prominence of startup VC affiliation on startups' ability to go public. Prior research has examined how founders' human capital and reputation affect the funding startups receive from VCs (e.g., Hsu, 2006; Hsu and Ziedonis, 2013). Other studies have shown how receiving backing by venture capitalists can help firms go public (Stuart et al., 1999; Gulati and Higgins, 2003; Chang, 2004; Ozmel et al., 2013). I build upon and extend this research by demonstrating the importance of founder effects in shaping the timing of firms' IPOs, and showing that founders' scientific and entrepreneurial attainments matter to a greater extent when startups cannot convey their prospects to potential investors in IPO markets on account of less prominent VC affiliations.

I also contribute to literature in strategy and entrepreneurship that has examined the role of founders on the performance of startups. Specifically, I explore the role of founder effects on startups' ability to go for an IPO and achieve faster access to public equity

markets. The findings suggest that founders' scientific and entrepreneurial accomplishments play an important role in effecting faster IPOs for startups. In this manner, I complement prior research (e.g., Eisenhardt and Schoonhoven, 1990, 1996; Colombo and Grilli, 2005; Colombo and Grilli, 2010) which suggests the significance of founder's experience and competence on the growth and performance of entrepreneurial ventures.

1.3 Conclusion

In summary, I draw insights from economics of information concerning the risk of adverse selection and its remedies (e.g., Akerlof, 1970; Spence, 1973) and suggest that founders' superior credentials serve as credible signals for the quality of their unobservable human capital and know-how. I show that founders' distinct technical and entrepreneurial credentials facilitate important milestones for startups, such as strategic alliances and initial public offering, which ensure startups' growth and survival. I also show the contingent effects of these credentials of startup founders on the degree of uncertainty that prevails for potential alliances partners and investors about startups' underlying quality. Put together, the three studies provide new evidence about the signaling role of startup founders' credentials and enhance the theoretical and empirical understanding about the role of founders in shaping growth prospects and performance of startups.

CHAPTER 2. FOUNDERS' CREDENTIALS AND FORMATION OF COOPERATIVE COMMERCIALIZATION AGREEMENTS FOR STARTUPS

2.1 Introduction

Early-stage startups require financial resources and complementary capabilities develop their nascent ideas and innovations (e.g., Stinchcombe, 1965). For example, early stage to startups that possess new technologies or ideas for new products - such as a movie script, mechanical device, a program, or a method for a drug - require financial capital, supplies, and knowledge about useful complementary methods and resources in order to enter product markets and make profitable gains from their discovered ideas and technologies (e.g., Teece, 1986). However, during their early stages, startups lack the track records that enable them to access capital and factor markets (e.g., Rao, 1994). Startups therefore face challenges in their gestation stages assembling organizational resources for developing their discoveries and ideas (e.g., Stinchcombe, 1965; Stuart et al., 1999).

As a consequence, early stage startups can engage in cooperative commercialization strategies with established incumbents to overcome these impediments to their development and growth (e.g., Ahuja, 2000; Gans and Stern, 2003; Hsu, 2006). Cooperative commercialization strategies between startups and established incumbents occur as technology licensing and/or strategic alliances, and can be an efficient alternative to internal development (e.g., Pisano, 1990; Williamson, 1991), allowing startups to

garner resources and capabilities from established incumbents and quickly translate their embryonic ideas and technologies into profitable outcomes (e.g., Greis, Dibner, and Bean, 1995; Eisenhardt and Schoonhoven, 1996; Katila, Rosenberger, and Eisenhardt, 2010). For example, early stage startups in the biotechnology industry establish cooperative relationships with incumbents through various forms of strategic alliances (e.g., Baum and Silverman, 2004; Stuart et al., 2007), which enable startups to exploit their technological know-how and expertise by combining their ideas and technologies with the commercialization capabilities of incumbents (e.g., Pisano 1990; Alfonso and Gambardella, 1990).

However, the formation of cooperative agreements between early stage startups and incumbents is hampered by the risk of adverse selection because of the information asymmetries surrounding the prospects of early stage startups and innovators' proposals (e.g., Mody, 1993; Pisano, 1997; Lerner and Merges, 1998). Early stage startups usually lack track records (e.g., Stuart et al., 1999; Baum et al., 2000) that can credibly provide information to potential collaborators about startups' proprietary ideas and innovations (e.g., Amit et al., 1990; Hsu, 2006). Collaborative partnerships between startups and incumbents may fail to occur because incumbents find it costly to judge startups' underlying resources before making commitments to develop startups' ideas and technologies (e.g., Stigler, 1961; Rangan, 2000; Rothaermel and Deeds, 2004). Such information costs arise in part because early stage startups wish to avoid disclosing proprietary information that might be misappropriated (Arrow, 1962), and they have incentives to overstate their ideas, other intangible resources, and their prospects (e.g., Gulati, 1999, Hsu, 2006).

Previous research in strategy and entrepreneurship has emphasized the various ways in which startups can mitigate the effects of informational asymmetries on their ability to transact with investors and strategic partners. For example, early stage startups can pursue actions which credibly signal their underlying quality, thereby facilitating exchanges in various market contexts (e.g., Lee, 2001; Certo, 2003; Sanders & Boivie, 2004; Dewally & Ederington, 2006). For instance, evidence suggests that in high-tech industries an innovative early stage startup can affiliate with prominent venture capitalists (VCs), incur discounted valuations (Hsu, 2004), and distinguish itself from other startups to attract cooperative agreements with partners (e.g., Hsu, 2006). Other research suggests that startups can convey signal the value of their resources and market prospects by developing positions in networks (e.g., Nicholson et al., 2005; Ozmel et al., 2013) or through patenting activities (e.g., Long, 2002, Haussler et al., 2009).

For startups, however, these signals can take considerable time to develop. In this paper, I build upon and extend this research by suggesting that founders' credentials are valuable in conveying information about startups' quality and their commercialization prospects to would-be partners. During their early stages, startups' plans, ideas, and innovations are a direct result of their founders' intangible skills and human capital (e.g., Klepper, 2001; Shane and Stuart, 2002). Indeed, when startups are in their earliest stages of development, incumbents can determine the attractiveness of an early stage startup's latent innovations based on the credentials and track records of their founders (e.g., Amit, Glosten, and Muller, 1990; Rao, 1994; Venkataraman, 1997). This suggests that even in the presence of substantial uncertainty and absence of other signals (e.g., a technological track record through patenting, networks, etc.), early stage ventures might still be

successful at forming transactions with partners. Specifically, prospective collaborators can distinguish early stage startups on the basis of their founders' professional accomplishments and track records (e.g., Shane and Stuart, 2002).

In this paper, I therefore build upon ideas expounded in the economics of information about the risk of adverse selection and its remedies (e.g., Akerlof, 1970; Spence, 1973) in the context of the market for ideas and technologies in order to develop hypotheses about the remedial role of founders' credentials in promoting collaborative commercialization opportunities for early stage startups. More specifically, I unpack three distinct credentials of founders and discuss their positive effects at the earliest stages of new venture development when startups are otherwise devoid of any track record indicating their type to prospective collaborators.

In the empirical context of this study involving startups in biopharmaceutical industry, cooperative commercialization agreements between startups and incumbents are ubiquitous (e.g., Arora, Fosfuri, and Gambardella, 2001; Stuart et al., 2007). Moreover, early stage startup activity is largely driven by intangible technical and human capital of founders which is nevertheless unobservable to outsiders (e.g., Pisano, 1990; Zucker and Darby, 1996). In this regard, founders who attained scientific star credentials, favorable employment credentials such as prior employment with prominent firms, or prior entrepreneurial success in the public equity markets can play important roles in enabling cooperative commercialization for early stage startups with incumbent partners. Moreover, I also argue and show that these three distinct credentials of founders can be especially beneficial for a startup when it lacks a technological track record, such as a patent

publication that conveys information about the early stage technological activity of the startup.

Broadly, my theoretical contribution therefore lies in investigating the role of three distinct founders' credentials for cooperative commercialization and in demonstrating their contingent effects based on the institutional mechanism of patent publication. My study extends research on market for ideas and technologies as well as interfirm collaboration in several ways. First, it contributes to research on market for ideas and technologies and collaborative R&D partnerships by suggesting that founders' credentials play an important role in reducing risks of adverse selection for incumbents and enabling transactions with suppliers of technologies, thus facilitating the division of innovative labor and cooperative commercialization opportunities for startups (e.g., Arora et al., 2001).

Second, for research in strategy and entrepreneurship concerning interfirm collaboration, this study underscores the importance of founder effects and value of credentialing mechanisms in these markets. Previous research has examined the roles of inter-organizational relationships (e.g., Gulati, 1999, Ozmel et al., 2013), affiliations with prominent venture capitalists (e.g., Hsu, 2006), technological track records (e.g., Stuart, 1998; Rothaermel and Boeker, 2008), and experience of top management team members (e.g., Eisenhardt and Schoonhoven, 1996) in facilitating alliances for new ventures. I therefore complement this research by showing how founders' credentials shape alliance formation for early stage startups.

Finally, I contribute to research on resource-based theory (RBT) (e.g., Penrose, 1959; Wernerfelt, 1984; Barney, 1991) and emerging stream of research about the role of founders' experience and human capital (e.g., Eisenhardt and Schoonhoven, 1996;

Colombo and Grilli, 2005; Chandler and Hanks, 1998) by arguing and demonstrating that the credentials of founders can also be instrumental for startups by offering signaling services (e.g., Brush et al., 2001; Hsu and Ziedonis, 2013) that shape cooperative commercialization agreements during their founding stages.

2.2 Theory and Hypotheses

High-tech startups that possess good ideas and technologies but lacking demonstrative track records of their own can overcome information barriers to trade inherent to market for ideas and technologies in various ways. Specifically, good quality startups can separate from inferior startups through signals that efficiently convey information about the unobservable features of their superior ideas by engaging in actions that are costly for others to imitate (Spence, 1973). Spence (1973) originally proposed the role of signaling mechanisms in ameliorating the risk of adverse selection and facilitating exchange between agents. Many studies in management and economics literatures elucidate various signaling mechanisms which can enable entrepreneurs and startups to obtain necessary resources of growth in a wide range of market settings (e.g., Amit, Glosten, and Muller, 1990; Carter and Manaster, 1990; Megginson and Weiss, 1991; Stuart et al., 1999; Certo, 2003; Hsu, 2006; Cohen and Dean, 2005; Levitas and McFayden, 2009; Zhang and Wiersema, 2009; Hsu and Ziedonis, 2013).

While these signaling mechanisms promote exchanges and provide access to external resources for high-tech startups during their various phases of growth, the credentials of founders can also be instrumental in facilitating cooperative exchanges. Specifically, a set of founder credentials that is costly to earn for other startup founders can

positively shape the beliefs of incumbents about the startup's underlying nature. Spence (1973, 2002) suggests that in the labor market employers can ex ante distinguish abilities and productivity levels of job applicants based on their educational credentials. Because the costs to acquiring relevant educational credentials vary with underlying abilities of individuals, applicants who are less capable than their peers incur substantially higher costs to acquire credentials that are valuable signals for the employer. Analogously, in the market for ideas scientific and technological track records of individuals are indicative of the unobservable attributes of their abilities and know-how (e.g., Spence, 2002; Luo, Koput, and Powell, 2009). Specifically, in markets that involve the exchange of innovations and knowledge, individuals with higher levels of scientific achievements and technical endeavors are viewed as possessing superior productive skills and know-how (e.g., Burton, Sorenson, and Beckman, 2002), and startups founded by them are more likely to be widely visible in the market and considered as comprising good ideas (e.g., Burton, Sorenson, and Beckman, 2002).

The research hypotheses in this study develop a theory of founders' credentials and propose three distinct credentials of high-tech startups' founders – successful entrepreneurs, former employees of prominent firms, and scientific stars – that credibly convey information about the quality of their ideas, technologies, and prospects and facilitate commercialization opportunities for startups. Moreover, given the importance of patenting activity in high-tech industries, I discuss how a published patent application increases the chances of striking a deal for a startup firm by enhancing its visibility in the market and conveying information about its ideas. Further, I suggest that credentials of

startup founders that are not easily attainable for others substitute for the lack of a published patent application, so startups that do not yet have a published patent application can use their founders' credentials as a bootstrap to overcome the risk.

2.2.1 Scientific Stars

When the characteristics of ideas and technologies of early stage high-tech startups are hard to observe and measure, distinguishable scientific and technical track records of their founders help early stage high-tech startups convey information about the value of their intangible ideas to prospective partners. In particular, because early stage startups usually lack the experience and necessary track records (e.g., Stuart et al., 1999), in the initial stages of a startup's development, founders' observable scientific credentials that are costly for other startup founders to imitate can enable potential partners, such as established incumbents, to adjust their beliefs about the latent quality of the startup's technological features.

Startup innovators create new ideas and develop products and services by combining existing knowledge (e.g., Schumpeter, 1934; Henderson and Clark, 1990). While individuals can be limited in their capacity to process information and assimilate knowledge (Simon, 1945), individuals with superior knowledge and abilities are more likely to perceive opportunities and advance innovations. In high-tech industries such as biotechnology, semiconductors, and computer software, good quality ideas are formulated by integrating technical knowledge to solve practical problems (e.g., Nelson, 1959), and usually individuals with deeper theoretical and technical knowledge are more likely to possess superior inventive abilities and be successful at devising better innovations (e.g., Schmoolker and Brownlee, 1962; Nelson and Winter, 1982; Cohen and Levinthal, 1990).

Typically, innovative abilities are distributed heterogeneously among individuals (e.g., Haltiwanger and Waldman, 1985; Teece, 2003), and a few are more sophisticated in their ability to combine knowledge and create novel ideas. In any industry, these exceptional individuals are likely to be more competent at producing innovative approaches for designing products and services (Teece, 2003). Specifically, they pioneer the development of new ideas and technologies and play a key role in fostering innovation (e.g., Zucker and Darby, 1996; Nelson and Winter, 2002).

Given the fact that high-tech startups are largely built on scientific and technical ideas (e.g., Henderson and Cockburn, 1994; Sorenson and Fleming, 2004), founding members' scientific and technical accomplishments and depth of know-how strongly shape the subsequent quality of startups' innovations as well as the startups' success in transforming ideas into commercializable products and services (e.g., Zucker and Darby, 1996; Arora, Fosfuri, and Gambardella, 2001; Santoro and McGill, 2005). Superior innovators can have a greater impact on the direction of innovation (Tushman, 1977), and are more likely to develop novel ideas and technologies that can contribute to the performance of their firms as well as their exchange partners (e.g., Simon, 1991; Lavie and Rosenkopf, 2006). So, high-tech startups that are founded by individuals having an outstanding scientific and technical track record yet difficult to build for other startup founders can be viewed more favorably by incumbents.

Prior research has argued and shown that firms in industries such as biotechnology can enhance their performance and innovative output by affiliating with "star scientists" (e.g., Zucker, Darby, and Armstrong, 2002; Rothaermel and Hess, 2007). Stars are highly exceptional innovators who are valuable for their ability to generate cutting-edge ideas and

technologies that are less uncertain (e.g., Stuart, Ozdemir and Ding, 2007), and enable startups accelerate the commercialization process (e.g., Agrawal, 2006). Moreover, ventures that are associated with scientific stars are likely to be perceived as better quality by investors in public capital markets (e.g., Higgins et al., 2011; Fuller and Rothaermel, 2011). Scientific stars therefore serve as credible signals for difficult to observe technical attributes of early stage high-tech startups in various market settings. Inasmuch as uncertainty and asymmetric information about startups' technical quality impede cooperative commercialization opportunities in the market for ideas and technologies, affiliations with scientific stars will mitigate the risk of adverse selection and enable startups to obtain form cooperative agreements. I thus posit:

Hypothesis 2.1 *An early stage high-tech startup firm founded by a scientific star is more likely to establish a cooperative commercialization agreement, compared to startups whose founders are not scientific stars.*

2.2.2 Former Employees of Prominent Firms

While the foregoing hypothesis suggests how distinguished scientific credentials of founders can shape collaborative opportunities for early stage startups, my broad interest lies in understanding the distinct types of founders' credentials that play an instrumental role in obtaining cooperative commercialization agreements for early stage startups. In this regard, I note that while scientific accomplishments of founders signal the underlying technical quality of the startup's ideas and innovations, there are other types of credentials that enable potential exchange partners to draw inferences about the prospects of an early stage startup's latent technologies. In particular, potential partners can also draw such inferences by observing the employment credentials of their founders. Employment

credentials of startup founders serve as signals of their unobservable human capital and innovative capacities, but nonetheless costly for other startup founders to develop and indicate. Thus, I argue below that startups founded by individuals who previously worked with prominent firms are more likely to be considered as valuable startup collaborators in the market for ideas and technologies.

In high-technology industries, it is well acknowledged that individuals' career experience shapes firm founding activities (e.g., Shane and Khurana, 2003). Employees of incumbent firms leave their employers to found startups, often in the same industry (e.g., Klepper, 2001). Previous employment affiliations benefit startup founders in assimilating technical know-how as well as development and market know-how, which are essential capabilities for achieving greater success (e.g., Agarwal, et al., 2004; Buenstorf and Klepper, 2009). In particular, prior employment with prominent firms provides individuals opportunities for gaining deeper knowledge about their industry and information about entrepreneurial opportunities, and specifically such opportunities will be widely available for employees of prominent firms (e.g., Audia and Rider, 2005). Prominent firms have greater incentives and resources to invest in research and development activities which provide access to new information and knowledge about pioneering technologies (e.g., Cohen and Levinthal, 1990; Kogut and Zander, 1992; Burton et al., 2002). In this regard, individuals who are employed with prominent firms in the industry are more likely to possess knowledge and information that is technically and commercially valuable, enabling them an entrepreneurial advantage when they found their startup later in their career (e.g., Venkataraman, 1997; Burton et al., 2002; Agarwal et al., 2004). For example, at least a quarter of the biotechnology firms that went public during 1976-1996 were

founded by former employees of Baxter, a prominent life sciences firm in the United States (Higgins, 2005), suggesting that prior affiliation with Baxter helped these individuals discover entrepreneurial opportunities within the biotechnology industry and develop their ideas independently by founding their own startups. More importantly, because prior positions at prominent firms are likely to have an effect on startup founders' innovations and strategies (e.g., Boeker, 1988), individuals who previously worked as research engineers and scientists, chief technology officers at prominent firms are at a greater chance of gaining exposure to emerging ideas and technologies that are also commercially feasible (e.g., Gompers et al., 2005). Furthermore, previous research suggests and showed that such highly skilled individuals who were affiliated with prominent firms in their past are also more likely to perform better (Chatterji, 2009) and get noticed in the market (e.g., Burton et al., 2002; Gompers et al., 2005).

Taken together, the above arguments suggest that previous employment affiliations of startup founders act as signals about their accumulated skills and know-how prior to founding their own startups. Inasmuch as information about founders' technical know-how and the quality of their innovations is costly to convey during early stages of a startup, and prospective buyers of ideas find it difficult to discern aspects of startup's latent technologies and founders' human capital, the prior employment affiliations of its founders with prominent firms in the industry credibly conveys information related to the unobservable details of the startup and its founders. Indeed, in their early stages, startups founded by individuals who had prior employment affiliations with prominent firms are likely to be viewed as more promising and favorable suppliers of new ideas and innovations by prospective collaborators. In the same manner as how an entrepreneurial venture's

affiliation with prominent venture capitalists and underwriters provides credibility and reduces uncertainty for external resource providers (e.g., Stuart et al., 1999; Hsu, 2006; Ozmel et al., 2013), founders' prior employment affiliation with prominent firms works as a credential that enables early stage startups to engage in cooperative commercialization agreements. Thus, I hypothesize:

Hypothesis 2.2 *An early stage high-tech startup firm founded by a former employee of a prominent firm is more likely to establish a cooperative commercialization agreement, compared to startups whose founders lack such affiliations.*

2.2.3 Successful Founders

In the preceding hypotheses, I discussed how founders' scientific credentials (Hypothesis 1) and their employment credentials (Hypothesis 2) positively affect the likelihood of cooperative commercialization agreements. Whereas the informational content of these two distinct credentials of a high-tech startup's founders allows potential partners to credibly distinguish the technical value of the underlying ideas and innovations of the startup, they might be less informative about the commercial prospects of the startup's difficult-to-observe ideas and technologies. Prospective partners would also consider signals that enable them to discern the market potential of the startup's ideas and technologies, and in the absence of such information, it might be more difficult for the startup to engage in cooperative commercialization agreements. In this regard, a high-tech startup that is founded by an entrepreneur who was previously successful in taking a venture through to an initial public offering (IPO) market is more likely to be valued as

commercially viable by incumbent collaborators, and to the startup is more likely to attract collaborative agreements.

Founders of startup firms vary based on their entrepreneurial experience and their prior track records of achieving entrepreneurial success. Studies in entrepreneurship suggest that founders with prior entrepreneurial experience are likely to have developed skills and competencies that enable them success in their subsequent ventures (Stuart and Abetti, 1990; Gimeno et al., 1997; Chandler and Hanks, 1998; Westhead and Wright, 1998; Colombo and Grilli, 2005; Delmar and Shane, 2006; Eesley and Roberts, 2012). Founders with prior entrepreneurial experience are likely to have developed the ability to sense opportunities (e.g., Teece, 2007) and produce innovations through trial and error (e.g., Brüderl et al., 1992; Callander, 2011). In particular, serial entrepreneurs are more likely to benefit from trial and error search (e.g., Bhide, 2000; Baum and Bird, 2009) and are therefore seen as capable at productive commercialization of their ideas and technologies (e.g., Hsu, 2007).

The above arguments suggest that prior entrepreneurial experience of founders can contribute to better growth prospects for startups. However, during transactions that provide access to external resources startups which are founded by serial entrepreneurs can be regarded as more assuring insofar as the serial founders' attributes are observable. Schumpeter (1934) suggests that an entrepreneur is an innovator who is adept at discovering new production techniques and ideas as well as developing them into commercializable products and services. Thus, serial entrepreneurs with demonstrably positive track records, yet difficult to attain by other startup founders, are more likely to have superior innovative skills and abilities to produce ideas that are both technically and

commercially valuable. I therefore expect that startups that are founded by serial entrepreneurs who were able to raise capital in the public markets for their previous ventures are more likely to realize collaborative opportunities with exchange partners. Serial founders who had previously taken their firms through the IPO stage gain prominence in the industry as successful entrepreneurs (e.g., Certo et al., 2001; Gompers et al., 2006). Additionally, serial founders' success in attracting investors in the public capital markets indicates that they are skillful innovators (e.g., Gompers et al., 2006). More specifically, in high-tech industries technical and commercial uncertainties critically constrain startups ability to attract investors at the IPO stage (e.g., Berk et al., 2004; Sanders and Boivie, 2004), so founders who were previously successful in promoting their startups from founding stages to obtaining funds in public equity markets gain recognition as prominent innovators of ideas and technologies. Furthermore, founders' success in the IPO market serves as a signal of their innovative quality (e.g., Gompers et al., 2006), and therefore their subsequent startups are more likely to be viewed as possessing good quality innovations and be sought after in the market for ideas and technologies. I therefore posit that successful founders, or those who have earned the credential of taking public firms in the past, will help secure cooperative commercialization opportunities to the startup:

Hypothesis 2.3 *An early stage startup firm founded by a successful founder is more likely to establish a cooperative commercialization agreement, compared to startups whose founders lack such success.*

2.2.4 Contingent Effects of Patent Publication

The foregoing hypotheses emphasize three distinct types of founders' credentials that can reduce the risk of adverse selection for buyers of latent technologies and ideas by

signaling the underlying worth of the early stage startups' embryonic technologies. I would also suggest that the extent to which founders' credentials can be valuable for early stage startups in credibly conveying information about startups' unobservable attributes will hinge upon the information environment of potential transactions. These signals will be most valuable when the risk of adverse selection is greater, whereas they are expected to matter less as information is produced on the firm, the startup develops a track record, and uncertainty subsidies on its technological resources and prospects. Given the importance of patenting in high-tech industries and in shaping the information environment of potential cooperative commercialization agreements, I argue that publication of filed patent applications can play a significant role in reducing the risk of adverse selection and facilitative collaborative exchanges.

Firms file patents for their ideas and innovations even as they are in early stages of development (Kitch, 1977). Patents owned by a firm embody information about its research activities and technical knowledge (e.g., Pakes and Griliches, 1980; Hall, Jaffe, and Trajtenberg, 2005). In particular, patents are important as signals for early stage startups that are innovative, enabling them to separate from the less innovative startups (e.g., Long, 2002). Patent filing is also a costly process for startups that entails attorney fees, procedural expenses (e.g., Graham and Sichelman, 2008; Levitas and MacFayden, 2009), and patents can serve as credible signals that help startups transmit private information about their innovativeness, R&D capabilities and knowledge stocks (e.g., Horstmann et al., 1985; Aboody and Lev, 2000; Hsu and Ziedonis, 2013).

For early stage high-tech startups, patents therefore lower the costs of obtaining finance, necessary complementary resources, and access to product markets (e.g., Kitch,

1977, Lemley, 2000). While obtaining a patent grant enables startup development (e.g., Mann and Sager, 2007), interestingly even in the absence of a patent grant startups can also be successful at gaining access to resources necessary for growth. In particular, while patent examination process can take as long as four years before a patent is granted (e.g., Popp et al., 2004), early stage startups can also enter into collaborative licensing agreements with partners even in the absence of granted patents (Gans et al., 2008). In the market for ideas and technologies, potential collaborative partners desire access to information to learn about the efficacy of startups' innovations and perform due-diligence during selection (e.g., Arrow, 1962; Merges, 1999).

In this regard, published patent applications of startups can be effective at broadcasting credible information about their early stage activities and attracting venture financing by reducing uncertainty about their prospects (e.g., Haussler et al., 2009; Hsu and Ziedonis, 2013). Recent research suggests that startups may be able to enter into cooperative licensing agreements during the pre-patent grant period if their patent application is published (Hegde and Luo, 2013). Publication of startups' patent application prior to its allowance reduces information asymmetries between early stage startups and potential partners and facilitates credible disclosure of information about their technological activities to potential exchange partners. Indeed, patent publication lowers the costs for early stage startups and incumbents of contracting with each other in the market for ideas by lowering information asymmetries, and patent publication allows a credible mechanism for incumbents to perform due-diligence and learn about the potential value of the startups hidden quality (e.g., Long, 2002).

The above ideas suggest that patent publication can be useful in producing information and signals on a startup's technological quality, so I expect it to be an important contingency that shapes the effects of the three founders credentials covered in the previous hypotheses. Prior to a patent publication, information asymmetry on an early-stage technology venture will be substantial, suggesting that the credentialing mechanisms I have theorized upon will be especially valuable in overcoming market frictions for cooperative commercialization opportunities. To the extent that these problems ease and more information becomes available on the startups' technologies with the patent public, the effects of founder credentials are expected to be less pronounced. Thus, I posit:

Hypothesis 2.4 *The positive effect of a scientific star founder on the likelihood of a cooperative commercialization agreement will be greater for early stage startups that lack a patent publication.*

Hypothesis 2.5 *The positive effect of a founder's previous employment affiliation with a prominent firm on the likelihood of a cooperative commercialization agreement will be greater for early stage startups that lack a patent publication.*

Hypothesis 2.6 *The positive effect of a successful founder on the likelihood of a cooperative commercialization agreement will be greater for early stage startups that lack a patent publication.*

2.3 Methods

2.3.1 Data and Sample

To test these hypotheses, I use a dataset of licensing and R&D alliances in the biopharmaceutical industry. This industry is a fitting empirical context for my analysis for several reasons. First, the industry is driven by scientific discoveries and laboratory experiments, and is representative of the features of market for ideas and technologies (e.g., Gans, Hsu, and Stern, 2002; Arora and Gambardella, 2010) where startup innovators trade their technologies and ideas by entering into technology licensing and collaborative R&D agreements. Second, technology startups in this industry rely upon alliances to commercialize their innovations and obtain necessary resources to develop their technologies (e.g., Pisano, 1990; Powell, Koput, and Doerr-Smith, 1996; Roijakkers and Hagedoorn, 2006). Third, startups taking part in these alliances often have short track records and difficult-to-evaluate technological resources and capabilities (e.g., Stuart et al., 1999; Nicholson, Danzon, and Mccullough, 2005; Levitas and McFayden, 2009). Finally, these startups and their collaborative agreements are well documented in this industry, providing rich information for empirical study.

To investigate the likelihood of cooperative commercialization agreements, my research design should incorporate alliances that could have formed but did not for every alliance that was realized. Startups in industries such as biopharmaceuticals and telecommunications are characterized by uncertainty and information asymmetries (e.g., Gompers and Lerner, 2001), and they depend heavily on venture capitalists to finance their early stage activities. I obtained the list of all VC-backed startups in the biopharmaceutical industry from Thomson Reuters' VentureXpert database. Venture capitalists focus their

investments in information technology and biotechnology industries (e.g., Hsu, 2006) and play a significant role in providing private financing to startups in these sectors (e.g., Sahlman, 1990). I assembled data on startup licensing agreements and collaborations in the biopharmaceutical industry between 1990-2012 from Thomson Reuters' Recap, which is considered robust and representative in its coverage of alliance agreements in this industry (Schilling, 2009). Data from Recap has been used extensively by researchers in management, economics, and finance to investigate startup activities such as cooperative strategies in the biopharmaceuticals industry (e.g., Robinson and Stuart, 2007). In their data, Recap denotes the party that provides the intellectual property, technology, and R&D services, as the seller, and the counterparty that obtains the license as the client firm.

Biopharmaceutical startups chiefly vary in terms of adopted technology platforms and therapeutic focus areas (FierceBiotech, 2013; Merck, 2013), which limit their cooperative activities with client firms to these focus areas. So, while constructing the set of unrealized alliances, I selected unrealized alliances that are comparable and similar to realized alliances in many ways. In particular, I identified startups for each actual alliance by performing a match between the therapeutic area of the focal alliance as well as the therapeutic focus areas of all startups that were VC backed and founded prior to the date of actual alliance. In this manner, I constructed the list of unrealized alliances from the universe of startups that potentially could have been considered for alliance by the client firm when it formed a deal with the focal startup firm.

I identified founders for all the startups obtained from VentureXpert. I relied on various sources to collect information about founders. Specifically, I used BioScan, VentureXpert, Bloomberg Businessweek, and company websites to collect names of

founders. In addition, I also used sources such as SEC filings, LexisNexis, and other web searches to obtain the names of all possible unique founders for each firm in my sample. In my data of firm founders, I have 1962 unique firms after correcting for name changes and 2984 unique founders. I tracked the career histories of all the 2984 founders in the sample using LinkedIn, company websites, university web pages, and other sources such as Bloomberg Investing to construct founder level explanatory and control variables. Furthermore, I used Thomson Reuters' Web of Science to collect information on scientific publications of founders in the data used for this study.

To construct the final sample for analysis, I combined the sets of actual and unrealized alliances of startups, and because I am interested in the role of founders when the startup firm lacked a technological track record, I identified alliances that were formed before the startup firm's first patent was granted. Historically, patent applications that are filed in the United States are publicly disclosed through a publication only when the patents are granted, limiting visibility and disclosure of ideas in the public domain. The United States federal law enacted the American Inventor Protection Act (AIPA) on November 29, 1999, which mandated the United States Patent and Trademark Office (USPTO) to publish patent applications filed on or after November 29, 2000 18 months after their filing date. Recent work sheds light on the role of a firm's published patent application on the likelihood of licensing (Luo and Hegde, 2013), noting that publication of a patent application reveals information about the underlying technology and enhances the visibility of the licensor firm in the market for ideas and technologies. Based on this understanding about the role of a published patent application, I accounted for the AIPA act and identified alliances of startups that were formed before and after their first patent application was

published by combining the alliance data of VC-backed startups with patent information from the United States Patent and Trademark Office (USPTO) and the National Bureau of Economic Research (NBER) after tracking company histories and name changes.

In order to reduce unobserved heterogeneity from cross-border transactions and maintain consistency with the patent information from USPTO and NBER, I limited my analyses to firms founded in the United States. Additionally, I considered only those alliances that were formed after the first found of VC funding, and excluded alliances where the startups received their last round of VC funding at least seven years before the time of alliance, in order to exclude firms that are defunct, or "living dead" (e.g., Ruhnka, Feldman, and Dean, 1992; Mason and Harrison, 2002). From the initial sample of 1962 VC backed firms I deleted diagnostics-based firms, bioinformatics firms, and firms that focus on agricultural research. After applying these sampling screens and accounting for extreme observations, I obtained a final sample of 51,881 actual and unrealized alliance deals of 1480 distinct startups.

2.3.2 Measures and Analysis

Dependent variable

I investigate the likelihood that a startup firm is able to form a cooperative commercialization agreement with a client firm. Accordingly, the dependent variable is $Cooperative\ Agreement_{ijt}$, which takes a value of 1 for all actual alliances formed between firm i and j in year t, and 0 for all unrealized alliances. I specified logistic regressions for models of the determinants of cooperative commercialization agreements, because the dependent variable in this study is dichotomous. Estimation of startup alliance formation using probit regression models as well as rare events logistic regression models yielded

results that offer same interpretations as those presented below. Because there are several counterfactuals for each actual alliance, I also randomly identified unrealized alliances for every actual alliance (i.e., one, three, five, or ten), and found similar interpretations as those reported above. Finally, I also used robust standard errors clustered by client firm in my analyses to accommodate the possibility that the observations are not independent.

Independent variables

In this study, the first hypothesis posited that the likelihood of a cooperative commercialization agreement by a startup is positively related to the *Scientific Stars* in the startup's founding team. Prior research has operationalized this variable in different ways. Zucker and Darby (1996) identified scientific stars on the basis of number of scientific articles published until 1990 that reported the discovery of at least one among the 40 genetic sequences which were described in GenBank (1990). Zucker and Darby (2006) used data of citation counts and publications of scientific articles provided by ISIHighlycited.com and ISI Web of Science to identify top researchers in science and engineering. Rothaermel and Hess (2007) constructed their measure of star scientists by compiling publication and citation information for all scientists working at various pharmaceutical firms in their sample, and identified stars as those who had received citations at least two standard deviations above the mean. Higgins, Stephan, and Thursby (2011) defined star scientists as university-affiliated researchers who are scientifically accomplished by identifying university scientists who won a Nobel Prize.

Considering these differences in defining star scientists based upon the focus and time frame of previous studies, I followed Rothaermel and Hess' (2007) approach since it is operationalizable across the long sequence of startup and alliance activity in my dataset.

Accordingly, I searched for publication and citation data of all 2984 founders in my sample of firm founders in Thomson Reuters' Web of Science database (formerly ISI Web of Knowledge) and identified publications for each founder by mapping their name, scientific field of study, and list of affiliated organizations. By matching in this manner, I extracted publication and citation information for 1117 founders during the period 1990-2012 who published scientific articles in fields related to biotechnology, pharmaceutical sciences, and medical sciences. The average number of citations that founders received for their scientific publications are 9578. I operationalized *Scientific Stars* as number of founders of a startup firm who had been cited more than two standard deviations above the mean of the natural logarithm of the number of citations during the 20-year span in my sample. There are 89 star scientists in my entire sample of founders, and are all affiliated to a research university and retained their affiliation with the startup either as members on the scientific board or as chief technology officers. I also performed robustness checks by constructing this measure using different cutoff values (e.g., one standard deviation above the mean and different percentiles (90^{th} and 95^{th}) and found the results to be robust.

Hypothesis 2 posited that employment of the startup founder at prominent biopharmaceutical firms prior to founding the focal startup firm positively affects the likelihood of cooperative agreements. I measured *Former Employees of Prominent Firm* as the number of founders with previous R&D work experience at prominent firms and had no entrepreneurial experience in the biopharmaceuticals industry prior to founding the focal startup firm in the alliance deal. I explored the possibility that firms entered into alliances with the founders' previous prominent employers, but such cases only amounted

to less than two percent of the total number of actual alliances, and results are robust to the inclusion or exclusion of these transactions.

The third hypothesis posited that a successful startup founder will positively shape the likelihood of startup cooperative commercialization for the startup. Accordingly, I measured *Successful Founders* as the number of founders who had biopharmaceutical industry experience, had not worked at prominent firms in the industry, and took public at least one of their previously founded firm in the biopharmaceutical industry.

In this study, the fourth independent variable is *Patent Publication*. I suggested in hypotheses 4, 5, and 6 that the positive effect of founders' credentials on likelihood of alliance formation is expected to be more pronounced for startups that lack technological credentials of their own. In this paper, I am particularly interested in the contingent effects of founders' credentials before or after a patent publication. *Patent Publication* equals 1 if the startup had its first patent application published prior to the focal alliance, and 0 otherwise. To identify startups that had their patent application published, I followed Hegde and Luo (2013) and accounted for the American Inventor Protection Act of November 29, 1999 (AIPA). Accordingly, for all actual and unrealized alliances of startups that had formed after the law went into effect one year later (i.e., November 29, 2000), I ascertained whether each startup firm participated in an alliance during the time period between the publication of its first patent application, 18 months after its filing date, and the patent grant date.

Control variables

In my analyses, I controlled for the effects of several variables at the founding team level, startup firm level, client firm level, and dyadic level that could be correlated to the

above covariates as well as the likelihood of alliance formation. To begin with, I controlled for the number of founders in the startup's founding team with entrepreneurial experience. I measured *Serial Entrepreneurs* as the number of serial founders with no track record of taking their previous ventures to the IPO stage. Founding teams that are scientifically prolific are likely to be considered of good quality by licensees and alliance partners, and therefore I controlled for founders' number of scientific publications before the date of alliance formation. Specifically, I measured *Founders' Publications* as the natural logarithm of the scientific publications of the most published founder among the startup firm's founding team at the time of the alliance. The average number of founders' publications in my sample is 62, and the maximum number of publications is 1323. All results are robust to alternative measurement of founders' publications in terms of total and average values of publications of the founding team at the time of alliance.

The biopharmaceutical startups in my sample are venture-backed, so I collected a vector of controls capturing the characteristics of the venture capitalist firm (VC firm) backing the startup firm and the venture funding received by the startup firm at the time of the potential alliance. Startups that obtained the backing of prominent VC firms would be able to distinguish themselves as having better prospects and obtain benefits in various market contexts (Stuart et al., 1999; Gulati and Higgins, 2003; Hsu, 2006; Ozmel et al., 2013). To control for the effects of prominent VC affiliations on alliance formation, I first calculated the prominence of VC firms as the Bonacich centrality measure (Bonacich, 1987; Sorenson and Stuart, 2001). Next, I measured *Prominent VC Backing* of the startups at the time of the alliance as a dichotomous variable that takes the value of 1 if the Bonacich VC centrality measure of the most central VC backing the startup firm at the time of the

alliance is greater than the median of VC centrality in the entire sample, and 0 otherwise (Hsu and Ziedonis, 2013). In supplemental analysis, I also measured VC prominence as the centrality measure of the most prominence VC firm backing the startup firm as well as the average centrality measure of VC firms backing the startup firm, and the results below are robust to these alternative measurements of the variable. Previous research suggests that the stage of VC funding and the amount of VC funding received by a startup firm are indicative of a startup firm's progress, maturity, and quality (e.g., Gompers, 1995; Lerner, 1995; Lerner and Gompers, 1998). Accordingly, I measured *Amount of VC Funding* as the natural logarithm of the total dollar amount of VC funding received by the startup firm prior to the time of alliance. *Early Stage of VC Investment* is defined as a dummy variable that takes the value of one if the startup firm is in early stage of VC funding (i.e., seed stage or early stage), and zero otherwise. *Startup Firm Age* is a natural logged value of the age of the startup firm at the time of alliance.

I also controlled for alliance activity of the startup firm, because the number of alliances that the startup firm was able to form even while it did not obtain a patent is indicative that the startup firm was subject to evaluations of quality by previous alliance partners (e.g., Stuart et al., 1999; Stuart, 2000) that enhances their credibility in the market for ideas. In addition, it also conveys information about its visibility and outside options in these markets, as well as its ability to be effective at engaging in licensing and collaborative activities with alliance partners (e.g., Hoang and Rothaermel, 2005; Hagedoorn et al., 2011). I measured *Startup Alliance Experience* as the number of alliances formed by the startup firm at the time of alliance to control for the startup firm's alliance activity and

network (e.g., Rothaermel and Boeker, 2008). The average startup firm formed approximately two alliances prior to the focal alliance.

Similarly, I measured for the client firm's alliance formation activity as the natural logarithm of number of alliances formed by the client firm at the time of the alliance (i.e., *Client Alliance Experience*); the average client firm formed roughly 14 alliances prior to the focal alliance. I also controlled for the technological capabilities of the client firm by measuring *Client Absorptive Capacity* as the natural logarithm of the number of issued patents at the time of alliance, the average client firm obtained 1108 patents at the time of alliance.

Client firms may find it difficult to locate as well as evaluate a startup firm that is not geographically proximate. I controlled for dyadic effects of geographic proximity on likelihood of alliance formation by measuring *Geographic Distance* as the natural logarithm of the great circle distance between the headquarters of the client firm and the startup firm. In addition, I also controlled for whether the startup firm and client firm are not located in a common biotechnology cluster by measuring *Not Collocated* as a dummy variable that equals 1 if they are not collocated and 0 otherwise (e.g., Narula and Santangelo, 2009). I also controlled for the age of the startup firm since startups may be technologically attractive to prospective partners but also can present greater uncertainty given a shorter track record (e.g., Stuart et al., 1999; Nicholson et al., 2005; Hsu, 2006). Finally, I controlled for fixed effects of the year (*Year Fixed Effects*) in which the alliance between the startup firm and client firm was formed.

2.4 Results

I have suggested that startups that are composed of founders who are scientific stars, former employees of prominent biopharmaceutical firms, and successful in taking firms public are more likely to obtain collaborative agreements. Summary statistics of key theoretical variables provides some key differences between the sets of actual and unrealized alliances. In my sample, the number of actual alliances that are formed between startups and client firms is 870, while the number of unrealized alliances is 51011. There are 106 successful founders in my sample, and the average value of successful founders in the set of actual alliances is 50 percent more than the value for unrealized alliances (0.15 and 0.10 respectively, $p<0.001$). The number of founders who have a PhD degree and previously worked for a prominent biopharmaceutical firm is 263. The average value of founders who were affiliated with prominent biopharmaceutical firms prior to founding the startup firm is 47 percent more than the value for unrealized alliances (0.31 and 0.21 respectively, $p<0.001$). Similarly, there are 73 scientific stars in my sample, and the average value of scientific stars in the set of actual alliances is 88 percent more than the value for unrealized alliances (0.17 and 0.09 respectively, $p<0.001$).

Correlations in Table 2.1 suggest that startups that received more funding from venture capitalist firms and are a later stage of VC investment are more likely to obtain an alliance with client firms ($p<0.001$ and $p<0.001$, respectively). Startups that are not collocated with client firms and are farther away from them are less likely to form alliances together ($p<0.001$ and $p<0.001$, respectively). The maximum value of the variance inflation factors is 1.36, less than the rule of thumb value of 10 used for assessing multicollinearity problems (Neter et al., 1989). The maximum condition number is 7.61,

which is below the threshold value of 30, indicating that there are no severe multicollinearity concerns (Belsley et al., 1980).

Table 2.2 reports the estimates of logistic regression models for the likelihood of startup alliance formation. Model 1 is a baseline specification model consisting of control variables. Specifically, Model 1 shows the direct effects of patent publication, serial entrepreneurs and founders' publications on likelihood of startup alliance formation ($p<0.05$, $p<0.05$, and $p<0.05$, respectively). Model 2 builds on Model 1 and shows the direct effects of all hypothesized founders' credentials. Overall, both models are significant ($p<0.001$), and inclusion of all hypothesized variables increases the explanatory power of the model ($p<0.001$).

In Hypothesis 1, I predict that the likelihood of a cooperative agreement will be higher for startups that are founded by scientific stars. The coefficient estimate of star scientists is positive and statistically significant ($p<0.01$). I estimated the economic significance of a star scientist on a firm's ability to earn an alliance. With all the other covariates at their means, a startup firm that has at least one scientific star in its founding team is 36 percent more likely to achieve an alliance with client firm, supporting H1. The second hypothesis in this study predicts that startups that have founders who had previously worked at prominent biopharmaceutical firms are more likely to secure an alliance with a client firm. The coefficient estimate of this variable is positive and significant ($p<0.01$) and is also economically meaningful. Specifically, a startup firm that has at least one founder who had worked at a prominent firm is 24 percent more likely to establish an alliance, with all other covariates at their mean values.

Table 2.1. Descriptive Statistics and Correlation Matrix[a]

	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Cooperative Agreement	1															
2	Successful Founders	**0.02**	1														
3	Fomer Employees of Prominent Firm	**0.03**	**-0.04**	1													
4	Scientific Stars	**0.03**	**0.19**	**-0.02**	1												
5	Patent Publication	0.00	**0.02**	**-0.02**	**-0.02**	1											
6	Serial Entrepreneurs	0.01	**-0.16**	**-0.12**	**0.10**	0.00	1										
7	Founders' Publicaions	0.01	**0.12**	**-0.05**	**0.40**	**-0.03**	**0.09**	1									
8	Prominent VC Backing	0.00	**0.04**	**0.03**	0.00	**0.11**	**0.06**	**0.02**	1								
9	Amount of VC Funding	**0.04**	**0.12**	**0.08**	**0.11**	**0.06**	0.00	**0.08**	**0.29**	1							
10	Early Stage of VC Investment	**-0.03**	**0.02**	0.00	**0.05**	**-0.07**	**0.08**	**0.04**	**-0.14**	**-0.42**	1						
11	Startup Alliance Experience	**0.13**	**-0.02**	**0.14**	**0.03**	**-0.02**	**-0.04**	-0.01	**-0.04**	**0.16**	**-0.22**	1					
12	Client Alliance Experience	**0.02**	0.00	0.00	0.00	**-0.02**	0.00	0.00	**-0.02**	0.00	0.01	**0.01**	1				
13	Client Absorptive Capacity	**0.01**	**-0.01**	-0.01	**-0.01**	**0.01**	0.00	**-0.02**	**0.01**	0.00	0.01	0.00	**0.73**	1			
14	Not Collocated	**0.03**	**-0.02**	0.01	0.00	0.00	**-0.01**	0.00	**-0.02**	**-0.07**	**0.03**	**-0.01**	**0.03**	**0.07**	1		
15	Geographic Distance	**-0.02**	**0.01**	0.00	0.00	0.00	**-0.02**	**-0.01**	0.01	0.00	-0.01	0.00	-0.01	0.00	**0.63**	1	
16	Startup Firm Age	**-0.02**	**-0.08**	**-0.02**	**-0.02**	**0.04**	**-0.06**	0.00	0.01	**0.24**	**-0.42**	**0.26**	**-0.02**	0.00	**0.04**	**0.01**	1
	Mean	0.02	0.11	0.22	0.09	0.08	0.22	2.22	0.54	9.11	0.46	2.36	1.81	2.84	0.87	6.6	7.45
	S.D.	0.13	0.32	0.48	0.34	0.27	0.47	2.28	0.5	1.73	0.5	5.94	1.22	3.33	0.34	1.73	0.81

[a]N=51,881. $p < 0.05$ in bold.

Table 2.2. Logistic Regression Estimation Results[a]

Variables	1	2
Constant	-0.731	-0.554
	(0.783)	(0.783)
Year Fixed Effects[b]	231.48***	222.01***
Startup Firm Age	-0.447***	-0.426***
	(0.045)	(0.045)
Geographic Distance	-0.341***	-0.338***
	(0.027)	(0.028)
Not Colocated	-2.479***	-2.458***
	(0.211)	(0.213)
Client Absorptive Capacity	-0.006	-0.005
	(0.019)	(0.019)
Client Alliance Experience	0.109*	0.108*
	(0.050)	(0.050)
Startup Alliance Experience	0.064***	0.064***
	(0.003)	(0.003)
Early Stage of VC Investment	-0.270**	-0.331***
	(0.096)	(0.098)
Amount of VC Funding	0.322***	0.289***
	(0.035)	(0.036)
VC Prominence	0.133	0.161†
	(0.084)	(0.085)
Founders' Publications	0.044*	0.011
	(0.019)	(0.021)
Serial Entrepreneurs	0.186*	0.312***
	(0.078)	(0.081)
Patent Publication	0.278*	0.293*
	(0.140)	(0.141)
Scientific Stars		0.312**
		(0.103)
Former Employees of Prominent Firm		0.213**
		(0.067)
Successful Founders		0.330**
		(0.101)
Log likelihood	-3817.91	-3803.97
Wald χ^2	994.15***	1034.27***

[a]N = 51,881. *** p<0.001, ** p<0.01, * p<0.05, †p<0.1. Clustered robust standard errors in parentheses .[b]χ^2 values of joint significance for fixed effects.

Table 2.3. Interaction Effects between Founders' Credentials and Patent Publication[a]

Variables	1	2	3	4
Constant	-0.537	-0.557	-0.569	-0.552
	(0.781)	(0.783)	(0.781)	(0.780)
Year Fixed Effects[b]	221.39***	222.05***	222.35***	221.73***
Startup Firm Age	-0.427***	-0.426***	-0.425***	-0.426***
	(0.045)	(0.045)	(0.045)	(0.045)
Geographic Distance	-0.339***	-0.338***	-0.338***	-0.339***
	(0.028)	(0.028)	(0.028)	(0.028)
Not Colocated	-2.463***	-2.460***	-2.460***	-2.463***
	(0.213)	(0.212)	(0.213)	(0.213)
Client Absorptive Capacity	-0.005	-0.005	-0.005	-0.005
	(0.019)	(0.019)	(0.019)	(0.019)
Client Alliance Experience	0.109*	0.108*	0.109*	0.110*
	(0.051)	(0.050)	(0.050)	(0.051)
Startup Alliance Expeirence	0.064***	0.064***	0.064***	0.064***
	(0.003)	(0.003)	(0.003)	(0.003)
Early Stage of VC Investment	-0.341***	-0.330***	-0.329***	-0.339***
	(0.099)	(0.098)	(0.098)	(0.099)
Amount of VC Funding	0.288***	0.289***	0.288***	0.287***
	(0.036)	(0.036)	(0.036)	(0.036)
VC Prominence	0.169*	0.163†	0.164†	0.170*
	(0.085)	(0.086)	(0.085)	(0.086)
Founders' Publications	0.010	0.011	0.010	0.009
	(0.021)	(0.021)	(0.021)	(0.021)
Serial Entrepreneurs	0.314***	0.313***	0.339***	0.337***
	(0.080)	(0.081)	(0.081)	(0.081)
Patent Publication	0.291*	0.292*	0.291*	0.290*
	(0.142)	(0.141)	(0.142)	(0.143)
Scientific Stars	0.376***	0.312**	0.318**	0.370***
	(0.105)	(0.103)	(0.104)	(0.105)
Former Employees of Prominent	0.215**	0.207**	0.209**	0.212**
Firm	(0.068)	(0.069)	(0.068)	(0.069)
Successful Founders	0.344***	0.331**	0.361***	0.366***
	(0.100)	(0.101)	(0.101)	(0.100)
Scientific Stars*Patent Publication	-0.418*			-0.386*
	(0.196)			(0.194)
Former Employees of Prominent		0.073		-0.013
Firm*Patent Publication		(0.128)		(0.131)
Successful Founders*Patent			-0.325*	-0.251†
Publication			(0.149)	(0.143)
Log likelihood	-3799.72	-3803.83	-3801.53	-3798.27
Wald χ^2	1040.33***	1033.25***	1044.86***	1052.38***

[a]N = 51,881. *** p<0.001, ** p<0.01, * p<0.05, †p<0.1.Clustered robust standard errors in parentheses.[b]χ^2 values of joint significance for fixed effects.

I also found support for Hypothesis 3, which predicts that successful founders on a startup firm's founding team have a positive impact on its likelihood of engaging in a cooperative commercialization agreement. The coefficient estimate of successful founders is positive and significant ($p<0.01$). Holding everything else constant, startups that have at least one successful founder on their founding teams are 39 percent more likely to achieve an alliance. Overall, the incremental effects of the three founders' credentials are significant and economically meaningful, and their effects on cooperative commercialization agreements are comparable.

Table 2.3 reports interaction effects between patent publication and the hypothesized founders' credentials. Hypotheses 4, 5, and 6 suggest that the above effects of founding team characteristics on a startup firm's ability to obtain an alliance will be more pronounced for startups that have yet to publish their first patent application. Specifically, Hypothesis 4 predicts that the positive effect of having a scientific star on the founding team will be more pronounced for a startup firm that lacks publication of itsfirst patent application. The coefficient estimate of the interaction variable is negative and significant ($p<0.05$) and supports my prediction in H4. Hypothesis 5 suggests that the positive effect of a founder who had prior employment at a prominent biopharmaceutical firm will be more pronounced when the startup firm had not published its first patent application. The coefficient estimate of the interaction variable is not significant and does not support my prediction. Interpretation of marginal effects and graphical analysis also did not support H5. In Hypothesis 6, I posited that the positive effect of a successful founder will be stronger for a startup firm that did not obtain publication of its first patent application. Consistent with this prediction, the coefficient estimate of the interaction

variable is negative and significant (p<0.05). The marginal effects of the interactions are also consistent with the above interpretations.

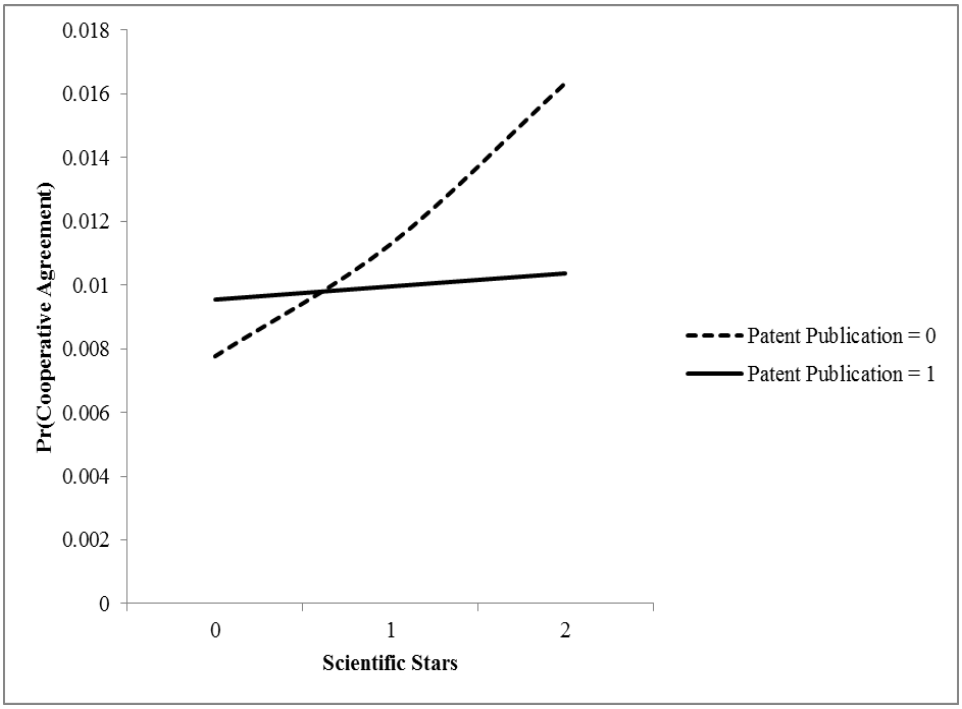

Figure 2.1. Interaction Effect between Scientific Stars and Patent Publication on the Likelihood of Formation of Cooperative Agreement

In Figures 2.1 and 2.2, I provide graphical illustrations for interaction effects of star scientists and successful founders with patent publication. Figure 2.1 shows the negative interaction between star scientists and patent publication. A star scientist on a startup firm's founding team increases the chances of alliance formation for the startup firm by 45 percent when it does not have a published patent application, but this effect no longer holds once a patent is published. Furthermore, I infer from Figure 2.1 that the positive effect of a patent publication is most prominent (nearly 30 percent) for startups that do not have star scientists on their founding team.

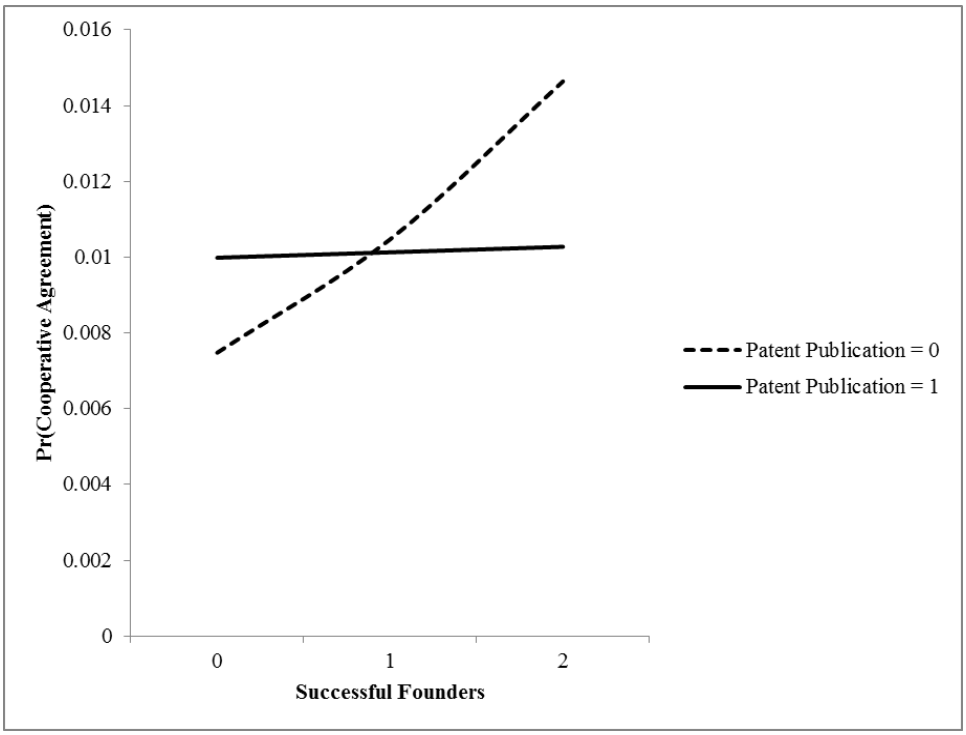

Figure 2.2. Interaction Effect between Successful Founders and Patent Publication on the Likelihood of Formation of Cooperative Agreement

Figure 2.2 shows the negative interaction between successful founders and patent publication. Startups that lack a patent publication are 40 percent more likely to obtain an alliance in the market for ideas when they have a successful founder on their founding team, and this effect is no longer evident once the firm has published a patent. This offers support for the predictions about the role of startup firm founders' entrepreneurial credentials in effecting transactions in the market for ideas and technologies, especially when the startup lacks a track record and technological credentials to offer to prospective collaborators.

Results for some of the control variables are also notable. The coefficient estimate for a startup firm's patent publication is positive and significant ($p<0.05$). This result lends

support for research that argued for the role of patents in reducing uncertainty and information asymmetry between a seller and a potential buyer of technology and R&D services in the market for ideas (e.g., Gans and Stern, 2003; Gans et al., 2008; Hegde and Luo, 2013). I also note that a startup firm that is affiliated to a prominent venture capitalist firm as well as received more funding from VCs is more likely to successful in forming an alliance ($p<0.1$ and $p<0.001$, respectively), which is consistent with the argument that VC affiliations enable young ventures to enhance their growth prospects during various stages of development (e.g., Stuart et al., 1999; Hsu, 2006). Startups that are in their early stages of VC investment are less preferred in the market for ideas ($p<0.001$), perhaps because they are still in a nascent stage and uncertainty about their technologies will be naturally higher. Finally, startups that gained visibility and credibility in the market for ideas through previous alliance transactions are more likely to become successful in selling their technologies as well as R&D services ($p<0.001$).

2.5 Discussion

2.5.1 Contributions and Implications

In this paper, I extend the fundamental ideas proposed in the economics of information to the context of market for ideas and technologies and examine the mechanisms through which startups can prevail over the adverse effects of informational asymmetries and uncertainties which restrict their early stage growth opportunities. Early stage startups typically try to obtain resources from external agents (e.g., Stuart et al., 1999; Shane and Cable, 2002) and are devoid of track records (e.g., Shane and Stuart, 2002) that enhance their visibility and establish credibility to resource providers. Potential investors and collaborators face difficulties locating and selecting early startups lacking credible

track records (e.g., Baum and Silverman, 2004). In this regard, the theoretical contribution of this study is that founders' credentials play an influential role in shaping early stage commercialization opportunities for startups by signaling the value of startups' latent ideas and technologies. Specifically, I unpack three distinct credentials of startup founders that are costly for others to attain and which enable transactions with firms by reducing their costs of search and selection. Moreover, the findings indicate that these credentials of founders matter more when the startup lacks a patent publication, which is a critical accomplishment for startups in their early stages of development (e.g., Kitch, 1977; Long, 2002; Hegde and Luo, 2013).

In this study, I advance the concept of founder's credentials and contribute in several ways to research on cooperative commercialization strategies of new ventures in strategy and entrepreneurship. For the strategy literature, I build upon the recent stream of research on market for ideas and technologies (e.g., Arora, Fosfuri, and Gambardella, 2001; Gans and Stern, 2003, 2010) and extend information economics by considering the ex-ante formation of cooperative agreements between upstream suppliers of ideas and complementary resource owners. Prior work (Arora, Fosfuri, and Gambardella, 2001) emphasizes licensing of intellectual property and division of innovative labor between upstream suppliers of ideas and technologies and developers of ideas, but does not adequately contribute to understanding about how these transactions between upstream and incumbent parties come into existence. I thus complement the research on market for ideas and technologies and collaborative R&D partnerships (e.g., Stuart, 1998; Gulati. 1999), and broadly to research on alliances and partner selection (Li et al., 2008; Rothaermel and Boeker, 2008; Diestre and Rajagopalan, 2012). In particular, I suggest that founders'

credentials play an important role in enabling startups transact with incumbent partner firms by reducing information asymmetries and risks of adverse selection for incumbent firms, thus creating the division of innovative labor and cooperative commercialization opportunities for startups. In future research it will be interesting to examine how founding team credentials shape the choice, design, and structure of cooperative commercialization agreements with incumbent firms (e.g., Gulati 1995; Gulati and Singh, 1998; Lerner and Merges, 1998; Anand and Khanna, 2000; Robinson and Stuart, 2007; Li et al., 2008)

I also contribute to research invoking signaling theory to examine the different types of signals that enable performance for new ventures in various market contexts. This stream of research has shown that ties to prominent organizations such as venture capitalists reduces adverse selection risk by signaling quality and thereby helps startups gain access to various resources required for their growth and survival (e.g., Stuart et al., 1999; Gulati and Higgins, 2003; Hsu, 2006, Ozmel et al., 2013). My study complements this stream of work by demonstrating the instrumental role that founders' credentials play in signaling the underlying nature and quality of early stage startups' ideas and technologies and accomplishing relations with incumbent partners. Given that firms can signal their prospects in several different ways (e.g., Riley, 2001; Long, 2002; Certo, 2003; Hsu, 2006; Zhang and Wiersema, 2009; Connelly et al., 2011), for future research it will be interesting to examine the relationship between these other signals and founders' credentials in shaping collaborative outcomes for startups.

My study also informs research on founding team in enhancing performance and growth prospects of entrepreneurial firms. This stream of research examined the effects of founders' human capital and networks on performance of entrepreneurial ventures

(Eisenhardt and Schoonhoven, 1990; Gimeno et al., 1997; Baum et al., 2000; Colombo and Grili, 2005; Delmar and Shane, 2006; Eesley and Roberts, 2012) and alliance formation (e.g., Eisenhardt and Schoonhoven, 1996; Stuart et al., 2007; Hallen, 2008; Luo et al., 2009). My study complements prior research by explicating three distinct credentials of founders and showing that they reduce information asymmetries about an early stage startup's ideas and technologies and create cooperative strategies. In this regard, I suggest that while human capital of individuals is not observable by outsiders (e.g, Mincer, 1958; Coff, 1997), founders' credentials positively correlate with unobservable human capital of founders, and enable potential collaborators draw inferences about expected quality of ideas and inventions of early stage startups.

Furthermore, I also extend previous research that discussed the effect of star scientists on the performance of high-tech startups (e.g., Zucker et al., 2002; Rothaermel and Hess, 2007; Higgins et al., 2011; Fuller and Rothaermel, 2011) by showing that superior scientific track record of a founder in a significant manner effects collaborative opportunities for early stage startups, particularly when they lack patent credentials. In addition, the finding that superior employment credentials of founders shape collaborative relations for early stage startups connects to the stream of research that examined how founder's prior employment affiliations enables performance for entrepreneurial firms (e.g., Beckman, 2006, Beckman and Burton, 2008). Furthermore, my theory about the role of founding team in enabling cooperative strategies for startups complements the research on top management team (TMT) experience and prestige of performance of new ventures (Kor, 2003; Cohen and Dean, 2005; Kroll et al., 2007; Certo et al., 2001; Certo, 2003). Given that there is more than one type of founders' credentials, it will be interesting to

examine how they interact with each other and shape innovative performance and outcomes for startups in various market contexts.

Finally, I contribute to research on resource-based theory (RBT) (e.g., Penrose, 1959; Wernefelt, 1984) and resource based view (e.g, Barney 1991) and complement emerging stream of research about the role of founders' experience and human capital (e.g., Eisenhardt and Schoonhoven, 1996; Colombo and Grilli, 2005; Chandler and Hanks, 1998). This study demonstrates that credentials of founders can also be instrumental as "resources" for startups (Brush et al., 2001) during their founding stages , and provide signaling services and compensate for the lack of a patent (e.g., Hsu and Ziedonis, 2013).

2.5.2 Limitations and Future Research Directions

In addition to the research opportunities discussed above, future research might also address several limitation of this study. First, the empirical context in this study is biotechnology sector, where patents offer strong appropriability for firms and where cooperative commercialization activity between upstream suppliers and incumbent firms is significant. It would therefore be interesting to examine what credentials of startup founders are relevant in in other empirical contexts where appropriability regimes are weak, or based on secrecy, such as movie industry, video game industry, and computer software industry. Furthermore, it will be useful to examine whether effect of founders' credentials on reducing informational asymmetries are contingent on other signaling mechanisms such as certification, contracts and warranties.

Second, while I emphasized the role of founders' credentials in this study, there could be other factors that could be shaping collaborative agreements for startups. For example, mobility of individuals who were previously employed at potential collaborators

may also be playing a role in formation of deals with firms (e.g., Rosenkopf and Almeida, 2003), or by the founders' social capital and industry-level networks (e.g., Rosenkopf et al., 2001; Hallen, 2008). Therefore, in future research it will be worth investigating the effects of founders' networks and mobility of employees from other organizations in shaping collaborative exchanges for startups, and their contingent effects on the founders' credentials in reducing adverse effects of informational asymmetries.

Third, given that I focus on early stage biopharmaceutical startups that are VC backed, my study is silent about firms that are not venture backed. Previous research indicates that skillful entrepreneurs are widely visible and less likely to depend on experienced VCs to attract commercialization opportunities (Gompers et al., 2006). So, while paucity of data on startups that are not venture backed limited the scope of analysis in this study, it will be useful in future work to examine how the effect of founders' credentials on collaborative outcomes varies between startups that are venture backed startups and startups that received other forms of funding such as angel funding (e.g., Kerr et al., 2014). Also, because my study has focused on early stage startups that lack a patent grant, in future work it will be valuable to investigate how the signaling benefits of founders' credentials in conveying information about the unobservable quality of the startup's knowledge varies with the startup's patenting track record and its patenting quality (e.g., Hall, Jaffe, and Trajtenberg, 2005; Hsu and Ziedonis, 2013).

2.6 Conclusion

This study extends the fundamental ideas of economics of information and unpacks founders' attributes and their contingent effects in the context of market for ideas and technologies. Specifically, I suggest three distinct credentials of founders – scientific stars,

former employees of prominent firms, and successful founders - which can be instrumental in reducing the adverse effects of informational asymmetries and facilitating collaborative commercialization agreements for startups. Yet, the positive impact of these distinct credentials of founders will be more pronounced when startups are deficient of track records such as a published patent application.

CHAPTER 3. FOUNDERS' CREDENTIALS AND RISK ALLOCATION IN COOPERATIVE COMMERCIALIZATION AGREEMENTS OF STARTUPS

3.1 Introduction

Early stage high-tech startups generally lack financial and organizational resources and track records (e.g., Shane and Stuart, 2002; Stinchcombe, 1965), and engage in cooperative modes of commercialization allow startups to mitigate resource deficiencies (e.g., Pisano, 1989; Ahuja, 2000; Lerner, Shane, and Tsai, 2003), access incumbents' complementary organizational capabilities (Gans, Hsu, and Stern, 2002; Shan, Walker, and Kogut, 1994; Rothaermel and Deeds, 2004), and capture value from their promising ideas and technologies (e.g., Teece, 1986). Further, incumbents also gain opportunities to learn about new ideas and technologies developed externally and stay up-to-date with the latest developments in an industry (Arora and Gambardella, 1990). Broadly, cooperative commercialization arrangements between startups and established incumbents occur as licensing and R&D agreements, or strategic alliances, which involve a collaborative process wherein the startups specialize in supplying new ideas, technologies, research services, and know-how (e.g., Teece, 1988; Powell et al., 1996; Arora, Fosfuri, and Gambardella, 2002; Gans and Stern, 2003), and incumbents financially support and

compensate startups for "selling" their ideas and knowledge services (e.g., Lerner and Merges, 1998; Robinson & Stuart, 2007; Gans and Stern, 2010).

However, incumbents would be generally cautious about the technological innovativeness of startups' ideas as well as startups' incentive to misrepresent the overall prospects of their ideas (e.g., Arrow; 1962), and would be induced to reallocate risk by providing financial resources contingent on technical or product market milestones (e.g., Gallini and Wright, 1990; Nicholson et al., 2005). In high-tech sectors such as biotechnology, the hazards of misrepresentation and uncertainty about prospects of high-tech startups' ideas can be acute for incumbents given startups' intangible resources and their strategic need for collaborations even before obtaining a demonstrable track record (e.g., Stuart, 1998; Gulati and Higgins, 2003). Unless these hazards are mitigated, startups that possess intrinsically good quality ideas cannot persuade prospective collaborators to provide financial payments and organizational resources for developing startups' ideas and projects. Prior research in strategy and entrepreneurship has suggested that early stage startups can pursue actions that credibly signal the underlying quality of their resources, thereby facilitating exchanges in various market contexts (e.g., Lee, 2001; Long, 2002; Certo, 2003; Sanders and Boivie, 2004; Dewally and Ederington, 2006; Hsu, 2006; Ozmel et al., 2013). While there are many likely signals a firm might utilize (Riley, 2001; Connelly *et al.*, 2011), most of these signals can take considerable time to develop and can even be absent for early stages of startups.

Startups' plans, ideas, and innovations are a direct result of their founders' intangible skills and human capital (e.g., Klepper, 2001; Shane and Stuart, 2002). Indeed,

when startups are in their earliest stages of development, incumbents can evaluate the prospects of an early stage startup's latent innovations based on the credentials and track records of their founders (e.g., Amit, Glosten, and Muller, 1990; Rao, 1994; Venkataraman, 1997). This suggests that even in the absence of other signals (e.g., a technological track record through patenting, establishing networks, etc.), startup founders' accomplishments can act as signals and credibly reduce uncertainty for potential collaborators about the quality of startups' ideas (e.g., Shane and Stuart, 2002). When faced with uncertainty and the risk of adverse selection about the technical and commercial prospects of early stage startups' ideas and projects, potential collaborators would be wary about committing capital to the startup in the form of cash payments, and will favor shifting part of the overpayment risk to the startup having better information on its resources and prospects (e.g., Coff, 1999; Kohers & Ang, 2000; Datar *et al.*, 2001). In this regard, I suggest that relevant accomplishments of startups' founders provide credible means for potential collaborators to learn about the underlying technical and commercial prospects of early stage startups' ideas and enhance the informational efficiency of their transactions by favorably altering collaborators' beliefs about the quality of startups' nascent ideas and innovations.

In this paper I build upon ideas expounded in the economics of information about the risk of adverse selection and its remedies (e.g., Akerlof, 1970; Spence, 1973) in the context of the market for ideas and know-how. More specifically, I develop hypotheses about the remedial role of startup founders' credentials in obtaining favorable payment structures for startups during collaborative commercialization with incumbents. In

particular, I propose two distinct credentials of startup founders and argue that they play an instrumental role in positively shaping the proportion of upfront payments that startups can obtain from their licensees, rather than deferred and contingent payments. More importantly, I provide evidence for the intuitive notion that the two distinct founders' credentials – star founders and successful founders – would complement each other. Finally, because high-tech startups are usually venture backed (e.g., Sahlman, 1990; Gompers and Lerner, 2001) and startups' venture activity produces information on startups' progress, I also suggest that the positive effects of these two distinct founders' credentials on the proportion of upfront payments that startups receive will vary within startups' venture activity. In particular, I suggest that the positive effect of founders' technical credentials on upfront proportion will be prominent for a startup in early stages of venture rounds, while the positive effect of founders' entrepreneurial credentials in the form of prior IPOs will be prominent during later stages of venture development.

At a broad level, I contribute to literature in strategy and entrepreneurship by examining the signaling role of founders' credentials in enhancing the value attained from their ideas and innovative capabilities from cooperative commercialization arrangements. Specifically, this study extends research on the market for ideas as well as interfirm collaborations in several ways. First, I investigate an underexplored aspect of startup performance – payment structures in cooperative agreements – and contribute to the research on market for ideas and collaborative R&D partnerships by suggesting that founders' credentials play an important role in reducing risks of adverse selection for prospective partners and shaping favorable compensation structures for startups. The

theory in this study suggests how founders' technical and entrepreneurial credentials are distinctive, yet complement one another.

Second, I also advance research in strategy and entrepreneurship by showing the importance of founder effects and the value of credentialing mechanisms in strategic alliances. Prior research has examined the roles of inter-organizational relationships (e.g., Gulati, 1999, Ozmel et al., 2013), affiliations with prominent venture capitalists (e.g., Hsu, 2006), technological track records (e.g., Stuart, 1998; Rothaermel and Boeker, 2008), and experience of top management team members (e.g., Eisenhardt and Schoonhoven, 1996) in facilitating collaborations for startups. I therefore complement this research by showing how founders' credentials shape payment structures and the allocation of risk in partnerships involving startups. By doing so, this study contributes to an emerging stream of work on the design of alliances which has so far emphasized contract complexity and specific provisions geared to partners' control and coordination concerns (e.g., Luo, 2002; Anderson & Dekker, 2005; Hagedoorn & Hesen, 2007; Mesquita & Brush, 2008; Hoetker & Mellewigt, 2009; Li, Poppo, & Zhou, 2010).

3.2 Theory and Hypotheses

In the market for ideas, early stage startups' poor information structure and incentive to misrepresent information contribute to the risk of adverse selection for incumbent partners (e.g., Leland and Pyle, 1977; Balakrishnan and Koza, 1993), and they will be unwilling to bear the risk of investing in the collaborative development of startups' innovations into commercial products. At the margin incumbents desire to safeguard against the 'lemons' problem (e.g., Akerlof, 1970) induced by uncertainty and asymmetric

information about quality of startups' innovations and respond by shifting the risks to startups through contingent contracts (e.g., Arrow, 1971). Unless, of course, startups can limit uncertainty and otherwise reduce the risk of adverse selection for the incumbent buyers in the market for ideas, startups are liable to suffer suboptimal financing arrangements for their projects and forgo growth opportunities (e.g., Hubbard, 1998).

In general, contingent-payment structures are quite popular in several market contexts burdened with uncertainty and adverse selection risks (e.g., Robichek and Myer, 1966). For example, in the venture capital industry, venture capitalists evaluate startups' promise based on their progress, and accordingly stage their investments in startups based on certain pre-specified measurable milestones (e.g., Gompers, 1995). Similarly, in the mergers and acquisitions context, acquirer firms use contingent earnouts as an instrument to mitigate overvaluation risk and uncertainties in valuation of privately-held targets lacking track records (e.g., Coff, 1999; Ragozzino and Reuer, 2009). In a similar manner, cooperative commercialization arrangements in the market for ideas and know-how entail a sequence of payments specified by incumbent firms to startups. These payments are usually structured as upfront payments, milestone payments, and royalties on sales. Especially, because uncertainty about quality will be high when startups lack track records that can attest to their unobservable attributes, incumbents face significant risk of overpaying for startups' ideas. In contrast, as I will discuss, when startups that are inherently 'good' can credibly signal the technical and commercial prospects of their intangible ideas and know-how, incumbents are likely to adjust their beliefs and structure a greater portion of the total negotiated value to startups as upfront payments.

Spence (1973) originally proposed the role of education credentials of employees as signaling mechanisms in ameliorating the risk of adverse selection for prospective employers in the labor market. Many studies in management and economics literatures elucidate various signaling mechanisms which can enable entrepreneurs and startup firms to obtain necessary resources of growth in a wide range of market settings (e.g., Amit, Glosten, and Muller, 1990; Carter and Manaster, 1990; Megginson and Weiss, 1991; Stuart et al., 1999; Certo, 2003; Cohen and Dean, 2005; Levitas and McFayden, 2009; Zhang and Wiersema, 2009; Hsu and Ziedonis, 2013). For instance, startup firms can engage in quality certification to mitigate the risk of adverse selection by contracting with prominent venture capitalists and prominent exchange partners even on heavily discounted terms (e.g., Hsu, 2004; Nicholson et al., 2005), to be able to strike future deals with incumbents (e.g., Hsu, 2006; Ozmel et al., 2013). Noting that startups' ideas are a direct result of their founders' unobservable abilities (Nelson and Winter, 1982), superior quality startups founded by highly accomplished founders will be able to distinguish themselves from others, and reduce their risk of incurring more of their innovations' returns as contingent payments rather than as upfront payments that increase profits and are resources available for immediate investment.

The research hypotheses in this study propose two credentials of startup founders that can effectively function as signaling devices, in the sense that they credibly update buyers' beliefs and are also costly to acquire and imitate for other startup founders (Spence, 1973). More importantly, I argue that these two distinct accomplishments of startup founders credibly attest to two distinctive, albeit complementary attributes, of startups'

ideas and know-how – their technical quality and commercial prospects. Finally, this study also suggests that the positive effects of these two distinct founders' accomplishments on the proportion of upfront payments that startups receive will vary with the stages of startups' development.

3.2.1 Star Founders

Startup founders' unobservable inventive and scientific competences have a direct bearing on the technical promise of their startups' ideas and know-how. When the characteristics of ideas and technologies of startups are hard to evaluate, startups' exchange partners can alternatively draw genuine inferences about startups' unobservable quality from startup founders' distinguishable scientific and technical track records. In a nutshell, while the core of startups' difficult-to-evaluate intangible ideas and knowledge assets are certainly shaped by startup founders' underlying skills and knowledge (e.g., Teece, 1981), startups' exchange partners can appraise the underlying epistemic worth of startups' ideas only through the observable distinctive technical and scientific accomplishments of founders. While costly for other startup founders to imitate, outstanding technical and scientific track records convey information about founders' unobservable human capital (Spence, 1973, 2002) and serve as credible signals for the quality of early stage startups' ideas. Such track records can therefore enable licensees of startups' ideas and know-how to adjust their beliefs about the latent technical quality and authenticity of startups' ideas.

Specifically, in knowledge-driven industries such as computer software and biopharmaceuticals, creation of new knowledge and ideas is critically determined by the scientific depth and technical know-how of individuals. In any field of activity not all

individuals can be equally good at developing high-quality ideas, and on the whole individuals equipped with deeper domain knowledge and demonstrated skills are more likely to generate technically-robust ideas (e.g., Nelson and Winter, 1982; Teece, 2003). Given the fact that individuals vary in their unobservable innovative abilities (e.g., Haltiwanger and Waldman, 1985; Felin and Hesterly, 2007), the ability to create superior quality know-how and ideas by experts cannot be easily acquired and replicated by other types of individuals.

Previous research suggests that expert individuals who earned credentials as star scientists (henceforth 'star founders') enable firms in knowledge-driven industries such as biotechnology enhance their performance and innovative output (e.g., Zucker, Darby, and Armstrong, 2002; Rothaermel and Hess, 2007). Generally, in knowledge-driven industries, star individuals are regarded highly for their exceptional ingenuity and are known for their ability to generate cutting-edge ideas and technologies that are less uncertain (e.g., Zucker, Darby and Armstrong, 1998). As a consequence, they enable startups to accelerate the commercialization process (e.g., Agrawal, 2006; Zucker, Darby, and Brewer, 1998). Moreover, firms associated with star individuals obtain superior performance in the public equity markets as they are perceived as better quality firms by investors (e.g., Higgins et al., 2011; Fuller and Rothaermel, 2011).

Spence (1973) suggests that in the labor markets employees with better educational qualifications are viewed as possessing productivity enhancing skills and rewarded higher wages by employers. In a similar way, in the market for ideas startup founders with star credentials are more likely to be regarded as having outstanding human capital capable of producing cutting-edge ideas and innovations (e.g., Burton, Sorenson, and Beckman,

2002). Inasmuch as uncertainty about the technical prospects of startups' ideas poses the risk of adverse selection for incumbents, startups founded by individuals who acquired star scientist credentials would be regarded as possessing ideas and projects that are technically superior. So, I would expect startups founded by stars to obtain a higher fraction of the total consideration as upfront payment from incumbent clients. By contrast, incumbents would be prone to adverse selection when transacting with startups that lack star founders and seek to transfer risk to them by offering lower upfront payments and providing contingent payments. I thus posit:

Hypothesis 3.1 *A star founder on a startup's founding team will have a positive effect on the proportion of upfront payments the startup receives in cooperative commercialization agreements.*

3.2.2 Successful Founders

While a star founder can credibly shape incumbents' beliefs about the underlying technical attributes of startup's ideas and their technical prospects, incumbents may still face considerable uncertainty about the commercial viability and market potential of startups' ideas. However, incumbents are likely to adjust their expectations about the commercial prospects of startups' ideas based on signals about the difficult-to-estimate market potential of startups' ideas. Specifically, startups founded by innovators who were successful in taking a previous venture through to an initial public offering (IPO) are more likely to be regarded as commercially promising and present a lower risk of adverse selection. Founders largely shape the transformation of an idea or concept into commercializable products and services (e.g., Feeser and Willard, 1990), and founders

differ in terms of their entrepreneurial abilities. As Schultz (1980) suggests, past experience endows founders with knowledge that is essential for production of entrepreneurial ideas. In general, experience imparts individuals with deeper knowledge and sharpens their abilities to grasp nuances about a given activity (e.g., Arrow, 1962).

Specifically, previous entrepreneurial experience can significantly enhance skills and competencies which widen founders' cognitive abilities and enable better performance of their subsequent entrepreneurial efforts (e.g., Nelson and Winter, 1982; Stuart and Abetti, 1990; Chandler and Hanks, 1998). The ability to recognize opportunities for innovation and undertake associated risks will be heterogeneous among founders (Khilstrom and Laffont, 1979; Teece, 2007), and likely to be superior for those with previous entrepreneurial experience. Prior entrepreneurial experience improves founders' ability to identify promising ideas and commercially exploit them using their acquired entrepreneurial skills (Rosen, 1972; Cooper et al., 1989; Brüderl et al., 1992; Teece, 2007; Callander, 2011). Moreover, because innovative activity is risky and accompanied by experimentation and problem-solving processes (e.g., Hippel and Tyre, 1995), startup founders with previous entrepreneurial experience are likely to be more capable at recognizing risks and developing ideas with commercial potential (e.g., Pisano, 1996; Bhide, 2000; Hsu, 2007; Baum and Bird, 2009).

While founders' entrepreneurial experience can make them adept at discovering new production techniques and play a key role in pioneering innovations (Schumpeter, 1934), founders may also tend to overestimate the quality and prospects of their ideas (Busenitz and Barney, 1997; Simon and Houghton, 2003). In this regard, incumbents would be generally cautious about founders' adverse incentive to overstate and tendency

to display optimism about the commercial prospects of their innovations, and safeguard against such risks through contingent payment provisions (e.g., Gallini and Wright, 1990; Riordan, 1984). Inasmuch as uncertainty about market potential of startups' ideas and misrepresentation trigger risks for potential collaborators, startups of serial founders with an established track record for developing technologies with market potential would be rated as possessing ideas with good market prospects (e.g., Frank, 1988; Fraser and Greene, 2006).

Specifically, founders who were successful in taking one of their previous ventures through to the public equity markets (henceforth 'successful founders') gain wide recognition as outstanding innovators (e.g., Certo et al., 2001; Gompers et al., 2010) and their later startups are likely to be judged positively by exchange partners and investors (Gompers et al., 2010; Hsu and Ziedonis, 2013). Studies in management and finance suggest that prior success of founders in the IPO market serves as credible signal (e.g., Gompers et al., 2010; Berk et al., 2004; Sanders and Boivie, 2004). Startups operating in high-tech sectors, such as software and biotechnology, face the challenge of convincing a large and diverse group of investors in public equity markets and cannot anticipate an optimal IPO unless investors are convinced of the venture's progress and commercial potential (e.g., Lerner, 1994; Chemmanur and Fulgheiri, 1999; Stuart et al., 1999; Ritter and Welch, 2002). In this regard, ventures started by founders with prior IPOs are likely to be regarded as having attractive market prospects (e.g., Berk et al., 2004; Sanders and Boivie, 2004).

Taken together, the above arguments suggest that cooperative exchange partners would be positive about the commercial prospects of startups founded by serial

entrepreneurs with prior IPOs. Inasmuch as incumbents as see a lower risk of adverse selection, they will have a reduced need for deferred, contingent payments in cooperative commercialization agreements. As a result, I expect startups founded by successful founders to enjoy higher upfront payments when they enter into such agreements. I thus posit:

Hypothesis 3.2 *A successful founder on a startup's founding team will have a positive effect on the proportion of upfront payments the startup receives in a cooperative commercialization agreement.*

3.2.3 Founders' Credentials and Complementarity

When incumbents enter into collaborative commercialization with early stage startups, they face uncertainty about the technical prospects and market potential of startups' ideas. On the one hand, ideas of startups may contain technical and intangible aspects that are privately known to the startup and hard to evaluate by outsiders, creating uncertainty about technical feasibility. On the other hand, insofar as the pre-contractual assessment of the commercial potential of startups' ideas is difficult and filled with uncertainty, potential exchange partners also face uncertainty and risk of adverse selection about the market potential of startups' ideas.

Broadly, incumbents face the risk of adverse selection when evaluating the technical and commercial feasibility of startups' ideas. In this regard, startups that are able to simultaneously signal their technical and commercial prospects are likely to perceived as most promising startups in the market for ideas and obtain superior payment structures.

Earlier, I argued that a star founder (H1) modifies information about the technical feasibility of startups' ideas and positively impacts the proportion of their cash payments. While founders' superior scientific accomplishments can establish credibility for the quality of startups' technical projects and ease adverse selection risks for incumbents, incumbent partners would also be highly concerned about the commercial prospects of startups' ideas.

Incumbents entering into collaborative commercialization agreements with startups invest in startup firms and commit their scarce organizational resources for further development and commercialization of startups' nascent innovations (e.g., Teece, 1986; Lerner and Merges, 1998; Ahuja, 2000; Baum et al., 2000; Gans et al., 2002). Consequently, incumbents would look to insure against possible risks pertaining to the overall success of startups' ideas, and their assessment about startups' ideas would be comprehensive and tied to the commercial promise, as well as technical quality, of startups' ideas.

Whereas startups that have scientific stars on their founding team are likely to be viewed as having ideas with excellent technical quality and less risky, incumbents are not entirely relieved of adverse selection risk as they also would be wary about commercial viability of startups' ideas. Founders who are technically specialized may be exceptional at applying their deep domain knowledge to create technically robust ideas, yet they may not be equipped with much needed understanding about commercial research opportunities (e.g., Knockaert et al., 2011). While having scientific star founders can be valuable in deepening a startup's research activities and developing possible solutions to technical

problems, a startup's substantial problem is to also consolidate their R&D projects and technical ideas into commercially promising innovations (e.g., Pisano, 1994; Jong, 2006).

Based on the foregoing arguments, startups that can demonstrate the scientific feasibility of their ideas can be further better-off within cooperative commercialization agreements when startups can also credibly establish the commercial promise of their nascent innovations for incumbent partners. Indeed, startup founders' prior commercialization experience and acquired innovative abilities largely shape the commercial development and orientation of startups' technologies (e.g., Feeser and Willard, 1990; Shane and Stuart, 2002). For example, in my empirical setting of biotechnology, founding team's ability to manage R&D projects and guide them through the product development and commercialization stages is regarded as highly valuable (e.g., Schoemaker and Schoemaker, 1998) in shaping commercial prospects of startups' projects.

Prior research suggests that previous entrepreneurial experience improves founders' ability to identify promising ideas and commercially exploit them using their acquired entrepreneurial skills (Rosen, 1972; Khilstrom and Laffont, 1979; Cooper et al., 1989; BrÜderl et al., 1992; Ardichvili et al., 2003; Teece, 2007; Callander, 2011). In particular, founders who have achieved success in their previous entrepreneurial endeavors are known to be adept at discovering new production techniques and are more likely to have developed expertise in pioneering innovations that are technically solid with high commercial value (Schumpeter, 1934; McGee et al., 1995; Arvanitis and Stucki, 2012).

Taken together, the above arguments suggest that scientific and entrepreneurial credentials of startup founders collectively modify startups' information structure and

credibly signal about the technical and commercial prospects of startups' ideas to incumbent partners. Because scientific star founders are technically specialized, they can be effective in mitigating adverse selection risks for incumbent partners only about technical prospects of startups' ideas. However, if these startups also have a founder with prior entrepreneurial success then adverse risks that incumbents might perceive about startups' commercial prospects would also be reduced, and thus they would be able to negotiate far higher fraction of upfront payments. Therefore, I intuit that star credentials and entrepreneurial accomplishments function as complementary signals in positively shaping the proportion of upfront payments obtained by startups. I thus posit:

Hypothesis 3.3 *The positive effect of a star founder on the proportion of upfront payments that a startup receives in a cooperative commercialization agreement will be greater when the startup also has a successful founder on its founding team.*

3.2.4 Startup Development and Contingent Effects of Founders' Credentials

Information environment of startups will influence the beliefs of collaborative partners and determines their allocation of financial resources to startups (e.g., Leland and Pyle, 1977). While the hypothesized founders' credentials function as signals and positively modify the information environment about startups' projects, their signaling value also varies according to the developments that take place in startups' research projects and activities.

When startups' ideas and projects are in the initial stages of development, verifiable information about the technical progress of their ideas is very limited and, therefore, exchange partners would not be able to assess the technical prospects of startups' projects in these situations. Shortage of information about the technical aspects of the project raises uncertainty about the technical feasibility of the startup's project and would preclude incumbents from providing financial support to the startups' projects. Incumbents would rather be inclined to stage their financing in early stage startups based on milestone attainments. In contrast, when startups' projects achieve technical outcomes, such as the design of a prototype or published results, feasibility could be gauged based on the produced technical information, meanwhile estimating their commercial prospects of the projects would still be difficult.

Startups in high-tech industries are usually backed by venture capital investments and the performance of startups in venture rounds would be indicative of the underlying nature of startups' projects. Typically, venture capitalists (VCs) invest in highly uncertain prospects and overcome informational asymmetries by staging their investments in startups (e.g., Sahlman, 1990; Gompers and Lerner, 2001). VCs monitor the progress of startups and warrant capital infusion in startups based on the progress of their proposed projects (e.g., Gompers, 1995; Kaplan and Stromberg, 2003) and retain right to abandon a startup whose prospects appear dull (Sahlman, 1990). VCs provide milestone-based financing to startups during their formative stages, and as information is produced on the prospects of startups' projects, VCs escalate their investments in these startups and advance their commitment into later rounds of financing (e.g., Lerner, 1994).

The above evidence points that the investment activity of VCs credibly broadcasts information to external resource providers and signals to collaborative partners about the prospects of startups' projects. In this regard, I argue that the relevance of my hypothesized variables would be contingent on the stage of VC investment in startups. Specifically, for a startup that is in early-stages of VC investment, incumbents are subject to asymmetric information about the technical progress of the startup's research projects and their commitment of financial capital to the startup will be largely contingent on milestones. However, a star founder on the startup's founding team credibly signals to incumbents about the technical prospects of the startup's projects and reduces the risk of adverse selection for incumbents about startups that are in their early-stages. Alternately, when a startup progressed beyond early-stages of VC investment, it credibly conveys to incumbents about the technical prospects of startup's projects and the startup will be able to obtain higher proportion of upfront payments. Yet, credible signals about commercial prospects of startup's projects and ideas would further induce incumbents to provide a higher portion of upfront payment. In particular, a startup firm which progressed to later stages of VC financing would be able to obtain higher fraction of upfront payment if it is also founded by an entrepreneur with prior IPOs. I thus posit:

Hypothesis 3.4 *The positive effect of a star founder on the proportion of upfront payments that a startup receives in a cooperative commercialization agreement will be greater for a startup in early-stages of VC investment.*

Hypothesis 3.5 *The positive effect of a successful founder on the proportion of upfront payments that a startup receives in a cooperative commercialization agreement will be greater for a startup that has progressed beyond early-stages of VC investment.*

3.3 Methods

3.3.1 Data and Sample

To test the hypotheses for this study, I use a dataset of cooperative commercialization agreements (such as licensing and collaborative R&D agreements) between startups and incumbent firms in the biopharmaceutical industry. The empirical setting of biopharmaceutical industry is suitable to investigate my hypotheses for several reasons. First, the industry is driven by scientific discoveries and laboratory experiments, and is representative of the features of market for ideas and technologies (e.g., Gans, Hsu, and Stern, 2002; Arora and Gambardella, 2010) in which startup innovators trade their technologies and ideas by entering into R&D licensing and collaborative agreements. Second, startups and incumbent firms in the biopharmaceutical industry often engage in early stage collaborative activity to develop drugs and obtain commercial success (e.g., Pisano, 1990; Powell, Koput, and Doerr-Smith, 1996; Jones and Clifford, 2005). Typically, in this industry the compensation incumbent firms provide to startups during collaborative agreements is structured in terms of upfront payments, milestone payments, and royalties (e.g., Higgins, 2007). Third, startups taking part in these alliances often have short track records and difficult-to-evaluate technological resources and capabilities (e.g., Stuart et al., 1999; Nicholson, Danzon, and Mccullough, 2005; Levitas and McFayden, 2009). Finally,

these startups and their collaborative agreements are well documented in this industry, providing rich information for modeling as well as for drawing comparison with prior alliance research.

In this study, I examine the determinants of the proportion of upfront payments startups receive in cooperative commercialization agreements. To this end, I assembled the list of VC-backed startups in the biopharmaceutical industry from Thomson Reuters' VentureXpert database. Venture capitalists focus their investments in information technology and biotechnology industries (e.g., Hsu, 2006) and play a significant role in providing private financing to startup firms in these sectors (e.g., Sahlman, 1990; Zucker, Darby, Brewer, 1998). I assembled data on startup licensing agreements and collaborations in the biopharmaceutical industry between 1990-2012 from Thomson Reuters' Recap database, which is considered robust and representative in its coverage of alliance agreements in this industry (Schilling, 2009). Data from Recap has been used extensively by researchers in management, economics, and finance to investigate startup activities such as cooperative strategies in the biopharmaceuticals industry (e.g., Robinson and Stuart, 2007). In their data, Recap denotes the party that provides the intellectual property, technology, and R&D services, as the R&D firm, and the counterparty that obtains the license as the client firm. In addition, they also provide information about the payments client firms provide to startups.

I identified founders for all the startup firms obtained from VentureXpert. I relied on various sources to collect information about founders. Specifically, I used BioScan, VentureXpert, Bloomberg Businessweek, and company websites to collect names of

founders. In addition, I also used sources such as SEC filings, LexisNexis, and other web searches to obtain the names of all possible unique founders for each firm in my data set. In my data of firm founders, I have 229 unique founders. I tracked the career histories of all the 229 founders in the sample using LinkedIn, company websites, university web pages, and other sources such as Bloomberg Investing to construct founder-level explanatory and control variables. Furthermore, I used Thomson Reuters' Web of Science to collect information on scientific publications of founders in my data set.

In this study, I am mainly interested in the role of startup founders' credentials in determining the proportion of upfront payments during licensing and R&D agreements when the startup lacked a technological track record. Accordingly, I identified alliances that are formed before the startup obtained its first patent grant by combining the alliance data of VC-backed startup firms with patent information from the United States Patent and Trademark Office (USPTO) and the National Bureau of Economic Research (NBER) after tracking company histories and name changes. In order to reduce unobserved heterogeneity from cross-border transactions and maintain consistency with the patent information from USPTO and NBER, I limited my analyses to firms founded in the United States.

Additionally, I excluded alliances where the startup firms received their last round of VC funding at least seven years before the time of alliance, in order to exclude firms that are defunct, or "living dead" (e.g., Ruhnka, Feldman, and Dean, 1992; Mason and Harrison, 2002). Because all the startups in my sample are venture backed, I also considered only those alliances that were formed after the startup's first round of VC funding. After applying these sampling screens, I obtained a final sample of 263 alliance

agreements which are indicated by Recap as collaboration, development, co-development, and research type agreements of 132 distinct human therapeutic biotech startups.

3.3.2 Measures and Analysis

Dependent Variable

I examine the proportion of upfront payment obtained at the contracting stage by a startup. Financial payments to fledgling startups during alliance agreements with incumbents often comprise of payments such as upfront payments, milestone payments, and royalties. While both milestone payments and royalties are contingent on a specified outcome such as a developed product or sales in product market, upfront payments are funds that the startup earns upon formation of the alliance and are available for immediate investment. So, startup firms are likely to have a preference for obtaining the value of their innovations upfront, because they are immediately realized and can mitigate resource constraints for early stage startups. At the same time, partners paying upfront are exposed to a higher risk of adverse selection, and can reduce such risks through deferred, contingent payments. Accordingly, I modeled *Proportion of Upfront Payment* as the fraction of total agreement value obtained as an upfront payment. Given that the dependent variable in this study is a fractional outcome ranging from 0 to 1, I follow Papke and Wooldridge (1996) and employ the fractional logistic regression approach, which is based on the binomial family and logistic link function within the generalized linear models framework. In supplemental analyses, I also used generalized linear regression models to examine effect of my hypothesized founders' credentials on logged values of agreement value and upfront amount and found similar interpretations as those presented below ($p<0.01$ and $p<0.01$,

respectively for agreement value; $p<0.001$ and $p<0.05$, respectively for upfront amount). I also used robust standard errors clustered by startup because some startups are involved in more than one alliance in the final sample.

Independent Variables

The first hypothesis posited that the proportion of upfront payments is positively related to *Star Founders* in the startup's founding team. Prior research has operationalized this variable in different ways. Zucker and Darby (1996) identified star founders on the basis of the number of scientific articles published until 1990 that reported the discovery of at least one among the 40 genetic sequences which were described in GenBank (1990). Zucker and Darby (2006) used data of citation counts and publications of scientific articles provided by ISIHighlycited.com and ISI Web of Science to identify top researchers in science and engineering. Rothaermel and Hess (2007) constructed their measure of star scientists by compiling publication and citation information for all scientists working at various pharmaceutical firms in their sample, and identified stars as those who had received citations at least two standard deviations above the mean. Higgins, Stephan, and Thursby (2011) defined stars as university-affiliated researchers who are scientifically accomplished by identifying university scientists who won a Nobel Prize.

Considering these differences in defining stars based upon the focus and time frame of previous studies, I followed Rothaermel and Hess' (2007) approach since it is operationalizable across the long sequence of startup and alliance activity in my data set. Accordingly, I searched for publication and citation data of all founders in my sample of firm founders in Thomson Reuters' Web of Science database (formerly ISI Web of

Knowledge) and identified publications for each founder by mapping their name, scientific field of study, and list of affiliated organizations. I extracted publication and citation information for all founders during the period 1990-2012 who published scientific articles in fields related to biotechnology, pharmaceutical sciences, and medical sciences. The average number of citations that founders received for their scientific publications is 9578. I operationalized *Star Founders* as number of founders of a startup firm who had been cited more than two standard deviations above the mean of the natural logarithm of the number of citations during the 20-year span in my sample. I also performed robustness checks by constructing this measure using different cutoff values (e.g., one standard deviation above the mean and different percentiles (90^{th} and 95^{th})) and found the results to be robust.

Hypothesis 2 posited that a startup founder with a credential of entrepreneurial success will positively shape the proportion of upfront payments by signaling the commercial prospects of the startup's ideas and innovations. Accordingly, I measured *Successful Founders* as the number of founders who took public at least one of their previously founded firm in the biopharmaceutical industry.

My third independent variable is *Early Stage of VC Investment*. Hypotheses 4 and 5 posit that the positive effect of founders' scientific credentials and entrepreneurial credentials on proportion of upfront payments is expected to vary with the startup's development. For startup firms, stages of VC investment highly correlate with development of startups' ideas and innovations (e.g., Gompers, 1995), and typically ideas and innovations of startups in their formative stages of development are considered nascent and their technical quality is highly uncertain (e.g., Hellman and Puri, 2000). *Stage of VC*

Investment equals 1 if the startup is in initial stages of VC investment (i.e., seed stage and early stage of venture financing), and 0 otherwise (e.g., Gompers, 1995).

Control Variables

In my analyses, I controlled for the effects of several variables at the founding team level, startup firm level, client firm level, and dyadic level that could be correlated to the above covariates as well as payment structures. To begin with, I measured *Former Employees of Prominent Firms* as the number of founders who were previously affiliated with prominent biopharmaceutical firms. Founding teams that are scientifically prolific may be considered as having better quality innovations, and therefore I controlled for founders' number of scientific publications prior to the focal alliance. Specifically, I measured *Founders' Publications* as the natural logarithm of the scientific publications of the most published founder among the startup firm's founding team at the time of the alliance. The average number of founders' publications in my sample is 62, and the maximum number of publications is 1323. All results are robust to alternative measurement of founders' publications in terms of total and average values of publications of the founding team at the time of alliance.

While a granted patent resolves uncertainty about the startup's underlying technological nature (e.g., Gans et al., 2008), in its absence client firms can draw inferences about the unobservable quality of the startup's knowledge base and innovations based on the number of patent applications filed by the startup firm prior to the alliance (e.g., Haussler et al., 2009; Hsu and Ziedonis, 2013). I control for the startup firm's difficult to observe technological endowments the absence of a granted patent by measuring *Startup*

Patent Applications as the number of patent applications filed by the startup firm prior to the alliance agreement. I also controlled for alliance activity of the startup firm, because the number of alliances that the startup firm was able to form even while it did not obtain a patent is indicative that the startup firm was subject to evaluations of quality by previous alliance partners (e.g., Stuart et al., 1999; Stuart, 2000) that enhances their credibility in the market for ideas. In addition, it also conveys information about its visibility and outside options in these markets, as well as its ability to be effective at engaging in licensing and collaborative activities with alliance partners (e.g., Hoang and Rothaermel, 2005; Hagedoorn et al., 2011). I measured *Startup Alliance Experience* as the number of alliances formed by the startup firm at the time of alliance to control for the startup firm's alliance activity and network (e.g., Rothaermel and Boeker, 2008).

The biopharmaceutical startups in my data set are venture-backed, so I collected a vector of controls capturing the characteristics of the venture capitalist firm (VC firm) backing the startup firm and the venture funding received by the startup firm at the time of the potential alliance. Startup firms that obtained the backing of prominent VC firms would be able to distinguish themselves as having better prospects and obtain benefits in various market contexts (Stuart et al., 1999; Gulati and Higgins, 2003; Hsu, 2006; Ozmel et al., 2013). To control for the effects of prominent VC affiliations on the proportion of upfront payments, I first calculated the prominence of VC firms as the Bonacich centrality measure (Bonacich, 1987; Sorenson and Stuart, 2001). Next, I measured *VC Prominence* of the startup firms at the time of the alliance as a dichotomous variable that takes the value of 1 if the Bonacich VC centrality measure of the most central VC backing the startup firm at

the time of the alliance is greater than the median of VC centrality in the entire sample, and 0 otherwise (Hsu and Ziedonis, 2013). In supplemental analysis, I also measured VC prominence as the centrality measure of the most prominence VC firm backing the startup firm as well as the average centrality measure of VC firms backing the startup firm, and I found my results below are robust to these alternative measurements of the variable. Previous research suggests that the amount of VC funding received by a startup firm is indicative of a startup firm's progress, maturity, and quality (e.g., Sahlman, 1990; Gompers, 1995; Lerner, 1995). Accordingly, I measured *Amount of VC Funding* as the natural logarithm of the total dollar amount of VC funding received by the startup firm prior to the time of alliance.

Alliance characteristics are likely to shape the proportion of upfront payments in a collaborative agreement. For example, it is possible that clients require a startup to bear a discount for its first alliance based on the signal the alliance itself sends to outside investors, so I include the dummy variable *First Alliance* to address this effect (Nicholson *et al.*, 2005). Since governance characteristics and payment structures jointly shape the incentive and control features of collaborative agreements, I included dummy variables *Equity* to indicate whether or not the deal is an equity alliance (Robinson & Stuart, 2007) and *Exclusivity* to indicate whether the deal contains terms of exclusivity (Somaya, King, & Vonortas, 2012). I also included the dummy variable *R&D component* to control for whether the alliance agreement encompasses R&D activities (Gulati, 1995). I control for the stage of the alliance within the drug development cycle and measured *Stage of Agreement* as a dichotomous variable that equals 1 if the alliance includes discovery,

preclinical, or lead molecule activities, and 0 otherwise. I also included *Agreement Value*, using a log transformation of the total payments to the R&D firm (Robinson & Stuart, 2007).

In addition, I also controlled for features of the client by incorporating an indicator variable to capture whether the client firm is a prominent pharmaceutical firm by including a dummy variable *Big Pharma Client*. I also included an indicator variable *Biotech Client* to identify deals where the client firm is an incumbent biotechnology firm (Lerner et al., 2003). I also measured for the client firm's alliance formation activity as the natural logarithm of number of alliances formed by the client firm at the time of the alliance (i.e., *Client Alliance Experience*); the average client firm formed roughly 14 alliances prior to the focal alliance. I also controlled for the technological capabilities of the client firm by measuring *Client Absorptive Capacity* as the natural logarithm of the number of issued patents at the time of alliance, the average client firm obtained 1108 patents at the time of alliance. Prior research suggests that public capital markets can also provide financial resources to new ventures and affect the bargaining power of the partners (Lerner *et al*., 2003). Accordingly, I include *Biotech Equity Index* to control for equity market conditions in the biopharmaceutical industry (Lerner, 1994). Finally, I also controlled for a series of fixed effects for the focal therapeutic domain for the alliance (*Therapeutic Effects*) (Macher and Boerner, 2006), its technological domain (*Technology Effects*) (Adegbesan and Higgins, 2011), and the year in which the collaborative agreement was signed (*Year Effects*).

3.4 Results

Table 3.1 provides descriptive statistics and correlations for my sample. The average proportion of upfront payment is 0.23, and it is positively correlated with star founders and successful founders ($p<0.05$, respectively). A startup with a star on its founding team obtains 24 percent of upfront proportion, while a startup that does not have a star founder receives only 16 percent ($p<0.05$). Similarly, a startup founded a successful founder on an average receives about 26 percent of upfront proportion. In comparison, a startup that does not have a successful founder receives only 19 percent of the value upfront ($p<0.05$). In addition, while 14 percent of the sampled collaborative agreements were first alliances of startups, such agreements also tended to obtain 15 percent of the total value as upfront payments (26 percent for others; $p<0.01$). Overall the correlations suggest no multicollinearity concerns. The maximum variance inflation factor is 2.51, which is well below the rule of thumb value of ten used to indicate multicollinearity problems (Neter et al., 1989). The maximum condition number is 9.76, which is below the threshold value of 30, indicating that there are no severe multicollinearity concerns (Belsley et al., 1980).

Table 3.2 reports the estimates of fractional logistic regression models for the proportion of upfront payments received by the startup. Model 1 is the baseline specification model consisting of control variables. Model 2 augments model 1 and shows the direct effects of my hypothesized variables. The first hypothesis predicted that a startups founded by star founders will receive greater portions of upfront payment in collaborative agreements. Consistent with this prediction, the coefficient estimate of star founders is positive and statistically significant ($p<0.05$). I estimated the economic

significance of a star founder on a startup's ability to obtain higher proportion of upfront payments. With all the other covariates at their means, a startup that has a star founder in its founding team increases the proportion of upfront payment by 47 percent. In hypothesis 2, I predicted a similar positive effect for founders' commercial credentials. The coefficient estimate of successful founders is positive and significant ($p<0.05$). The

effect is economically meaningful, as I find that an average startup founded by a successful founder increases the proportion of upfront amount it obtains by 53 percent.

Table 3.3 reports all hypothesized interactions in this study. Model 1 captures the interaction between star founders and successful founders posited in Hypothesis 3. Specifically, Hypothesis 3 predicts that the positive effect of a star founder will be more pronounced for a startup that also has a successful founder in its founding team. Consistent with this prediction, the coefficient estimate of the interaction between star founders and successful founders is positive and significant ($p<0.001$). Models 2 and 3 in Table 3.3 illustrate the interactions between stage of VC investment and the hypothesized founders' credentials in this study. Specifically, Hypotheses 4 suggests that the positive effect of a star founder on the proportion of upfront payments will be greater when the startup is in its initial stages of development, because client firms will be concerned about the technical prospects of the startup firm during these stages of development. The coefficient estimate of the interaction variable is not significant and does not support my prediction; however the coefficient estimate is positive and significant ($p<0.1$) in the full model (Model 4).

Table 3.1. Descriptive Statistics and Correlation Matrix[a]

	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	Proportion of Upfront Payments	1																				
2	Successful Founders	**0.01**	1																			
3	Star Founders	**0.08**	**0.37**	1																		
4	Early Stage of VC Investment	**-0.06**	-0.10	**0.18**	1																	
5	Former Employees of Prominent Firms	-0.05	-0.08	**-0.16**	0.02	1																
6	Founders' Publications	**0.13**	**0.25**	**0.43**	0.07	-0.08	1															
7	Startup Patent Applications	**0.09**	0.11	0.11	-0.10	-0.11	**0.12**	1														
8	Startup Alliance Experience	0.07	0.05	**0.21**	**-0.22**	0.06	0.08	0.03	1													
9	VC Prominence	0.05	0.08	-0.03	**-0.20**	-0.04	**-0.15**	-0.01	-0.10	1												
10	Amount of VC Funding	0.02	**0.15**	0.05	**-0.33**	0.01	0.11	0.05	**0.23**	**0.29**	1											
11	First Alliance	**-0.09**	0.01	**-0.12**	0.05	-0.03	0.00	0.07	**-0.68**	0.06	**-0.13**	1										
12	Equity	**-0.22**	-0.03	0.11	-0.05	-0.02	-0.01	0.05	-0.02	-0.05	**-0.13**	-0.04	1									
13	Exclusivity	**-0.27**	-0.07	**-0.13**	0.00	0.00	-0.06	-0.10	**-0.17**	0.09	-0.03	0.08	0.07	1								
14	RD Component	**-0.23**	0.02	**0.22**	-0.05	-0.01	0.10	0.01	0.20	-0.09	0.05	**-0.12**	0.11	-0.11	1							
15	Stage of Agreement	**-0.27**	0.07	**0.26**	0.02	**0.12**	**0.19**	0.10	0.07	-0.06	0.02	-0.07	**0.14**	-0.06	**0.44**	1						
16	Agreement Value	**-0.50**	0.07	0.09	-0.08	0.03	0.10	-0.07	-0.08	**0.16**	**0.23**	0.03	**0.24**	**0.26**	**0.12**	**0.17**	1					
17	Biotech Client	**-0.13**	-0.04	0.01	0.01	0.11	-0.05	-0.04	0.04	0.00	0.05	-0.04	-0.09	**-0.13**	**-0.12**	-0.07	**-0.26**	1				
18	Big Pharma Client	-0.16	0.07	-0.01	**-0.15**	0.04	0.05	0.04	-0.01	0.08	0.11	0.10	0.00	**0.13**	**0.18**	0.10	**0.36**	**-0.45**	1			
19	Client Alliance Experience	**-0.22**	**0.13**	0.05	**-0.20**	0.06	0.09	0.05	0.04	0.05	**0.20**	0.05	-0.04	0.06	**0.17**	**0.16**	**0.49**	**-0.45**	**0.64**	1		
20	Client Absorptive Capacity	**-0.13**	0.11	0.01	-0.11	0.01	0.08	0.07	0.04	0.06	**0.13**	0.04	-0.01	0.11	**0.16**	0.11	**0.36**	**-0.46**	**0.68**	**0.70**	1	
21	Biotech Equity Index	**0.03**	0.11	-0.04	-0.10	**0.13**	0.11	0.09	-0.04	**0.30**	**0.40**	0.05	**-0.16**	-0.01	-0.07	0.00	**0.39**	**0.17**	0.07	**0.28**	**0.17**	1
	Mean	0.23	0.13	0.19	0.33	0.36	2.46	3.34	1.43	0.53	10.03	0.16	0.31	0.65	0.37	0.60	2.74	0.47	0.44	2.07	3.29	2.80
	S.D.	0.31	0.42	0.50	0.47	0.66	2.22	7.62	0.90	0.50	1.44	0.36	0.46	0.48	0.48	0.49	2.25	0.50	0.50	1.47	3.33	1.35

[a]N = 263. $p<0.05$ in bold.

Table 3.2. Fractional Logit Regression Estimates[a]

Variables	1	2
Constant	0.221	1.388
	(1.423)	(1.412)
Year Effects[b]	306.06***	310.28***
Technology Effects[b]	22.66***	23.36***
Therapeutic Effects[b]	29.36***	37.49***
Biotech Equity Index	1.227*	0.857
	(0.613)	(0.609)
Client Alliance Experience	-0.163	-0.169
	(0.119)	(0.112)
Client Absorptive Capacity	0.004	-0.001
	(0.041)	(0.044)
Big Pharma Client	0.378	0.461
	(0.352)	(0.356)
Biotech Client	-0.496*	-0.476*
	(0.250)	(0.237)
Agreement Value	-0.586***	-0.582***
	(0.075)	(0.073)
Stage of Agreement	-0.524*	-0.598*
	(0.243)	(0.245)
R&D Component	-0.636†	-0.681†
	(0.369)	(0.359)
Exclusivity	0.120	0.137
	(0.375)	(0.359)
Equity	-0.248	-0.250
	(0.229)	(0.208)
First Alliance	-1.219**	-1.221**
	(0.445)	(0.435)
Amount of VC Funding	-0.102	-0.163
	(0.113)	(0.106)
VC Prominence	0.236	0.251
	(0.262)	(0.258)
Startup Alliance Experience	-0.232	-0.283†
	(0.155)	(0.165)
Startup Patent Applications	0.022**	0.023**
	(0.008)	(0.009)
Founders' Publications	0.026	-0.037
	(0.060)	(0.064)
Former Employees of Prominent Firms	-0.189	-0.269
	(0.297)	(0.254)
Early Stage of VC Investment	-0.476†	-0.484†
	(0.271)	(0.267)
Star Founders		0.574*
		(0.253)
Successful Founders		0.668*
		(0.320)
Log likelihood	-86.78	-85.56
Wald χ^2	866.27***	921.71***

[a]N=263. *** p<0.001, ** p<0.01, * p<0.05, † p<0.1. Clustered robust standard errors in parentheses.
[b]χ^2 values for joint significance of fixed effects.

Table 3.3. Estimates for Interaction Effects of Founders' Credentials[a]

Variables	1	2	3	4
Constant	0.537	1.354	0.945	0.112
	(1.451)	(1.417)	(1.447)	(1.493)
Year Effects[b]	289.87***	307.49***	289.42***	302.91***
Technology Effects[b]	28.83***	22.53***	22.54***	22.53***
Therapeutic Effects[b]	38.14***	36.68***	37.93***	37.93***
Biotech Equity Index	1.223*	0.846	1.039†	1.367*
	(0.623)	(0.619)	(0.631)	(0.650)
Client Alliance Experience	-0.128	-0.169	-0.156	-0.117
	(0.113)	(0.112)	(0.111)	(0.112)
Client Absorptive Capacity	0.010	-0.007	-0.005	-0.002
	(0.043)	(0.044)	(0.044)	(0.042)
Big Pharma Client	0.429	0.479	0.491	0.483
	(0.349)	(0.355)	(0.359)	(0.350)
Biotech Client	-0.383†	-0.491*	-0.449†	-0.387†
	(0.226)	(0.236)	(0.233)	(0.225)
Agreement Value	-0.601***	-0.578***	-0.583***	-0.596***
	(0.075)	(0.073)	(0.073)	(0.075)
Stage of Agreement	-0.465†	-0.592*	-0.597*	-0.448†
	(0.245)	(0.246)	(0.247)	(0.249)
R&D Component	-0.784*	-0.668†	-0.676†	-0.772*
	(0.366)	(0.358)	(0.348)	(0.358)
Exclusivity	0.219	0.097	0.111	0.136
	(0.372)	(0.368)	(0.352)	(0.376)
Equity	-0.161	-0.292	-0.201	-0.188
	(0.213)	(0.221)	(0.204)	(0.223)
First Alliance	-1.159**	-1.196**	-1.234**	-1.113**
	(0.430)	(0.432)	(0.438)	(0.427)
Amount of VC Funding	-0.143	-0.160	-0.159	-0.134
	(0.106)	(0.105)	(0.105)	(0.104)
VC Prominence	0.296	0.271	0.278	0.355
	(0.258)	(0.262)	(0.261)	(0.263)
Startup Alliance Experience	-0.250	-0.258	-0.255	-0.183
	(0.160)	(0.162)	(0.159)	(0.155)
Startup Patent Applications	0.023**	0.023**	0.024**	0.024**
	(0.008)	(0.009)	(0.009)	(0.008)
Founders' Publications	-0.033	-0.031	-0.022	-0.011
	(0.061)	(0.066)	(0.063)	(0.061)
Former Employees of Prominent Firms	-0.401	-0.251	-0.277	-0.393
	(0.262)	(0.257)	(0.253)	(0.265)
Early Stage of VC Investment	-0.454†	-0.483†	-0.550*	-0.500†
	(0.276)	(0.266)	(0.263)	(0.267)
Star Founders	1.057***	0.280	0.469†	0.443
	(0.245)	(0.468)	(0.248)	(0.415)
Successful Founders	0.442	0.709*	0.817*	0.601†
	(0.335)	(0.319)	(0.331)	(0.345)
Star Founders*Successful Founders	0.646***			0.677***
	(0.070)			(0.071)
Star Founders* Early Stage of VC Investment		0.131		0.249†
		(0.160)		(0.148)
Successful Founders*Stage of VC Investment			-0.530*	-0.394†
			(0.246)	(0.234)
Log likelihood	-84.73	-85.49	-85.24	-84.34
Wald χ^2	1130.72***	922.95***	978.07***	1307.43***

[a]N=263. . *** p<0.001, ** p<0.01, * p<0.05, † p<0.1. Clustered robust standard errors in parentheses. [b]χ^2 values for joint significance of fixed effects

In Hypothesis 5, I posited that the positive effect of a successful founder will be stronger for a startup firm that progressed into later stages of development where concerns about the commercial potential of its ideas will be greater for client firms. The coefficient of the interaction variable is negative and significant ($p<0.05$), supporting the prediction that the positive effect of successful founders will be prominent when the startup advances to later stages of development. The marginal effects of all the interactions are also consistent with my interpretations.

Figure 3.1 provides a graphical illustration of the complementary effect between star founders and successful founders. The positive effect of a star founder on the proportion of upfront payments will be enhanced by almost 60 percent when there is also a successful founder on the startup's founding team.

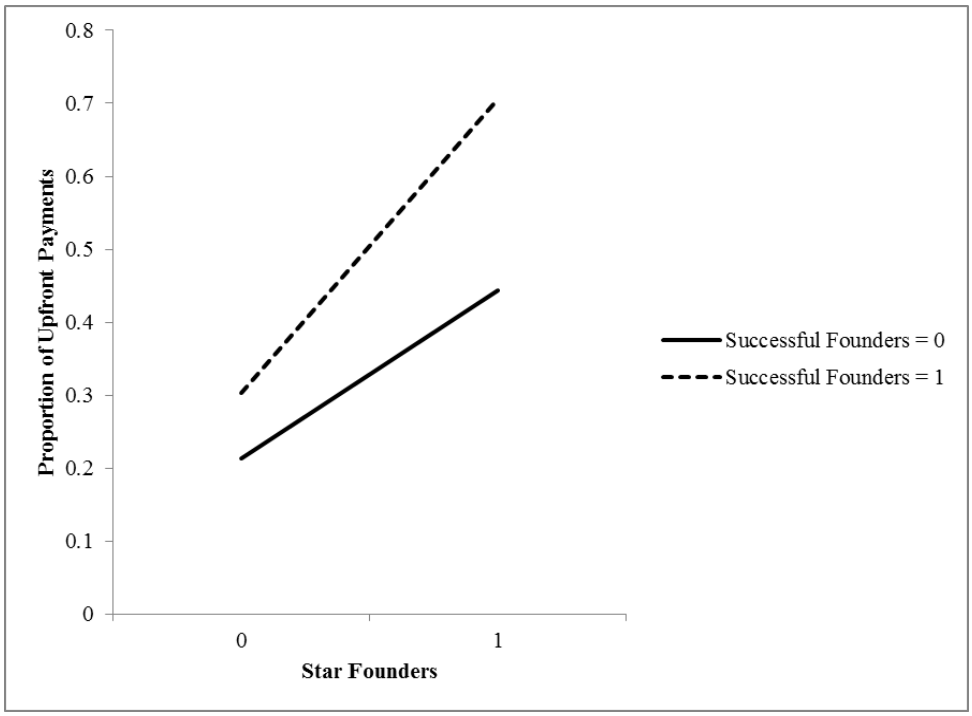

Figure 3.1. Interaction Effect between Star Founders and Successful Founders on Proportion of Upfront Payments

This offers support for my prediction about the complementarity between founders' entrepreneurial credentials and scientific credentials in mitigating asymmetric information about the startup's technical and commercial prospects, respectively. Figure 3.2 shows the negative interaction between successful founders and stage of VC investment. The positive effect of a successful founder on the proportion of payment obtained upfront by the startup will be twofold when the startup firm advances to later stages of development, when the commercial prospects of the startup are more pertinent for the client firm.

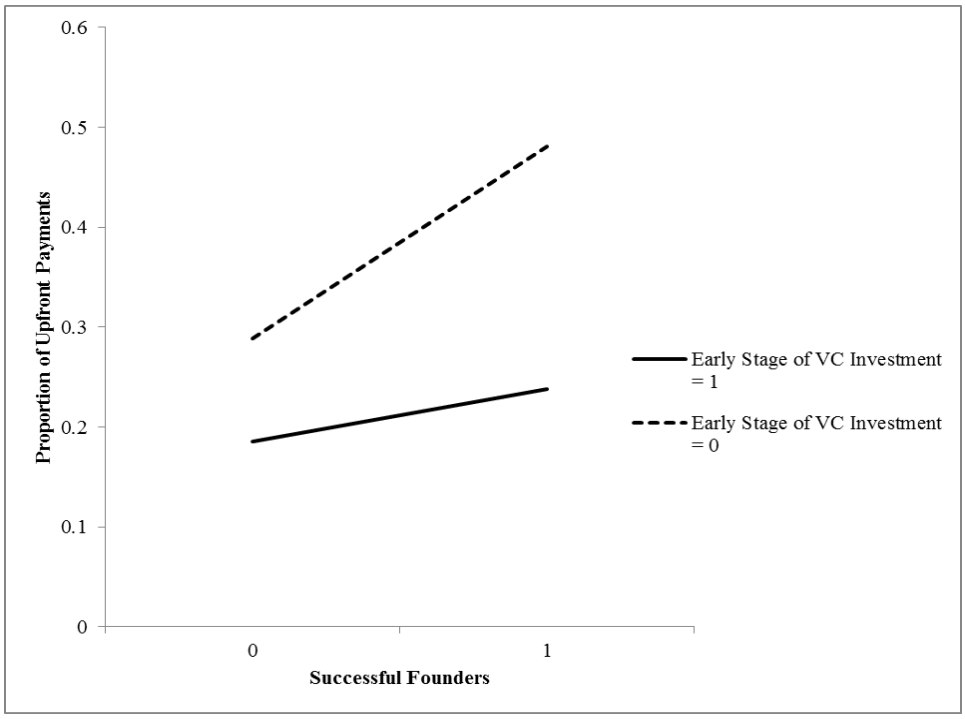

Figure 3.2. Interaction Effect between Successful Founders and Early Stage of VC Investment on Proportion of Upfront Payments

I also investigated the robustness of my results in several ways. First, I investigated whether the above results were potentially subject to sample selection bias. In my empirical

analysis, it is likely that the hypothesized founder variables and unobserved factors might influence the formation of alliances for the startups in my sample and bias the interpretations. To determine selection bias, in supplemental analyses I used two-stage Heckman method. Specifically, I formulated a first-stage probit model for alliance formation by constructing the list of unrealized alliances from the universe of startups that potentially could have been considered for alliance by the client firm when it formed a deal with the focal startup firm. In the second-stage when I performed a linear regression of logged values of upfront amount on all the explanatory variables and the correction term obtained from first-stage, the coefficient of the selection correction term was insignificant (t = -1.07, n.s.) and indicates that we cannot reject the null hypothesis of no sample selection bias. Supplemental analyses using Tobit models for my dependent variable yielded the same inferences as those presented above. I also used generalized linear regression models to examine whether my hypothesized variables have any significant effect on logged values of agreement value and upfront amount. The results indicate that both star founders and successful founders positively affect the total agreement value ($p<0.01$ and $p<0.01$, respectively) and size of upfront payment ($p<0.001$ and $p<0.05$, respectively), supporting the intuition that founders' credentials play a significant role in shaping favorable payment terms for startups.

Results for some of the control variables are also notable. The coefficient estimate for startup's patent applications is positive and significant ($p<0.01$). This result lends support for the role of patent applications in reducing uncertainty and risk of adverse selection for buyers of innovations and innovative R&D services in the market for ideas

(e.g., Gans and Stern, 2003; Gans et al., 2008), and more generally for startups' resource providers (e.g., Haussler et al., 2009; Hsu and Ziedonis, 2013). This study also finds support for the idea that startups incur less favorable payment structures in their first collaborative agreement. Specifically, the coefficient estimate of first alliance is negative and significant ($p<0.01$). In addition, when startups sell their innovations to incumbent biotech firms, they are likely obtain higher proportion of upfront payments ($p<0.05$) because biotech client firms are better able to evaluate biotech startups' underlying technological endowments.

3.5 Discussion

3.5.1 Contributions and Implications

In this study, I extend ideas proposed in information economics about remedies for adverse selection risks and examine the mechanisms through which startups can prevail over the adverse effects of informational asymmetries and uncertainties which restrict their early stage growth opportunities. Broadly, the theoretical contribution of this study is that founders' credentials play an influential role in determining returns from their ideas within early stage cooperative commercialization exchanges with incumbents. Specifically, I suggest and show that startup founders' technical and entrepreneurial accomplishments can reduce adverse risks for incumbents by credibly signaling the value of their startups' latent ideas and technologies to incumbents and accomplish favorable payment structures during collaborative exchanges. Moreover, out findings support the intuitive notion that the two distinct founders' credentials – star founders and successful founders – would complement

each other, and their prominence on payment structures would vary with stages of startup's venture activity.

In this study I highlight the role of founders' accomplishments as signaling devices for early stages startups' latent quality and contribute in several ways to research on cooperative commercialization strategies of new ventures in strategy and entrepreneurship. For the strategy literature, I build upon the recent stream of research on market for ideas and technologies (e.g., Arora et al., 2001; Gans and Stern, 2003, 2010) and extend information economics to examine the underexplored aspect of startup performance – payment structures in cooperative agreements. Specifically, this study contributes to the research on market for ideas and collaborative R&D partnerships by suggesting that startup founders' credentials play an important role in reducing risks of adverse selection for prospective partners and shaping favorable compensation structures for startups.

For the entrepreneurship literature, this study sheds light on a fresh aspect of startup performance by investigating the structure of payments startups receive in their strategic and collaborative partnerships. Prior research on startup performance has emphasized liquidity events such as initial public offerings (IPO) or being acquired, and this research has also emphasized the role that signals from venture capitalists and other inter-organizational relationships can play (e.g., Stuart *et al.*, 1999; Gulati & Higgins, 2003; Chang, 2004; Brau *et al.*, 2010). Whereas the event of going public and the value attained during an IPO are crucial for the survival and success of new ventures (e.g., Stinchcombe, 1965), it is also worth investigating how privately held young startups can yet obtain value from their organizational resources and gather additional resources even as they are lacking

networks and track records. I complement this stream of work by arguing that during startups' early stages credentials of founders can affect the perceptions of outsiders by signaling the value of their startups' inherent quality and shaping the terms of payments startups receive in alliance agreements. In future research it will be interesting to examine how founding team credentials can also determine the extent of value startups can attract in the public equity markets and prior to going public, including ties to venture capitalists, corporate venture capitalists, and universities, among others. While I showed that founders' credentials can influence the structure of payments, it will be interesting to examine how founding team credentials shape other features of alliance design such as governance choice, allocation of control rights and structure of cooperative commercialization agreements with established firms (e.g., Gulati 1995; Lerner and Merges, 1998; Anand and Khanna, 2000; Robinson and Stuart, 2007; Li et al., 2008).

I also contribute to research applying signaling theory to examine the different types of signals that enable performance for new ventures in various market contexts. This stream of research has shown that ties to prominent organizations such as venture capitalists reduces adverse selection risk by signaling quality and thereby helps startups gain access to various resources required for their growth and survival (e.g., Stuart et al., 1999; Gulati and Higgins, 2003; Hsu, 2006, Ozmel et al., 2013). My study complements this stream of work by demonstrating the instrumental role that founders' credentials play in signaling the underlying nature and quality of early stage startups' ideas and accomplishing favorable payment structures in collaborative exchanges. Given that firms can signal their prospects in several different ways (e.g., Riley, 2001; Long, 2002; Certo,

2003; Hsu, 2006; Zhang and Wiersema, 2009; Connelly et al., 2011), for future research it will be interesting to examine the relationship between these other signals and founders' credentials in determining outcomes for startup firms in various market contexts.

This study also contributes to research on founders' human capital and networks in enhancing performance and growth prospects of entrepreneurial firms (Eisenhardt and Schoonhoven, 1990; Gimeno et al., 1997; Baum et al., 2000; Colombo and Grili, 2005; Delmar and Shane, 2006; Eesley and Roberts, 2012) and alliance formation (e.g., Eisenhardt and Schoonhoven, 1996; Stuart et al., 2007; Hallen, 2008; Luo et al., 2009). I complement prior research by explicating two distinct credentials of founders and suggesting that they positively correlate with unobservable human capital (e.g., Spence, 1973; Coff, 1997) and reduce information asymmetries about an early stage startup's ideas and obtain favorable payment structures in interfirm collaborations. Furthermore, my theory about the role of founding team in enabling cooperative strategies for startup firms complements the research on top management team (TMT) experience and prestige of performance of new ventures (Kor, 2003; Cohen and Dean, 2005; Kroll et al., 2007; Certo et al., 2001; Certo, 2003). Given that there is more than one type of founders' credentials, it will be interesting to examine how they interact with each other and shape innovative performance and outcomes for startups in various market contexts.

Finally, I contribute to research on resource-based theory (RBT) (e.g., Penrose, 1959; Wernefelt, 1984) and resource based view (e.g., Barney 1991) and complement emerging stream of research about the role of founders' experience and human captial (e.g., Eisenhardt and Schoonhoven, 1996; Colombo and Grilli, 2005; Chandler and Hanks, 1998)

by demonstrating that credentials of founders can also be instrumental as “resources” for startup firms (Brush et al., 2001) during their founding stages , and provide signaling services and compensate for the lack of a patent (e.g., Hsu and Ziedonis, 2013).

3.5.2 Limitations and Future Research Directions

In addition to the research opportunities discussed above, future research might also address several limitation of this study. First, this study examines an underexplored dimension of alliance design - payment structures in alliance agreements, and investigates how founders’ scientific and entrepreneurial credentials shape favorable payment structures for startups in terms of favorable proportion of upfront payments. In future research, it would be valuable to examine how founders’ credentials and human capital affect the choice of hybrid forms of governance, such as equity, non-equity, and so forth. It would also be useful to examine how founders’ credentials provide signaling and bargaining benefits to startups and influence the controls rights allocation between startups and incumbents in cooperative commercialization agreements. Moreover, the empirical context for this study is biotechnology sector, where patents offer strong appropriability for firms and where cooperative commercialization activity between upstream suppliers and downstream firms is significant. It would therefore be interesting to examine how credentials of the founders are relevant in other empirical contexts where appropriability regimes are weak, or based on secrecy in reducing adverse selection risks and shaping payment structure for early stage startups. Furthermore, it will be useful to examine whether effect of founders’ credentials on reducing informational asymmetries are

contingent on other signaling mechanisms such as venture capital certification, contracts and warranties.

Second, because this study has focused on early stage startups that lack a patent grant, in future work it will be valuable to investigate how the signaling benefits of founders' credentials in conveying information about the unobservable quality of the startup's knowledge vary with the startup's patenting track record and its patenting quality (e.g., Hall, Jaffe, and Trajtenberg, 2005; Hsu and Ziedonis, 2013).

Third, while I focus on determinants of payments structures for early stage startups, my study is also silent on the implications of this facet of alliance design. It would be valuable to probe the dynamics of these agreements to study the payments that startups actually receive and how they renegotiate payment terms over time as information is produced on them. In addition, my theoretical focus has been on the startup and how signals of quality enable it to get gainful payment terms in alliances, so it would also be useful to study whether partners also benefit from reduced adverse selection in their partnerships and the terms they use to capture value.

3.6 Conclusion

In this study, I investigate the effect of founders' scientific and entrepreneurial credentials on an underexplored dimension of alliance contracting, that is payment structures, to provide new evidence about the signaling role of founders' distinct credentials. Specifically, I show that startup founders' scientific and entrepreneurial credentials function as credible signals, and consequently shape favorable payment

structures in terms of better proportion of upfront payments for startups by reducing the risk of adverse selection for cooperative commercialization partners about the inherent quality of startups' ideas. Further, I also show that founders' scientific and entrepreneurial credentials complement each other and collectively enhance startups' prospects for better payment structures by conveying information about the technical as well as commercial prospects of startups' technologies. I also show that the effect of founders' scientific and entrepreneurial credentials on upfront proportion varies with the stage of startup's venture activity.

CHAPTER 4. FOUNDERS' CREDENTIALS AND INITIAL PUBLIC OFFERINGS OF STARTUPS

4.1 Introduction

Going public marks an important milestone in the growth of many high-tech startups. These firms lack the necessary organizational and financial resources that are required for pursuing their growth prospects, and startups rely on external resource providers to secure resources and ensure their survival (e.g., Stinchcombe, 1965). Specifically, high-tech startups rely on outsiders such as venture capitalists, alliance partners, or consider going to public equity markets to finance their internal projects (e.g., Sahlman, 1990; Sorenson and Stuart, 2001; Pisano, 1989; Nicholson et al., 2005; Stuart et al., 1999).

Among the several options for high-tech startups to acquire resources, going public presents several attractive features for startups. For example, by going public startups can gain increased liquidity and easier access to a larger pool of capital (e.g., Chemmanur and Fulghieri, 1999). Going public generates information on the startup's commercial prospects and involves certain costs such as recruitment of underwriters, so startups can broadly advertise to heterogeneous investors in the equity markets and draw attention of prospective suppliers, employees, customers, and collaborative partners in the process (e.g., Certo, 2003). Further, IPOs provide attractive exit options for equity investors in the

startup such as VCs (e.g., Black and Gilson, 1998). Given these various reasons, an early IPO can facilitate an organization's access to resources, growth, and future prospects for exchange.

However, the decision to public can also be very intimidating for startups as they also face challenges conveying information about their prospects to potential investors in public markets. Specifically, high-tech startups' activities are largely driven by research and development activities that contain a high degree of intangible aspects and have a long lead time for realizing cash flows (e.g., Stuart et al., Colombo and Grilli, 2010). As a consequence, information about the impact of these activities on a startup's value and commercial prospects is quite difficult to convey to investors in public equity markets (e.g., Fukugawa, 2012). Moreover, startups often lack sufficient track records that might otherwise address uncertainty about the productive quality of startups' assets, thereby diminishing opportunities for startups to attract financing from outside investors (e.g., Shane and Stuart, 2002; Hsu and Ziedonis, 2013).

One way in which startups can reduce uncertainty about their quality and produce information on their underlying asset quality and prospects is by obtaining the affiliation of prominent outsiders such as VCs who are actively involved in financing high-risk startup activity (e.g., Megginson and Weiss, 1991; Stuart, Hoang, and Hybels, 1999). However, startups also have to incur significant cost to gain the endorsement of prominent VCs as they have to offer equity to the VCs, agree to stringent control and monitoring (e.g., Hsu, 2004) and postpone their plans of going public.

Similarly, startups can partner with prominent alliance partners to enhance their performance (e.g., Baum et al., 2000) and signal their quality to outsiders (e.g., Stuart et al., 1999). However, partnering with prominent partners may not be easy for startups, particularly those with radical innovations, because prominent partners are likely to be very selective in their choice of partners (e.g., Li et al., 2008; Ozmel et al., 2013). As a consequence, startups may incur loss of time while establishing alliances with prominent partners, or contract with them on less attractive terms (e.g., Danzon et al., 2005). Additionally, while startups can rely on the quality of their resource base and patent stocks to obtain resources from outsiders (e.g., Wagner and Cockburn, 2010; Hsu and Ziedonis, 2013), assembling these firm-level resources may take considerable time and resources, and may also not credibly reduce uncertainty for outside investors about the potential market prospects of startups' technologies (e.g., Long, 2002; Gans et al., 2008). Given these strategic considerations, the question arises whether there are other ways in which startups might build their credibility and convey information about their prospects to be able to go public more quickly.

Recognizing that startups' resources and prospects are rooted in the skills, knowledge, experience, and overall competences of members of their founding team (e.g., Klepper, 2001; Shane and Stuart, 2002), I develop the argument that startup founders play a central role in determining the startup's ability to go public by addressing these problems. Research in entrepreneurship suggests that when startups are in their formative stages startups' early projects and strategies are engineered by the human capital endowments of their founding team members (e.g., Rao, 1994; Venkataraman, 1997; Shane and Stuart,

2002). So, when startups approach potential investors to finance their projects, investors assess the quality of startups' intangible assets and their commercial prospects based on the track records and accomplishments of startup founders themselves (e.g., Amit, Glosten, and Muller, 1990). Prior research suggests that founders apply their acquired competences and learning from prior experience when they found startups and critically determine the quality of the choices startups make and the efficacy of their execution (e.g., Eisenhardt and Schoonhoven, 1990; Brown and Eisenhardt, 1997; Beckman, 2006).

These ideas suggest that founders' competences and track records are useful initial endowments for startups for several reasons. First, they are elemental for architecting startups' R&D projects, making technology-related choices, and streamlining produce development strategies. Second, founders' accomplishments and prior track records convey information to potential investors about the quality of startups' proposed innovations and their commercial prospects. Specifically, the credentials of startups' founders provide potential investors a basis to learn about the technical and commercial prospects of startups' ideas and alter investors' beliefs about financing startups' projects (e.g., Amit et al., 1990). Previous research suggests that the prestige and quality of top management team and board members can more generally shape organizations' ability to attract funding for their projects from private and public investors (e.g., Certo et al., 2001; Certo, 2003; Hsu, 2006; Beckman and Burton, 2008).

In this study, I build on the above ideas and develop hypotheses about the role of founders' credentials and track records on startups' rate of going public. In my hypotheses, I propose two distinct credentials of startup founders and suggest that they play a pivotal

role in positively influencing the startup's rate of going public. Specifically, I suggest that startups that have a scientific star or a founder with prior IPO experience on their founding team are able to go public faster. Given that high-tech startups are generally backed by venture capitalists (VCs) (e.g., Sahlman, 1990; Gompers and Lerner, 2001), the quality of startups' VC affiliations produce information on the startups' overall quality and market prospects for outsiders (e.g., Stuart et al., 1999; Gulati and Higgins, 2003; Hsu, 2004). Thus, I posit a contingency between the proposed founder credentials in this study, that is scientific and entrepreneurial credentials, and other potential means through which startups can credibly signify their overall prospects for commercial success. In particular, I argue that the prominence of startups' VC backing weakens the effect of our proposed founder credentials on startups' rate of going public.

At a broad level, I contribute to research in strategy and entrepreneurship on startups' IPO timing decisions and IPO performance. Prior research has investigated the role of startups' interorganizational relationships and endorsements (e.g., Stuart et al., 1999; Chang, 2004), top management team's experience (e.g., Beckman and Burton, 2008) and prestige (e.g., Certo et al., 2001) on the IPO timing and performance of startups. I complement this stream of research by showing how specific aspects of founders' credentials that are indicative of their scientific and entrepreneurial accomplishments are likely to have a strong bearing on startups' IPO decision.

Second, I extend prior research by showing the contingency between startup founders' scientific and entrepreneurial accomplishments and prominence of startup VC affiliation on startups' ability to go public. Prior research has examined how founders'

human capital and reputation affect the funding startups receive from VCs (e.g., Hsu, 2006; Hsu and Ziedonis, 2013). Other studies have shown how receiving backing by venture capitalists can help firms go public (Stuart et al., 1999; Gulati and Higgins, 2003; Chang, 2004; Ozmel et al., 2013). I build upon and complement this research by demonstrating the importance of founder effects in shaping the timing of firms' IPOs, and showing that founders' scientific and entrepreneurial attainments matter to a greater extent when startups cannot convey their prospects to potential investors in IPO markets on account of less prominent VC affiliations.

Finally, I also contribute to literature in strategy and entrepreneurship that has examined the role of founders on the performance of startups. Specifically, I explore the role of founder effects on startups' ability to go for an IPO and achieve faster access to public equity markets. The findings in this study suggest that founders' scientific and entrepreneurial accomplishments play an important role in effecting faster IPOs for startups. In this manner, I complement prior research (e.g., Eisenhardt and Schoonhoven, 1990, 1996; Colombo and Grilli, 2005; Colombo and Grilli, 2010) which suggests the significance of founder's experience and competence on the growth and performance of entrepreneurial ventures.

4.2 Theory and Hypotheses

Many studies in management and economics literatures elucidate various signaling mechanisms which can enable entrepreneurs and startup firms to obtain necessary resources of growth in a wide range of market settings (e.g., Amit, Glosten, and Muller, 1990; Carter and Manaster, 1990; Megginson and Weiss, 1991; Stuart et al., 1999; Certo,

2003; Cohen and Dean, 2005; Levitas and McFayden, 2009; Zhang and Wiersema, 2009; Hsu and Ziedonis, 2013). For instance, startup firms can engage in quality certification to mitigate the risk of adverse selection by contracting with prominent venture capitalists and prominent exchange partners even on heavily discounted terms (e.g., Hsu, 2004; Nicholson et al., 2005), to be able to strike future deals with incumbents (e.g, Hsu, 2006; Ozmel et al., 2013). Startups also invest in boosting their patent portfolios in order to attract external resource providers and investors (e.g., Hsu and Ziedonis, 2013).

Some of the above mentioned mechanisms such as prominent affiliations and patents are costly as well as time consuming for startups to organize, so startups might produce information about their general prospects through other means and enhance their ability to access public equity. Specifically, a startup can benefit from the credentials of the members of its founding team to convey credible information widely about the startup's underlying technical and commercial prospects. Indeed, Spence (1973) proposed that prospective employees who acquired education credentials that are costly to earn and imitate by others would be perceived superior and offered better compensation by employers. In the same manner, startups founded by individuals whose credentials are observable, and yet rare and difficult for other entrepreneurs to accumulate, are likely to be favored by potential investors.

Observing that the quality of startups' technologies and growth strategies are largely shaped by the ability and experience of the startups' founding team members, I suggest that startups with highly accomplished founding teams can anticipate a faster IPO. In the hypotheses below, I propose two distinct credentials of startup founders which

potentially can be very instrumental in modifying the information structure of the startup pertaining to its technical quality and commercial prospects, thereby facilitating the startup's chances of going public earlier than other startups. Specifically, I suggest that founders with superior scientific credentials and prior entrepreneurial experience of taking their ventures public would be able to credibly mitigate potential investors' concerns about startups' hidden quality and overall prospects, and consequently they would play an important role in affecting startup's chances of a faster IPO. Further, I also argue and show that founders' scientific and entrepreneurial accomplishments are particularly consequential for startups that lack affiliations of prominent VCs.

4.2.1 Scientific Stars

High-tech startups pursue activities that are research intensive and often are driven by the competence of the startup's research team. In knowledge-intensive industries, creation of new knowledge and ideas is an important activity which determines firms' competitive advantage (e.g., Cohen and Levinthal, 1990; Henderson and Cockburn, 1994; Grant, 1996). Prior research suggests that performance of firms is driven by the explicit and tacit knowledge of organizational members (e.g., Polanyi, 1966; Nelson and Winter, 1982) and in the case of startups it is largely powered by the scientific expertise and technical know-how of individuals in the startup's team (e.g., Chandler and Hanks, 1998; Argote, 1999; Knockaert et al., 2011). For example, in the biopharmaceuticals industry research activities precede any product development initiatives, and the quality of research determines the innovative output of startups (e.g., Pisano, 1994). In this regard, the quality of a startup's R&D team is a key contributing factor to the startup's ability to develop new

innovative products (e.g., DeCarolis and Deeds, 1999). Specifically, the skills and knowledge of the startup founders play a pivotal role in determining the direction and depth of the startup's research activities and the quality of the startup's intangible ideas and knowledge bases (e.g., Teece, 1981; Beckman et al., 2007).

The above insights suggest that the scientific and technical capabilities of startup founders are central to the quality of startup's proposed projects and technologies. Previous research suggests that expert individuals who earned credentials as star scientists enable firms in knowledge-driven industries such as biotechnology enhance their performance and innovative output (e.g., Zucker, Darby, and Armstrong, 2002; Rothaermel and Hess, 2007). Generally, in knowledge-driven industries, individuals with star credentials are regarded highly for their exceptional capability to generate breakthrough ideas and pursue research projects that whose outcomes are estimable and less uncertain (e.g., Zucker, Darby, and Armstrong, 1998). These capabilities are particularly valuable for high-tech startups, whose activities are particularly subject to unforeseeable hazards that may hamper startups' technical progress and disrupt product development plans.

Because technology trajectories are highly uncertain in high-tech industries and unforeseen changes could derail startups' research programs (e.g., Tushman and Rosenkopf, 1992), outside investors tend to be cautious about them and may not be favorable towards startups whose technical prospects are laden with uncertainty. Furthermore, because startups would have incentives to misrepresent their quality and overstate their prospects (e.g., Arrow, 1962; Eisenhardt, 1989), the technical quality of high-tech startups is difficult to ascertain for outsiders (e.g., Akerlof, 1970; Cumming,

2006). Overall, uncertainty about the scientific promise and technical prospects of high-tech startups would predictably affect startups' beliefs about their ability to raise capital in the public equity markets and their decision to go public.

In this regard, scientific star founder's scarce technical knowledge that is derived from prior discovery and research experience is a valuable asset for a high-tech startup (e.g., Murray, 2002; Junkunc and Eckhardt, 2009), because it not only allows the startup obtain success in its innovative projects, but also grants credibility to the startup's proposed activities (e.g., Audretsch and Stephan, 1996; Powers and McDougall, 2005). To the extent uncertainty about the technical prospects of startups poses hazards for outsiders, startups founded by scientific stars are likely to be viewed as endowed with promising technological prospects. The presence of scientific stars on a startup's founding team therefore modifies the information structure of the startups about its difficult-to-assess R&D projects and innovative activities, potentially reducing uncertainty and the risk of adverse selection for potential investors. Given the signaling benefits that scientific stars bestow to their firms, a startup founded by scientific star may find it easier to finance their projects through an IPO. Therefore, I expect startups founded by scientific stars to go public earlier than other startups. Thus, I posit:

Hypothesis 4.1 *A scientific star on a high-tech startup's founding team will have a positive effect on the startup's rate of going public.*

4.2.2 Founder IPO Experience

The foregoing hypothesis suggests how startups' considerations about being able to credibly convey their technical prospects to outsiders influences startups' IPO timing decisions, and discusses how scientific star founders have a part in enhancing startups' potential to go for an earlier IPO. While potential investors in public investors would have problems discerning the hidden technical quality of startups' innovations, they would also be concerned about misrepresentation risks related to the likely commercial value of startups' innovations.

Specifically, potential investors in public markets would be uncertain about the startups' potential to translate innovation into realizable revenue. Potential investors would be subject to the classical 'lemons' problem (Akerlof, 1970) and their misgivings about startups' commercial prospects would significantly affect startups' ability to consider going public. Most startups are resource-constrained and operate with short track records (e.g., Stinchcombe, 1965; Shane and Stuart, 2002), and usually have limited experience with organizing product development strategies and often function on ad-hoc procedures (e.g., Baum and Silverman, 2004). In the absence of any credible means through which startups can convey their commercialization potential and market prospects, startups are less likely to be able to carry out an IPO to access external sources of funding.

Alternatively, startups can draw on the competence of their founders who have developed distinguishable abilities, recognition, and also networks through their prior experience (e.g., Burton et al., 2002; Beckman and Burton, 2008) to drive startups' commercialization success. Indeed, in their early stages the commercial and market success

of startups' anticipated products and technologies are largely determined by founders' commercialization experience and abilities (e.g., Feeser and Willard, 1990; Shane and Stuart, 2002). For example, in my empirical setting of biotechnology, entrepreneurs' ability to manage R&D projects and guide them through the product development and marketing stages is regarded as scarce and highly valuable (e.g., Schoemaker and Schoemaker, 1998). This suggests startups can capitalize on the commercialization expertise and networks of founders to navigate the formidable process of translating outputs from R&D into profitable revenue streams. Given that startups are subject to liability of newness and smallness (e.g., Freeman, Carroll, and Hannan, 1983), founders' ability to create and identify propitious projects and expertise in captaining their implementation is an important endowment for startups. Moreover, such skills of founders are important for startups in reducing concerns of potential outside investors about startups' chances of achieving success.

Prior research suggests that previous entrepreneurial experience improves founders' ability to identify promising ideas and commercially exploit them using their acquired entrepreneurial skills and networks (Rosen, 1972; Khilstrom and Laffont, 1979; Cooper et al., 1989; BrÜderl et al., 1992; Ardichvili et al., 2003; Teece, 2007; Callander, 2011). Because building potentially commercializable technology is accompanied by experimentation and problem-solving processes (e.g., Hippel and Tyre, 1995), startup founders with prior entrepreneurial experience are likely to be more capable at recognizing risks and developing ideas with commercial potential (e.g., Pisano, 1996; Bhide, 2000; Hsu, 2007; Baum and Bird, 2009).

In particular, founders who have achieved success in their previous entrepreneurial endeavors are known to be adept at discovering new production techniques and are more likely to have developed expertise in pioneering innovations that are technically solid with high commercial value (Schumpeter, 1934; McGee et al., 1995; Arvanitis and Stucki, 2012). Inasmuch as uncertainty about market potential of startups' ideas triggers risks for potential investors, startups of serial entrepreneurs who have demonstrated their competence for developing technologies with market potential and commercial viability would be in a better position to attract investments for their R&D projects (e.g., Frank, 1988; Fraser and Greene, 2006). Specifically, founders who were able to take one of their previous ventures public are likely to attain wide recognition as outstanding entrepreneurs (e.g., Certo et al., 2001; Gompers et al., 2010) and their later startups are likely to be judged positively by potential investors and collaborators (Gompers et al., 2010; Hsu and Ziedonis, 2013).

Studies in management and finance suggest that prior success of founders in the IPO market serves as credible signal (e.g., Gompers et al., 2010; Berk et al., 2004; Sanders and Boivie, 2004). Because high-tech startups face the challenge of convincing a large and diverse group of investors in public equity markets, they cannot anticipate an optimal IPO unless investors are convinced of the venture's progress and commercial potential (e.g., Lerner, 1994; Chemmanur and Fulgheiri, 1999; Stuart et al., 1999; Ritter and Welch, 2002). In this regard, founders with prior IPO experience gain legitimacy among seasoned investors and startups founded by founders with prior IPO experience are likely to be

regarded as having attractive market prospects favorable by diverse investors in public equity markets (e.g., Berk et al., 2004; Sanders and Boivie, 2004).

Taken together, the above arguments suggest startups established by founders with prior IPO experience are more likely to be viewed as having superior prospects by investors, and consequently they would also be able to enjoy an earlier IPO. Thus, I posit:

Hypothesis 4.2 *A founder with IPO experience on a high-tech startup's founding team will have a positive effect on the startup's rate of going public.*

The arguments I have developed so far suggest that startups that can credibly convey the quality of their technical and commercial prospects would be able to go public sooner, as they would be viewed favorably by potential investors in public markets. In particular, in the foregoing hypotheses I argued that startup founders' scientific and entrepreneurial accomplishments lend credence to the technical quality and commercial prospects of startups, and advance startups' potential to attract outside investors. However, the effect of our hypothesized founder credentials on the startup's IPO rate can also be contingent on the presence or absence of other means through which startups can credibly convey their quality and prospects to potential public investors.

Prior research suggests that startups can rely on the prominence of their affiliations and prior alliance partnerships in order to credibly convey their quality and prospects to outsiders and distinguish from other startups with lesser quality ideas and prospects suggests that (e.g., Stuart et al., 1999; Gulati and Higgins, 2003; Chang, 2004; Nicholson et al., 2005). Given that startups are initially financed by specialized investors such as VCs,

who focus their investments in startups operating in highly uncertain industries (e.g., Gorman and Sahlman, 1989; Sahlman, 1990), I anticipate that the positive effects of scientific stars and founder IPO experience to be contingent on the prominence of the startup's VC affiliations. Below, I develop hypotheses about the contingency between our hypothesized founders' credentials and prominence of startup's VC affiliations on its rate of going public.

4.2.3 Contingent Effect of VC Prominence

VCs are regarded as important financial intermediaries who provide capital to startups which find it difficult to attract capital from public markets (e.g., Gompers and Lerner, 2001). VCs overcome informational problems by gathering as much information as possible about startups, perform due diligence, and periodically evaluate startups' prospects (e.g., Gompers, 1995; Lerner, 1995). So, outside investors can infer much about the quality of prospective startups based on the quality of startups' VC affiliations (e.g., Megginson and Weiss, 1991; Stuart et al., 1999). Startups can indicate their quality to and alleviate risks for potential public investors through the quality of their VC affiliations. Specifically, startups that are backed by prominent VCs are more likely to be regarded as less uncertain and having superior prospects for achieving success.

Prior research in strategy and finance (e.g., Megginson and Weiss, 1991; Stuart et al., 1999) shows that affiliating with prominent VCs helps startups lessen concerns of potential public investors about the hidden aspects of startups' technologies and their expected future value (e.g., Gulati and Higgins, 2003). From an outside investor's perspective certifications of prominent VCs are likely to be credible because prominent

VCs perform extensive due diligence to safeguard their reputation (e.g., Megginson and Weiss, 1991; Hsu, 2004).

Prominent VCs are established in the industry and tend to invest in a startup only there are indications that the startup is doing well and shows good prospects (e.g., Lerner, 1994). Moreover, prominent VCs are well connected with other VCs in the industry and use their network to gather extensive information about the potential startup's technology and assess its prospects before committing capital (e.g., Sorenson and Stuart, 2001). Furthermore, in addition to lending capital and monitoring progress, prominent VCs also support startups with extra-financial services such as helping them in recruiting human capital and connecting them with potential collaborators (e.g., Bygrave and Timmons, 1992; Hellmann and Puri, 2000, 2002; Ozmel et al., 2013). Prominent VC affiliations enable startups establish commercialization agreements with incumbent firms (Hsu, 2006). Broadly, startups with prominent VC backing are more likely to possess superior quality resources and prospects for success, and also better positioned to access outside resources. Consequently, outside investors would consider startups backed by prominent VCs less risky and having bright prospects for success.

Whereas the above ideas suggest that prominent VC backing reduces uncertainty for potential outside investors, startups backed by less prominent VCs are likely to be viewed as inferior by potential investors. However, while prominent VC backing may be sufficient for startups to convey their quality to outsiders, even in its absence startups' chances for accessing resources for growth from external resource providers and public markets are likely to be bright. In particular, startups can be positive about attracting

outside investors when they are endowed with easily accessible firm-level endowments that can substitute for prominent VC affiliations. As suggested in previous hypotheses (H1 and H2), founders with scientific star credentials and prior IPO experience can be substantial in demonstrating the inherent worth of startups' ideas and technologies for prospective investors. Further, startups founded by scientific stars and successful entrepreneurs also enjoy greater prospects for attracting commercialization opportunities as they would also be widely known to and highly regarded by potential alliance partners, suppliers, and customers.

Given that scientific stars and successful entrepreneurs can be effective at reducing information asymmetry for outsiders, prominent VC affiliations would be redundant for startups that are founded by scientific stars and founders with prior IPO experience. These startups can rather avoid the costs of affiliating with more prominent VCs (e.g., Hsu, 2004) and still be able to credibly convey information about their technological prospects and capacity to commercialize their innovations. Based on the above arguments, I expect that scientific star founders and successful founders can compensate for the lack of prominent VC backing and enable startups a faster IPO. Thus, I posit:

Hypothesis 4.3 *The positive effect of a scientific star founder on the rate of going public will be more pronounced for a startup that is backed by less prominent VCs.*

Hypothesis 4.4 *The positive effect of a startup founder's IPO experience on the rate of going public will be more pronounced for a startup that is backed by less prominent VCs.*

4.3 Methods

4.3.1 Data and Sample

To test the hypotheses in this study, I formed a dataset of private venture-backed biopharmaceutical startup firms specializing in human diagnostics and human therapeutics that are based in the United States and founded during the 2000 to 2011 time period. Since all the firms in our sample are VC-backed, I assembled venture level data of all the startups in our sample from Thomson Reuters' VentureXpert database. Venture capitalists largely focus their investments in high-technology industries such as information technology, semi-conductors and biotechnology (e.g., Hsu, 2006) and form an important part of biopharmaceutical startups' financing strategy (e.g., Sahlman, 1990; Zucker et al., 1998). In addition, I identified biotech firms that filed for an IPO during our sample period from VentureXpert data, which also includes data on the IPO of all VC-backed firms.

In this study, I theorize on the effects of founders' IPO experience and scientific prominence on startups' rate of going public. I collected information about founders from various reliable sources. Specifically, I relied on Bloomberg Businessweek, BioScan, VentureXpert, CrunchBase, LinkedIn, company websites, and numerous web searches to gather founders' names and their career histories. In addition, I also used other sources such as SEC filings, LexisNexis, and other web searches to obtain information about names of all possible founders and their association with their firms. I only considered founders as those individuals who had an ongoing relationship with the startup either as a company executive, board member, or scientific advisor. In my data set, I have 763 unique founders and 309 distinct biopharmaceutical startups. To construct other founder-level explanatory

and control variables, I relied on sources such as Bloomberg Businessweek, Forbes, LinkedIn, company websites, CrunchBase, university web pages, and other web searches. In addition, I collected data on founders' scientific and technical publications from Thomson Reuters' Web of Science database.

I also obtained information about startups' patenting activity from the United States Patent and Trademark Office (USPTO) and the National Bureau of Economic Research (NBER) after tracking firm histories and name changes. I also collected information about startups' alliance activity by using data on strategic alliances from Thomson Reuters' Recap data base, which is considered to offer a robust representation of alliance agreements in biopharmaceutical industry (e.g., Schilling, 2009). I collected data on startups' drug approvals and pipeline from Orange Book, which is a drug database organized by the United States Food and Drug Administration (FDA) agency.

In this study, I measure the startups' rate of going public. While all firms in my sample could be "at risk" of going public, some biotech startups experienced either failure or acquisition by another firm before undertaking an IPO. I also accounted for these possibilities and identified all the VC-backed startups in our sample that have been defunct, or "living dead" (e.g., Ruhnka et al., 1992; Mason and Harrison, 2002) during our period of observation using VentureXpert database. I supplemented VentureXpert database with SDC's Mergers and Acquisition database, and assembled the universe of all acquisitions that occurred during 2000-2011. In this manner, I identified 18 startups that became defunct or "living-dead", and 97 startups that were acquired during 2000-2011. I controlled for these events in the final construction of the sample and right-censored on the date they

became defunct or “living-dead”, or were acquired. Of the remaining 194 startups, 36 startups experienced IPOs prior to the end of 2011, and the remaining 158 startups were right censored at the end of this year. I concluded my analysis in 2011, because I did not have data on some of the explanatory variables (patenting and VC variables) employed in this study beyond that time. After accounting for missing values, my final sample for analysis contains 2,912 observations for 309 startups.

4.3.2 Measures and Analysis

Dependent variable

The objective of this study is to investigate the effect of founders’ scientific prominence and IPO experience on startups’ IPO hazard rate. Specifically, in this paper I am interested in modeling a startup’s instantaneous rate of going public. My analysis employs Cox proportional hazard models with time-varying regressors to estimate the hazard rate of going public for a startup. Cox proportional hazard model (Cox, 1972) is widely used for survival analysis, and incorporates a hazard rate specification that is continuous-time with an arbitrary baseline hazard rate and multiplicative term with exponentiated regressors (Lancaster, 1990). The model that we estimate for hazard rate of IPO for startup *i* can be written as:

$$\delta_{i,\mathrm{IPO}}(\mathrm{t}) = \delta_0(\mathrm{t}) * \exp(\alpha_i + \beta \mathrm{X}_{i\mathrm{t}} + \gamma \mathrm{Y}_{i\mathrm{t}} + \epsilon \mathrm{Z}_{\mathrm{t}}) \qquad (1)$$

where $\delta_0(t)$ represents the unspecified baseline hazard rate, α_i is a vector of time-invariant characteristics of startup *i* such as founding team characteristics, X_{it} is a vector of time-varying measures of startup *i*, Y_{it} is a vector of time-varying measures of venture

activity of startup *i*, and Z_t is a vector of time-varying environmental conditions, and α,β,γ, and δ are parameters to be estimated. Because there could be situations in my data where more than one firm might have experienced an IPO, I used Efron's method (Efron, 1977; Hertz-Picciotto and Rockhill, 1997) for handling tied events as it adjusts for risk sets in the analysis using probability weights for each subsequent failure and is considered a closer approximation to the exact partial likelihood function (Cleves, 208). I used robust standard errors clustered by startups. In supplemental analyses, I performed robustness checks of our results using other specifications such as Weibull and exponential hazard functions, and our estimates are consistent across these models. In supplemental analyses, I also investigated startups' instantaneous risk of being acquired and found similar results are those presented below for startups' hazard rate of going public.

Independent Variables

The first hypothesis in this study posited that the hazard rate of going public is positively related to *Scientific Stars* in the startup's founding team. Prior research has operationalized this variable in different ways. Zucker and Darby (1996) identified scientific stars on the basis of number of scientific articles published until 1990 that reported the discovery of at least one among the 40 genetic sequences. Rothaermel and Hess (2007) constructed a measure of star scientists by compiling publication and citation information for all scientists working at various pharmaceutical firms in their sample, and identified stars as those who had received citations at least two standard deviations above the mean. Higgins, Stephan, and Thursby (2011) defined star scientists as university-

affiliated researchers who are scientifically accomplished, and they did so by identifying university scientists who won a Nobel Prize.

Considering these differences in defining star scientists based upon the focus and time frame of previous studies, I followed Rothaermel and Hess (2007) since this measure is operationalizable across the long sequence of founders' publication activity and startups' innovative activity in my sample. I searched for publication data of all 1279 founders in my sample using the Web of Science database and identified publications for each founder by mapping their name, scientific field of study, and list of affiliated organizations. By matching in this way, I developed publication and citation data for 614 founders who published scientific articles in fields related to biotechnology, pharmaceutical sciences, and medical sciences. The average number of scientific publications is 145 and the average number of citations that founders received for their scientific publications is 11781. I operationalized *Scientific Star* as the number of founders of a startup firm who had been cited more than one standard deviation above the mean of the natural logarithm of the number of citations during the 12-year span in our sample. There are 97 star scientists in our entire sample of founders. I also performed robustness checks by constructing this measure using different cutoff values (e.g., above the mean and different percentiles (90^{th} and 95^{th}) and found the results to be robust. I also investigated an indicator variable that captures whether or not a star scientist is a founder of the firm and obtained similar interpretations.

Hypothesis 2 posited that the hazard rate of going public is positively related to *Founder IPO Experience* of founders in the startup's founding team. I measured *Founder*

IPO Experience as the number of founders who took public at least one of their previously founded startup in the biopharmaceutical industry (e.g., Hsu and Ziedonis, 2013). I also investigated an indicator variable that captures whether or not a startup has a founder with prior IPO experience and obtained similar interpretations.

In Hypotheses 3 and 4, I posited that the positive effect of startup founders' scientific and entrepreneurial credentials would be more pronounced when there is uncertainty about the technical and commercial prospects of the startup. Previous research in strategy, management, and finance literature suggests that the prominence of startups' VC backing reduces uncertainty for potential investors, partners, and customers (e.g., Megginson and Weiss, 1991; Stuart et al., 1999; Zhang, 2004; Hsu, 2006; Ozmel et al., 2013). I measured *VC Prominence* as the natural logarithm of the Bonacich centrality of the most central VC backing the startup prior to the year *t* (e.g., Bonacich, 1987; Sorenson and Stuart, 2001). More specifically, I calculated the eigenvector centrality of each VC backing the firm within the VC syndication network, in order to capture the direct and indirect ties among venture capitalists at a given point in time (Bonacich, 1987). I defined the centrality of a VC firm, indexed by *i*, as the Bonacich two-parameter measure in year *t* using a five-year time window between *t*-5 and *t*:

$$\text{VC firm centrality}_{i,t}\ (C_{i,t}) = \sum_{j=1}^{N_t}(\alpha_t + \beta_t C_{j,t})R_{i,j,t} \quad (2)$$

where $C_{j,t}$ is the centrality score of VC firm *j* in year *t*, and $R_{i,j,t}$ is an element of the relationship matrix R_t, indicating the co-investments between VC firms *i* and *j* during the five year window. α_t is a scale parameter chosen so that the sum of the squares of centralities of all firms in a network in a given year equals the number of units in the

network (i.e., N_t). β_t is a weighting coefficient, indicating the effect of centralities of investment partners on the firm's centrality and is conventionally set to three-fourths of the reciprocal of the largest eigenvalue of the relationship matrix R_t

Control Variables

I also controlled for several variables that account for characteristics of the founding team, startup firm, and overall biotech market conditions. To begin with, I controlled for the number of founders in the startup's founding team with entrepreneurial experience. I measured *Founders Prominent Firm as* the number of founders who had worked at prominent biopharmaceutical firms.

Previous research in strategy, management, and finance literature suggests that venture capital financing is strongly related to product market strategies of startups (e.g., Hellman and Puri, 2000), and the amount of pre-IPO, private equity raised by a startup is a good indicator of the level of uncertainty surrounding its technical progress and commercial prospects (e.g., Admati and Pfleiderer, 1994; Gompers, 1995; Stuart et al., 1999). I measure *VC Funding* as the cumulative amount of VC funding received by the startup prior to the year *t*. I also measured *VC Rounds* to control for the number of rounds of VC investment experienced by the startup prior to year *t*.

Technological capabilities and the quality of a startup also determine a startup's ability to develop innovative products and the quality of its proposed projects (e.g., Stuart, 2000), as well as opportunities for going public (e.g., Stuart et al., 1999). I controlled for the startup's technological assets and measured *Patent Stock* as the count of patents issued

to the startup prior to year *t*, and *Patent Citations* as the natural logarithm of the total number of citations received by startup's issued patents prior to year *t* (e.g., Jaffee et al., 1993; Hall, Jaffe, and Trajtenberg, 2005). Moreover, a startup's drug pipeline demonstrates its R&D productivity and technological accomplishments and conveys information to outsiders about its commercial prospects (e.g., DeCarolis and Deeds, 1999). I measured *Biotech Drug Pipeline* as the number of applications for new molecules and drugs of the startup that were approved by the Food and Drug Administration (FDA) prior to year *t*.

I also controlled for alliance activity of the startup firm, because the number of alliances formed by the startup is indicative of the fact that startup has access to these external resources and was subject to evaluations by alliance partners (e.g., Stuart et al., 1999; Stuart, 2000). I measured *Alliance Experience* as the natural logarithm of the number of strategic alliances formed by the startup prior to year *t*. To account for the startup's development and commercialization experience, I measured *Exploitative Experience* as the natural logarithm of the number of development and commercial alliances formed by the startup prior to year *t*. In addition to the above variables, I also controlled for *Firm Age* as the age of the firm at year *t*. I also controlled for industry subgroup effects and measured *Biotech Research* as a dummy variable that is equal to 1 if the startup belongs to biotech research category, and *Biotech Human* equal to 1 if it belongs to biotech human category, with the pharmaceutical category as the baseline.

I also included several measures to control for overall biotech market conditions. I measured *Biotech IPO Intensity* as the number of new biotech IPOs that occurred in year *t*. I also controlled for the density of VC-backed biotech startups and measured *Biotech Firm*

Density as the number of biotech firms that are at risk of an IPO in year *t.* In addition, I also controlled for overall public equity market conditions for biotech firms (e.g., Lerner and Merges, 1998) and measured *Biotech Equity Index* as the annual average Nasdaq Biotechnology Index. Finally, I also controlled for fixed effects of biotechnology clusters (*Biotech Cluster Effects*) (e.g., Deeds, DeCarolis, and Coombs, 1997) and included *Year Effects*.

4.4 Results

In my sample, the average value for founder's IPO experience is 0.27 for startups that experienced an IPO, while it is 0.09 for startups that did not have an IPO ($p<0.001$). The mean value number of founders with IPO experience is 0.23 for a startup that experienced an IPO within the first three years of founding, while it is 0.10 for another that did not have an IPO ($p<0.05$). The average number of scientific stars is 0.53 for startups that experienced an IPO, while it is 0.44 for startups that did not go public ($p<0.1$). The mean number of scientific stars is 0.85 for a startup that had an IPO within the first three years of founding, whereas it is 0.48 for a startup without an IPO ($p<0.05$). For a startup founded by a founder with IPO credential the hazard rate is enhanced by 244 percent, whereas for a startup founded by a scientific star the rate of going public increases by 58 percent. However, on a relative scale, the effect of a founder with IPO experience on the hazard rate is twofold more pronounced than that of a scientific star, suggesting that a founder with prior IPO experience is more influential than a scientific star on a startup's rate of going public. Table 4.1 provides additional descriptive statistics and correlations for my sample. Overall the correlations suggest no multicollinearity concerns. The maximum

Table 4.1. Descriptive Statistics and Correlation Matrix[a]

	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Founder IPO Experience	1.00																
2	Scientific Stars	**-0.11**	1.00															
3	Founders Prominent Firm	**-0.10**	**0.18**	1.00														
4	VC Prominence	0.04	**0.12**	0.03	1.00													
5	VC Funding	**0.07**	**0.06**	0.04	**0.31**	1.00												
6	VC Rounds	**0.06**	**0.04**	**0.04**	**0.30**	**0.74**	1.00											
7	Biotech IPO Heat	0.01	-0.02	-0.03	**-0.08**	**-0.19**	**-0.17**	1.00										
8	Biotech Firm Density	-0.02	0.02	**0.11**	**0.15**	**0.35**	**0.30**	**-0.20**	1.00									
9	Biotech Equity Index	-0.01	0.01	0.03	**0.12**	**0.23**	**0.28**	**0.20**	**0.11**	1.00								
10	Biotech Drug Pipleline	-0.01	**-0.06**	0.04	-0.01	**0.09**	**0.09**	0.03	0.02	0.00	1.00							
11	Patent Stock	0.04	0.03	-0.03	**0.08**	**0.28**	**0.30**	-0.03	**0.10**	**0.10**	-0.03	1.00						
12	Patent Citations	**0.07**	**0.04**	**-0.06**	**0.09**	**0.26**	**0.26**	-0.02	**0.07**	**0.07**	-0.03	**0.74**	1.00					
13	Alliance Count	**0.04**	0.00	0.01	**0.10**	**0.48**	**0.53**	**-0.14**	**0.26**	**0.25**	**0.07**	**0.31**	**0.27**	1.00				
14	Exploitative Experience	0.01	**-0.05**	0.01	-0.02	**0.22**	**0.26**	**-0.06**	**0.10**	**0.15**	0.00	**0.07**	0.03	**0.50**	1.00			
15	Firm Age	-0.01	**-0.04**	**-0.08**	**0.20**	**0.62**	**0.60**	**-0.21**	**0.48**	**0.27**	0.01	**0.28**	**0.29**	**0.54**	**0.24**	1.00		
16	Biotech Human	**-0.05**	**0.16**	0.03	**0.04**	0.03	**0.06**	-0.02	0.03	**0.04**	**-0.09**	**0.07**	**0.09**	**-0.06**	-0.03	-0.04	1.00	
17	Biotech Research	**0.06**	-0.03	**0.07**	-0.02	0.00	-0.01	0.02	**-0.05**	**-0.01**	-0.03	-0.02	-0.02	0.03	0.00	0.02	**-0.40**	1.00
	Mean	0.10	0.45	0.39	0.49	6.01	2.05	7.66	0.93	1.62	0.06	1.91	0.50	0.53	0.16	1.34	0.66	0.07
	S.D.	0.31	0.80	0.59	1.39	4.73	2.32	5.45	0.09	0.12	0.58	4.79	1.28	0.67	0.49	0.72	0.47	0.26

[a]N=2,912. $p<0.05$ in bold.

Table 4.2. Estimates for COX Proportional Hazard Model[a]

Variables	1	2
Year Effects[a]	4.17	4.16
Biotech Cluster Effects[a]	1.60	0.62
Biotech Research	0.759	0.642
	(0.752)	(0.671)
Biotech Human	-0.377	-0.371
	(0.527)	(0.464)
Firm Age	-0.532***	-0.552***
	(0.124)	(0.141)
Exploitative Experience	0.584	0.687
	(0.780)	(0.610)
Alliance Experience	1.195**	1.102***
	(0.396)	(0.325)
Patent Citations	-0.330	-0.291
	(0.349)	(0.267)
Patent Stock	0.106*	0.104*
	(0.050)	(0.041)
Biotech Drug Pipeline	0.248***	0.295***
	(0.068)	(0.087)
Biotech Equity Index	7.041†	6.751
	(4.035)	(4.443)
Biotech Firm Density	0.242†	0.231
	(0.142)	(0.162)
Biotech IPO Intensity	0.088	0.090†
	(0.057)	(0.046)
VC Rounds	0.240**	0.285**
	(0.091)	(0.100)
VC Funding	0.110	0.095
	(0.097)	(0.076)
VC Prominence	-0.164	-0.468
	(0.427)	(0.579)
Founder Prominent Firm	-0.408	-0.123
	(0.468)	(0.350)
Scientific Stars		0.458*
		(0.230)
Founder IPO Experience		1.236**
		(0.416)
Log likelihood	-209.54	-205.07
Wald χ^2	311.14***	302.78***

[a]N=2,912. Clustered robust standard errors in parentheses. [b]χ^2 values for joint significance of fixed effects. *** p<0.001, ** p<0.01, * p<0.05, †p<0.1.

variance inflation factor is 3.36, which is well below the rule of thumb value of ten used to indicate multicollinearity concerns (Neter et al., 1989).

Table 4.2 reports the Cox proportional hazard estimates for IPO rate. Model 1 is the baseline model consisting of all the control variables. Model 2 augments model 1 and shows the effects of our hypothesized variables. In the first hypothesis, I predicted that a startup founded by a scientific star is at a greater risk of experiencing an IPO. Consistent with this prediction, the coefficient estimate of scientific star is positive and statistically significant ($p<0.05$). I also estimated the economic significance of a scientific star founder on the rate of going public. With all the other covariates at their mean values, a startup that has a scientific star on its founding team is 1.6 times more likely to experience an IPO compared to another that does not have a scientific star. In Hypothesis 2, I predicted that a startup established by a founder with prior IPO experience is at a higher risk of going public. The coefficient estimate of founder IPO experience is positive and statistically significant ($p<0.01$). The effect is also economically meaningful, as we find that an average startup having a founder with IPO experience on its founding team is 3.4 times more at risk of experiencing an IPO compared to another average startup that does not have founders with IPO experience.

Table 4.3 presents Cox hazard estimates for the interactions of scientific stars and founder IPO experience with VC prominence, respectively. Specifically, Hypothesis 3 suggests that the positive effect of scientific stars on the IPO rate will be contingent on the prominence of startup's VC affiliations, and more pronounced when the startup's VC backing is less prominent.

Table 4.3. Interaction Effects between Founders' Credentials and VC Prominence[a]

Variables	1	2	3	4
Year Effects[b]	4.16	4.25	4.13	4.15
Biotech Cluster Effects[b]	0.62	1.35	0.85	1.22
Biotech Research	0.642	0.604	0.949	0.837
	(0.671)	(0.815)	(0.755)	(0.786)
Biotech Human	-0.371	-0.414	-0.430	-0.408
	(0.464)	(0.543)	(0.562)	(0.556)
Firm Age	-0.552***	-0.544***	-0.537***	-0.533***
	(0.141)	(0.123)	(0.124)	(0.123)
Exploitative Experience	0.687	0.714	0.521	0.563
	(0.610)	(0.753)	(0.771)	(0.750)
Alliance Experience	1.102***	1.139**	1.248***	1.222***
	(0.325)	(0.360)	(0.376)	(0.371)
Patent Citations	-0.291	-0.232	-0.255	-0.237
	(0.267)	(0.295)	(0.309)	(0.298)
Patent Stock	0.104*	0.100*	0.103*	0.102*
	(0.041)	(0.045)	(0.047)	(0.046)
Biotech Drug Pipeline	0.295***	0.315***	0.307***	0.315***
	(0.087)	(0.074)	(0.075)	(0.076)
Biotech Equity Index	6.751	6.683†	6.376†	6.460†
	(4.443)	(3.912)	(3.860)	(3.911)
Biotech Firm Density	0.231	0.228	0.218	0.220
	(0.162)	(0.140)	(0.139)	(0.140)
Biotech IPO Intensity	0.090†	0.091	0.095	0.094
	(0.046)	(0.058)	(0.058)	(0.058)
VC Rounds	0.285**	0.275**	0.268**	0.255**
	(0.100)	(0.091)	(0.091)	(0.090)
VC Funding	0.095	0.082	0.087	0.087
	(0.076)	(0.094)	(0.091)	(0.091)
VC Prominence	-0.468	0.066	0.010	0.280
	(0.579)	(0.481)	(0.426)	(0.488)
Founder Prominent Firm	-0.123	-0.105	-0.125	-0.136
	(0.350)	(0.430)	(0.447)	(0.453)
Scientific Stars	0.458*	0.570*	0.572*	0.582*
	(0.230)	(0.239)	(0.250)	(0.234)
Founder IPO Experience	1.236**	1.304**	1.186**	1.265**
	(0.416)	(0.494)	(0.441)	(0.456)
Scientific Stars*VC Prominence		-0.393**		-0.314*
		(0.131)		(0.159)
Founder IPO Experience*VC Prominence			-0.544*	-0.451†
			(0.220)	(0.267)
Log likelihood	-205.07	-202.55	-202.26	-201.35
Wald χ^2	302.78***	286.09***	277.49***	269.56***

[a]N=2,912. Clustered robust standard errors in parentheses. [b]χ^2 values for joint significance of fixed effects. *** p<0.001, ** p<0.01, * p<0.05, † p<0.1.

The interaction between scientific stars and VC prominence is negative and statistically significant ($p<0.01$) and consistent with the prediction. Likewise, Hypothesis 4 posited a substitution effect between founder IPO experience and the prominence of VCs affiliating with the focal startup. Consistent with this prediction, the coefficient estimate of the interaction variable is negative and statistically significant ($p<0.05$).

It is well recognized that interpreting interaction effects for nonlinear models such as Cox proportional hazard models is difficult. I examined the interaction effects graphically (please see Figures 4.1 and 4.2) to illustrate the interaction effects.

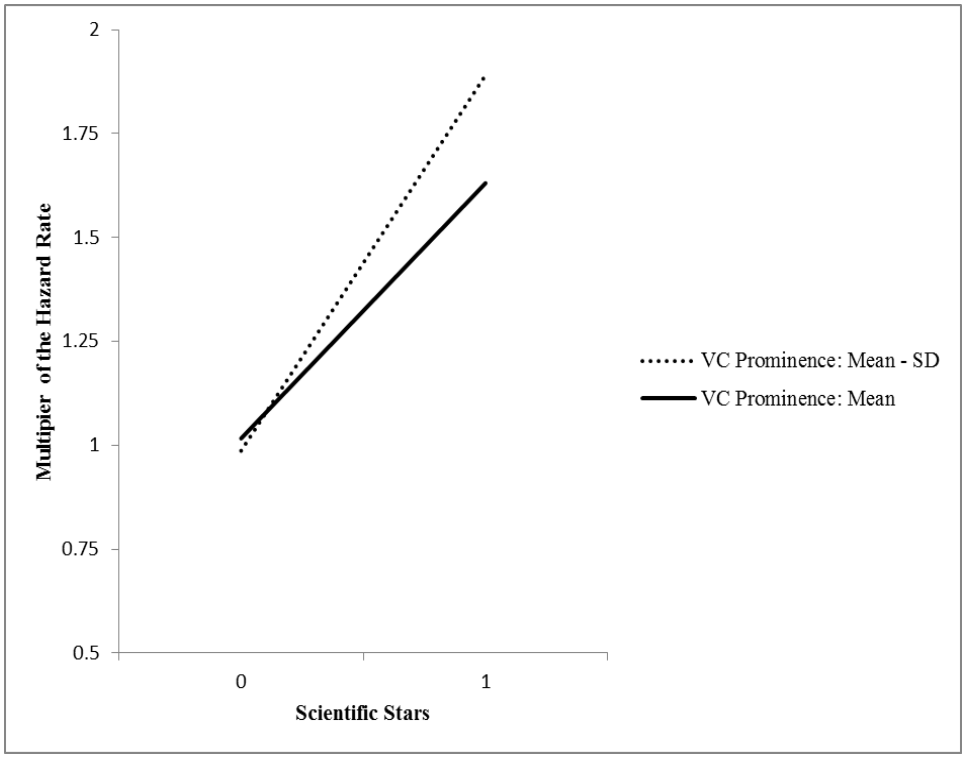

Figure 4.1. Interaction Effect between Scientific Stars and VC Prominence on IPO Hazard Rate

Figure 1 shows the interaction effect between scientific stars and VC prominence. A one standard deviation decrease in VC prominence augments the positive effect of founder IPO experience on IPO rate by 16 percent. Figure 2 depicts the interaction effect between founder IPO prominence and VC prominence. A one standard deviation decrease in VC prominence augments the positive effect of founder IPO experience on IPO rate by 27 percent.

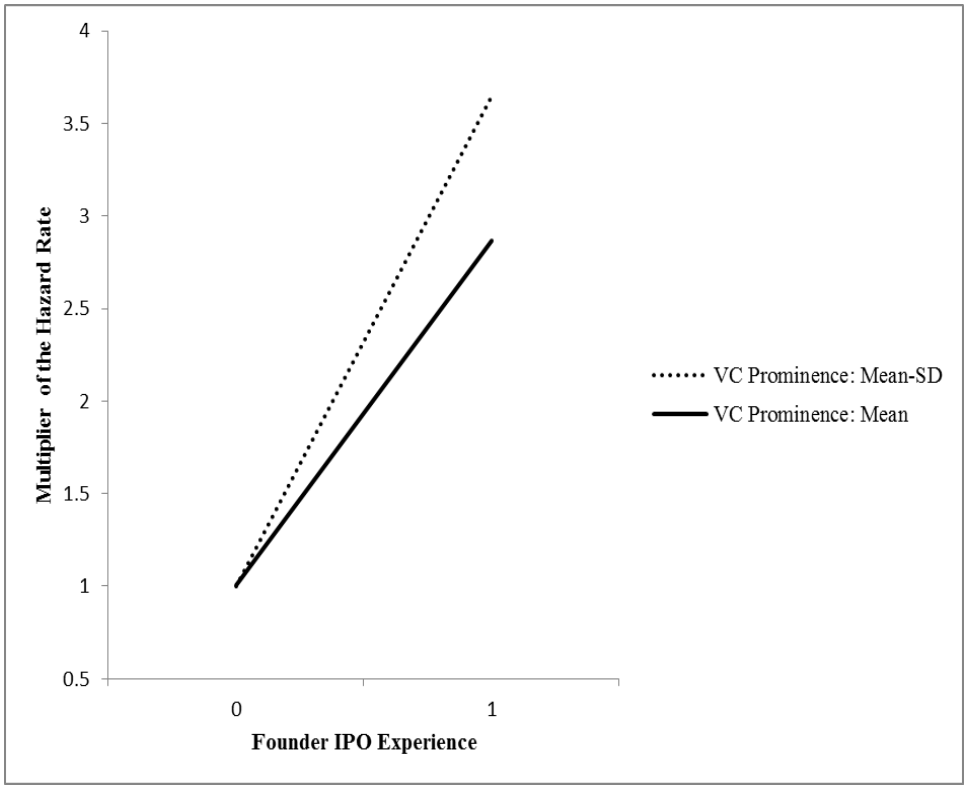

Figure 4.2. Interaction Effect between Founder IPO Experience and VC Prominence on IPO Hazard Rate

In supplemental analyses, I employed alternative specifications such as Weibull and exponential hazard functions and observed similar inferences as those presented above. Supplemental analyses of time-to-IPO using Tobit models suggested that startups founded

by scientific stars and founders with prior IPO experience undergo IPOs sooner that other startups. In supplemental analyses, I also investigated startups' instantaneous risk of being acquired and found similar results as those presented above for startups' hazard rate of going public. Results for some of the control variables are also noteworthy. The coefficient estimate for patent stock is positive and significant ($p<0.05$). This result provides support for the informational role of patents in enabling a startup go to IPO faster. It is also interesting to note that the coefficient estimate of startup's drug pipeline is positive and significant ($p<0.001$), suggesting that startups that accumulated demonstrable product development expertise are at a greater risk of going public.

4.5 Discussion

4.5.1 Contributions and Implications

In this study, I develop hypotheses about the role of founders' distinct credentials and track records on startups' rate of going public. I focus on the startups' IPO event, because going IPO is a significant milestone for startups as it enables startups raise capital to finance their projects and advertises to the broader community of resource providers, suppliers, alliance partners, and customers.

In the hypotheses, I propose two distinct credentials of startup founders and suggest that they play a pivotal role in positively influencing the startup's rate of going public. Specifically, I suggest that startups founded by scientific stars and founders with prior IPO experience, respectively, achieve faster IPO rate. Given that high-tech startups are generally backed by venture capitalists (VCs) (e.g., Sahlman, 1990; Gompers and Lerner,

2001), the quality of startups' VC affiliations produce information on the startups' overall quality and market prospects for outsiders (e.g., Stuart et al., 1999; Gulati and Higgins, 2003; Hsu, 2004). Thus, I also suggest that founders' scientific and entrepreneurial credentials are more substantial when startup lack other potential means through which they can credibly indicate their overall prospects. In particular, I argue that the positive effect of the hypothesized founder credentials on startups' rate of going public will be more pronounced for startups that are backed by less prominent VCs.

At a broad level, I extend research in strategy and entrepreneurship on startups' IPO timing decisions and IPO performance. Prior research has investigated the role of startups' interorganizational relationships and endorsements (e.g., Stuart et al., 1999; Chang, 2004), top management team's experience (e.g., Beckman and Burton, 2008) and prestige (e.g., Certo et al., 2001) on the IPO timing and performance of startups. I complement this stream of research by showing how specific aspects of founders' credentials that are indicative of their scientific and entrepreneurial accomplishments are likely to have a strong bearing on startups' IPO decision.

Second, I also contribute to research applying signaling theory to examine the different types of signals that enable performance for new ventures in several market contexts. Prior research (e.g., Stuart et al., 1999; Chang, 2004) showed how interorganizational relationships and endorsements affect IPO timing and performance of startups by conveying their quality to potential public investors. I complement this stream of research by showing how distinct track records of founders play an instrumental role in shaping IPO decisions for startups and enable a faster IPO. By investigating the

contingency between founders' credentials and startups' quality of VC affiliations on startups' rate of going public, I contribute to prior research which suggests the relationship between the different signals in determining outcomes for startups in various market contexts. (e.g., Riley, 2001; Long, 2002; Certo, 2003; Hsu, 2006; Zhang and Wiersema, 2009; Connelly et al., 2011).

Third, I contribute to research in strategy and entrepreneurship on startups' IPO timing decisions and IPO performance. Prior research investigated the role of startups' interorganizational relationships and endorsements (e.g., Stuart et al., 1999; Chang, 2004), top management team's experience (e.g., Beckman and Burton, 2008) and prestige (e.g., Certo et al., 2001) on the IPO timing and performance of startups. I extend this stream of research by showing specific aspects of founders' credentials that are likely to have a strong bearing on startups' IPO decision and their contingent effects on quality of startups' VC affiliations.

Finally, I also contribute to research on resource-based theory (RBT) (e.g., Penrose, 1959; Wernefelt, 1984) and resource based view (e.g., Barney 1991) and complement emerging stream of research about the role of founders' experience and human capital (e.g., Eisenhardt and Schoonhoven, 1996; Colombo and Grilli, 2005; Chandler and Hanks, 1998). In particular, I demonstrate that credentials of founders can also be instrumental as valuable initial "endowments" for startups (Brush et al., 2001) and accelerate their growth and evolution towards becoming public firms.

4.5.2 Limitations and Future Research Directions

There are several limitations to this study which future research might be able to address. First, in this study I focus on two distinct aspects of founders' track records, that is scientific and entrepreneurial accomplishments of founders, which I believe contribute to startups internal growth and ability to raise capital from outside sources to finance their projects. While micro-level data on founding team is one limitation of this study, it will be interesting to examine how the above credentials of founders interact with other kinds of founder attributes such as their networks, prior affiliations with prominent firms, specific kinds of experience such as marketing and commercialization experience (e.g., Beckman et al., 2007; Beckman and Burton, 2008).

Second, in this study I suggest that founders' scientific as well as entrepreneurial credentials convey information about the quality of startups' prospects. In future research it will be valuable to investigate how their effect on startups' rate of going public varies with other aspects of startups such as patents, product pipelines and so forth.

Third, while this study examines how founders' scientific and entrepreneurial credentials are contingent on startups' venture progress and quality of VC affiliations, it is also silent about how founders' credentials interact with other endorsements besides VCs (e.g., Stuart et al., 1999). In future research it will be useful to investigate how founders' credentials, startup's interorganizational networks, relationships with underwriters, and technological prominence interact with each other in shaping outcomes for startups in various market contexts.

4.6 Conclusion

In this study, I investigate the role of founders' distinct credentials and track records on startups' rate of going public. In particular, I propose two distinct credentials of startup founders which separately signal founders' unobservable scientific and entrepreneurial human capital, and suggest that they play a pivotal role in positively influencing the startup's rate of going public. Specifically, I suggest that startups founded by scientific stars and founders with prior IPO experience, respectively, achieve faster IPO rate. I also argue and show that founders' scientific and entrepreneurial credentials are more substantial when startup lack other potential means, such as prominent VC affiliations, through which they can credibly indicate their overall prospects to potential outside investors.

CHAPTER 5. CONCLUSION

In this dissertation, I provide new insights about the role of founders in the growth and performance of young high-tech startups. I present three studies which focus on strategies and outcomes for high-tech startups that facilitate their commercialization and overall growth prospects. The three studies draw upon ideas from the economics of information about the risk of adverse selection and its remedies in various market contexts and examine the signaling value of founders' distinct credentials for startups in advancing the growth and performance of startups. The studies are also unified by a common focus on the role of founders' distinct credentials in shaping success for startups in cooperative commercialization agreements and initial public offerings, which are significant developmental milestones for startups. I depart from prior literature in strategy and entrepreneurship about the role of startup founders on startups' performance, and rather advance the idea that startup founders' distinctive human capital has a much broader role for startups in the context of startups' strategic alliances and financing strategies. I argue that while a founder's human capital is private information, potential collaborators and investors in alliance and capital markets can learn about founders' human capital by evaluating their career track records and accomplishments. In particular, I conceptually distinguish features of startup founders into distinct credentials which function as credible signals of founders' unobservable scientific and entrepreneurial human capital, and investigate their impact on the performance of young high-tech startups in the market for

ideas and initial public offerings. Further, I also examine the contingent effects of these credentials of startup founders on the degree of uncertainty that prevails for potential alliances partners and investors about startups' underlying quality. The three studies in this dissertation also have broad implications for startups. Evidence across the three studies suggests that high-tech startups having individuals with prominent credentials on their founding team enjoy a competitive advantage relative to other startups.

5.1 Summary of Findings

The first study (Chapter 2) proposes three distinct credentials of startup founders and explores their impact on startups' alliance formation in the context of market for ideas and technologies. Early stage startups typically try to obtain resources from external agents (e.g., Stuart et al., 1999; Shane and Cable, 2002) and are devoid of track records (e.g., Shane and Stuart, 2002) that enhance their visibility and establish credibility to resource providers. In this regard, I unpack three distinct credentials of startup founders -- scientific stars, employees of prominent incumbents, and successful founders -- that are costly for other founders to attain and which enable transactions with firms by reducing their costs of search and selection. Further, I develop the argument that the impact of founders' credentials is contingent on other signals that can effectively convey the underlying quality of startups' quality to potential collaborators and mitigate uncertainty. I find evidence that a startup's published patent application diminishes the positive effect of founders' credentials on formation of cooperative agreements with incumbents. This paper contributes to research on alliances and collaborative R&D partnerships (e.g., Stuart, 1998; Gulati. 1999), by suggesting that founders' credentials play an important role in addressing

information asymmetries and reducing risks of adverse selection faced by incumbent firms and enabling transactions with upstream suppliers of technologies.

The second study (Chapter 3) examines an underexplored dimension of alliance contracting, in particular the payment structures that parties negotiate for their high-tech partnerships, and develops hypotheses about the remedial role of startup founders' credentials in obtaining favorable payment structures for startups during collaborative commercialization with incumbents. Specifically, I investigate two distinct credentials of startup founders and argue that they play an instrumental role in positively shaping the proportion of upfront payments that startups can obtain from their licensees, rather than deferred and contingent payments that routinely feature in these transactions. More importantly, I provide evidence for the intuitive notion that the two distinct founders' credentials – star founders and successful founders – would complement each other. Finally, I also suggest that the positive effects of these two distinct founders' credentials on the proportion of upfront payments that startups receive will vary based upon startups' venture development stages. At a broad level, this study contributes to literature in strategy and entrepreneurship by examining the signaling role of founders' credentials in enhancing the value attained from their ideas and innovative capabilities from cooperative commercialization arrangements.

In the third study (Chapter 4) I develop hypotheses about the role of founders' credentials on startups' rate of going public. I propose that startup founders' scientific and entrepreneurial credentials play a pivotal role in positively influencing the startup's ability to go public. Specifically, I suggest that startups that have a scientific star or a founder with

prior IPO experience on their founding team are able to go public faster. I also suggest that the effects of founders' scientific and entrepreneurial credentials are contingent on other potential means through which startups can credibly convey their overall quality and prospects. Notably, given the fact that high-tech startups are generally backed by venture capitalists (VCs) (e.g., Sahlman, 1990; Gompers and Lerner, 2001) and the quality of their VC affiliations produce information on startups' quality, I suggest that prominent VC affiliations moderate the effects of founders' credentials on startup's rate of going public. This study complements previous research on startups' IPO timing decisions and IPO performance by showing how specific aspects of founders' credentials that are indicative of their scientific and entrepreneurial accomplishments are likely to have a strong bearing on startups' IPO decision.

5.2 Implications for Future Research

Overall, this research sheds new light about the significance of founders in shaping the performance as well as growth prospects of startups. Research in entrepreneurship suggests that startup founders' knowledge, skills, experience, know-how and expertise are part of startups' initial endowments, and critically determine the performance and survival of startups (e.g., Cooper et al., 1994). A large body of research in strategy strongly suggests that startups largely rely on strategic alliances with incumbent firms and investors to access complementary resources and capital to promote startups' growth and performance (e.g., Pisano, 1989; Gulati, 1998; Stuart et al., 1999; Ahuja, 2000; Baum et al., 2000; Baum and Silverman, 2004). Given the significance of founders in shaping startups' strategic growth and development, there is a need for understanding how and to what extent founders affect

outcomes for startups in important strategic contexts, such as strategic alliances and initial public offerings.

From a theoretical standpoint, the arguments and evidence in this study suggest that founders' superior credentials serve as credible signals for the quality of their unobservable human capital and function as effective means for reducing adverse selection risks for incumbent partners and investors. In this regard, this study is one of the first to provide systematic evidence about the role of founders in accomplishing growth prospects for startups though strategic alliances and initial public offerings. However, the focus of this dissertation is also necessarily limited. I suggest a few valuable research opportunities that are possible by combining the insights from this study with prior literature to examine some interesting questions.

For instance, while a part of this study explored how founders' credentials shape formation of alliance agreements as well as payment structures for startups in these agreements, it is silent on the structure and design of these agreements between startups and incumbents. Prior research emphasizes the role of hierarchical governance structures in mitigating partners' concerns about behavioral uncertainty as well as coordination costs (e.g., Gulati and Singh, 1998). Even though we suggested that founders' credentials reduces risk of adverse selection for alliance partners, it is also likely that superior credentials produce reputation effects for founders and reduce the need for stronger hierarchical governance structures such as equity alliances (e.g., Williamson, 1991). Also, given the fact that a large component of founders' human capital is tacit in nature and very valuable for partners in the collaborative development of startups' specific ideas (e.g.,

Polanyi, 1966), partner firms would also prefer to employ more hierarchical structures (e.g., Kogut, 1988). Therefore, a logical extension of this study is to understand how different credentials of founders influence the design and choice of governance structure for cooperative commercialization agreements of startups.

In this dissertation, I show that founders' credentials function as signals of their unobservable human capital and reduce adverse selection risks for potential alliance partners and investors. A notable implication of founders' credentials for startups is that they also create outside options for startups and expand their portfolio of potential commercialization partners and investors. As a result, founders' superior credentials broadly enhance the attractiveness of startups and improve their bargaining power while negotiating with collaborative commercialization partners and investors. Given the signaling and bargaining considerations of startup founders' credentials, it will be very useful to examine how founders' credentials influence the distribution of control rights and appropriation of value for startups within cooperative commercialization agreements and R&D alliances (e.g., Lerner and Merges, 1998; Adegbesan and Higgins, 2011). In future research, it will also be fruitful to examine the effect of founders' credentials in other contexts such as Mergers and Acquisitions, which are also valuable strategic milestones for startups.

In summary, across these three studies I show that founders' distinct technical and entrepreneurial credentials facilitate important milestones for startups, such as strategic alliances and initial public offering, which ensure startups' growth and survival. I also show the contingent effects of these credentials of startup founders on the degree of uncertainty

that prevails for potential alliances partners and investors about startups' underlying quality. Put together, the three studies provide new evidence about the signaling role of startup founders' credentials and enhance the theoretical and empirical understanding about the role of founders in shaping growth prospects and performance of startups.

LIST OF REFERENCES

REFERENCES

Adegbesan, J. A., & Higgins, M. J. 2011. The intra-alliance division of value created through collaboration. ***Strategic Management Journal***, 32(2): 187–211.

Admati, A. R., & Pfleiderer, P. 1994. Robust financial contracting and the role of venture capitalists. ***The Journal of Finance***, 49(2): 371–402.

Agarwal, R., Echambadi, R., Franco, A. M., & Sarkar, M. 2004. Knowledge transfer through inheritance: spin-out generation, development, and survival. ***The Academy of Management Journal***, 47(4): 501–522.

Agrawal, A. 2006. Engaging the inventor: exploring licensing strategies for university inventions and the role of latent knowledge. ***Strategic Management Journal***, 27(1): 63–79.

Agrawal, A., Cockburn, I., & Zhang, L. 2013. Deals not done: Sources of failure in the market for ideas. ***National Bureau of Economics Research***.

Ahuja, G. 2000. Collaboration networks, structural holes, and Innovation: A longitudinal study. ***Administrative Science Quarterly***, 45(3): 425–455.

Akerlof, G. A. 1970. The market for “lemons”: Quality uncertainty and the market mechanism. ***The Quarterly Journal of Economics***, 84(3): 488–500.

Amit, R., Glosten, L., & Muller, E. 1990. Entrepreneurial ability, venture investments, and risk sharing. ***Management Science***, 36(10): 1232–1245.

Anand, B. N., & Khanna, T. 2000. Do firms learn to create value? The case of alliances. ***Strategic Management Journal***, 21(3): 295–315.

Anderson, S. W., & Dekker, H. C. 2005. Management control for market transactions: The relation between transaction characteristics, incomplete contract design, and subsequent performance. ***Management Science***, 51(12): 1734–1752.

Anton, J. J., & Yao, D. A. 1994. Expropriation and inventions: Appropriable rents in the absence of property rights. ***The American Economic Review***, 84(1): 190–209.

Ardichvili, A., Cardozo, R., & Ray, S. 2003. A theory of entrepreneurial opportunity identification and development. ***Journal of Business Venturing***, 18(1): 105–123.

Arvanitis, S., & Stucki, T. 2012. What determines the innovation capability of firm founders? ***Industrial and Corporate Change***, 21(4): 1049–1084.

Argote, L. 2012. ***Organizational Learning: Creating, Retaining and Transferring Knowledge***. Springer Science & Business Media.

Arora, A., & Gambardella, A. 1990. Complementarity and external linkages: The strategies of the large firms in biotechnology. ***The Journal of Industrial Economics***, 38(4): 361–379.

Arora, A., & Gambardella, A. 1994. Evaluating technological information and utilizing it: Scientific knowledge, technological capability, and external linkages in biotechnology. ***Journal of Economic Behavior & Organization***, 24(1): 91–114.

Arora, A., & Gambardella, A. 2010. Ideas for rent: An overview of markets for technology. ***Industrial and Corporate Change***, 19(3): 775–803.

Arora, A., Fosfuri, A., & Gambardella, A. 2001. Markets for technology and their implications for corporate strategy. ***Industrial and Corporate Change***, 10(2): 419–451.

Arrow, K. J. 1962. Economic welfare and the allocation of resources for invention. ***The rate and direction of inventive activity: Economic and social factors***: p. 609 – 626. New Jersey: Princeton University Press.

Arrow, K. J. 1971. Insurance, Risk and Resource Allocation. ***SSRN Electronic Journal***. Rochester, NY: Social Science Research Network.

Arvanitis, S., & Stucki, T. 2012. What determines the innovation capability of firm founders? ***Industrial and Corporate Change***, 21(4): 1049–1084.

Audia, P. G., & Rider, C. I. 2005. A garage and an idea: What more does an entrepreneur need? ***California Management Review***, 48(1): 6–28.

Audretsch, D. B., & Stephan, P. E. 1996. Company-scientist locational links: The case of biotechnology. ***The American Economic Review***, 86(3): 641–652.

Balakrishnan, S., & Koza, M. P. 1993. Information asymmetry, adverse selection and joint-ventures: Theory and evidence. ***Journal of Economic Behavior & Organization***, 20(1): 99–117.

Barney, J. 1991. Firm resources and sustained competitive advantage. ***Journal of Management***, 17(1): 99–120.

Baum, J. A. C., Calabrese, T., & Silverman, B. S. 2000. Don't go it alone: Alliance network composition and startups' performance in Canadian biotechnology. ***Strategic Management Journal***, 21(3): 267–294.

Baum, J. A. C., & Silverman, B. S. 2004. Picking winners or building them? Alliance, intellectual, and human capital as selection criteria in venture financing and performance of biotechnology startups. ***Journal of Business Venturing***, 19(3): 411–436.

Baum, J. R., & Bird, B. J. 2009. The successful intelligence of high-growth entrepreneurs: Links to new venture growth. ***Organization Science***, 21(2): 397–412.

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

Beckman, C. M., & Burton, M. D. 2008. Founding the future: Path dependence in the evolution of top management teams from founding to IPO. ***Organization Science***, 19(1): 3–24.

Beckman, C. M., Burton, M. D., & O'Reilly, C. 2007. Early teams: The impact of team demography on VC financing and going public. ***Journal of Business Venturing***, 22(2): 147–173.

Belsley, D.A., Kuh, E., & Welsch, R.E. 1980. ***Regression diagnostics: Identifying influential data and sources of collinearity***. New York: John Wiley & Sons.

Berk, J. B., Green, R. C., & Naik, V. 2004. Valuation and return dynamics of new ventures. ***Review of Financial Studies***, 17(1): 1–35.

Bhide, A. V. 2000. ***The Origin and Evolution of New Businesses***. New York: Oxford University Press.

Black, B. S., & Gilson, R. J. 1998. Venture capital and the structure of capital markets: Banks versus stock markets. ***Journal of Financial Economics***, 47(3): 243–277.

Boeker, W. 1988. Organizational origins: Entrepreneurial and environmental imprinting of the time of founding. ***SSRN Electronic Journal*.** Rochester, NY: Social Science Research Network.

Bonacich, P. 1987. Power and centrality: A family of measures. ***American Journal of Sociology***, 92(5): 1170–1182.

Brau, J. C., Sutton, N. K., & Hatch, N. W. 2010. Dual-track versus single-track sell-outs: An empirical analysis of competing harvest strategies. ***Journal of Business Venturing***, 25(4): 389–402.

Brown, S. L., & Eisenhardt, K. M. 1997. The art of continuous change: Linking complexity theory and time-paced evolution in relentlessly shifting organizations. ***Administrative Science Quarterly***, 42(1): 1–34.

Brüderl, J., Preisendörfer, P., & Ziegler, R. 1992. Survival chances of newly founded business organizations. ***American Sociological Review***, 57(2): 227–242.

Brush, C. G., Greene, P. G., & Hart, M. M. 2001. From initial idea to unique advantage: The entrepreneurial challenge of constructing a resource base. ***The Academy of Management Executive***, 15(1): 64–78.

Buenstorf, G., & Klepper, S. 2009. Heritage and agglomeration: The Akron tyre cluster revisited. ***The Economic Journal***, 119(537): 705–733.

Burton, M. D., Sørensen, J. B., & Beckman, C. M. 2002. Coming from good stock: Career histories and new venture formation. ***Research in the Sociology of Organizations***, 19: 229–262.

Busenitz, L. W., & Barney, J. B. 1997. Differences between entrepreneurs and managers in large organizations: Biases and heuristics in strategic decision-making. ***Journal of Business Venturing***, 12(1): 9–30.

Bygrave, W. D., & Timmons, J. A. 1992. ***Venture Capital at the Crossroads***. Harvard Business Press.

Callander, S. 2011. Searching and learning by trial and error. ***The American Economic Review***, 101(6): 2277–2308.

Carter, R., & Manaster, S. 1990. Initial public offerings and underwriter reputation. ***The Journal of Finance***, 45(4): 1045–1067.

Certo, S. T. 2003. Influencing initial public offering investors with prestige: Signaling with board structures. ***Academy of Management Review***, 28(3): 432–446.

Certo, S. T., Covin, J. G., Daily, C. M., & Dalton, D. R. 2001. Wealth and the effects of founder management among IPO-stage new ventures. ***Strategic Management Journal***, 22(6-7): 641–658.

Chandler, G. N., & Hanks, S. H. 1998. An examination of the substitutability of founders' human and financial capital in emerging business ventures. ***Journal of Business Venturing***, 13(5): 353–369.

Chang, S. J. 2004. Venture capital financing, strategic alliances, and the initial public offerings of internet startups. ***Journal of Business Venturing***, 19(5): 721–741.

Chatterji, A. K. 2009. Spawned with a silver spoon? Entrepreneurial performance and innovation in the medical device industry. ***Strategic Management Journal***, 30(2): 185–206.

Chemmanur, T. J., & Fulghieri, P. 1999. A theory of the going-public decision. ***The Review of Financial Studies***, 12(2): 249–279.

Cleves, M. 2008. ***An Introduction to Survival Analysis Using Stata, Second Edition***. Stata Press.

Coff, R. W. 1997. Human assets and management dilemmas: Coping with hazards on the road to resource-based theory. ***The Academy of Management Review***, 22(2): 374–402.

Coff, R. W. 1999. When competitive advantage doesn't lead to performance: The resource-based view and stakeholder bargaining power. ***Organization Science***, 10(2): 119–133.

Cohen, B. D., & Dean, T. J. 2005. Information asymmetry and investor valuation of IPOs: Top management team Legitimacy as a Capital Market Signal. ***Strategic Management Journal***, 26(7): 683–690.

Cohen, W. M., & Levinthal, D. A. 1990. Absorptive capacity: A new perspective on learning and innovation. ***Administrative Science Quarterly***, 35(1): 128–152.

Colombo, M. G., & Grilli, L. 2005. Founders' human capital and the growth of new technology-based firms: A competence-based view. ***Research Policy***, 34(6): 795–816.

Colombo, M. G., & Grilli, L. 2010. On growth drivers of high-tech start-ups: Exploring the role of founders' human capital and venture capital. ***Journal of Business Venturing***, 25(6): 610–626.

Connelly, B. L., Certo, S. T., Ireland, R. D., & Reutzel, C. R. 2011. Signaling theory: A review and assessment. ***Journal of Management***, 37(1): 39–67.

Cooper, A. C., Woo, C. Y., & Dunkelberg, W. C. 1989. Entrepreneurship and the initial size of firms. ***Journal of Business Venturing***, 4(5): 317–332.

Cox, D. R. 1972. Regression Models and Life-Tables. ***Journal of the Royal Statistical Society. Series B (Methodological)***, 34(2): 187–220.

Cumming, D. 2006. Adverse selection and capital structure: Evidence from venture capital. ***Entrepreneurship Theory and Practice***, 30(2): 155–183.

Datar, S., Frankel, R., & Wolfson, M. 2001. Earnouts: The effects of adverse selection and agency costs on acquisition techniques. ***Journal of Law, Economics, & Organization***, 17(1): 201–238.

DeCarolis, D. M., & Deeds, D. L. 1999. The impact of stocks and flows of organizational knowledge on firm performance: an empirical investigation of the biotechnology industry. ***Strategic Management Journal***, 20(10): 953–968.

Deeds, D. L., Decarolis, D., & Coombs, J. E. 1997. The impact of firmspecific capabilities on the amount of capital raised in an initial public offering: Evidence from the biotechnology industry. ***Journal of Business Venturing***, 12(1): 31–46.

Delmar, F., & Shane, S. 2006. Does experience matter? The effect of founding team experience on the survival and sales of newly founded ventures. ***Strategic Organization***, 4(3): 215–247.

Dewally, M., & Ederington, L. 2006. Reputation, certification, warranties, and information as remedies for seller-buyer information asymmetries: Lessons from the online comic book market. ***The Journal of Business***, 79(2): 693–729.

Diestre, L., & Rajagopalan, N. 2012. Are all "sharks" dangerous? New biotechnology ventures and partner selection in R&D alliances. ***Strategic Management Journal***, 33(10): 1115–1134.

Dyer, J. H., & Singh, H. 1998. The relational view: Cooperative strategy and sources of interorganizational competitive advantage. ***The Academy of Management Review***, 23(4): 660–679.

Eesley, C. E., & Roberts, E. B. 2012. Are you experienced or are you talented?: When does innate talent versus experience explain entrepreneurial performance? ***Strategic Entrepreneurship Journal***, 6(3): 207–219.

Efron, B. 1977. The efficiency of Cox's likelihood function for censored data. ***Journal of the American Statistical Association***, 72(359): 557–565.

Eisenhardt, K. M. 1989. Agency theory: An assessment and review. ***The Academy of Management Review***, 14(1): 57–74.

Eisenhardt, K. M., & Schoonhoven, C. B. 1990. Organizational growth: Linking founding team, strategy, environment, and growth among U.S. semiconductor ventures, 1978-1988. ***Administrative Science Quarterly***, 35(3): 504–529.

Eisenhardt, K. M., & Schoonhoven, C. B. 1996. Resource-based view of strategic alliance formation: Strategic and social effects in entrepreneurial firms. ***Organization Science***, 7(2): 136–150.

Feeser, H. R., & Willard, G. E. 1990. Founding strategy and performance: A comparison of high and low growth high tech firms. ***Strategic Management Journal***, 11(2): 87–98.

Felin, T., & Hesterly, W. S. 2007. The knowledge-based view, nested heterogeneity, and new value creation: philosophical considerations on the locus of knowledge. ***The Academy of Management Review***, 32(1): 195–218.

FierceBiotech. 2013. ***Industry Voices: Platform technologies--The foundations of Big Pharma or its nemesis?*** (September 6). Accessed December 29, 2013.

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

Frank, M. Z. 1988. An intertemporal model of industrial exit. ***The Quarterly Journal of Economics***, 103(2): 333–344.

Fraser, S., & Greene, F. J. 2006. The effects of experience on entrepreneurial optimism and uncertainty. ***Economica***, 73(290): 169–192.

Freeman, J., Carroll, G. R., & Hannan, M. T. 1983. The liability of newness: Age dependence in organizational death rates. ***American Sociological Review***, 48(5): 692–710.

Fukugawa, N. 2012. Impacts of intangible assets on the initial public offering of biotechnology startups. ***Economics Letters***, 116(1): 83–85.

Fuller, A. W., & Rothaermel, F. T. 2012. When stars shine: The effects of faculty founders on new technology ventures. ***Strategic Entrepreneurship Journal***, 6(3): 220–235.

Gallini, N. T., & Wright, B. D. 1990. Technology transfer under asymmetric information. ***The RAND Journal of Economics***, 21(1): 147–160.

Gans, J. S., & Stern, S. 2003. The product market and the market for “ideas”: commercialization strategies for technology entrepreneurs. ***Research policy***, 32(2): 333–350.

Gans, J. S., & Stern, S. 2010. Is there a market for ideas? ***Industrial and Corporate Change***, 19(3): 805–837.

Gans, J. S., Hsu, D. H., & Stern, S. 2002. When does start-up innovation spur the gale of creative destruction? ***The RAND Journal of Economics***, 33(4): 571–586.

Gans, J. S., Hsu, D. H., & Stern, S. 2008. The impact of uncertain intellectual property rights on the market for ideas: Evidence from patent grant delays. ***Management Science***, 54(5): 982–997.

GenBank. 1990. ***Release 65.0, machine readable database***. IntelliGentics, Inc., Palo Alto, CA.

Gimeno, J., Folta, T. B., Cooper, A. C., & Woo, C. Y. 1997. Survival of the fittest? Entrepreneurial human capital and the persistence of underperforming firms. ***Administrative Science Quarterly***, 42(4): 750–783.

Gittelman, M. 2007. Does Geography matter for science-based firms? Epistemic communities and the geography of research and patenting in biotechnology. ***Organization Science***, 18(4): 724–741.

Gompers, P. 2001. The venture capital revolution. ***Journal of Economic Perspectives***, 15(2): 145–168.

Gompers, P. A. 1995. Optimal investment, monitoring, and the staging of venture capital. ***The Journal of Finance***, 50(5): 1461–1489.

Gompers, P., & Lerner, J. 2001. The venture capital revolution. ***The Journal of Economic Perspectives***, 15(2): 145–168.

Gompers, P., Lerner, J., & Scharfstein, D. 2005. Entrepreneurial spawning: Public corporations and the genesis of new ventures, 1986 to 1999. ***The Journal of Finance***, 60(2): 577–614.

Gompers, P., Kovner, A., Lerner, J., & Scharfstein, D. 2006. Skill vs. luck in entrepreneurship and venture capital: Evidence from serial entrepreneurs. ***National Bureau of Economic Research.***

Gompers, P., Kovner, A., Lerner, J., & Scharfstein, D. 2010. Performance persistence in entrepreneurship. ***Journal of Financial Economics***, 96(1): 18–32.

Gorman, M., & Sahlman, W. A. 1989. What do venture capitalists do? ***Journal of Business Venturing***, 4(4): 231–248.

Graham, S. J. H., & Sichelman, T. 2008. Why do start-ups patent. ***Berkeley Technology Law Journal***, 23: 1063.

Grant, R. M. 1996. Toward a knowledge-based theory of the firm. ***Strategic Management Journal***, 17: 109–122.

Greis, N. P., Dibner, M. D., & Bean, A. S. 1995. External partnering as a response to innovation barriers and global competition in biotechnology. ***Research Policy***, 24(4): 609–630.

Groysberg, B., & Lee, L.-E. 2009. Hiring stars and their colleagues: Exploration and exploitation in professional service firms. ***Organization Science***, 20(4): 740–758.

Gulati, R. 1995. Does familiarity breed trust? The implications of repeated ties for contractual choice in alliances. ***The Academy of Management Journal***, 38(1): 85–112.

Gulati, R., & Singh, H. 1998. The architecture of cooperation: Managing coordination costs and appropriation concerns in strategic alliances. ***Administrative Science Quarterly***, 43(4): 781–814.

Gulati, R. 1999. Network location and learning: The influence of network resources and firm capabilities on alliance formation. ***Strategic Management Journal***, 20(5): 397–420.

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

Hagedoorn, J., & Hesen, G. 2007. Contract law and the governance of inter-firm technology partnerships – An analysis of different modes of partnering and their contractual implications*. ***Journal of Management Studies***, 44(3): 342–366.

Hagedoorn, J., Letterie, W., & Palm, F. 2011. The information value of R&D alliances: The preference for local or distant ties. ***Strategic Organization***, 9(4): 283–309.

Hall, B. H., Jaffe, A., & Trajtenberg, M. 2005. Market value and patent citations. ***The RAND Journal of Economics***, 36(1): 16–38.

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.

Haltiwanger, J., & Waldman, M. 1985. Rational expectations and the limits of rationality: An analysis of heterogeneity. ***The American Economic Review***, 75(3): 326–340.

Häussler, C., Harhoff, D., & Müller, E. 2009. To be financed or not…- The role of patents for venture capital financing. ***SSRN Electronic Journal***.

Hegde, D., & Luo, H. 2013. Imperfect information, patent publication, and the market for ideas. ***Harvard Business School Strategy Unit Working Paper*** , 14-019.

Hellmann, T., & Puri, M. 2000. The interaction between product market and financing strategy: The role of venture capital. ***The Review of Financial Studies***, 13(4): 959–984.

Hellmann, T., & Puri, M. 2002. Venture capital and the professionalization of start-up firms: Empirical evidence. ***The Journal of Finance***, 57(1): 169–197.

Henderson, R. M., & Clark, K. B. 1990. Architectural innovation: The reconfiguration of existing product technologies and the failure of firms. ***Administrative Science Quarterly***, 35(1): 9–30.

Henderson, R., & Cockburn, I. 1994. Measuring competence? Exploring firm effects in pharmaceutical research. ***Strategic Management Journal***, 15(S1): 63–84.

Hertz-Picciotto, I., & Rockhill, B. 1997. Validity and efficiency of approximation methods for tied survival times in Cox regression. ***Biometrics***, 53(3): 1151–1156.

Higgins, M. C. 2005. ***Career imprints: Creating leaders across an industry***. John Wiley & Sons.

Higgins, M. J. 2007. The allocation of control rights in pharmaceutical alliances. ***Journal of Corporate Finance***, 13(1): 58–75.

Higgins, M. J., Stephan, P. E., & Thursby, J. G. 2011. Conveying quality and value in emerging industries: Star scientists and the role of signals in biotechnology. ***Research Policy***, 40(4): 605–617.

Higgins, M. J., Stephan, P. E., & Thursby, J. G. 2011. Conveying quality and value in emerging industries: Star scientists and the role of signals in biotechnology. ***Research Policy***, 40(4): 605–617.

Hippel, E. von. 1994. “Sticky information” and the locus of problem solving: Implications for innovation. ***Management Science***, 40(4): 429–439.

Hippel, V. E., & Tyre, M. J. 1995. How learning by doing is done: problem identification in novel process equipment. ***Research Policy***, 24(1): 1–12.

Hoang, H., & Rothaermel, F. T. 2005. The effect of general and partner-specific alliance experience on joint R&d project performance. ***Academy of Management Journal***, 48(2): 332–345.

Hoetker, G., & Mellewigt, T. 2009. Choice and performance of governance mechanisms: Matching alliance governance to asset type. ***Strategic Management Journal***, 30(10): 1025–1044.

Horstmann, I., MacDonald, G. M., & Slivinski, A. 1985. Patents as information transfer mechanisms: To patent or (maybe) not to patent. ***Journal of Political Economy***, 93(5): 837–858.

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

Hsu, D. H. 2006. Venture capitalists and cooperative start-up commercialization strategy. ***Management Science***, 52(2): 204–219.

Hsu, D. H. 2007. Experienced entrepreneurial founders, organizational capital, and venture capital funding. ***Research Policy***, 36(5): 722–741.

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

Hubbard, R. G. 1998. Capital-market imperfections and investment. ***Journal of Economic Literature***, 36(1): 193–225.

Jaffe, A. B., Trajtenberg, M., & Henderson, R. 1993. Geographic localization of knowledge spillovers as evidenced by patent citations. ***The Quarterly Journal of Economics***, 108(3): 577–598.

Jones, A., & Clifford, L. 2005. Drug discovery alliances. ***Nature Reviews Drug Discovery***, 4(10): 807–808.

Jong, S. 2006. How organizational structures in science shape spin-off firms: The biochemistry departments of Berkeley, Stanford, and UCSF and the birth of the biotech industry. ***Industrial and Corporate Change***, 15(2): 251–283.

Junkunc, M. T., & Eckhardt, J. T. 2009. Technical specialized knowledge and secondary shares in initial public offerings. ***Management Science***, 55(10): 1670–1687.

Kaplan, S. N., & Strömberg, P. 2003. Financial contracting theory meets the real world: An empirical analysis of venture capital contracts. ***The Review of Economic Studies***, 70(2): 281–315.

Katila, R., Rosenberger, J. D., & Eisenhardt, K. M. 2008. Swimming with sharks: Technology ventures, defense mechanisms and corporate relationships. ***Administrative Science Quarterly***, 53(2): 295–332.

Kerr, W. R., Lerner, J., & Schoar, A. 2014. The consequences of entrepreneurial finance: Evidence from angel financings. ***Review of Financial Studies***, 27(1): 20–55.

Kihlstrom, R. E., & Laffont, J. J. 1979. A general equilibrium entrepreneurial theory of firm formation based on risk aversion. ***Journal of Political Economy***, 87(4): 719-748.

Kitch, E. W. 1977. The nature and function of the patent system. ***Journal of Law and Economics***, 20(2): 265–290.

Klepper, S. 2001. Employee startups in high-tech industries. ***Industrial and Corporate Change***, 10(3): 639–674.

Knockaert, M., Ucbasaran, D., Wright, M., & Clarysse, B. 2011. The relationship between knowledge transfer, top management team composition, and performance: The case of science-based entrepreneurial firms. ***Entrepreneurship Theory and Practice***, 35(4): 777–803.

Kogut, B. 1988. Joint ventures: Theoretical and empirical perspectives. ***Strategic Management Journal***, 9(4): 319–332.

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

Kohers, N., & Ang, J. 2000. Earnouts in mergers: Agreeing to disagree and agreeing to stay. ***The Journal of Business***, 73(3): 445–476.

Kor, Y. Y. 2003. Experience-based top management team competence and sustained growth. ***Organization Science***, 14(6): 707–719.

Kroll, M., Walters, B. A., & Le, S. A. 2007. The impact of board composition and top management team ownership structure on post-IPO performance in young entrepreneurial firms. ***The Academy of Management Journal***, 50(5): 1198–1216.

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

Lee, C., Lee, K., & Pennings, J. M. 2001. Internal capabilities, external networks, and performance: a study on technology-based ventures. ***Strategic Management Journal***, 22(6-7): 615–640.

Lee, C. M. . 2001. Market efficiency and accounting research: a discussion of "capital market research in accounting" by S.P. Kothari. ***Journal of Accounting and Economics***, 31(1–3): 233–253.

Leland, H. E., & Pyle, D. H. 1977. Informational asymmetries, financial structure, and financial intermediation. ***The Journal of Finance***, 32(2): 371–387.

Lemley, M. A. 2000. Reconceiving patents in the age of venture capital. ***Journal of Small and Emerging Business Law***, 4: 137.

Lerner, J. 1994. The syndication of venture capital investments. ***Financial Management***, 23(3): 16–27.

Lerner, J. 1994. Venture capitalists and the decision to go public. ***Journal of Financial Economics***, 35(3): 293–316.

Lerner, J. 1995. Venture capitalists and the oversight of private firms. ***The Journal of Finance***, 50(1): 301–318.

Lerner, J., & Merges, R. P. 1998. The control of technology alliances: An empirical analysis of the biotechnology industry. ***Journal of Industrial Economics***, 46(2): 125–156.

Lerner, J., Shane, H., & Tsai, A. 2003. Do equity financing cycles matter? Evidence from biotechnology alliances. ***Journal of Financial Economics***, 67(3): 411–446.

Levin, R. C., Klevorick, A. K., Nelson, R. R., Winter, S. G., Gilbert, R., & Griliches, Z. 1987. Appropriating the returns from industrial research and development. ***Brookings Papers on Economic Activity***, 1987(3): 783–831.

Levitas, E., & McFadyen, M. A. 2009. Managing liquidity in research-intensive firms: Signaling and cash flow effects of patents and alliance activities. ***Strategic Management Journal***, 30(6): 659–678.

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

Li, J. J., Poppo, L., & 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.

Long, C. 2002. Patent signals. ***The University of Chicago Law Review***, 69(2): 625–679.

Luo, X. R., Koput, K. W., & Powell, W. W. 2009. Intellectual capital or signal? The effects of scientists on alliance formation in knowledge-intensive industries. ***Research Policy***, 38(8): 1313–1325.

Luo, Y. 2002. Building trust in cross-cultural collaborations: Toward a contingency perspective. ***Journal of Management***, 28(5): 669–694.

Macher, J. T., & Boerner, C. 2012. Technological development at the boundaries of the firm: a knowledge-based examination in drug development. ***Strategic Management Journal***, 33(9): 1016–1036.

Mann, R. J., & Sager, T. W. 2007. Patents, venture capital, and software start-ups. ***Research Policy***, 36(2): 193–208.

Mason, C. M., & Harrison, R. T. 2002. Barriers to investment in the informal venture capital sector. ***Entrepreneurship & Regional Development***, 14(3): 271–287.

Mazzoleni, R., & Nelson, R. R. 1998. The benefits and costs of strong patent protection: A contribution to the current debate. ***Research Policy***, 27(3): 273–284.

McGee, J. E., Dowling, M. J., & Megginson, W. L. 1995. Cooperative strategy and new venture performance: The role of business strategy and management experience. ***Strategic Management Journal***, 16(7): 565–580.

Megginson, W. L., & Weiss, K. A. 1991. Venture capitalist certification in initial public offerings. ***The Journal of Finance***, 46(3): 879–903.

Merck & Co., Inc. 2013. ***Therapeutic areas and technologies.*** Whitehouse Station. NJ.

Merges, R. P. 1999. As many as six impossible patent before breakfast: Property rights for business concepts and patent system reform. ***Berkeley Technology Law Journal***, 14: 577.

Mesquita, L. F., & Brush, T. H. 2008. Untangling safeguard and production coordination effects in long-term buyer-supplier relationships. ***The Academy of Management Journal***, 51(4): 785–807.

Mincer, J. 1958. Investment in human capital and personal income distribution. ***Journal of Political Economy***, 66(4): 281–302.

Mody, A. 1993. Learning through alliances. ***Journal of Economic Behavior & Organization***, 20(2): 151–170.

Mowery, D. C., Oxley, J. E., & Silverman, B. S. 1996. Strategic alliances and interfirm knowledge transfer. ***Strategic Management Journal***, 17: 77–91.

Murray, F. 2002. Innovation as co-evolution of scientific and technological networks: exploring tissue engineering. ***Research Policy***, 31(8–9): 1389–1403.

Narula, R., & Santangelo, G. D. 2009. Location, collocation and R&D alliances in the European ICT industry. ***Research Policy***, 38(2): 393–403.

Nelson, R. R. 1959. The simple economics of basic scientific research. ***Journal of Political Economy***, 67(3): 297–306.

Nelson, R. R., & Winter, S. G. 1982. ***An Evolutionary Theory of Economic Change***. Harvard University Press.

Nelson, R. R., & Winter, S. G. 2002. Evolutionary theorizing in economics. ***The Journal of Economic Perspectives***, 16(2): 23–46.

Neter, J., Wasserman, W., & Kutner, M. H. 1989. ***Applied linear regression models*** (2 Sub.). Richard D Irwin.

Nicholson, S., Danzon, P. M., & McCullough, J. 2005. Biotech-pharma alliances as a signal of asset and firm quality. ***Journal of Business***, 78(4): 1433–1464.

Ozmel, U., Reuer, J. J., & Gulati, R. 2013. Signals across multiple networks: How venture capital and alliance networks affect interorganizational collaboration. ***Academy of Management Journal***, 56(3): 852–866.

Pakes, A., & Griliches, Z. 1980. Patents and R&D at the firm level: A first report. ***Economics Letters***, 5(4): 377–381.

Penrose, E. 1959. ***The Theory of the Growth of the Firm***. Oxford: Blackwell.

Pisano, G. P. 1989. Using equity participation to support exchange: Evidence from the biotechnology industry. ***Journal of Law, Economics, & Organization***, 5(1): 109–126.

Pisano, G. P. 1990. The R&D boundaries of the firm: An Empirical Analysis. ***Administrative Science Quarterly***, 35(1): 153–176.

Pisano, G. P. 1994. Knowledge, integration, and the locus of learning: An empirical analysis of process development. ***Strategic Management Journal***, 15(S1): 85–100.

Pisano, G. P. 1996. Learning-before-doing in the development of new process technology. ***Research Policy***, 25(7): 1097–1119.

Plant, A. 1934. The economic theory concerning patents for inventions. ***Economica***, 1(1): 30–51.

Polanyi, M. 1966. The logic of tacit inference. ***Philosophy***, 41(155): 1–18.

Popp, D., Juhl, T., & Johnson, D. K. N. 2003. Time in Purgatory: Determinants of the Grant Lag for U.S. Patent Applications. ***National Bureau of Economic Research.***

Powell, W. W., Koput, K. W., & Smith-Doerr, L. 1996. Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. ***Administrative Science Quarterly***, 41(1): 116–145.

Powers, J. B., & McDougall, P. P. 2005. University start-up formation and technology licensing with firms that go public: A resource-based view of academic entrepreneurship. ***Journal of Business Venturing***, 20(3): 291–311.

Ragozzino, R., & Reuer, J. J. 2009. Contingent earnouts in acquisitions of privately held targets. ***Journal of Management***.

Rangan, S. 2000. The problem of search and deliberation in economic action: When social networks really matter. ***The Academy of Management Review***, 25(4): 813–828.

Rao, H. 1994. The social construction of reputation: Certification contests, legitimation, and the survival of organizations in the American automobile industry: 1895–1912. ***Strategic Management Journal***, 15(S1): 29–44.

Riley, J. G. 2001. Silver signals: Twenty-five years of screening and signaling. ***Journal of Economic Literature***, 39(2): 432–478.

Riordan, M. H. 1984. Uncertainty, asymmetric information and bilateral contracts. ***The Review of Economic Studies***, 51(1): 83–93.

Ritter, J. R., & Welch, I. 2002. A review of IPO activity, pricing, and allocations. ***The Journal of Finance***, 57(4): 1795–1828.

Robichek, A. A., & Myers, S. C. 1966. Valuation of the firm: Effects of uncertainty in a market context. ***The Journal of Finance***, 21(2): 215–227.

Robinson, D. T., & Stuart, T. E. 2007. Financial contracting in biotech strategic alliances. ***Journal of Law and Economics***, 50(3): 559–596.

Roijakkers, N., & Hagedoorn, J. 2006. Inter-firm R&D partnering in pharmaceutical biotechnology since 1975: Trends, patterns, and networks. ***Research Policy***, 35(3): 431–446.

Rosen, S. 1972. Learning by Experience as Joint Production. ***The Quarterly Journal of Economics***, 86(3): 366–382.

Rosenkopf, L., & Almeida, P. 2003. Overcoming local search through alliances and mobility. ***Management Science***, 49(6): 751–766.

Rosenkopf, L., Metiu, A., & George, V. P. 2001. From the bottom up? Technical committee activity and alliance formation. ***Administrative Science Quarterly***, 46(4): 748–772.

Roth, A. E., & Vate, J. H. V. 1991. Incentives in two-sided matching with random stable mechanisms. ***Economic Theory***, 1(1): 31–44.

Rothaermel, F. T., & Boeker, W. 2008. Old technology meets new technology: Complementarities, similarities, and alliance formation. ***Strategic Management Journal***, 29(1): 47–77.

Rothaermel, F. T., & Deeds, D. L. 2004. Exploration and exploitation alliances in biotechnology: A system of new product development. ***Strategic Management Journal***, 25(3): 201–221.

Rothaermel, F. T., & Hess, A. M. 2007. Building dynamic capabilities: Innovation driven by individual-, firm-, and network-level effects. ***Organization Science***, 18(6): 898–921.

Ruhnka, J. C., Feldman, H. D., & Dean, T. J. 1992. The “living dead” phenomenon in venture capital investments. ***Journal of Business Venturing***, 7(2): 137–155.

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

Sanders, W. G., & Boivie, S. 2004. Sorting things out: Valuation of new firms in uncertain markets. ***Strategic Management Journal***, 25(2): 167–186.

Santoro, M. D., & McGill, J. P. 2005. The effect of uncertainty and asset co-specialization on governance in biotechnology alliances. ***Strategic Management Journal***, 26(13): 1261–1269.

Schilling, M. A. 2009. Understanding the alliance data. ***Strategic Management Journal***, 30(3): 233–260.

Schmookler, J., & Brownlee, O. 1962. Determinants of inventive activity. ***The American Economic Review***, 52(2): 165–176.

Schoemaker, H. J. P., & Schoemaker, A. F. 1998. The three pillars of bioentrepreneurship. ***Nature Biotechnology***, 16: 13–15.

Schultz, T. W. 1980. Investment in entrepreneurial ability. ***The Scandinavian Journal of Economics***, 82(4): 437–448.

Schumpeter, Joseph A. 1934. ***The Theory of Economic Development***. Cambridge, Massachusetts: Harvard University Press.

Shan, W., Walker, G., & Kogut, B. 1994. Interfirm cooperation and startup innovation in the biotechnology industry. ***Strategic Management Journal***, 15(5): 387–394.

Shane, S. 2001. Technology regimes and new firm formation. ***Management Science***, 47(9): 1173–1190.

Shane, S., & Cable, D. 2002. Network ties, reputation, and the financing of new ventures. ***Management Science***, 48(3): 364–381.

Shane, S., & Khurana, R. 2003. Bringing individuals back in: The effects of career experience on new firm founding. ***Industrial and Corporate Change***, 12(3): 519–543.

Shane, S., & Stuart, T. 2002. Organizational endowments and the performance of university start-ups. ***Management Science***, 48(1): 154–170.

Simon, Herbert A. 1945. ***Administrative Behavior***. New York: Free Press.

Simon, H. A. 1991. Bounded rationality and organizational learning. ***Organization Science***, 2(1): 125–134.

Simon, M., & Houghton, S. M. 2003. The relationship between overconfidence and the introduction of risky products: Evidence from a Field Study. ***The Academy of Management Journal***, 46(2): 139–149.

Somaya, D., Kim, Y., & Vonortas, N. S. 2011. Exclusivity in licensing alliances: Using hostages to support technology commercialization. ***Strategic Management Journal***, 32(2): 159–186.

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

Spence, M. 1973. Job market signaling. ***Quarterly Journal of Economics***, 87(3): 355–374.

Spence, M. 2002. Signaling in retrospect and the informational structure of markets. ***American Economic Review***, 92(3): 434–459.

Stigler, G. J. 1961. The economics of information. ***Journal of Political Economy***, 69(3): 213–225.

Stinchcombe, A. L. 1965. Social structure of organizations. In J.G. March (Ed.), ***Handbook of Organizations***: 142–93. Chicago: Rand McNally.

Stuart, R. W., & Abetti, P. A. 1990. Impact of entrepreneurial and management experience on early performance. ***Journal of Business Venturing***, 5(3): 151–162.

Stuart, T. E. 1998. Network positions and propensities to collaborate: An investigation of strategic alliance formation in a high-technology industry. ***Administrative Science Quarterly***, 43(3): 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., & Hybels, R. C. 1999. Interorganizational endorsements and the performance of entrepreneurial ventures. ***Administrative Science Quarterly***, 44(2): 315–349.

Stuart, T. E., Ozdemir, S. Z., & Ding, W. W. 2007. Vertical alliance networks: The case of university–biotechnology–pharmaceutical alliance chains. ***Research Policy***, 36(4): 477–498.

Subramanian, A. M., Lim, K., & Soh, P.-H. 2013. When birds of a feather don't flock together: Different scientists and the roles they play in biotech R&D alliances. ***Research Policy***, 42(3): 595–612.

Teece, D. J. 1981. The market for know-how and the efficient international transfer of technology. ***Annals of the American Academy of Political and Social Science***, 458: 81–96.

Teece, D. J. 1986. Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. ***Research Policy***, 15(6): 285–305.

Teece, D. J. 1988. Capturing value from technological innovation: Integration, strategic partnering, and licensing decisions. ***Interfaces***, 18(3): 46–61.

Teece, D. J. 2003. Expert talent and the design of (professional services) firms. ***Industrial and Corporate Change***, 12(4): 895–916.

Teece, D. J. 2007. Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. ***Strategic Management Journal***, 28(13): 1319–1350.

Tushman, M. L. 1977. Special boundary roles in the innovation process. ***Administrative Science Quarterly***, 22(4): 587–605.

Tushman, M. L., & Rosenkopf, L. 1992. Organizational determinants of technological change: Toward a sociology of technological evolution. ***Research in Organizational Behavior,*** 14: 311-347.

Venkataraman, S. 1997. The distinctive domain of entrepreneurship research. ***SSRN Electronic Journal***. Rochester, NY: Social Science Research Network.

Von Hippel, E., & Tyre, M. J. 1995. How learning by doing is done: problem identification in novel process equipment. ***Research Policy***, 24(1): 1–12.

Wagner, S., & Cockburn, I. 2010. Patents and the survival of Internet-related IPOs. ***Research Policy***, 39(2): 214–228.

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

Westhead, P., & Wright, M. 1998. Novice, portfolio, and serial founders: are they different? ***Journal of Business Venturing***, 13(3): 173–204.

Williamson, O. E. 1991. Comparative economic organization: The analysis of discrete structural alternatives. ***Administrative Science Quarterly***, 36(2): 269–296.

Zhang, Y., & Wiersema, M. F. 2009. Stock market reaction to CEO certification: The signaling role of CEO background. ***Strategic Management Journal***, 30(7): 693–710.

Zucker, L. G., & Darby, M. R. 1996. Star Scientists and institutional transformation: Patterns of invention and innovation in the formation of the biotechnology industry. ***Proceedings of the National Academy of Sciences of the United States of America***, 93(23): 12709–12716.

Zucker, L. G., Darby, M. R., & Armstrong, J. 1998. Geographically localized knowledge: Spillovers or markets? ***Economic Inquiry***, 36(1): 65–86.

Zucker, L. G., Darby, M. R., & Armstrong, J. S. 2002. Commercializing knowledge: University science, knowledge capture, and firm performance in biotechnology. ***Management Science***, 48(1): 138–153.

VITA

VITA

RAMAKRISHNA DEVARAKONDA

rama@purdue.edu

EDUCATION

2011-2015 Doctor of Philosophy, Management, Purdue University

2008-2010 Master in Public Policy, National University of Singapore

2002-2006 Bachelor of Technology, Indian Institute of Technology Bombay

RESEARCH AND PUBLICATIONS

Publications

- R&D Alliance Formation among VC-Backed Entrepreneurial Firms. Forthcoming in *Frontiers of Entrepreneurship Research BCERC Proceedings* (with Jeffrey Reuer)

Under Review

- Partner Selection in R&D Collaborations: Effects of Affiliations with Venture Capitalists. *Organization Science*, Revise and Resubmit. (with Jeffrey Reuer)
- Payment Structures in High-Tech Partnerships: The Impact of Affiliations with Venture Capitalists. *Strategic Management Journal*, Revise and Resubmit. (with Jeffrey Reuer and Shivaram Devarakonda)

Working Papers

- Founders and Strategic Alliances: Unpacking the Impact of Founders' Credentials on Cooperative Commercialization Agreements of Startups (with Jeffrey Reuer)
- Founders' Credentials and Risk Allocation in Cooperative Commercialization Agreements of Startups. (with Jeffrey Reuer)
- Founders' Credentials and the Initial Public Offerings of Startups. (with Jeffrey Reuer)
- The Effect of Founders' Credentials on the Allocation of Control Rights in Cooperative Commercialization Agreements. (with Jeffrey Reuer, and Harsha Tadikonda)

AWARDS

- The Stevens Institute Wesley J. Howe Award for excellence in corporate entrepreneurship research, 2014 Babson College Entrepreneurship Research Conference.

INVITED PRESENTATIONS AND CONSORTIA

Invited Paper Presentations

- Hong Kong University of Science and Technology, Hong Kong
- City University of Hong Kong, Hong Kong
- The Chinese University of Hong Kong, Hong Kong
- Nanyang Technological University, Singapore

- Singapore Management University, Singapore

Conference Presentations

- X, XI, XII Atlanta Competitive Advantage Conference
- Darden & Cambridge Judge Entrepreneurship and Innovation Research Conference
- XXXIV Babson College Entrepreneurship Research Conference
- LXXIII, LXXV Annual Meeting of the Academy of Management

PROFESSIONAL ACTIVITIES

Reviewing

- *Ad-hoc* Reviewer, Academy of Management Annual Meetings

Affiliations and Memberships

- BPS, TIM, ENT Divisions, Academy of Management
- American Economic Association

WORK EXPERIENCE

- July 2006 – June 2008 Indian School of Business, Hyderabad, India. Researcher.
- July 2010 – June 2011 Institute of Water Policy, NUS, Singapore. Researcher.