Organizational Genealogy: Boundaries and Extensions of the Biological Metaphor

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DEDICATION

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PREFACE

Management scholars have long sought to understand the genesis of core strategies and practices that are selected at the formation of new entrepreneurial ventures. Past work has drawn from the biological sciences, invoking genealogy in an effort to better define the legacy benefits passed from parent firms to their associated progeny, the new ventures formed when employees leave to pursue entrepreneurial opportunities. This dissertation proposes new avenues for understanding the extensions and limitations of the genetic metaphor. Foundations of population ecology are linked to areas such as founding team dynamics and managerial cognition to study the conditions under which the routines and practices, or "genes" of the parent firm will be propagated. A summary of the field of organizational genealogy and two empirical research studies are presented.

CHAPTER 1 - THEORETICAL FOUNDATIONS AND REVIEW OF THE LITERATURE

INTRODUCTION

One of the fundamental questions in organizational research is how do firms identify and select the core strategies and practices that are incorporated at their conception? New venture founders face a challenging environment with imperfect information, unfamiliar roles, and difficult choices that must be made to chart the early direction of the organization. Organizational genealogy focuses on the study of a particular class of new ventures, those formed by teams of founders coming from incumbent firms within the same industry. In contrast to organizations formed by industry outsiders, genealogical ventures carry with them an observable history, roots established by the tenure of their founders at prior organizations. These roots represent a form of path dependency, in which the endowment from the parent organization influences the characteristics and outcomes of the progeny. At the same time, such ventures represent an intriguing variation on the biological metaphor in which the progeny has the power to choose its own genes, to some extent selecting the practices, competences, and values that will be propagated in the next generation of firm. A greater understanding of the content and conditions of transfer from parent firm to progeny firm can provide theoretical insight into the selection of strategies and practices in entrepreneurial ventures, as well as practical guidance for the assembly of founding teams and the choice to fund new ventures.

Foundational theories in management strategy have sought to explain the emergence and survival of different organizational forms by drawing on the natural sciences. Hannan and Freeman (1977, 1984, 1989) apply the framework of population ecology to better understand

the emergence of new organizational forms, how their environment influences them, and whether they survive to propagate within the market ecosystem. The mechanism of survival for new organizational forms is often viewed as analogous with the natural world processes of variation, selection, and retention (Campbell, 1960; Nelson and Winter, 1982; Baum and McKelvey, 1999). Finally, the characteristics and behaviors of firms have been equated to genetic information that is shared across common species of firms (McKelvey, 1982). This notion that organizations can share common genes and, consequently, that this genetic information can be passed from parent to progeny firms has served as the basis for a new area of research, organizational genealogy.

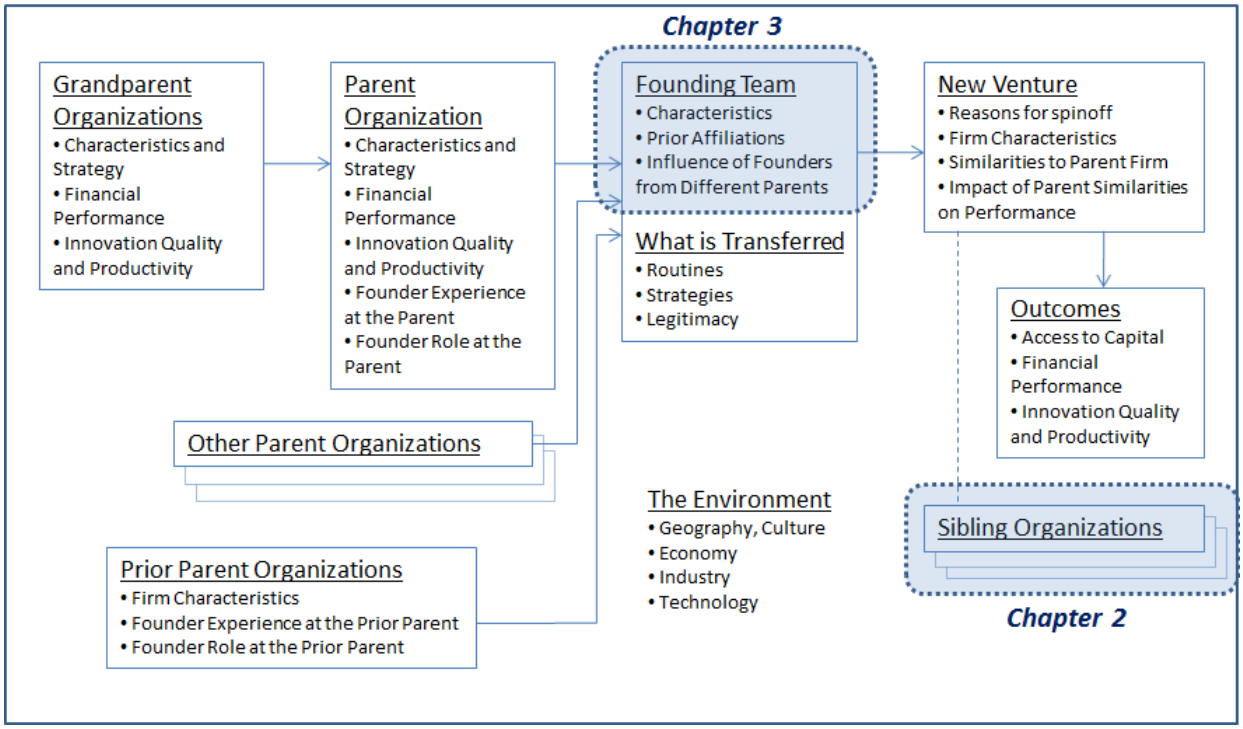
The literature in organizational genealogy has most frequently focused on the formation of progeny ventures (Gompers et al., 2005; Sorenson, 2007; Klepper, 2009) and their relative performance advantages over other market entrants (e.g. Phillips, 2002; Klepper and Sleeper, 2005; Chatterji, 2009). Genealogical new ventures have been shown to play an important role in the development of industries and regional concentrations of talent and resources (Klepper and Thompson, 2006; Klepper, 2007; Buenstorf and Klepper, 2009). At the same time, the developing field of organizational genealogy has yet to fully address the nature of the genetic information that is transferred from parent to progeny, the consequences of conflicting legacies from divergent types of parent organizations, the competitive characteristics of genealogical ventures as a class of organization, and the ultimate extensions and limitations of the genetic metaphor as a framework for understanding the emergence and development of new ventures.

This dissertation addresses the question, what are the boundaries of genealogical theory in describing new venture formation and outcomes? This can be answered through a theory of genetic transfer channeled through both founder agency and institutional forces in determining

which practices, routines and ceremonies are carried forward from the parent organization. Key objectives of the first study of the dissertation are to: 1) Revisit the core organizational theories that draw from the natural sciences to explain new venture founding, 2) Review the literature that has built upon these core theories to advance our understanding of organizational genealogy, and 3) Propose a theoretical model for the categories and conditions through which genes are passed from parent organizations to their progeny. The final two parts of the dissertation present two new empirical studies that attempt to advance the horizons of organizational genealogy research.

Figure 1-1 illustrates a number of potential avenues for future research in organizational genealogy. As shown, the empirical studies included in this dissertation address the areas of organizational siblings and characteristics of the venture's founding team.

Figure 1-1: A Proposed Research Map for Organizational Genealogy



Other promising extensions for the domain of organizational genealogy are also shown. Research into the heritage of grandparent firms, organizations two generations removed from the focal firm, may reveal lasting effects that are passed across multiple generations. Additionally, greater examination of parent firm characteristics and the selection among the influences of multiple parents may prove to be fruitful paths for future research. Overall, the field of organizational genealogy is well positioned to make significant contributions to our understanding of entrepreneurship and management strategy.

THE FOUNDATIONS OF ORGANIZATIONAL GENEALOGY

Past research in the study of organizations has drawn upon the biological sciences through two foundational perspectives: ecology and genealogy. Ecology deals with the interaction among species and the environment. It focuses on phenotype, the observed form of organizations, analogous to observed characteristics of living organisms. In contrast, genealogy deals with the genetic information that is common to a specific organizational form or population or is transferred through hereditary lineage. It focuses on genotype, the knowledge, competences, and routines that are carried forward in new generations of organizations in a process that equates to the transfer of the characteristic genetic code specific to a given biological species.

Population ecology is arguably the most extensive research stream to apply natural science concepts of species and environment to organizational development. Starting with their 1977 work, Hannan and Freeman proposed a theoretical model in which organizational populations are viewed as analogous to biological species. New organizational forms emerge

that either fail or succeed based on the suitability of the new form, the resource munificence of the environment, and the competition among "species." Theirs is a true selection theory, in which classes of firms have limited ability to react to change and are dependent on the suitability of their initial form for survival and prosperity. Concentrating on the species level, population ecology does not carefully address the mechanisms of inheritance that enable the propagation of discrete forms at the organizational (i.e. organism) level, the primary focus of organizational genealogy.

The genealogical perspective has received less attention in the foundations of organizational theory. In his 1982 work on organizational systematics, Bill McKelvey advocates a wide-ranging effort within the field of management strategy to thoroughly classify organizational forms based on their core operational characteristics. The genetic information in the framework proposed by McKelvey takes the form of dominant competences that are learned by individuals or teams within existing organizations and carried forward in new firms. This effort is analogous to the work of biological scientists to classify and associate species of living organisms. McKelvey observes that an extensive classification of organizational forms would improve empirical study by identifying homogeneous samples, reducing the error variance in statistical studies, and allowing more comprehensive replication of the results of functional research into organizations.

To build on the research in organizational genealogy and draw further insights from the biological metaphor, it is necessary to link the theoretical contribution of population ecology with its mechanisms of environmental interaction to the concepts of organizational inheritance. Baum and Singh (1994) provide a meaningful theoretical framework for relating the ecological and genealogical perspectives. They observe that ecological entities such as communities and

populations are the structural and behavioral expressions of genealogical entities such as species or groupings of common organizational form. Ecological entities interact with each other, the environment, and other populations to influence the processes of resource exchange and transformation. An organization in the ecological sense is comprised of interacting constituent workgroups and individuals that implement practices and routines. In contrast, genealogical entities are associated with the process of replication or preservation of organizing information. An organization in the genealogical sense is best described as a repository of knowledge socially embodied in its employees at a given point in time.

Baum and Singh identify the need to further define the processes of genealogical inheritance as one of the key challenges within their framework. This challenge serves as a helpful point of departure for: 1) a comprehensive review of the subsequent body of research that has attempted to add to our understanding of organizational genealogy, and 2) the development of new theory to help explain the dynamics of genealogical inheritance.

REVIEW OF ORGANIZATIONAL GENEALOGY RESEARCH AND ADJACENT FIELDS

For purposes of review, the literature on organizational genealogy and its associated adjacent fields are divided into categories based on their focus. Prior research into the direct phenomenon of genealogy and hereditary transfer can be usefully organized into studies that deal with the genealogical emergence of new ventures and their outcomes in terms of survival and performance. As a helpful tool in understanding hereditary transfer, the literature on routines and executive migration provide insight into the nature of organizational transfer from

parent to progeny. Though not directly focused on genealogy, the literatures on founding team dynamics and founder prior experience help inform the mechanisms through which parent firm characteristics are selected and propagated. Finally, environmental factors such as market structure and industry agglomeration provide insight into the higher order conditions and consequences of genealogical venture formation.

Genealogical Formation of New Ventures

One of the foundational questions in the study of organizational genealogy is why do progeny organizations form? More specifically, what is it that leads individuals from the parent organization to engage in entrepreneurial activity, trading their relatively safe position in an established firm for the risks and rewards of self-employment? Prior research has focused on the opportunities available to the individuals who choose to form spinouts and the characteristics of the parent organizations from which they depart.

Many terms such as "spinouts," "spinoffs," and "progeny ventures" have been used to describe various phenomena associated with employee entrepreneurship. In the context of this dissertation, I focus on a specific model in which individuals choose to leave their employment at incumbent firms in order to launch an entrepreneurial venture within the same industry. On the one hand, the resulting new ventures lack any formal sanction, contractual affiliation or financial support from the parent organization. At the same time, they are distinguished from de novo entrepreneurial ventures in that founding team members bring with them industry knowledge and experience gained from their previous positions within the parent firm. Similarly, they hold an experiential advantage over de alio entrants, existing firms that choose

to diversify into the focal industry by leveraging knowledge and resources obtained from external markets.

Research into entrepreneurship and genealogical new venture formation suggests that the experiences and prospects of individuals at parent firms set the stage for the decision to form new organizations. Drawing from the entrepreneurship literature, opportunity recognition represents a plausible triggering mechanism that leads employees of parent firms to start new ventures. In Schumpeter's classic framework (1934), entrepreneurs recognize and pursue new combinations of the means of production, fueling a "creative destruction" that undermines the prior market equilibrium and sets the stage for new innovations. Individuals will vary in terms of their ability to recognize these new opportunities based on their prior experience and access to information (Shane, 2000). Research into the formation of progeny firms has incorporated these concepts, examining how an individual's career prospects and access to information shape the decision to form a new venture.

Founder Opportunities

Amit, Muller, and Cockburn (1994) study the propensity of employees at incumbent firms to leave their position and engage in self-employment. Using a broad data set from Canadian labor market statistics, they find that these new entrepreneurs face a lower opportunity cost in terms of foregone wages at the incumbent firm relative to those who choose to remain in their current position. While their study fails to distinguish those entrepreneurs who form true spinouts (firms in the same industry as the parent), it does suggest that the prospects of individuals for realizing their goals within an incumbent firm vs. those of self-employment directly influence the choice to launch new ventures.

Klepper (2001) evaluates several competing theories for their ability to explain the choice of individuals to found spinout organizations. Studying the high tech industries of semiconductors, disk drives, and industrial lasers, he finds the strongest support for a model of employee learning, in which individuals are exposed to crucial technologies and strategies. This knowledge allows them to recognize new market opportunities outside the parent firm, influencing their decision to form a spinout.

Gompers, Lerner, and Scharfstein (2005) test competing explanations for spinout formation. On the one hand, the failure of parent firms to fully exploit market or technology opportunities becomes a source of frustration for skilled employees, leading them to pursue their own entrepreneurial ventures. On the other hand, the success of the parent firm provides individuals with entrepreneurial knowledge and resources that leads them to recognize and pursue external opportunities. They find support for the latter model, exemplified in the history of Fairchild, an early firm in the semiconductor industry that spawned a number of successful spinout organizations.

Collectively, these studies suggest that experiences at a parent firm allow spinout founders to learn the ropes, recognizing potential entrepreneurial opportunities, and evaluating their personal goals and outcomes in the decision to leave.

Parent Firm Characteristics

Given the importance of the parent firm as an incubator for entrepreneurial opportunities, the next logical pursuit is to examine how the characteristics of parent firms influence genealogical new venture creation. One study that bridges the ideas of parent firm characteristics and entrepreneurial opportunity is Agarwal et al. (2004). In their examination of

the disk drive industry, they find that greater parent capabilities in either technology development or market development lead to greater likelihood that individuals in the parent firm will leave to form spinouts. Interestingly, this effect is reduced when the parent has strong capabilities in both technology and market development. This suggests that the decision of individuals to form spinouts is strongly linked to the presence of entrepreneurial opportunities expressed as gaps in the strategy and market coverage of the parent firm.

Klepper and Sleeper (2005) develop a theoretical framework to account for spinout formation in the context of the opportunities that are created in the wake of parent organization activities. Spinout founders obtain unique information on technologies and markets through their tenure at the parent firm. This information reveals niche market opportunities that are adjacent to the parent's area of focus but are too small or incongruent for the parent firm itself to pursue them. As a result, these founders gain a unique opportunity that is not available to de novo entrants. Furthermore, the formation of these niche opportunities grows as the parent firm matures, engages in more intensive technology development, or experiences instability due to acquisition or top management transitions.

Other studies have extended the link between parent characteristics and spinout formation. Sorenson (2007) observes that larger and older firms associated with higher levels of bureaucracy tend to stifle spinout activity. This possibly stems from a reduced orientation of their employees toward entrepreneurial opportunities, limited environmental exposure, and perhaps an increase in opportunity costs associated with the decision to leave. Klepper (2009) discusses a more nuanced relationship between parent age and spinout formation, finding that spinout formation activity from a given parent increases over time, peaks at around 15 years for technology firms and then begins to decline. Better performing and smaller parent firms tend to

have higher spinout rates. Finally, he demonstrates that parent firms located in geographic clusters associated with their markets or technologies tend to have greater spinout activity, an observation that will be examined further in the discussion of environmental influences on spinouts. Figure 1-2 provides a summary of prior research into spinout formation.

Figure 1-2: Prior Research on Spinout Formation

Study	Research Question(s)	Data	Dependent Variable	Key Findings
Amit, Muller, and Cockburn - 1994, Journal of Business Venturing	Do low opportunity costs correlate with the likelihood of deciding to become an entrepreneur?	Canadian labor market statistics on those who moved from paid to self employment	Decision to engage in self employment	Wages of self-employed individuals prior to switching into self-employment were, on average, 10.5% lower than those of paid workers who did not make the switch.
Klepper - 2001, Industrial and Corporate Change	Why do employees leave incumbent firms to start their own firms in the same industry?	Spinouts in the semiconductor, disk drive, and industrial laser industries	Choice to form spin-out, survival, performance	Evaluates a number of theories that could explain the phenomenon of spinouts, finds support for the process of employee learning
Gompers, Lerner, and Scharfstein - 2005, The Journal of Finance	What are the determinants of entrepreneurial spawning from publicly traded corporations?	15,297 founders from 5,112 U.S. entrepreneurial ventures between 1986 and 1999 in the Venture One database	Entrepreneurs spawned	Presents contrasting models to explain the choice of employees at incumbent firms to leave and start new ventures: 1) employee dissatisfaction with the management of the parent firm, 2) employee opportunities to learn the methods and practices associated with new market entry; findings support the learning model
Agarwal, Echambadi, Franco, and Sarkar - 2004, Academy of Management Journal	What types of firms are most likely to generate spin-outs? Is there a knowledge legacy that links incumbent parents to spin-outs? What are the implications of such heritage?	Spinouts in the disk drive industry from 1977-1997.	Spinout generation, technological know-how, market pioneering know-how, survival	Integrated ideas on knowledge inheritance and employee entrepreneurship to construct theory on spin-out formation and development; provided evidence that genealogical links exist between parent and progeny organizations
Klepper and Sleeper - 2005, Management Science	How do industry factors, market conditions, and parent firm characteristics influence market entry by spinoffs?	Spinoffs in the laser industry from 1961 to 1994, a total of 79 firms	Spinoff formation	Spinoff rates increase with age, peaking in the middle age cycle of the parent firm; spinoff rates are not as responsive to market effects as the rates of de novo entrants
Sorenson - 2007, Administrative Science Quarterly	Does the social context of the parent firm with respect bureaucracy impact the choice of individuals to engage in entrepreneurship?	Danish labor market data on 282,911 individuals tracked from 1980 to 1997	Decision to engage in self employment	Larger and older firms, hence more bureaucratic, are less likely to spawn entrepreneurs
Klepper - 2009, European Management Review	How well do proposed theories of spinoffs explain the empirical observations? What are the research opportunities in this field?	Summarizes work in a number of industries: automobiles, tires, semiconductors, lasers, law firms, biotech, disk drives, medical devices, wine, IT, fashion design	Spinout formation, performance, success	Higher spinout rates are linked to parent firm success, age, and acquisition or CEO transition; spinouts have an advantage relative to de novo entrants that increases with parent firm success; spinouts tend to follow in parent technology areas; spinouts tend to form in locations of industry concentration

Organizational Transfer

If the genealogical concept of the organization hinges on the hereditary information from parent organizations passed through the prior experience of individuals into the new venture, then the nature of this information transfer is of fundamental importance to a theory of organizational genealogy. McKelvey (1982) recognized this central role of genetic information. He based his system of organizational classification on the concept of *dominant competence*, a core set of activities that is fundamental to the operation and survival of the firm. He defines the knowledge associated with the dominant competence as the *compool*. This is the retained information that is critical to the execution and perpetuation of activities that support the dominant competence and is often distributed across the members of an organization; due to its complexity and extent, no single individual would be able to retain the entire set of information. This concept is broadly consistent with the notion of *routines* as organizational memory and the repository of organizational characteristics discussed by Nelson and Winter (1982). Given the limits of human cognition and bounded rational behavior, they observe that prior organizational patterns form a baseline for future action and the resolution of conflict within the organization. Hereditary transfer has also been viewed in a cultural context: Weeks and Galunic (2003) examine how memes or cultural modes of thought influence the evolution of organizations. They suggest that firms are connected by "family resemblance" – shared beliefs, values, meanings and language. Organizational genealogy theory relies heavily on the concepts of transferred genetic information and is informed by adjacent studies in the diffusion of practices and migration of employees within an industry.

Diffusion of Strategy and Technology

Prior research in organizational genealogy and adjacent fields has investigated how routines, characteristics, and strategies are carried across organizational boundaries. Boeker (1997) describes how the movement of executives can impact the strategic direction of the recipient firm, contingent on the tenure and functional role of the individual. Sorenson (1999) shows that through executive migration, firms gain flexibility and competitive advantage related to the experience and career history of the individuals who join them.

Simons and Roberts (2008) show that novel organizational forms can emerge from founders with greater non-local experience. At the same time, parent firms may resist the transfer of knowledge and experience. In the semiconductor industry, Agarwal, Ganco, and Ziedonis (2009) link higher litigiousness of a parent or source firm to a reduction in the use of their innovations in subsequent technologies developed by recipient firms. In summary, the movement of individuals to other existing firms or as founders of new organizations involves a transfer of information and practices that are shaped by their prior experiences, including their role and exposure to practices at firms in earlier stages of their careers.

The Role of Routines

Organizational routines represent one mechanism that may explain the nature of genealogical transfer. Routines imply knowledge coupled with action or patterns of practice that are developed over time. Edmondson, Bohmer, and Pisano (2001) study the adoption by hospitals of new technologies in cardiac surgery, finding that the combination of technology and organizational context are critical in implementing new innovations. Consequently, routines may be viewed as a critical type of knowledge that allows information to be transferred in a useable form across organizations. Feldman and Pentland (2003) develop a theoretical

framework to explain how routines provide both organizational stability and flexibility. They focus on the role of human agency in varying, selecting, and retaining new organizational practices to suit emerging needs. This concept is consistent and fully compatible with the metaphor of genetic transfer, in which useful information from prior generations is preferentially propagated in new organizations.

In the domain of spinouts, researchers have drawn directly on the concept of routines as a source of founder information. Phillips (2002) uses the setting of Silicon Valley law firms to demonstrate how spinouts draw on the resources and routines of parent organizations. Guided by their previous experiences, founders replicate and adapt routines and practices from the prior generation. Chatterji (2009) demonstrates that information related to technology is not the only source of value passed to the spinout. Routines associated with navigating regulatory requirements and exploiting market opportunities provide advantage to spinouts in the medical devices industry.

Figure 1-3 provides a summary of prior research into organizational transfer.

Figure 1-3: Prior Research on Organizational Transfer

Study	Research Question(s)	Data	Dependent Variable	Key Findings
Edmondson, Bohmer, and Pisano - 2001, Administrative Science Quarterly	How does the development of organizational routines support the adoption of new technology?	Qualitative study of 16 hospitals that chose to adopt an innovative technology for cardiac surgery	Successful adoption of new technology	A process model for successful adoption of new technologies involves the organizational steps of enrollment, preparation, trials, and reflection; both leaders and team members playing a vital role in building the necessary organizational routines
Feldman and Pentland - 2003, Administrative Science Quarterly	How do organizational routines contribute to both stability and flexibility?	Theoretical framework based on the metaphor of academic hiring	N/A	Beyond the traditional conception of routines as a source of stability, the authors argue for routines as a basis for organizational flexibility through the mechanism of human agency - self-monitoring and interdependent action among individuals
Phillips - 2002, Administrative Science Quarterly	How do the characteristics of resources and routines from the parent to the progeny impact the survival likelihood of both?	513 law partnerships founded from 1945 to 1996, including 137 spinouts from other firms	Law firm failure	Demonstrates that progeny firms receive routines and resources from their parents
Chatterji - 2009, Strategic Management Journal	How does prior employment impact the entrepreneurial process? How does knowledge gained at the parent firm impact the performance and innovative activities of the spawned venture?	Spinouts in the medical devices industry, sample of 650 founders in 191 firms	Time to funding, performance (rounds of VC funds, product commercialization)	Shows the importance of non-technical knowledge transfer from parent to spawn
Boeker - 1997, Administrative Science Quarterly	How does the migration of executives impact firm strategy?	67 silicon valley semiconductor firms from 1976 to 1993.	Strategic change - dichotomous variable capturing the entry of a firm into new product markets	Market entry decisions are shaped by the prior experiences of executives, enhanced through functional experience, tenure, and prior CEO role
Sorenson - 1999, Social Science Research	How does executive migration impact competition within an industry?	Stations in the 15 largest U.S. television markets from 1961 to 1988	Growth rate of television stations	Executive migration serves as a basis for competitive advantage within an industry; Individual careers act as a source of change in an organizational population
Klepper and Sleeper - 2005, Management Science	How do industry factors, market conditions, and parent firm characteristics influence market entry by spinoffs?	Spinoffs in the laser industry from 1961 to 1994, a total of 79 firms	Spinoff formation	The probability of spinoff is related to specific technical knowledge, rather than general experience
Simons and Roberts - 2008, Administrative Science Quarterly	How does non-local pre-founding experience enable changes in local organizational form?	138 Israeli wineries from 1983 to 2004, the period of emergence of the novel form of non-kosher organizations	Choice to found a new venture of a novel organizational type; venture performance	Non-local experience promotes the choice of a novel organizational form; pre-founding experience of all types improves the performance of firms that choose a novel form, improving the impact and longevity of these organizations
Agarwal, Ganco and Ziedonis - 2009, Strategic Management Journal	How do IP protection actions of parent firms impact the flow of information and knowledge spillovers through departing employees?	Patent and litigation activity of 447 firms in the semiconductor industry from 1973 to 2003.	Patent citations of parent firm knowledge made by recipient firm	Higher litigiousness of a parent or "source" firm reduces the knowledge spillovers from the departure of employee inventors

Parent Firm Experience

The idea that parent firm knowledge and routines are carried forward in a spinout organization suggests that prior career history is critical to this process. How do the experiences of the founders during their prior tenure at the parent firm shape strategies and outcomes for the spinout? This question must be addressed at both the individual founder level and at the team level, where individual experiences combine to influence the direction of the new venture.

Technical and Industry Experience

Research focused on entrepreneurial ventures, though not specifically spinouts, has examined the impact of the prior experience of founders in areas such as growth, financial performance, and technology strategy. In technology spinouts, one of the most beneficial sources of transferred information is the technical knowledge obtained during the founders' tenure at the parent firm. Complex technical knowledge is often tacit in nature, requiring an individual to obtain it through hands-on experience. Additionally, the structure and nature of the knowledge possessed by parent firms has been shown to influence the knowledge quality that is subsequently produced by the spinout (Boeker et al., 2010). Understanding the findings of the broader entrepreneurship literature can help reveal the role that founder experience plays in genealogical transfer.

Kimberly and Bouchikhi (1995) examine the concept of organizational biography, how prior events play a role in shaping the developmental trajectories of organizations. They provide an in-depth study of a French firm in the computer industry to understand how the biographical history of founders shapes the development and success of a new venture. Their results link the prior experiences of the founder to the subsequent development of culture,

management of external pressures, and strategies toward expansion. The link between founder industry experience and successful management of growth is investigated by Kor (2003). This study shows that higher rates of growth for companies in the medical instruments industry are associated with greater industry experience of the top management team. However, this effect is weaker in cases where the top management team has greater shared experience, a theme that is elaborated in other studies showing that diversity of background is also critical in founding team experience.

If prior experience matters, it is necessary to understand the scope of its impact – i.e., to what extent can differences in the experiences of individuals swing the fortunes of entire organizations? Rothaermel and Hess (2007) study the relationship between antecedents to innovation at different levels of analysis. Through their data on the biotech industry, they find that intellectual human capital at the individual level can act as a substitute for firm-level antecedents to innovation. In particular, the presence of star scientists (those with productivity and influence at an order of magnitude greater than their contemporaries) drives organizational innovative output and can substitute for firm-level investment and capabilities. Tzabbar (2009) also studies U.S. biotechnology firms and shows that the recruitment of key scientists with experience in more distant technological areas can shift the technological focus of the firm. Also drawing on the concept of star scientists, he shows that to the extent that a firm's innovation rests in the hands of a small team of such scientists, technological direction of the venture is less likely to shift as a result of recruitment. This research highlights the significance of the technical experience of individual employees. In the context of spinouts, it lends support to the notion that genealogical transfer of technical knowledge through a small team of founders can have a broad impact on the new venture.

Founding Team Affiliations

The individual experiences of founders are combined in the mixing bowl of the spinout venture. One can imagine that prior associations among founders can affect the choices ratified by the team as the routines and practices of different parent firms are weighed for their benefit and relevance to the new firm. Prior research suggests that affiliations matter in terms of who is involved in decision-making, how technology development is pursued, how external stakeholders view the firm, and its prospects for performance.

At a broad level, team members may be affiliated through common functional backgrounds or shared work experience. Bunderson (2003) studies data from business unit management teams in Fortune 100 consumer products companies. He shows support for the hypotheses that the functional background of founders in areas valued in the firm or in areas that are shared with other team members leads to their involvement in important decisions. Taylor and Greve (2006) study the creative teams that produce comic books. In evaluating the effects of prior experience on the value of the finished product in the market, they find that teams with prior experience working together have a greater variance in outcome. Their prior affiliations improve their familiarity in working together, streamlining the process of communicating and allowing the team to draw more efficiently on the greater breadth of ideas available to teams relative to that of individuals.

In the context of founding teams, affiliations are shown to play a role in the approach and outcome for new ventures. Beckman (2006) demonstrates that greater common affiliations among founding team members lead to greater technology exploitation, while lower affiliation favors an exploration strategy in new ventures. Founding teams with greater prior affiliations

tend to focus on shared firm-specific knowledge learned during their tenure at the parent firm. They lack the diverse contacts and experiences that would lead founders without shared affiliations to engage more in exploration behaviors. Greater affiliation among founders is also shown to influence the direct use of parent technologies. Boeker et al. (2009) demonstrate that founders with common parent organizations are more likely to cite the patents of the parent firms, leveraging this knowledge in the development of their own innovations.

Founding team affiliations also impact external outcomes. In their study of Silicon Valley start-ups, Beckman, Burton, and O'Reilly (2007) show that greater diversity in prior parent firms is associated with a greater likelihood of venture capital financing and IPO. Higgins and Gulati (2006) look at ventures in the biotech industry, examining the affiliations of founding team members with respect to the vertical structure of the industry. Those firms with greater TMT diversity of links with upstream, horizontal, and downstream companies in biotech and pharmaceuticals tend to have legitimacy and levels of investment.

Figure 1-4 provides a summary of prior research into parent firm experience.

Figure 1-4: Prior Research on Parent Firm Experience

Study	Research Question(s)	Data	Dependent	Key Findings
Bunderson - 2003, Academy of Management Journal	How does functional background influence the involvement of team members in decision making?	Survey research of management teams in a Fortune 100 consumer products company	Involvement in making important decisions	Functional experience in valued areas or similar to the functional experience of other team members leads to inclusion in decision making; this relationship is moderated by the power centrality in the team
Beckman - 2006, Academy of Management Journal	How do common prior affiliations among founders influence the choice to pursue exploration vs. exploitation innovation strategies?	Survey and archival data on 141 spinout technology firms in silicon valley	Exploration vs. exploitation; firm performance	Greater prior affiliation among founding team members leads to a greater use of an exploitative innovation strategy, while lower prior affiliation leads to greater exploration; firms with both common and diverse affiliation have performance advantages
Higgins and Gulati - 2006, Strategic Management Journal	How does the composition of the TMT impact organizational legitimacy and influence investment?	858 firms in the U.S. biotech industry founded between 1961 and 1994	Number and quality of investors who choose to invest in the venture IPO	Investor decisions with respect to new ventures are influenced by TMT affiliations with prominent downstream organizations, diversity of their affiliations, and the experience of the chief science officer
Taylor and Greve - 2006, Academy of Management Journal	How should teams be composed in terms of knowledge and experience in order to promote innovation?	4485 comic books published from 1972 to 1996	Collector market value of a comic	Variance in performance is greater for teams with multiple members, diverse experience, and experience working together; individuals are capable of more creative integration of diverse experiences
Beckman, Burton, and O'Reilly - 2007, Journal of Business Venturing	How do TMT prior affiliations and experiences impact outcomes for new ventures?	Top management team characteristics at 161 Silicon Valley firms at risk of IPO in 1994-95	Venture capital funding and IPO	Greater diversity in number of prior employers and greater diversity in prior functional experience of the top management team lead to greater likelihood of IPO for the new venture
Kimberly and Bouchikhi - 1995, Organization Science	How can the study of organizational biography contribute to the understanding of firm growth and performance?	Qualitative study of the biographical experiences of the founder of a French firm in the computer industry	Growth and performance of the new venture	The developmental trajectory of an entrepreneurial venture is fundamentally shaped by the prior experiences of founders
Kor - 2003, Organization Science	How do top management team experience and competence across multiple levels affect organizational outcomes?	73 U.S. firms in the medical, surgical, and dental instruments industry that went public between 1990 and 1995	Annual rate of sales growth	Top management team experience and prior industry experience have a positive effect on growth; this effect weakens with greater shared team experience or industry experience among top managers
Rothaermel and Hess - 2007, Organization Science	Are firm dynamic capabilities associated with innovation driven by individual, firm, or network effects?	81 firms in the pharmaceutical industry from 1980 to 2001	Innovative output measured through granted patents	Firm-level and collective-level antecedents to innovation act as complements; intellectual human capital acts as a substitute to these factors
Tzabbar - 2009, Academy of Management Journal	How can recruitment of external scientists transform the technological direction of an organization?	456 U.S. biotech firms studied between 1973 and 1999	Technological repositioning based on vector measures of patent technology area	Recruiting technologically distant scientists can reposition an organization's technological focus; this effect is diminished when the organization depends on a few "star" scientists

Founding Team Dynamics

Two concepts from the foundational theories of ecology and genealogy support the proposition that founding team dynamics plays a prominent role in the transmission of parent firm behaviors and characteristics to progeny ventures. From organizational ecology, we observe that their environment shapes organizations. In the classic formulation of ecological theory, firms have little flexibility or recourse to adapt in the face of environmental forces. Other extensions of the theory accept the role of managerial agency in which decision-makers within a firm evaluate the implications of the environmental stimulus and determine the nature of the associated response (analogous to the distinction between Mendelian and Lamarckian genetics in the biological domain, a topic that I will describe in greater detail in subsequent sections). From genealogy, we learn that genetic information is socially constructed and retained, requiring the coordinated action of a group within the new venture. In both cases, the founding team of the progeny venture fills these important roles. Consequently, the nature of the interactions among founding team members is an important element in understanding genealogical transfer.

When experiences and routines from multiple parents are merged in the formation of the spinout, what determines the dominant practices that will be adopted?

Characteristics

The characteristics of the top management team influence strategy and outcome for new ventures. Given that founding team members are the conduits for hereditary transfer of practices and information from parent firms, the collective characteristics of the founding team in a spinout shape the way in which transfer occurs. Carpenter and Fredrickson (2001)

demonstrate that the global strategy of a firm is impacted by top management team characteristics. They observe the decisions of firms in the S&P industrial index to pursue global strategies, finding that educational and tenure heterogeneity increase the likelihood of international strategic moves, while functional heterogeneity works in the opposite direction. Carpenter (2002) builds on the study of TMT heterogeneity, finding that differences in education, functional background, and tenure are positively linked with firm performance. Cohen and Dean (2005) study the external perceptions of top management teams, showing that greater legitimacy is associated with reductions in undervaluation for firms going through the IPO process.

Imprinting

Research on organizational imprinting has revealed that the starting conditions of new ventures have a persistent effect in terms of strategy, flexibility, and other characteristics (Boeker, 1989). Because founders of spinouts draw on experiences from their tenure at parent firms, hereditary transfer is likely to play a prominent role in the starting conditions of the venture that are imprinted into its structure and practices. As a result, beyond the short term influence on performance and access to resources that has been most often studied in the field of organizational genealogy, hereditary transfer should also have long term consequences consistent with those observed in the literature on imprinting.

Imprinting is manifested in long term effects on strategy and culture. Holbrook et al. (2000) develop a case study of four early entrants in the U.S. semiconductor industry. They find that the nature and timing of entry, along with entry conditions have a lasting effect that shapes the approach of the firm toward technology development and long term performance.

Boeker (1989) demonstrates that founding conditions create inertia, leading to long-range implications for strategy and influence within the management team. Ogbonna and Harris (2001) examine imprinting in terms of the organizational culture that is established at founding. Whether culture is initially implemented in a constraining or flexible fashion determines the nature of its effects; it acts as either a legacy that constrains future action or as a heritage that provides beneficial direction for the future development of the organization. Johnson (2007) defines two stages of imprinting. In the initial establishment of the organization, cultural and entrepreneurial influences are fixed. In subsequent periods, organizational characteristics are reproduced, with the process shaped through environmental forces. To the extent that parent firm hereditary transfer influences entry conditions, the effects of imprinting are likely to manifest in spinout organizations.

Figure 1-5 provides a summary of prior research into founding team dynamics.

Figure 1-5: Prior Research on Founding Team Dynamics

Study	Research Question(s)	Data	Dependent Variable	Key Findings
Boeker - 1989, Administrative Science Quarterly	How is organizational power structure established and sustained over time?	53 Silicon Valley Semiconductor Firms	Importance of functional areas within the firm	Organizational power is defined by both current conditions and the effects of imprinting at founding
Carpenter and Fredrickson - 2001, Academy of Management Journal	How do TMT demographics impact global strategy? How does uncertainty influence this relationship?	300 companies from the S&P industrial index and midcap index observed from 1984 to 1996	Global strategic posture: composite measure of foreign sales, foreign production, and geographic diversity	Firms are more likely to pursue a global strategic posture when the top management team has greater international experience and educational and tenure heterogeneity; less likely when the team has functional heterogeneity
Carpenter - 2002, Strategic Management Journal	How does heterogeneity in the top management team impact performance?	247 companies from the S&P industrial index observed from 1990 to 1997	Return on assets	In a complex strategic context, TMT heterogeneity in education, functional background, and tenure have a positive relationship with firm performance; this relationship is stronger in teams of short tenure
Cohen and Dean - 2005, Strategic Management Journal	How does TMT legitimacy impact the financial results of ventures undergoing IPO?	221 U.S. firms randomly selected from all IPO's in 1998 and 1999	Stock price run-up after IPO	Higher TMT legitimacy reduces the undervaluation of firms in the IPO process
Holbrook, Cohen, Hounshell, and Klepper - 2000, Strategic Management Journal	What are the sources and effects of differences between firms in an industry?	Case study of four early entrants in the U.S. semiconductor industry	Technological and financial performance	Organizational origins and entry conditions create constraints that influence technology goals and performance
Ogbonna and Harris - 2001, British Journal of Management	How do organizational founding vision, objectives, and decisions influence subsequent choices?	Case study analysis of two retail store firms	Flexibility or constraint in current period strategic decisions	Strong organizational culture established at founding create an adherence to founding strategy and objectives; the flexibility of the initial strategy determines whether it provides a beneficial heritage or constraining legacy
Weeks and Galunic - 2003, Organization Studies	How do memes, or cultural modes of thought influence the definition and evolution of organizations?	N/A	N/A	Development of a cultural evolutionary theory of the firm, socially defined through collectively held ideas and beliefs
Johnson - 2007, American Journal of Sociology	How do cultural context and entrepreneurial action shape the organizational imprinting process for new ventures?	The 17th century founding of the Paris Opera	Perpetuation of organizational characteristics established at founding	Imprinting involves two stages, cultural and entrepreneurial influences fixed at creation and the reproduction of organizational characteristics in subsequent periods; both entrepreneurial action and environmental forces shape this process

Venture Outcomes

The core theories that have examined organizations through the biological metaphor can offer insight into the determinants of progeny firm performance and survival. The ecological perspective recognizes the role of variation in organizational form as a driver of change and determinant of organizational success or failure. Campbell (1960) argues that the process of blind variation, selection, and retention (BVSR) is a fundamental requirement for the advancement of knowledge and improvement in the fit of a system to its environment. Much of the theory developed around the BVSR process is centered at a population level (Hannan and Freeman, 1977), examining how environmental conditions lead a particular organizational species to either prosper or falter. Elements of this framework may also be applied at the organizational level to understand how genealogical inheritance influences the survival and outcome of progeny firms. McKelvey (1982) ventured down this path in his discussion of compools as a mechanism for beneficial change, though adding the agency role of management in selecting and adapting beneficial knowledge in subsequent organizational generations. While the knowledge and routines contained within the compools of an industry become stable and homogenized over time through employee migration and the identification of superior practices, disruptive technologies may reveal superior mutations that are adopted in the dominant competences of the industry. This has two implications for the theory of organizational genealogy: 1) progeny firm founders who have access to the dominant competences of the industry obtain an advantage over new ventures that lack this resource, and 2) progeny firm founding teams within an industry may represent an important organizational-level mechanism that enables the creation of new, more favorable variations that are observed at the population

level. Whether explicitly or implicitly, research in organizational genealogy has built on these ideas in addressing whether hereditary new ventures survive and succeed.

Performance and Access to Resources

Entrepreneurial ventures represent early stage organizations that do not have the track record of performance and market expansion that can be studied for older firms. As a result, research often addresses the access of new firms to resources and, in the case of technology firms, their ability to successfully attain IPO status. Genealogical firms are no exception to this trend.

Beckman and Burton (2008) study Silicon Valley firms, finding that the legacy of experience and initial conditions of functional structure impact access to venture capital funding and the ability to successfully complete the IPO process. Chatterji (2009) shows that the acquisition of capital by spinout firms is linked to their legitimacy, which in large measure depends on the reputation developed through tenure at the parent firm. Roberts, Klepper, and Hayward (2009) examine the Australian and New Zealand wine industries, finding that pre-founding experience in the same industry has a positive effect on size and scope of the firm.

Survival of Spinouts

At a more basic level, new venture outcomes can be evaluated through the simple observation of their survival or failure. Either as spinouts or de novo entrants, new organizations represent attempts to establish a new technology, exploit a niche market, or achieve some other risky goal with an uncertain outcome. Organizational genealogy researchers have used the observation of survival to attempt to identify whether spinouts have some incremental advantage over other market entrants.

The work of Phillips (2002) demonstrates that spinouts are more likely to survive than their de novo entrant counterparts. At the same time, the extraction of critical human resources and legitimacy can actually threaten the survival of the associated parent organization. Dahl and Reichstein (2007) use Danish labor market data to capture the results of a wide sample of new ventures in manufacturing industries. They find that spinouts from surviving parents and firms with prior industry experience are more likely to survive. Lange, Boivie, and Henderson (2009) study survival of spinouts at a broader level. In their study of the PC industry, they find that corporate parents lend legitimacy to a new industry but give birth to organizational children that have lower probabilities of survival.

Figure 1-6 provides a summary of prior research into spinout venture outcomes.

Figure 1-6: Prior Research on Venture Outcomes

Study	Research Question(s)	Data	Dependent Variable	Key Findings
Beckman and Burton - 2008, Organization Science	How do the experience and structure of a new venture TMT influence subsequent management teams and the structure of the organization?	167 high tech firms in Silicon Valley studied through archival means and interviews from 1994 to 1997	Organizational functional structure, team member functional experience, and firm performance outcomes	Management teams are constrained by the initial conditions of their functional structure; more complete functional structure and broader management team experience have a positive impact on funding and IPO
Chatterji - 2009, Strategic Management Journal	How does prior employment impact the entrepreneurial process? How does knowledge gained at the parent firm impact the performance and innovative activities	Spinouts in the medical devices industry, sample of 650 founders in 191 firms	Time to funding, performance (rounds of VC funds, product commercialization)	Demonstrates the role of legitimacy and status in spinout acquisition of capital
Roberts, Klepper, and Hayward - 2009, Working Paper	How does the pre-founding experience of founders impact organizational size and scope?	Australian and New Zealand wine producers	Production volume; export destinations	Pre-founding experience in the same industry has a positive effect on the initial size and scope of the firm, which persists over time
Phillips - 2002, Administrative Science Quarterly	How do the characteristics of resources and routines from the parent to the progeny impact the survival likelihood of both?	513 law partnerships founded from 1945 to 1996, including 137 spinouts from other firms	Law firm failure	Progeny firms have increased chances for survival; parent firms that spawn ventures face their own threat to survival
Dahl and Reichstein - 2007, Industry and Innovation	Are spin-offs more likely to survive than de novo entrants?	Danish labor market data; 2497 start-ups between 1984 and 1991 in manufacturing industries	Organizational survival, takeover, or exit	Spin-offs from surviving parents and firms with prior industry experience are more likely to survive; spin-offs from failed parents are less likely to survive
Lange, Boivie, and Henderson - 2009, Academy of Management Journal	How do the organizational "children" of existing diversifying firms influence the survival prospects of firms in a new industry?	173 corporate children and 533 stand-alone businesses in the PC industry studied from 1975 to 1994	Firm failure rates	Corporate parents lend legitimacy to a new industry but give birth to organizational children that have lower probabilities of survival

Environment – Culture, Market, Industry, Community

The environment often provides a key element in the selection mechanism for new organizational forms (Hannan and Freeman, 1977; McKendrick et al., 2003; Hsu, 2006).

Species of firms suited to their surroundings, available resources, and the intensity and nature of competition with other species survive to propagate and are retained within the market ecosystem. What role does environment play in the specific category of progeny new ventures? How do these ventures in turn influence the environment through geographical agglomeration or other means? Some prior research has attempted to address environmental interactions of spinout firms.

Market Structure

Beyond the organizational level, broader structures in the market may define outcomes for spinout ventures. Klepper and Simons (2000) demonstrate that relevant experience from the radio industry for new entrants into television led to earlier entry, longer survival, and larger market share. Klepper and Thompson (2006) show that the emergence or obsolescence of submarkets influences the performance and survival of organizations within an industry. Simons and Roberts (2008) describe how non-local experience promotes the choice of a novel organizational form; pre-founding experience of all types improves the performance of firms that choose a novel form, improving the impact and longevity of these organizations

Agglomeration

Regionally based resources of personnel, technology, and markets lead to geographical concentrations of firms in common industries. This phenomenon is described as agglomeration and has been researched in the context of spinout activity. Buenstorf and Klepper (2009) show that agglomeration is a result of spinout activity; founders coming from existing ventures in the same industry demonstrate a propensity to launch their spinout in the same region. Disagreements over management practices and strategy lead to spinouts; valuable local

knowledge leads the founders of new ventures to remain in the same geographic region (Klepper, 2007).

Regulatory Environment

The enforcement of non-compete agreements impacts the mobility of scientists from technology ventures. This impacts their movement to other firms or toward the formation of start-ups in adjacent markets (Marx, Stumsky, and Fleming, 2009).

Figure 1-7 provides a summary of prior research into environmental factors that influence spinouts.

Figure 1-7: Prior Research on Environmental Factors

Study	Research Question(s)	Data	Dependent Variable	Key Findings
Klepper and Simons - 2000, Strategic Management Journal	How does prior experience condition entry, performance, and the evolution of market structure in an industry?	265 firms in the radio industry, among which 56 chose to enter the television industry	Firm entry, survival, and market share	Relevant experience from the radio industry for new entrants into television led to earlier entry, longer survival, and larger market share
Klepper and Thompson - 2006, RAND Journal of Economics	How can submarkets explain the growth, decline, and failure of firms?	464 entrants into the U.S. laser industry from 1961 to 1994.	Firm entry and exit; expansion and contraction	The emergence or obsolescence of submarkets influences the performance and survival of organizations within an industry
Simons and Roberts - 2008, Administrative Science Quarterly	How does non-local pre-founding experience enable changes in local organizational form?	138 Israeli wineries from 1983 to 2004, the period of emergence of the novel form of non-kosher organizations	Choice to found a new venture of a novel organizational type; venture performance	Non-local experience promotes the choice of a novel organizational form; pre-founding experience of all types improves the performance of firms that choose a novel form, improving the impact and longevity of these organizations
Buenstorf and Klepper - 2009, The Economic Journal	How do organizational reproduction and heredity influence industry agglomeration?	607 U.S. automotive tire producers from 1905 to 1980	Geographic location of new firm entry	Organizational competence is inherited by spinouts in the form of knowledge of technology, production processes, and markets; knowledge of the region influences choice of founding location, beyond the effects of agglomeration economies
Klepper - 2007, Management Science	How can the regional agglomeration of industries be explained?	Spinoffs and de novo entrants to the U.S. automobile industry from 1895 to 1966	Spinoff rate, firm performance, geographic location of entrant	Disagreements over management practices and strategy led to spinoffs from four early players in the industry; valuable local knowledge, rather than agglomeration economies accounts for the choice to launch within the same region
Marx, Strumsky, and Fleming - 2009, Management Science	How do noncompete agreements influence scientist mobility?	Organizational mobility among patent holders in the state of Michigan before and after implementation of legislation strengthening enforcement of noncompete agreements	Churning - patent inventors with different organizational patent assignees in subsequent patents	Scientist mobility significantly decreases in an environment with strong enforcement of noncompete agreements

THE BOUNDARIES OF THE BIOLOGICAL METAPHOR

Revisiting the Biological Metaphor

Gregor Johann Mendel is generally recognized as the founder of the field of genetics. In his 1866 paper he presented a study of the characteristics of garden pea plants, observing the

inheritance of traits in the plants. He found that this inheritance followed certain laws in terms of the transmission of hereditary characteristics from parent organisms to their offspring. This work largely went unnoticed until Hugo de Vries, a Dutch botanist in the 1880's independently discovered the forgotten principles established by Mendel, demonstrating Mendel's law of segregation across many plant species. He extended the theory of heredity to incorporate the mechanism of *genes*, self-replicating structures in living organisms that are concentrated in the nuclei of all cells. This concept was later extended and refined by Wilhelm Johansen into genotype and phenotype in the early 1900's, establishing the foundation for modern genetics. Over the next century, a series of discoveries and advances increased the understanding of genetic genealogy. Lilian Vaughan Morgan discovered the attached X chromosome in fruit flies. Oswald Avery discovered that genes are composed of nucleic acids, establishing DNA as the hereditary material in bacteria and other living organisms. Maurice Wilkins, James Watson, and Francis Crick discovered the structure of the DNA molecule in 1953. Most recently, the Human Genome Project successfully mapped the more than 20,000 genes of the human genome, completing their work in 2006 and crossing a significant milestone in the scientific understanding of life.

Prior to the discoveries of Mendel, an alternative mechanism was proposed for the emergence and transfer of species traits. In his *Philosophie Zoologique* (1809), Jean-Baptiste de Lamarck suggested that beyond its role in the selection and retention of species, the environment could encourage habits and behaviors that shape evolution. Organisms take action in response to the challenges of their surroundings, influencing the subsequent behavior and characteristics of future generations. As a result, the Lamarckian theory holds that organism

behavior exerts an influence on evolutionary selection and retention outside of the genotypic information passed on through genealogical inheritance.

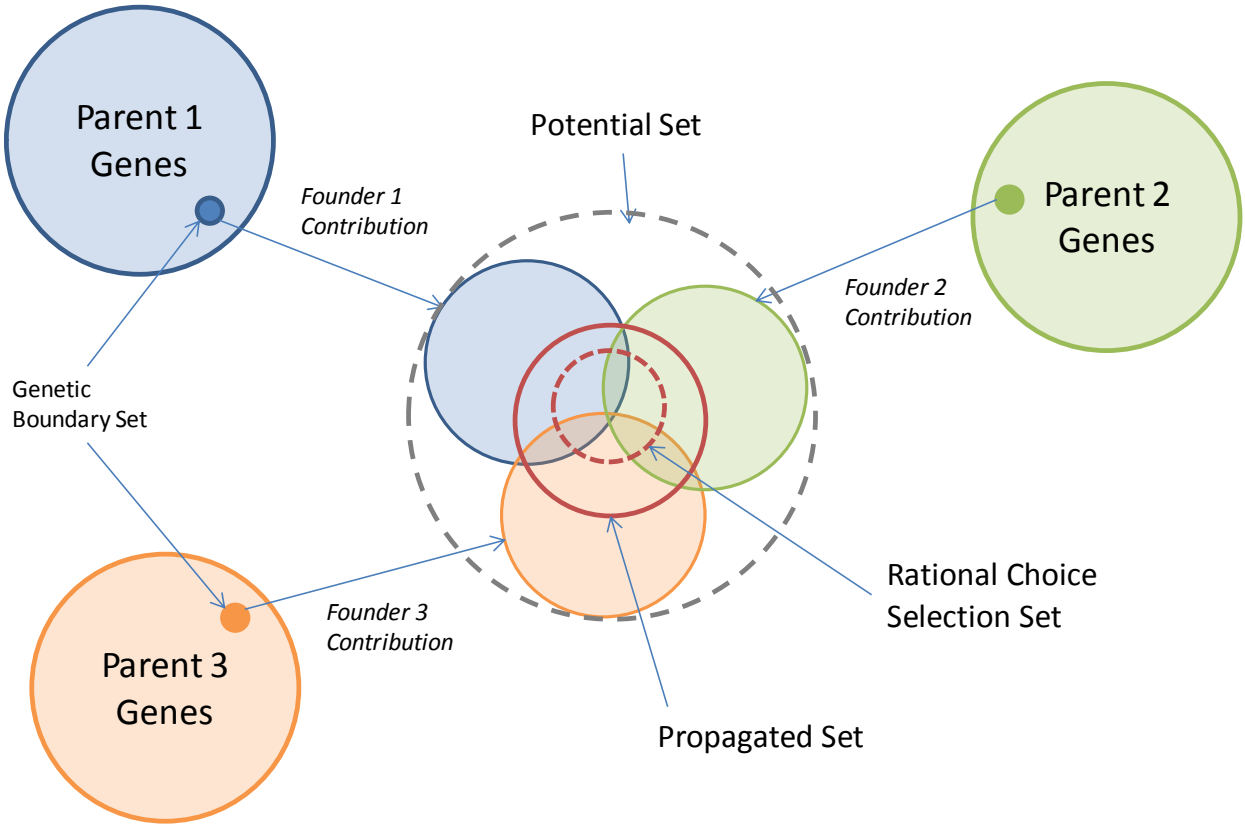
A Theoretical Framework

To understand how hereditary transfer shapes the formation and success of entrepreneurial ventures, it is necessary to develop a more coherent theory explaining the mechanisms and circumstances under which different types of organizational genes are passed to the offspring. Is it possible to explain which organizational genes are self-selected and which ones are passed along unwittingly? The contrast between the Mendelian and Lamarckian views in the realm of genetic biology may hold promise for extending organizational theory. Humans have limited agency to control their genetic heritage; science gives us the ability to identify genetic flaws and compensate through health habits and behaviors that reduce the risks coded into our genes. In an organizational context, the role of agency is greater. Wise founders may recognize where their routines and experiences are lacking, allowing them to compensate through contracting, learning, or expanding the founding team. At the same time, there are still elements that lie beyond their cognition and control. A theory that can define the boundaries between these categories will allow scholars to advance research in organizational genealogy and understand its implications at a finer level of detail.

The common element in all forms of organizational genealogical transfer is the founding team of the new venture. At a basic level, the founding team members' associations with parent firms create the opportunity for the new organization to absorb transferred genes. Additionally, the duration and nature of their experiences at parent firms, exposure to routines and strategies executed in those firms, and capacity to retain this information define the extent and limits of

the genetic information that may pass to the entrepreneurial venture. For each founder, the sum of these experiences and observations form a *genetic boundary set*, information from the parent firm that is available to the individual founder for application in the new venture. Collectively, the genetic boundary sets brought by all founders form the *potential set* for the new firm. This potential set represents an overlapping pool of knowledge, perceptions, habits, etc. from which the basis of the new organization is established. This relationship is illustrated in Figure 1-8.

Figure 1-8: A Proposed Theoretical Model of Genealogical Transfer



Organizations rest on a socially constructed framework (Granovetter, 1985). Human limitations and biases play a fundamental role in the creation of this framework. Routines and preferences are aggregated at a collective level among founders through a social negotiation

process that is both conscious and unwitting in its nature. Their choices, biases, and strategies define what genetic information from the potential set is actually carried forward in this second generation of organization. As shown in exhibit 2, this information constitutes the *propagated set*.

Boundaries of cognition help define which functions are retained within a firm, rather than left to market devices (Coase, 1937). The marginal utility of absorbing additional business functions decreases as the nature of these functions diverges from the core knowledge and the overall complexity of operations increases. By the same token, cognitive limitations must play a role in limiting the ability of an individual or group of founders to select the practices that they will knowingly perpetuate from their parent firm(s). Humans are limited in their ability to foresee all future outcomes and to rationally assess the merits of all possible decision alternatives.

At the core of genes propagated from parent organizations, there resides the subset of routines and preferences that are consciously implemented in the new organization. This subset is characterized by the focal strategies of technology and market selection that are most proximal to the operation and survival of the new venture. Founders are likely to have had direct experience with these elements during their tenure at the parent firm, increasing their ability to replicate and adapt the knowledge and routines for use in the new venture. The choices among the elements are openly discussed among team members and are likely to be selected through a process of rational choice, with the utility of various options linked to objective value metrics such as return on investment or market growth. These items constitute the *rational choice selection set* of genes that are adapted from the parent firm for use in the progeny organization.

Near the boundaries of the rational choice selection set the knowledge of founders regarding the routines of the parent firms diminishes. They perceive some value or link to performance from propagating certain practices, but they are less certain of the mechanisms through which the parent firms obtained this value. Perhaps their roles at the parent firms were functionally adjacent to this set of routines, but did not allow them to obtain the tacit knowledge necessary to fully replicate them. As with the central choices of the selection set, the use of these practices will be openly negotiated, but decisions are more likely to be made through subjective analysis and general perceptions of their utility and legitimacy. ROI will be replaced by concerns of external image and normative influences, and replication will be more strongly influenced by uncertainty.

The narrow window of conscious choice lies within a socially determined framework of constraint that is influenced by shared understanding and prior experience (Ingram and Clay, 2000). As a result, founding teams will include within their organizational behaviors a set of practices that are brought from the parent firm without a conscious decision to do so. In the genealogical transfer framework, the region that is within the propagated set but outside the rational choice selection set contains those practices and routines that are carried forward without the conscious scrutiny of founding team members. These routines persist as myths and ceremonies formerly absorbed in parent organizations and carried forward through institutional forces, beyond the discretion of any individual or groups (Meyer and Rowan, 1977). The decision to perpetuate such practices is not openly negotiated among founders but rests in an unwitting social aggregation of influences from parent organizations. These practices lie outside the "cognitive radar" of the founding team and are more likely to exist in environments of high complexity in which the new firm faces a daunting set of choices and processes that

must be established for operation and survival. The phenomenon of genealogical imprinting is likely to reside in this category of transfer. The beginning state and characteristics of the founding team leave a mark on organizational decisions and structures that persist well beyond the purpose of their origin and without intervention (Clemens and Cook, 1999).

The categories of genetic transfer are summarized in Figure 1-9.

Figure 1-9: Theoretical Categories of Genealogical Transfer

Category of Genetic Transfer	Characteristics	Influencing Factors	Examples
Rational Choice to Adopt Parent Practices	• Objective value link to organizational performance • Practices are within the direct experiences of the founding team	Return on Investment	Choice to pursue specific technologies or markets based on experiences at the parent firm(s)
Imitation of Parent Practices	• Perceived link to performance • Practices that may be known to founders but outside their direct experience • Normative influences of successful or socially prominent parent firms	Perceived Legitimacy of Practice Uncertainty	Choice to structure the organization in a similar fashion to that of the parent
Institutional Propagation of Parent Practices	• Routines, myths, or ceremonies that persist without coordinated action or agency on the part of founders; i.e. outside their "cognitive radar" • No objective link to organizational performance	Complexity	Imprinted organizational structures that link back to the parent firm

DISCUSSION

The Limits of Organizational Genealogy

Organizational genealogy is an evolving field (if the reader may pardon the pun). Basic questions of the performance advantages of spinouts and the nature of genetic transfer from parent organizations have been studied, but there are significant avenues of research that have

yet to be explored. Can organizational genealogy serve as a basis for a theory of the firm? To answer this question, it may be useful to refer once again to the biological metaphor. Does the parent-progeny transfer of characteristics through genetic material provide a comprehensive explanation for the outcome of individual organisms? Clearly, genetic genealogy can help explain the emergence of certain characteristics in offspring, but it cannot explain the presence, origins, or outcomes of natural organisms. In a similar fashion, organizational genealogy is a powerful theoretical lens for explaining important characteristics and behaviors of firms, but it cannot fully predict their success.

CHAPTER 2 - CONFLICT IN GENEALOGICAL NEW VENTURES: COMMERICAL AND ACADEMIC FOUNDERS

ABSTRACT

This study investigates how contrasting organizational backgrounds drawn from their parent firms influence innovation and performance for genealogical new ventures. Set within the context of biotech ventures formed by founders from academic and commercial parent organizations, knowledge quality and IPO outcomes are studied for 242 start-ups in the period from 1990 to 2000, with a total of 1,210 firm-year observations arrayed in a panel design. The empirical findings support the notion that broadly diverse backgrounds within founding teams may undermine new venture innovation and growth. Additionally, founders may reduce or increase this effect through their choice to engage in activities that are more closely associated with technology commercialization vs. academic research pursuits. Implications for organizational genealogical research and academic entrepreneurship are discussed.

INTRODUCTION

The initial stages of a new firm are critical in setting strategy and organizing principles that shape its subsequent direction and performance (Stinchcombe, 1965; Boeker, 1989). Lacking its own prior history, the nascent firm draws on the experiences of founding team members, leveraging their combined experience and knowledge heritage from prior organizations. Understanding how this merger of founder backgrounds works and under what conditions it may influence organizational performance are important issues for management strategy research.

Researchers have explored the role of transferred routines (Nelson and Winter, 1982; Phillips, 2002) and organizational backgrounds (Dearborn and Simon, 1958; Beyer et al., 1997) in defining strategy and outcome for organizations. The incorporation of beneficial routines among top management team members increases performance (Eisenhardt and Schoonhoven, 1990), while favorable organizational approach can promote entrepreneurial success (Ireland et al., 2003; Shepherd et al., 2010). Other research has examined differences in backgrounds and characteristics among management team members (Wiersma and Bantel, 1992). Under certain circumstances, such differences have been associated with faultlines, divisive subgroups that may hamper decision making and undermine performance in top management teams (Lau and Murnighan, 1998, 2005).

An area that has not been addressed is the integration of widely different routines among founders of divergent experiential backgrounds within the context of an entrepreneurial venture. Such a combination may lead to dissonance among founding team members during the critical stages of strategy formation for the new firm. Given differences in operating practices and

perceptions between individuals from academia and those from commercial business, this dynamic may plausibly occur when academic founders are involved in entrepreneurial business ventures. It is possible that firms with founding members from both domains will display significant differences in their strategies, their access to resources, and their ultimate performance.

This paper addresses the following research question: how does the combined legacy of parent organizations with significantly different routines and backgrounds impact the knowledge quality and performance of genealogical ventures? This question is explored through an empirical study in the biotech industry, sampling 242 genealogical new ventures founded from 1990-2000. By examining the role of resources provided by academic founders and the effects of dissonant routines, this study provides evidence of how their attributes and behaviors impact the venture's performance in terms of the creation of high quality knowledge and likelihood of achieving IPO.

THEORY AND HYPOTHESES

Organizational Genotype and Compatibility

Much research has been devoted to the phenotype, or observed form of organizations. Population ecology has sought to understand organizations as common categories or species that share characteristics and survival chances in the broader economic environment (Hannan and Freeman, 1977). Less emphasis has been placed on the genotype, or transferred genetic structures that are propagated from earlier organizations through the experiences and strategies of new venture founders (McKelvey, 1982). The concept of genotype can be examined in two ways within the context of new firm formation: the transfer of routines from founders' prior

organizations, and the role of founders' experience and organizational background. Both modes of 'genetic' transfer have the potential to lend insight into the building blocks of firms and their strategies, perhaps explaining variance in the empirically observed performance and survival outcomes of entrepreneurial ventures.

Integration of Contrasting Routines

Organizations rely on routines in order to function. Routines serve as the genetic material in the social realm that passes characteristics and processes across organizations. Firms with superior routines can achieve higher performance (Nelson and Winter, 1982). Though composed of the interactions and behaviors of individuals (Feldman and Pentland, 2003), routines reside and have an effect at the organizational level (Dosi, Nelson, and Winter, 2000). As a result, the particular combination of routines developed and retained in an organization plays a significant role in its strategies and outcomes (Cohen and Bacdayan, 1994).

Founders from different backgrounds or organizational domains may bring forward different routines. Managers in a new entrepreneurial venture are most likely to replicate routines from prior generations of organizations based on the scope and constraints of their previous experience (Phillips, 2002). At the same time, individuals are able to respond to the exposure to different organizational influences. The integration of prior individual experience and present team interaction creates an environment in which organizational routines must be combined and adapted to the founding of a new venture.

In the integration process that occurs within a new founding team, the merger of different routines may create a dissonance that negatively impacts performance (Coriat and Dosi, 1998). Performance is linked to the common routines developed by prior joint work

experience of founding teams (Eisenhardt and Schoonhoven, 1990). The presence of both academic and corporate founders may lead to dissonance in organizational routines and behaviors that adversely impact the performance outcome of new ventures. Top management teams with poor behavioral integration among founding team members are associated with greater levels of internal conflict and relatively poor performance (Hambrick, 1995). Given their substantial differences in background and routines relative to commercial managers, the involvement of academic entrepreneurs in the founding team may result in negative consequences.

Contrasting Backgrounds of Founders

The functional background of managers has been shown to influence their observations and approach to decision making. Dearborn and Simon (1958) proposed the concept of selective perception, the tendency of executives to approach business issues from the perspective of their own functional background. In the face of cognitive limitations, managers develop simplified mental representations, or belief structures (Fiske and Taylor, 1984) that are shaped by their functional experience (Walsh, 1988). These structures influence the way managers perceive organizational effectiveness (Waller et al., 1995), directing their attention away from stimuli not associated with their functional background during the decision making process (Beyer et al., 1997). The belief structures of genealogical venture founders are likely to reflect prior functional experience from their parent organizations, leading them to apply these perspectives to strategy decisions in the new firm.

Demographic characteristics of managerial teams have also been shown to have a significant impact on strategy and decision making. Wiersma and Bantel (1992) explored how

management team demographics impact perceptions of future events, possible alternatives, and potential consequences of decisions. Their study demonstrated that characteristics such as age, tenure, and educational background shape managers' cognitive perspectives, influencing their willingness to pursue strategic change within the organization. In the context of a genealogical new venture, characteristics of founding team members are to some extent linked to the nature of their experiences at the parent firm. Longer tenure at the prior firm, exposure to unique learning experiences, etc. can plausibly shape the cognitive perspectives of founders and their biases and decisions with respect to strategies for the new venture.

Extending the work on demographics, other researchers have suggested that faultlines may form in managerial teams, creating subgroup divisions that impact decision making and performance (Lau and Murnighan, 1998; Li and Hambrick, 2005). Faultlines are characterized as hypothetical dividing lines centered on one or more attributes (Lau and Murnighan, 1998). The strength of the resulting divisions depends on the number and alignment of apparent distinguishing attributes in the team, along with the corresponding number of potentially homogeneous subgroups. In teams with strong faultlines, individuals tend to identify more closely with the members of their subgroup (Lau and Murnighan, 2005), and faultlines may negatively impact strategic decisions such as foreign expansion (Barkema and Shvyrkov, 2007). To the extent that differences in parent organizational heritage create distinguishing subgroups within their ranks, detrimental faultlines may form among founding team members of genealogical new ventures.

Academic Entrepreneurs

The phenomenon of academic entrepreneurship provides a potential testing ground for the merging of dissimilar organizational backgrounds. The involvement of academic scientists in the founding team has widely been viewed as a beneficial characteristic for a new entrepreneurial venture. It has not yet been established under what conditions, if any, academic founders would lead to negative consequences for such firms. Given the likely differences between academic and commercial parent organizations, founding teams containing members from both worlds may experience faultlines or conflicts in organizing principles that could, under certain circumstances, undermine the advantages associated with academic entrepreneurs.

Resource Contributions of Academic Entrepreneurs

Many issues relevant to the transition of academic researchers to industrial pursuits have been addressed in management research (Rothaermel et al., 2007). Prior work has examined the decision of the academic scientist to pursue commercial applications (Stuart and Ding, 2006), the activities of universities and other institutions in encouraging this activity (Meyer, 2003), the role of experience and background in the identification of entrepreneurial opportunities for university inventions (Shane, 2000), and the complementary nature of academic research relative to industrial R&D (Hsu et al., 2007). The ability to exploit recent advances in basic science research (Zucker and Darby, 2007) fuels the perception that academic scientists represent an important source of competitive advantage for entrepreneurial ventures in technology industries.

Academic entrepreneurs bring with them a set of direct resources in the form of knowledge, patented inventions, or grant funds that have been obtained through their prior research activities. By gaining access to the unique set of resources held by an academic

founder, a firm may obtain an advantage relative to competitors (Barney, 1991). Furthermore, the tacit knowledge and expertise of the academic scientist represents a resource that is difficult for other firms to imitate (Kogut and Zander, 1992). The involvement of academic researchers who are highly prominent in their field, so-called "star scientists," has been shown to have a positive effect on the quality of knowledge of a new venture (Zucker, Darby, and Armstrong, 2002).

The contrast between academic and commercial backgrounds may have a negative impact on the outcomes and performance of genealogical new ventures under certain circumstances. New ventures may be successfully fashioned in the open source, cooperative structure commonly found in academic research, or they may be structured in the mold of commercial ventures. The performance of the venture is likely to suffer when the firm fails to establish a clear structure in one or the other of these models. Given the potential consequences for firm performance, it is important to establish the conditions under which this conflict is most likely to occur.

Consequences of Divergent Heritage

Biology demonstrates that only certain organisms are genetically compatible and able to produce viable offspring. In the domain of organizations, there may be a similar threshold of compatibility that is required for the routines of dissimilar parent firms to be productively combined in an entrepreneurial venture. This limitation would be most readily apparent when influences within founding teams are evenly matched between individuals from dissimilar categories of organizational parents. Such founders may bring to the new venture widely

divergent practices or assumptions that undermine the efficient development of market strategies and technologies that promote organizational success.

Academics bring with them technologies, ideas, and an intimate understanding of the basic science that underlies new innovations. While academic founders may offer substantial technology and legitimacy advantages to a new venture, their prior experience is framed in the context of academic organizations, with perspectives or adopted routines that may be significantly different from commercial ventures (Bower, 2003). They tend to work in an open-source environment without the secrecy that is characteristic of commercial R&D (von Hippel and von Krogh, 2003). They are recognized and rewarded for the sharing of their inventions and technology advances through the institution of academic publication, rather than relying solely on financial reward for their efforts. They tend to work in a more independent fashion, with greater freedom to choose directions of their research than scientists who are closely budgeted and managed through a commercial R&D department.

In the context of a genealogical entrepreneurial venture, founders with academic and commercial backgrounds may advocate strategies that are consistent with their individual prior experiences. A founding team evenly divided between these two perspectives may experience strong faultlines between subgroups of academics and commercial founders (Lau and Murnighan, 1998). Power may be distributed between subgroups in the team (Boeker, 1989), making it difficult to resolve areas of contrast or conflict between commercial and academic institutional logics (Thornton and Ocasio, 1999). For example, founders may struggle to choose between organizational preferences for collaborative technology development vs. concerns for secrecy and the protection of intellectual property. Dissonance may delay important processes in the early stages of the new venture, leading to reduced success in both the development of

high quality innovations and in achieving commercial goals. On the other hand, founding teams with a dominant approach grounded in either the commercial or the academic background will avoid such conflict, allowing them to more efficiently pursue key operational and technology strategies. This leads to the following hypotheses:

Hypothesis 1a: The proportion of academic founders has a u-shaped curvilinear influence on the quality of knowledge developed by the venture.

Hypothesis 1b: The proportion of academic founders has a u-shaped curvilinear influence on the likelihood of the firm achieving IPO.

Organizational size is another characteristic of genealogical heritage that may lead to faultline differences among founding team members. Scientists working at large firms may enjoy the benefits of access to greater resources or a broader pool of knowledge among colleagues within the organization (Argyres and Silverman, 2004), enabling successful innovation (Leiponen and Helfat, 2010). At the same time, these large organizations may suffer from greater levels of bureaucracy and slower reaction times as key decisions must make their way through multiple levels of management (Damanpour, 1996). In contrast, small firms or research laboratories may enjoy flexibility in their approach to R&D, reacting more quickly to new developments and adapting to shifts in the state of the art within their field of research (Rothwell and Dodgson, 1991; Ebben and Johnson, 2005). On the downside, small firms employ fewer scientists, limiting the base of knowledge and experience that may be brought to bear in the development of new technologies.

Founders from parent organizations of similar size may share common organizational expectations. In some respects, research scientists at large universities or non-profit research

laboratories may have more in common with their counterparts in large corporations than with individuals in small academic institutions. They may be familiar with practices around problem solving and decision-making that are common to larger organizations (Harris, 1994). From their common experiences, they may be equally adept in navigating bureaucratic channels or use similar persuasion techniques to advance new ideas in the context of a large R&D team. Founding team members coming from small commercial firms or non-profit or academic laboratories may also have much in common. They may be accustomed to levels of autonomy and flexibility that are well suited to the context of an entrepreneurial start-up. It may be easier for them to quickly adapt to new opportunities and developments in their field.

When greater differences exist in the size of founders' parent firms, it may negatively impact the performance of the genealogical new venture. Founding teams that include individuals from large and small organizations may have a greater contrast in their organizational backgrounds which will inhibit strategy formation and action in the new venture. Founders from small parents may become frustrated at the slow pace of decision-making and relative lack of flexibility demonstrated by their peers from larger organizations. At the same time, founders from the larger firms may enjoy a broader context in evaluating the merits of new technologies and approaches, becoming frustrated from the relatively parochial perspective of individuals from smaller parent firms. As a result of these differences, it may become more difficult for the new venture to develop new innovations, limiting their production of high quality knowledge and slowing or undermining the process of successful commercialization of new technologies. This leads to the following hypotheses:

> **Hypothesis 2a:** Greater variance in the size of founders' parent organizations is negatively associated with a higher quality of knowledge developed by the venture.

Hypothesis 2b: Greater variance in the size of founders' parent organizations is negatively associated with the likelihood of the firm achieving IPO.

Post-Founding Focus and Founding Team Dissonance

To some extent, academic founders' actions can enhance or mitigate the impact of divergent organizational backgrounds. If an academic founder continues to invest time and effort into activities associated with maintaining her prominence, she will be less likely to be engaged in the critical activities necessary to commercialize new technologies (Calderini, Franzoni, and Vezzulli, 2007). Such founders may assume a hybrid role, retaining both their university position and their role in the new venture (Nicolau and Birley, 2003). The loss or diminished access to the tacit knowledge held by the commercial founder will have negative consequences for the new venture.

New ventures represent a combination of experiences and observed best practices of their founders (Klepper, 2001; Beckman, 2006). In charting the strategic, technological, and operational direction of the venture, founders will have a differential influence based on their background and importance to the firm. Star scientists are shown to have a significant impact on the innovation performance of an organization (Zucker and Darby, 2007; Hess and Rothaermel, 2011). With a high level of prominence in their discipline, they are likely to wield greater influence in the foundational decisions of the venture. As a result, the firm will incorporate those elements of the academic perspective that are considered to be beneficial by the highly prominent founder, and the academic model of organization will be dominant in the new venture. Given her experience and prior success in her chosen area of technology, this influence to shape the decisions of the new venture will result in greater performance of the

venture, both in terms of the quality of the technologies pursued and with respect to eventual success at marketing innovations and achieving IPO.

When academic founders come from a background of low prominence in their field of study, they may lack the influence to significantly shape the strategic direction of the firm. Without substantial successes in technology development or a significant reputation in the research community, the inputs of academic founders in this category will be subordinate to the judgments of members of the founding team coming from commercial backgrounds. Few elements of the academic perspective will be incorporated in the operations of the venture. With the dominant model of a commercial organizational structure, their ventures will have clarity around the mission of developing technologies for market applications. This focus on commercialization of technology will boost the market performance and likelihood of IPO for the firm.

The potential for conflict and detrimental impact to performance exists when the new venture incorporates academic founders of moderate prominence. The first reason for this lies in the potential conflict of interest of the academic founders. Their time and efforts may be divided between the ongoing goal of preserving their reputation and prominence in the academic research community and achieving entrepreneurial success. Both endeavors require intensive work and engagement, making it unlikely that the academic scientists can do both, particularly given their status and prior track record of average performance. The second reason relates to the conflict that may be generated by the presence of these individuals in the founding team. Their prior success and status in the academic world may give them sufficient confidence and influence to try and shape the strategic direction of the new venture, though they may lack the high quality ideas and insights that can make the firm successful in pursuing an academic

organizational approach. At the same time, fellow founders from commercial backgrounds will accept the influence and opinions of moderately prominent academics to a point, but they will challenge the decisions of these individuals, particularly in the context of the marketing and commercialization of technologies. Neither the academic nor the commercial model will dominate the strategies and organizing principles of the new firm. Possible evidence for this dynamic is found in prior research, which shows that genealogical firms with multiple parent organizations are more likely to fail (Phillips, 2002). Through either the impact of mixed loyalties or the conflict created by clashing perspectives, the inclusion of moderately successful academic scientists on founding teams will lead to relatively poor outcomes for entrepreneurial ventures.

Hypothesis 3a: Knowledge quality will be greater when either commercial or academic founders are dominant in the founding team.

Hypothesis 3b: The likelihood of the firm achieving IPO will be greater when either commercial or academic founders are dominant in the founding team.

While the efforts of academic founders to advance their prominence in their technical discipline may come at a cost to the new venture, they can mitigate this effect by embracing the activities associated with commercial success. Technology start-ups receive venture capital funding with the expectation of investors that they will achieve a favorable outcome, such as a successful initial public offering. To reach this desired result, the firm must not only identify valuable new technologies, but it must also bring these technologies to market. While academic founders provide unique and substantial advantages in the effort to identify new technologies,

the nature of their actions will determine whether their involvement will lead to successful commercial products.

The activities of an academic founder in the critical period of growth following the founding of the firm play a significant role in determining the success of the venture. If the founder focuses her attention on activities associated with technology development for commercial applications, this will have a positive impact on the outcomes of the new venture. Academic scientists have a tremendous depth of understanding of the underlying mechanisms of new inventions. Their skills can be gainfully applied not only in the effort to create new technologies, but also to explain the workings and relevance of these technologies through the peer-reviewed publication process. As a result, academic scientists have certain advantages of knowledge and understanding over their commercial counterparts who are focused to a greater extent on the applications of new technologies.

When their advantages are brought to bear, the involvement of academic scientists in the efforts to commercialize technologies should translate to more favorable outcomes for the new venture. A greater commercial focus of academic founders is associated with their direct involvement in creating new inventions, patenting ideas that are likely to have a positive impact on the quality of technologies developed by the firm. By engaging more directly in the invention process, they are able to improve opportunity recognition and problem solving in the technology development process. By the same token, their efforts should contribute to the commercial success of the new venture. Academic founders that remain closely involved in creating new inventions will offer insight and valuable suggestions as technologies are adapted to market demands. Their substantial knowledge of the science underlying these technologies

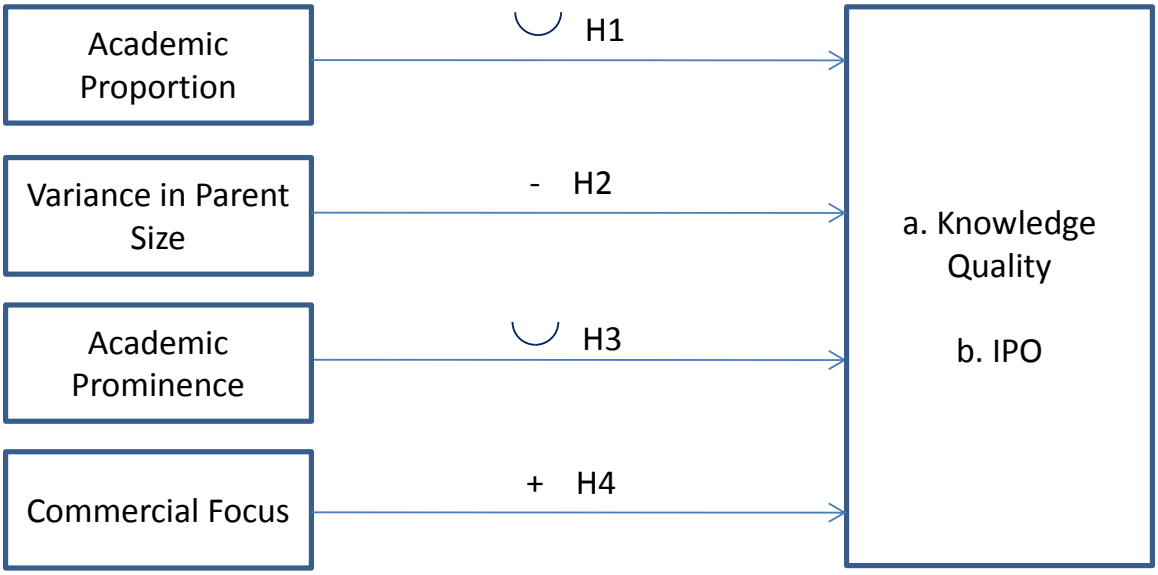
may translate into more effective products, improvements in quality, or greater efficiency in manufacturing.

Hypothesis 4a: Greater commercial focus of academic founders is positively associated with a higher quality of knowledge developed by the venture.

Hypothesis 4b: Greater commercial focus of academic founders is positively associated with the likelihood of the firm achieving IPO.

The hypothesized relationships for the study are diagrammed in Figure 2-1.

Figure 2-1: Hypothesized Relationships



METHODS

Sample and Data Sources

The biotech industry serves as the domain for the study, given the prevalence in this field of academic founders and the common practice of sourcing new innovations through research at academic institutions (Stuart and Ding, 2006; DeVol and Bedroussian, 2006). Founding team data on biotech start-ups that launched in the period from 1990 to 2000 were obtained through Dow Jones VentureSource, a proprietary database of information on start-up firms. Among the 392 firms in the baseline sample, 242 were identified as genealogical ventures, meaning that they had traceable links to parent organizations through the prior patent history of their founders. The sample is restricted to this subset in order to study the role of parent-progeny influences exhibited through the interactions of the founding teams; firms with no genealogical link would not be impacted by these dynamics. Among the sampled firms, there are a total of 517 founders, with 165 of them (roughly one third) coming from an academic or nonprofit laboratory parent organization.

Dependent Variables

Knowledge Quality is the focus of hypotheses 1-4a. This dependent variable measures the impact of new inventions created by the genealogical venture, as assessed by external observers in the industry. The measure is constructed by capturing all third party citations of focal venture patents during a uniform 5 year window after the successful application of each patent listing the focal firm as the assignee and recorded by the U.S. Patent and Trademark Office. By excluding self-citations of the focal firm, this measure provides an objective evaluation of the quality and importance of new inventions in a broader market context, avoiding issues with internal patent citations that may be pursued for strategic or legal reasons. The measure of external forward citations is averaged across the number of successful patent applications in the observation year in order to provide a common metric assessing the mean

quality of inventions produced by the focal firm. Data to construct this measure was obtained through the patent database of the National Bureau of Economic Research and the database search engine of the U.S. Patent and Trademark Office website.

Hypotheses 1-4b address the likelihood that focal firms in the study will achieve their initial public offering. This is operationalized as a binary variable, valued as 1 if the firm achieves IPO during the observation window, zero otherwise. Among the 242 firms studied, 16 of them successfully achieve IPO during the 5 year window of observation following their founding.

Independent Variables

As hypothesized, greater proportional representation in the founding team may tend to increase the effect of academic founders in the new venture in terms of their influence on strategy and structure of the firm. A*cademic Proportion* measures the ratio of academic founders to commercial founders in the founding team of the focal firm.

Variance in the size of the parent organizations associated with founding team members is hypothesized to have an impact on firm innovation quality and successful completion of the IPO process. Many potential measures of parent size are conceivable, from financial metrics to number of employees, etc. In order to provide a measure that is most salient to the knowledge transfer process, the size of the parent is operationalized through the size of the co-inventor network of the founder exhibited in his or her prior patenting activity. U.S. PTO patent applications list the names of all inventors attributed to an invention, thus providing a collaboration history that can be tracked for individuals throughout their careers. Using the VentureSource dataset, the names of all founders were mapped to the unique individual ID

codes established in the disambiguated Harvard inventor data (Lai, D'Amour, and Fleming, 2009). The count of prior co-inventors for each founder was then obtained from the U.S. PTO patent record. From this measure, *Variance in Co-inventor Network Size* is derived as the calculated variance in total number of patent collaborators across founders of the focal venture, measured over the previous five years.

The next set of predictors addresses the prominence of academic founders who participate in the creation of genealogical new ventures. *Academic Prominence* is operationalized in two ways. *Founder Publications* is a simple count of peer-reviewed academic articles published in each year of observation. Publication counts are associated with greater reputation and visibility within an academic discipline and are associated with favorable career outcomes such as academic tenure, financial compensation, and professional recognition (Owen-Smith and Powell, 2003). This information is collected through EBSCO Academic Search Complete, a journal database containing publication information from all academic disciplines. The second measure of prominence is *Founder Publication Impact*, calculated as the average number of citations of the individual's academic publications, also obtained through EBSCO Academic Search Complete. Some genealogical ventures in the study sample include more than one academic entrepreneur in the founding team. In these cases, the prominence measure is totaled across all academic founders in the firm.

Finally, *Commercial Focus* measures the tendency of academic founders to engage in activities that are directly associated with the commercial success of the new venture. Academic founders are in a unique position to provide significant inputs for the development of high quality technologies within the new firm. Their participation in this activity will be tracked as the total number of successful patent applications listing the academic founder as the

inventor and recorded by the U.S. Patent and Trademark Office. Again, in the case of multiple academic founders in the focal new venture, the sum of the individual patent counts is recorded. As with innovation quality, data to construct this measure is obtained through the patent database of the National Bureau of Economic Research and the database search engine of the U.S. Patent and Trademark Office website.

Control Variables

Beyond the measures hypothesized to influence dissonance in genealogical new ventures, there are other plausible relationships and effects that might arise from a founder's work background in the academic domain. These factors may have a confounding effect on the results of the study and must be addressed. One alternative factor that may influence the dynamics in the new venture is the prominence of the academic institution where the founder has most recently worked. Founders from highly prestigious schools may wield more power in strategy and technology decisions, independent of their own technical knowledge and skill. For this reason, *school prominence* is included as a control variable, measured as the total amount of grant money received by the founder's school through the National Institute of Health (NIH) in the year prior to the formation of the new venture.

In order to isolate the mean vs. variance effects of independent variables, their corresponding counterparts are included as controls. Because academic prominence is measured as an average value for firms that include more than one academic founder, *Variance in Founder Publications* and *Variance in Founder Publication Impact* are included as controls. These covariates address any potential effects in the dependent variables that may be a result of wide swings or differences across the academic prominence of different members of the

founding team. In a similar fashion, *Variance in Founder Patents* controls for potential swings in the patenting of new inventions among multiple academic founders in the period following the launch of the new firm. Since hypotheses 4a, b address variance in the size of the founder co-inventor network size, the mean values of size are included to control for its direct effects on knowledge quality and likelihood of IPO. *Average Founder Co-inventor Network Size* is measured as the number of founder co-inventors revealed in the patent record for the prior five years.

The outcome variables in the study may be influenced by the success of non-academic parent organizations from which commercial members of the founding team received their training and experience. Firms with greater levels of innovation productivity or financial resources may provide a more favorable environment for the commercial members of the founding team to gain critical information on successful practices and technologies. *Parent Patents* controls for the total number of successful patent applications for all commercial parent organizations of the focal firm during the five year period preceding its launch. *Public Parents* is a count variable capturing the number of commercial parent organizations that were publicly traded firms at the time of the launch of the new venture. Publicly traded firms have access to equity markets and are likely to enjoy greater financial resources than closely held firms in technology intensive industries.

Resources and connections related to the size of the founding team may influence both the access to venture capital and the performance outcomes of the new ventures. As a result, *Number of Founders* is used as a control variable to capture the total number of members in the founding team.

The base technology strategy and performance of the new venture may impact the outcomes of the study. *New Venture Technology Breadth* captures the diversity of technology areas pursued by the focal firm. It is measured as the count of distinct primary international patent classification (IPC) categories listed in patent applications filed by the firm in the five year window prior to and including the year of observation. *Innovation Productivity* captures the number of successful patent applications by the focal firm in the year of observation. Controlling for this factor helps isolate knowledge quantity vs. knowledge quality in the tests of study hypotheses.

Cumulative rounds of VC funding is included as a firm-level control variable to address the potential advantage to organizations that have successfully obtained prior rounds of venture capital investment. The completion of such milestones may indicate a track record of performance that could lead venture capital firms to increase their subsequent level of investment in the focal firm. Such firms may also demonstrate greater productivity in developing new knowledge. Information on cumulative rounds of funding for each firm in the sample is collected through the VentureXpert database and recorded for each year of observation.

At the industry segment level, new technology breakthroughs from non-sibling competitors may have an impact on the innovation performance of the venture. *Industry Segment Patents* controls for this potential effect. It is measured as the total number of successful patent applications within the segment in the year of observation.

Several effects at the broader biotech industry level are controlled in the study. *Industry Patents* measures the number of successful patent applications launched across all biotech firms

in each observation year. *Industry VC Deals* and *Industry VC Funds* capture the number of venture capital deals and amount of venture capital funding invested in each year of the study. These variables account for potential industry environmental effects of munificence and innovation that may contribute to firm-level outcomes.

Other economic and environmental factors may have an impact on study outcomes. For this reason, dummy variables are included for the year of observation and for the industry segment of the focal venture. Industry segment dummies are constructed from the four categories provided in the Dow Jones VentureSource data: drug development technologies, drug delivery, pharmaceuticals, and biotechnology therapeutics.

Modeling and Study Design

To provide a strong test of the hypotheses put forth in this study, it is necessary to address and exclude other known and potentially unknown explanations for variance in the dependent variables. Panel data methods are employed to address this concern. All study covariates are observed for a uniform 5 year period following the founding of each genealogical venture included in the sample. With 242 firms in the sample, this results in a total of 1,210 firm-year observations. In the tests of hypotheses associated with knowledge quality, fixed effects regression models are used. This reduces the likelihood of endogenous effects confounding the observed results.

Knowledge quality is a count measure based on external forward citations. The Poisson regression model is the typical choice for a count distribution; however, the sample data exhibits overdispersion, a greater incidence of zero valued outcomes than is anticipated in the

normal distribution. For this reason, panel-based negative binomial models are used to test the hypotheses associated with this variable.

Survival analysis with the Cox regression model is used in assessing the likelihood of IPO. This is a widely used technique in testing time-based binary outcomes. It has the advantage of handling right-censored data in which the tested outcome may occur outside the window of observation (Zhou, 2001). The results of the Cox regression provide hazard rates associated with each of the covariates, along with tests of significance for each factor. This determines which factors have a significant influence in either increasing or decreasing the likelihood of firms achieving IPO.

RESULTS

Descriptive statistics and bivariate correlations for all study variables are included in Table 2-1.

Table 2-1: Descriptive Statistics and Correlations

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1 Knowledge Quality	1.60	5.14																					
2 IPO	0.02	0.15	0.02																				
3 Founder Publications	1.12	3.03	-.073*	.025																			
4 Founder Publication Impact	176.06	650.68	-0.05	.056	.694**																		
5 Founder Patents	2.27	3.82	.078**	.069*	.175**	.209**																	
6 Academic Proportion	0.32	0.44	-0.01	.042	.164**	.117**	.015																
7 Variance in Founder Co-inventor Network Size	106.57	542.53	-0.01	.013	.173**	.130**	.565**	.027															
8 School Prominence ($M)	68.50	140.09	-.050	0.00	.345**	.246**	.126**	.453**	.040														
9 Average Founder Co-inventor Network Size	17.08	27.28	.049	.078**	.171**	.155**	.523**	-.103**	.334**	-.022													
10 Variance in Founder Patents	0.69	3.19	.020	0.03	.077**	.075*	.518**	-0.01	.767**	.010	.258**												
11 Variance in Founder Publications	0.76	4.95	-.043	.019	.673**	.459**	.117**	.079**	.192**	.187**	.065*	.075*											
12 Variance in Founder Publication Impact	46803	537537	-.024	-.008	.285**	.637**	.095**	0.02	.103**	.043	.039	.069*	.435**										
13 Parent Patents	188.37	483.19	-.005	-.011	.064*	.077**	.101**	-.090**	.109**	-.095**	.111**	.129**	.011	.030									
14 Public Parents	0.40	0.57	-.008	.016	-.032	-.019	-.018	-.168**	.005	-.045	-.038	.014	-.055	.007	.087**								
15 Number of Founders	2.26	1.17	-.017	.072*	.252**	.231**	.137**	.055	.136**	.261**	-.040	.176**	.201**	.135**	.002	.067*							
16 New Venture Technology Breadth	0.83	2.89	.118**	.210**	.027	.035	.148**	-.040	.148**	-.021	.091**	.116**	-.009	-.004	.059*	.024	.060*						
17 Innovation Productivity	1.82	6.24	.110**	.255**	0.05	.064*	.239**	.015	.215**	-.007	.126**	.111**	.008	.012	.033	.031	.051	.886**					
18 Cumulative Rounds of VC Funding	1.77	1.75	.027	.201**	.061*	.061*	.093**	.020	.058*	-.011	.169**	.064*	.029	.020	.071*	-.083**	.055	.068*	.086**				
19 Industry Segment Patents	183.18	127.08	-.146**	.088**	.105**	.108**	.033	-.026	.005	.078**	.050	-.025	.069*	.040	.094**	.019	.113**	.089**	.109**	.149**			
20 Industry Patents	3640.03	781.06	-.185**	.038	.137**	.104**	.031	.081**	.078**	.088**	.135**	.051	.064*	.041	.076*	.072*	.099**	.052	.047	.229**	.540**		
21 Industry VC Deals	502.91	172.63	-.210**	.084**	.193**	.141**	.030	.017	.088**	.120**	.123**	.030	.103**	.034	.068*	.050	.123**	.080**	.084**	.280**	.642**	.644**	
22 Industry VC Funding	2902.91	1561.28	-.215**	.086**	.166**	.123**	.054	.008	.085**	.110**	.119**	.037	.078**	.023	.068*	.043	.118**	.086**	.091**	.272**	.692**	.643**	.960**

*. Correlation is significant at the 0.05 level

**. Correlation is significant at the 0.01 level

Hypotheses 1-4a examine the effects of founder actions and parent organization characteristics on the quality of knowledge developed by the new genealogical venture. The results of the panel-based negative binomial regression models testing these effects are presented in Table 2-2.

Table 2-2: Test of Venture Knowledge Quality Hypotheses

Model Type	Negative Binomial Panel Regression		
Dependent Variable	Knowledge Quality		
	Model 1	Model 2	Model 3
Independent Variables			
Academic Proportion		0.276	-5.172*
Academic Proportion^2 (H1a)			5.634*
Variance in Founder Co-inventor Network Size (H2a)		-3.01E-04*	-2.99E-04*
Founder Publications		-0.022	-0.154
Founder Publications^2 (H3a)			0.006+
Founder Publication Impact		-1.03E-05	2.51E-04
Founder Publication Impact^2 (H3a)			-5.63E-08
Founder Patents (H4a)		0.067***	0.079***
Control Variables			
School Prominence ($M)	-2.24E-09	-2.22E-09	-2.15E-09
Average Founder Co-inventor Network Size	0.006	0.003	0.003
Variance in Founder Patents	-0.013	-0.011	0.001
Variance in Founder Publications	0.004	0.002	0.005
Variance in Founder Publication Impact	-1.31E-07	-9.72E-08	0.000
Parent Patents	2.98E-04	4.00E-04	5.59E-04
Public Parents	-0.381+	-0.341	-0.324
Number of Founders	0.204+	0.208+	0.252*
New Venture Technology Breadth	0.074**	0.104**	0.114***
Innovation Productivity	-0.008	-0.022	-0.029+
Cumulative Rounds of VC Funding	0.018	0.008	-0.010
Industry Segment Patents	-5.33E-04	2.22E-04	7.34E-05
Industry Patents	0.002	0.002	0.002
Industry VC Deals	-0.005	-0.003	-0.003
Industry VC Funding	0.001*	8.94E-04	9.01E-04
Observation Year Dummy Variables	included	included	included
Industry Segment Dummy Variables	included	included	included
Constant	-12.87	-12.17	-11.66
Wald Chi^2	94.40***	108.66***	115.29***

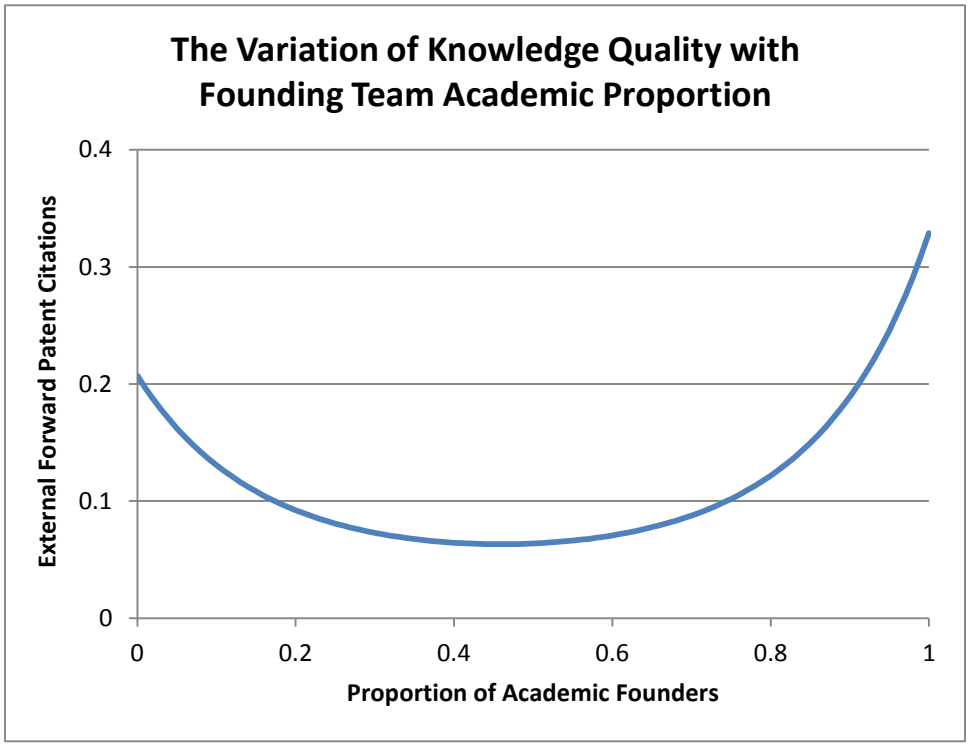
+p<.1 *p<.05 **p<.01 ***p<.001

Model 1 includes all of the control variables in the tests for knowledge quality. As shown, firms that engage in a relatively broader set of new technologies are more likely to develop higher quality inventions. In terms of the environmental controls, periods of greater venture capital funding at the industry level appear to be significantly associated with higher quality knowledge, perhaps giving a sense of linkages between technological advance and greater interest in investment in the biotech industry.

The direct effect independent variables are loaded in Model 2, along with the linear terms associated with the quadratic covariates to be added in Model 3. These terms are added for the sake of conservatism, in order to ensure that the linear effects of founder prominence and academic proportion do not undermine the direct effect hypotheses, though the results are robust independent of their inclusion. As demonstrated, greater variance in founder co-inventor network size is shown to have a negative, significant effect ($p<.05$) on knowledge quality. This is consistent with the theory proposed in hypothesis 2a, that greater differences in parent organization size may undermine the success of the new firm in generating higher quality inventions. At the same time, the coefficient associated with founder patent activity is positive and highly significant ($p<.001$), providing support for hypothesis 4a.

Model 3 incorporates the quadratic terms. The coefficient for the quadratic term associated with academic proportion in the founding team is positive and significant ($p<.05$), providing clear support for hypothesis 1a. To better interpret these findings, the relationship between academic proportion and knowledge quality is plotted in Figure 2-2.

Figure 2-2: Relationship between Founding Team Academic Proportion and Venture Knowledge Quality



The plot is generated by varying the proportion of academic founders from zero to one, holding all other covariates at their mean values. As anticipated, an even split between founders with academic vs. commercial backgrounds appears to result in a relative minimum in knowledge quality. In fact, the data indicates that the minimum occurs at an academic founder proportion of 0.46. Within the range of possible founding team proportions, it is interesting to note that the tails of the graph are not symmetric. Higher levels of academic founders (i.e. proportion approaching one) lead to greater knowledge quality than low levels (proportion approaching zero). At least within the study sample, this suggests that genealogical ventures formed around a dominant team of academic scientists are more likely to generate higher quality innovations.

Between the two operationalizations of founder academic prominence, *Founder Publications* provides some evidence of a positive (u-shaped) curvilinear effect. However, the coefficient for this variable is marginal ($p<.1$), and thus hypothesis 3a is not supported.

Hypotheses 1-4b test the effects of the independent variables on the outcome of IPO. The results of these tests are shown in Table 2-3. Hazard ratios are reported for all covariates in the Cox regression models. Significant values greater than one indicate that the variable increases the likelihood of IPO, while terms with significant values less than one demonstrate that greater values of the corresponding variable lead to lower likelihood of IPO.

Table 2-3: Test of Venture IPO Hypotheses

Model Type	Cox Regression Survival Analysis		
Dependent Variable	IPO (Hazard Ratios Reported)		
	Model 4	Model 5	Model 6
Independent Variables			
Academic Proportion		1.685	0.062
Academic Proportion^2 (H1b)			30.121
Variance in Founder Co-inventor Network Size (H2b)		0.998*	0.998*
Founder Publications		0.805	0.411
Founder Publications^2 (H3b)			1.029***
Founder Publication Impact		1.001*	1.005***
Founder Publication Impact^2 (H3b)			0.999*
Founder Patents (H4b)		1.174*	1.253*
Control Variables			
School Prominence ($M)	1.000	1.000	1.000
Average Founder Co-inventor Network Size	1.014+	1.010	1.007
Variance in Founder Patents	1.161	1.160	1.121
Variance in Founder Publications	1.013	1.077	1.097**
Variance in Founder Publication Impact	0.999	0.999*	0.999
Parent Patents	0.998	0.999	0.999
Public Parents	0.779	0.853	0.895
Number of Founders	1.210	1.113	1.109
New Venture Technology Breadth	1.123+	1.15*	1.159*
Innovation Productivity	1.021	1.024	1.027
Cumulative Rounds of VC Funding	1.574***	1.522***	1.527***
Industry Segment Patents	0.977	0.997	0.995
Industry Patents	1.003**	1.003***	1.003***
Industry VC Deals	1.124***	1.119***	1.127***
Industry VC Funding	1.009***	1.008***	1.009***
Observation Year Dummy Variables	included	included	included
Industry Segment Dummy Variables	included	included	included
Wald Chi^2	61295.98***	80864.32***	102587.85***

+p<.1 *p<.05 **p<.01 ***p<.001

Among the control variables loaded in Model 4, it is not surprising that several of them are highly significant in predicting a greater likelihood of IPO. At the firm level, more cumulative rounds of VC funding are associated with increased chances for the firm to go

public. This makes sense, given that venture capitalists use milestones attached to rounds of funding to provide incentive for greater firm performance. At the industry level, greater numbers of patents, more VC deals, and higher levels of overall VC funding correspond to greater chances at IPO. As observed in the knowledge quality models, this suggests the importance of trends in the broader biotech industry relative to the prospects for individual new ventures.

Model 5 incorporates linear terms for the independent variables. Once again, the linear components of the hypothesized quadratic relationships are included, though the results are robust to their omission. The variance in founder co-inventor network is significant ($p<.05$) and slightly lower than one. This provides support for hypothesis 2b, demonstrating that greater differences in parent organization size have a significant, if modest effect in diminishing the firm's chances to go public. The hazard ratio associated with founder patents is significant ($p<.05$) and greater than one, supporting the notion of hypothesis 4b, that founders engaged in the commercial activity of patenting increase the performance outcomes of the firm.

The quadratic terms are included in Model 6. The coefficient associated with the square of the proportion of academic scientists on the founding team is not significant. Thus, hypothesis 1b is not supported. The quadratic term for founder publications is highly significant ($p<.001$) in influencing chances for IPO. With a positive hazard ratio, this is consistent with the u-shaped curvilinear effect proposed in hypothesis 3b. At the same time the squared term for founder academic publication impact is significant ($p<.05$), though slightly lower than one. At a minimum, this suggests that academic publishing activity has a substantially different influence on firm outcomes than the impact of the academic founder's work. Perhaps higher quality

academic founders are better able to deliver impactful research in their field while maintaining a positive contribution for the new venture.

DISCUSSION

Contribution

The early stages of new venture formation are critical in shaping the strategy and performance prospects of nascent firms. This study contributes to our understanding of the role of genealogical organizational legacy in this process. In the absence of its own heritage, the new venture draws upon parent organizations as represented through members of the founding team. When the combination of backgrounds conveyed through founders incorporates divergent perspectives, this work suggests that there are potential negative consequences for the firm in terms of quality of knowledge creation and financial success.

This study also adds greater perspective to the role of academic entrepreneurs. While there has long been a sense of their importance in bridging the domains of basic science research and technology commercialization, we now have a better concept of conditions that may enhance or inhibit this relationship.

Limitations and Future Research

The concept of founding teams as an organizational melting pot opens broad avenues of investigation that are not addressed in this study. The contrasts of academic vs. commercial and large vs. small firm backgrounds are convenient first steps, well suited to the archival research methods employed in this paper. However, there are many other rich and interesting elements

that can be examined in future research. For example, what role does parent firm organizational culture play in the genealogical venture?

At a broad level, the theoretical lens of organizational culture provides ideas that may complement the notion of negative effects from founders' contrasting backgrounds. Cultural memes correspond to patterns and behaviors within social groups that are passed to subsequent generations (Dawkins, 1976). They provide an explanatory basis for the firm, and can either promote or decrease its performance (Weeks and Galunic, 2003). Culture plays a role in the pursuit and success of entrepreneurial activities. Capabilities such as opportunity recognition are enabled through organizational culture (Ireland et al., 2003). Culture interacts with managerial mindset to amplify or diminish entrepreneurial actions within an organization (Shepherd, Patzelt, and Haynie, 2010). The empirically observed underperformance of technology acquisitions (Fowler and Schmidt, 1988; Ranft and Lord, 2002; Kapoor and Lim, 2007) has been linked in some measure to the cultural conflicts that arise in the merger or integration of external firms (Weber, Shenkar, and Raveh, 1996). Cultural conflict or cultural distance can result in barriers to knowledge flow when organizations are merged, an assertion supported by experimental evidence (Weber and Camerer, 2003). Entrepreneurial ventures combining significantly different organizational cultures may experience analogous conditions and outcomes to those observed in dissonant mergers and acquisitions. Though more difficult to operationalize, differences in organizational cultural heritage within the founding team would provide the basis for an interesting next step in this domain of research.

Conclusion

This study examines the role of contrasting organizational backgrounds in influencing innovation and performance outcomes for genealogical new ventures. Set within the context of biotech ventures formed by founders from academic and commercial parent organizations, knowledge quality and IPO outcomes are studied for 242 start-ups in the period from 1990 to 2000. The empirical findings support the notion that broadly diverse organizational backgrounds within founding teams may undermine new venture innovation and growth. Additionally, founders may reduce or increase this effect through their choice to engage in activities that are or are not associated with the commercial goals of the organization.

CHAPTER 3 - ORGANIZATIONAL SIBLINGS: THE DYNAMICS BETWEEN GENEALOGICAL VENTURES FROM COMMON ORGANIZATIONAL PARENTS

ABSTRACT

Organizational genealogy examines the generational links between firms, demonstrating how founders of entrepreneurial ventures leverage the valuable knowledge and routines obtained from their experience with prior employers. Extending the analogy of the family tree, this study investigates organizational siblings, entrepreneurial firms whose founders share a knowledge heritage from their prior experiences with a common parent organization. Drawing from resource partitioning theory and knowledge spillover research, concepts of competition and mutualism are applied to propose a dual effect of siblings on organizational performance. These relationships are tested through a panel data design, examining VC-funded organizations in the biotech industry over 1,960 firm-year observations. Results support the notion of a "love/hate" relationship between siblings, with positive and negative effects on innovation and financial performance. These findings extend the theory of organizational genealogy and offer applications for technology strategy.

INTRODUCTION

Organizational genealogy is a unique and interesting research domain within the broader discipline of entrepreneurship (Klepper, 2001; Phillips, 2002). It examines the phenomenon of entrepreneurial ventures that are spawned from established firms, drawing on the underlying intuition that success breeds success (Agarwal et al., 2004). Tremendously successful and innovative high tech firms such as Fairchild, Microsoft, and Intel are perceived to be the launch pads for ambitious employees who choose to leave, applying their knowledge and experience to their own start-up firms. Given the history of these firms in spawning many successful new ventures, it is valuable to the field of management strategy to develop a greater understanding of the characteristics and interactions of "siblings," ventures from common parent organizations.

Prior research has studied the benefits that accrue to genealogical new ventures and the nature of interaction among related groupings of organizations. Genealogical new ventures have been theorized to gain advantage over non-genealogical entrants by efficiently pursuing market niches proximate to their parent firms (Klepper and Sleeper, 2005). This enables founders to effectively utilize the experience obtained during their tenure with the parent firm and lower the entry costs and risks associated with launching a new venture. This legacy of parent knowledge has been shown to improve legitimacy and access to funding (Chatterji, 2009) and boost the performance of the new venture (Phillips, 2002). In a separate stream of research, resource partitioning theory has provided valuable insights into the dynamics of survival and competition among firms pursuing different market niche strategies. This work demonstrates how generalists and specialists in a market can coexist by drawing on different resources (Carroll, 1985) and the impact on organizational founding and mortality caused by greater market concentration (Carroll and Swaminathan, 1999) and market niche width (Dobrev, Kim, and Hannan, 2001).

Prior work has not examined the dynamic interactions among communities of genealogically related "sibling" organizations. These firms are likely to compete in closely adjacent segments of the market as they build upon the heritage gained from their shared experiences with parent organizations. New research into this unique class of entrepreneurial venture provides an interesting opportunity to explore the dynamics between members of a sibling cohort. It is unclear whether they suffer from the intense competition with peer organizations from the same parent, or if they gain collective benefits from the pursuit of adjacent niche market opportunities.

This study addresses the following research question: How does the launch of multiple genealogical ventures from a common parent organization impact the innovation and financial performance of these firms? To address this question, the study examines firms in the biotech industry, evaluating the impact of sibling organizations through a panel data design spanning 392 new ventures tracked through 1,960 firm-year observations. This paper contributes to the organizational genealogy and entrepreneurship literatures by exploring organizational siblings as a novel class of marketplace competitors and helps develop a greater understanding of parent-progeny transfer.

THEORY AND HYPOTHESES

Genealogical Transfer of Knowledge

For any entrepreneurial venture, access to resources is a critical determinant of survival and success (Stinchcombe, 1965). Organizational resource endowment is critical to gaining competitive advantage, and market competitors benefit to the extent that they can maintain a favorable relative resource position (Wernerfelt, 1984). Within technology firms, knowledge is a

critical resource, socially constructed and often difficult to transfer or imitate (Kogut and Zander, 1992). While codified knowledge can be observed and replicated by outsiders, many aspects of technology and operating knowledge are tacit in nature, requiring first-hand experience to understand and apply them in external organizations (Howells, 1996). For this reason, opportunities to gain knowledge through direct participation can provide organizations with a substantial competitive advantage.

Genealogical firms represent a unique form of entrepreneurial venture in which founders have had the prior opportunity to participate in the training ground of successful industry incumbents. Genealogical firms can be defined as startups that are launched by founders who choose to leave their positions at "parent" organizations, established firms within the industry. Prior research in organizational genealogy has developed an intriguing body of evidence to suggest that such firms draw from their genetic lineage, gaining an edge over their competition. Genealogical ventures have been shown to enjoy an advantage over non-genealogical entrants in terms of survival (Phillips, 2002), funding (Chatterji, 2009), and productivity (Roberts, Klepper, and Hayward, 2009).

The source of advantage for genealogical ventures is thought to be the transfer of knowledge and routines from the parent to the progeny firm (e.g. Agarwal et al., 2004). Parent firms provide educational opportunities for entrepreneurial employees (Klepper and Sleeper, 2005), exposing them to proven practices and strategies associated with successful competition in the focal industry. The tacit knowledge gained by working at a parent firm is both rare and difficult to replicate by outsiders, making it a highly desirable and unique resource that can provide significant competitive advantage to progeny firms (Barney, 1991). At the same time,

the presence of firms in a position to draw from this same valuable source of knowledge may have important theoretical implications for competition and success of genealogical ventures.

It is possible to extend the notion of genealogy among organizations, revisiting the metaphor of the family tree by considering the case of organizational siblings. Sibling firms can be defined as genealogical entrepreneurial ventures founded by employees from a common industry parent. Employees at the parent organization may share similar access to research and development, have common experiences within the firm's social framework of knowledge, and have the same opportunity to observe successful and unsuccessful outcomes of technology projects. When multiple employees of the parent firm leave to found entrepreneurial ventures, they build on this common base of knowledge and experience. Thus, siblings are in a position to capitalize on the same knowledge endowment. They may represent a competitive threat to the unique resource advantage held by the focal genealogical venture, holding the potential to erode the competitive advantage that can be obtained through this otherwise rare and inimitable resource.

A Resource Partitioning Model of Sibling Competition

A theory of organizational siblings should explain the relationships between parents and their organizational progeny and describe the competition or coexistence among offspring. Natural science provides a potential foundation through the phenomenon of resource partitioning. Similar species in the same ecological community divide resources in a manner that allows greater organic diversity to survive in the environment (Schoener, 1974). Biological species coexist by drawing on different resources or using the same resources in a different

manner (e.g. Lawler and Morin, 1993). When the use of resources overlaps, species compete for survival in the natural environment.

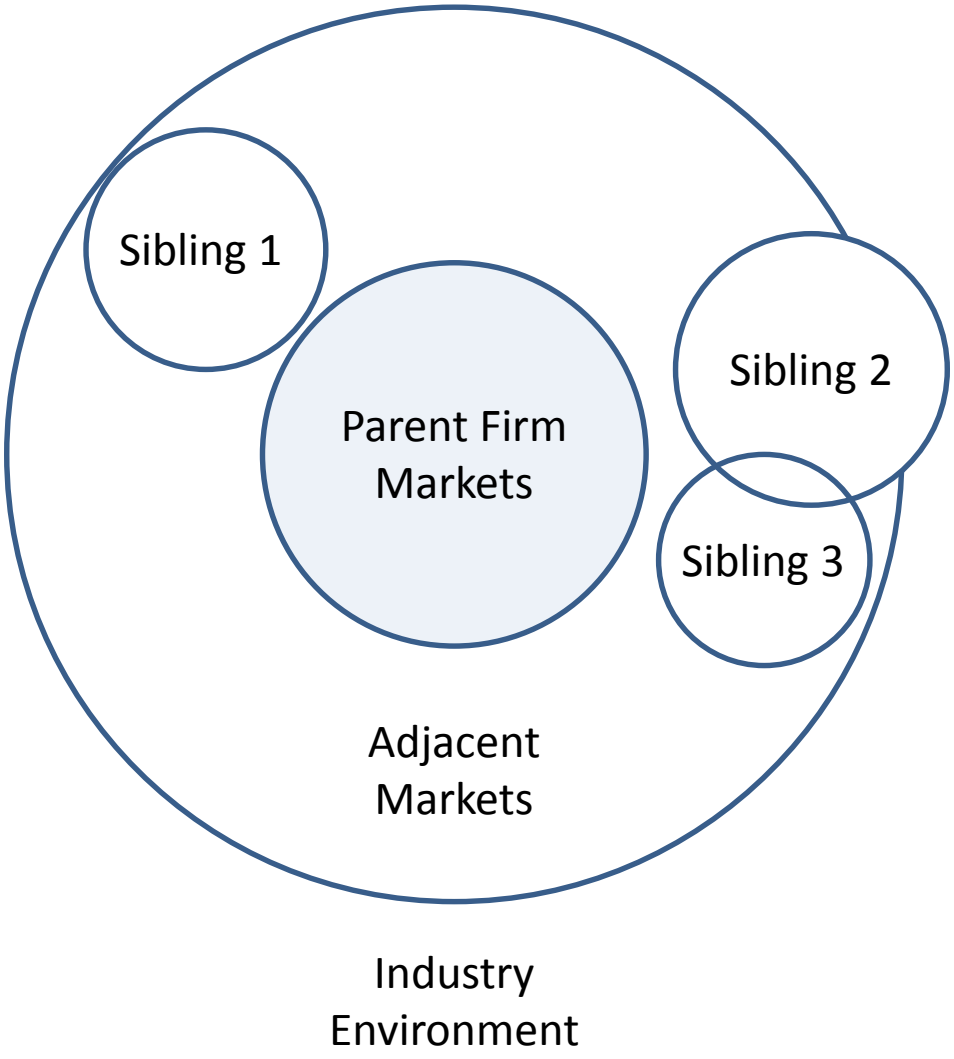
The theory of resource partitioning has a long history of useful application in the study of organizations. Markets are treated as the analogues of environmental resources; firms rely on the industry customer base within the market for growth and survival. In their efforts to compete in the environment, firms must choose strategies to pursue specific niches or to generalize across multiple market segments (Carroll, 1985). Firms that specialize tend to out-compete generalists in the narrow market regions that they target, while generalists are more likely to outlast specialists, spreading risk by drawing from resources across multiple market segments (Hsu, 2006). At the same time, the strategies of specialists and generalists allow them to coexist within the market. The market coverage of broad generalist firms leaves gaps in the resource environment (Peli and Nooteboom, 1999), allowing specialists to occupy smaller niche markets that avoid the attention of generalist firms.

The resource partitioning model offers a useful framework for understanding the relationship between genealogical parents and their multiple progeny organizations. Parent firms focus on a defined set of market segments within their industry. As established firms, they have identified their niche in the market resource space. They will center their efforts in the market position that is most advantageous in addressing consumer preferences, based on their technologies and capabilities. Whether parent firms act as generalists or specialists in the broader context of their industry, their role is analogous to that of the generalist organization within the smaller ecosystem comprised of the parent and its progeny. As successful, established firms, they will occupy a larger space in the market and serve a broader set of customers relative to the initial market focus of their offspring.

Within the genealogical ecosystem, progeny ventures are likely to occupy the specialist role in the resource partitioning model. In explaining the advantage of genealogical new ventures, Klepper and Sleeper (2005) argue that employees at the parent firm obtain specialized knowledge suited to the pursuit of adjacent market niches, outside the boundaries of the parent's direct focus. They suggest that the parent firm either fails to recognize these opportunities or unsuccessfully gambles that employees will not leave to pursue them. Resource partitioning theory provides a third explanation, that progeny firms play the role of specialists, occupying market resource locations that are outside the area of interest of the generalist firm (Carroll, 1985). At least in their initial founding stage, they will pursue a smaller, more focused market segment than that served by the parent organization. As a consequence, they are able to coexist with the parent firm, drawing on different resources in the environment and thus presenting no direct competitive threat to the parent.

It is possible to conceive of adjacent market knowledge obtained from the parent in a spatial sense, with the progeny venture's zone of advantage occupying a specific, finite space of market opportunities. This concept is illustrated in figure 3-1.

Figure 3-1: Market Segment Relationships among Siblings



Employees within the parent organization gain knowledge of parent firm markets and those that are directly adjacent. As discussed, founders who leave to form genealogical firms do best to pursue segments that are beyond the boundary of operations for the parent firm, avoiding direct competition with such an established and capable player within the industry. At the same time, genealogical ventures gain the most benefit from parent knowledge when they pursue market segments or niches adjacent to those of the parent. They are likely to choose a space

sufficiently close to parent firm market segments that the knowledge obtained during their tenure at the parent remains relevant and useful.

From the market opportunity constraints placed on genealogical ventures, it follows that the valuable resource of adjacent market knowledge is bounded. To the extent that adjacent niche market technology opportunities are finite, the emergence of multiple genealogical ventures from a common parent may result in competition between these firms, leading to different outcomes for those ventures that are more or less successful in capitalizing on the knowledge and experience gained from the parent firm. Siblings that are spatially and temporally adjacent to each other in the market environment may compete for the favorable niche opportunities that can be reaped through their exposure at the parent firm.

The sibling's choice of niche market location can impact the degree of competition with the focal firm. An illustration of this effect might be the proximal launch of two genealogical firms in the biotech industry from a common parent, one which uses gene splicing processes based on parent technologies to cure human disease, while the other applies similar technologies in the agriculture market, developing disease resistant crops. They would each benefit from the initial knowledge legacy from the parent, without the threat that their sibling's technologies would be commercialized in their specific market. This situation is represented in Figure 3-1 as the relationship between sibling 1 and sibling 2. Though the two firms occupy market locations that are adjacent to the parent organization, they are positioned in distant segments relative to each other. In contrast, if the siblings both used gene splicing technologies for similar human treatments, there will be substantial similarity in terms of the resources they require from the market environment for survival and success. This is represented in Figure 3-1 as the relationship

between sibling 2 and sibling 3. The market niches of these firms overlap, greatly increasing the likelihood of competition.

The potential for overlap and resulting competition between siblings has negative implications for the performance of the focal firm. In the resource partitioning model, the mortality rate of an organization is found to increase with greater niche overlap density (Dobrev, Kim, and Hannan; 2001). Applying this concept to the genealogical ecosystem, greater market overlap between siblings in the finite space adjacent to the parent firm will similarly lead to negative outcomes. Potential investors may view the presence of siblings in close market proximity as an ominous sign. They will once again consider the launch of the new venture to involve greater risk and have greater reluctance in their decision to fund the firm.

Hypothesis 1: The presence of genealogical siblings in the same industry segment will decrease the funding that is received by the focal firm.

The performance of its siblings is an important factor that is likely to impact the outcomes for a focal genealogical venture. One critical domain of competition among emerging entrepreneurial ventures is the acquisition of financial resources. Entrepreneurial ventures are generally privately owned, revealing limited information on their performance and success. Access to investment funding can serve as a proxy measure of success, demonstrating the decisions of knowledgeable investors to support or not support the venture (Baum and Silverman, 2004). It can be inferred from their decisions whether the capabilities and strategies of the new venture are likely to lead to success.

If the adjacent market space was not bounded or was not pertinent to sibling competition, greater funding for siblings would be irrelevant to the decisions of investors to back subsequent

genealogical ventures. One could even make the argument that success of a sibling may actually serve as a positive signal. Through some mechanism of organizational legitimacy, firms with more successful siblings might reap a halo effect, boosting their access to investment. However, under the proposed model of sibling competition, the adjacent market space surrounding the parent firm is finite. The presence of a successful sibling that has obtained access to greater funding suggests that a significant position in the adjacent market space is occupied by a capable competitor, thus limiting the prospects for the focal entrepreneurial venture. Informed investors will observe this development and be guarded in their willingness to provide funding for the new firm. The risk of investing in such a firm is heightened by the financial strength of its siblings, making investors more reluctant to participate. This leads to the following hypothesis:

> **Hypothesis 2:** The presence of genealogical siblings that have obtained more investment funding will decrease the funding that is received by the focal firm.

Sibling firms that are well-established may also represent a formidable threat to the focal venture. First-movers in a given market may gain advantages in building market share and developing their strategies and operational skills in the new business (Kerin et al., 1992). Older sibling firms will have had a chance to establish themselves in the marketplace and more effectively overcome the general liabilities of newness associated with entrepreneurial ventures (Stinchcombe, 1965). They will have more time to engage in research and development of their initial products, and they may be closer to achieving profitability.

In the context of the genealogical ecosystem, the "eldest" siblings have the early opportunity to build on parent knowledge and skills. These first ventures in the sibling cohort have the advantage of selecting the most promising niche market positions adjacent to the parent.

In the time prior to the launch of subsequent siblings, the eldest siblings monopolize the advantages of their heritage, providing them an exclusive position in reaping the genealogical benefits over non-progeny firms in the marketplace (Phillips, 2002; Chatterji, 2009). At the same time, they obtain critical experience and fortify their position relative to emergent siblings, the one class of competitors that has the ability to counter or at least match the competitive benefits of knowledge taken from the parent organization.

Venture capitalists and other investors may question the ability of a genealogical venture to overcome the advantageous market position of previously established siblings. As a consequence, investors may be less sanguine in their assessment of the prospects for success of the focal venture. Potential competition with established siblings leads to increased risk, leaving investors less willing to provide greater levels of funding. This leads to the following hypothesis:

> **Hypothesis 3:** The presence of older genealogical siblings will decrease the funding that is received by the focal firm.

Sibling organizations that are both well-established and occupy a relatively close region of the genealogical opportunity space provide the most potent competitive threat to the new venture. First-mover advantages of increased market share, greater customer awareness, and greater operational efficiency (Kerin et al., 1992) gained by established siblings more directly impact the new venture. In their efforts to obtain resources, they must overcome rivals that 1) have had more time to develop new products and technologies from the parent's legacy knowledge and 2) have applied this knowledge in the same target markets. Potential investors are likely to consider this greater competitive threat in their decision to fund the focal firm. Competitors that have a time-based advantage and are proximally located to the market segment

of the new firm increase the level of risk for investors, potentially making them less willing to invest or to causing them to reduce the amount of investment in the genealogical new venture.

> **Hypothesis 4:** The presence of genealogical siblings that are both better established and located in the same market segment will have an interactive compounding effect in reducing the funding of the focal firm.

Sibling Mutualism through Knowledge Spillover

The dynamics among organizational siblings may not be confined to detrimental effects. It is possible that genealogical ventures may benefit from their membership in the sibling cohort. Concepts drawn from research in community ecology may support this assertion. Community ecology examines groupings of organizations that share a common geographical position or common location within the resource space (Freeman and Audia, 2006). Within the context of community ecological systems, the negative impact of competitive forces plays an important role, but beneficial effects are also observed among organizations within the system. Under some circumstances within the community, a greater population density of organizations drives higher mortality due to competition; under other circumstances, greater density reduces mortality through the effects of mutualism (Barnett, 1990). This beneficial effect of mutualism is described as "supplementary similarities" or "complementary differences" among firms (Hawley, 1950). These are characteristics of organizations that allow them to benefit from each other's existence, outside of the deleterious effects of direct competition.

Prior research has provided empirical evidence of competition and mutualism in community ecological systems. Localized competition in the Manhattan hotel industry is observed to increase with similarities in size, geographic location, and price (Baum and Mezias,

1992). Within the same localized industry segment, firms are shown to benefit through spillovers from adjacent competitors, provided they are sufficiently different to avoid direct competition (Baum and Haveman, 1997). In this case, price similarity leads to advantageous clustering of local hotels that are adequately differentiated by size to attract distinct target groups of customers.

Drawing from the concept of mutualism, there may be conditions in which firms benefit from their membership in the sibling cohort. The genealogical venture may profit from the opportunity to observe sibling technologies, in spite of their competitive relationship in the market environment. Prior research has shown that competitors may gain information through knowledge spillover, obtaining technologies from an external firm and organizing them in new combinations or applications (Jaffe et al., 1993). Firms conducting research in areas that are more extensively researched by other organizations are shown to have higher innovation productivity (Jaffe, 1986). Bower (2003) describes the example of Genentech, which established core technologies around the isolation of genes for use in therapeutic treatments. This key development was leveraged by both external competitors and direct genealogical descendants of the firm, allowing them to create subsequent innovations that covered a wide array of applications.

Through a process of reverse spillover, the focal firm may also observe new knowledge combinations and benefit from new ideas or a fresh perspective on the application and advancement of their technologies (Yang et al., 2010). This relationship is enhanced through greater relative absorptive capacity between spillover firms (Lane and Lubatkin, 1998). Familiarity with technologies of the external firm provides the focal organization with the

knowledge and technological capability to recognize spillover opportunities and successfully pursue them.

Genealogical siblings may be in a unique position to benefit from the process of knowledge spillover. The common experience and exposure to technologies during their tenure at the parent firm may give founders an advantage in recognizing new opportunities from the innovations developed by their siblings. Common heritage and expertise may heighten the relative absorptive capacity between these firms, providing them with a shared language or frame of reference through which to build on each other's innovations. When market competitors are siblings, the opportunities for spillover and reverse spillover may be more numerous, leading to a higher likelihood that the focal firm will benefit in the form of greater levels of innovation.

A genealogical venture may have greater opportunities to benefit from knowledge spillover when it has higher quality siblings. Such siblings may develop stronger ideas and more innovative technologies. They may possess a greater level of absorptive capacity, enabling them to capitalize on external technological developments and translate them into useful applications (Cohen and Levinthal, 1990). This greater innovation productivity may lead to more opportunities for spillover exploitation for their fellow sibling firms. This relationship leads to the following hypothesis:

> **Hypothesis 5:** Genealogical siblings with greater innovation performance will increase the innovation performance of the focal firm.

The most valuable opportunities for knowledge spillover among sibling firms are likely to emerge when the siblings are engaged in adjacent technologies. Greater relative absorptive capacity through common bases of knowledge has been shown to increase learning between

organizations (Lane and Lubatkin, 1998). Greater adjacency or technology overlap is associated with siblings that have chosen a common trajectory for the innovations they build from the technological heritage of the parent firm. They will possess higher levels of relative absorptive capacity, taking a similar approach in building on the unique knowledge and language that represent their common heritage from the parent firm. Their ideas are more likely to be useful in each other's market applications. The core knowledge contained in the new ideas is more likely to overlap, making it easier for sibling organizations to understand and recognize incremental opportunities.

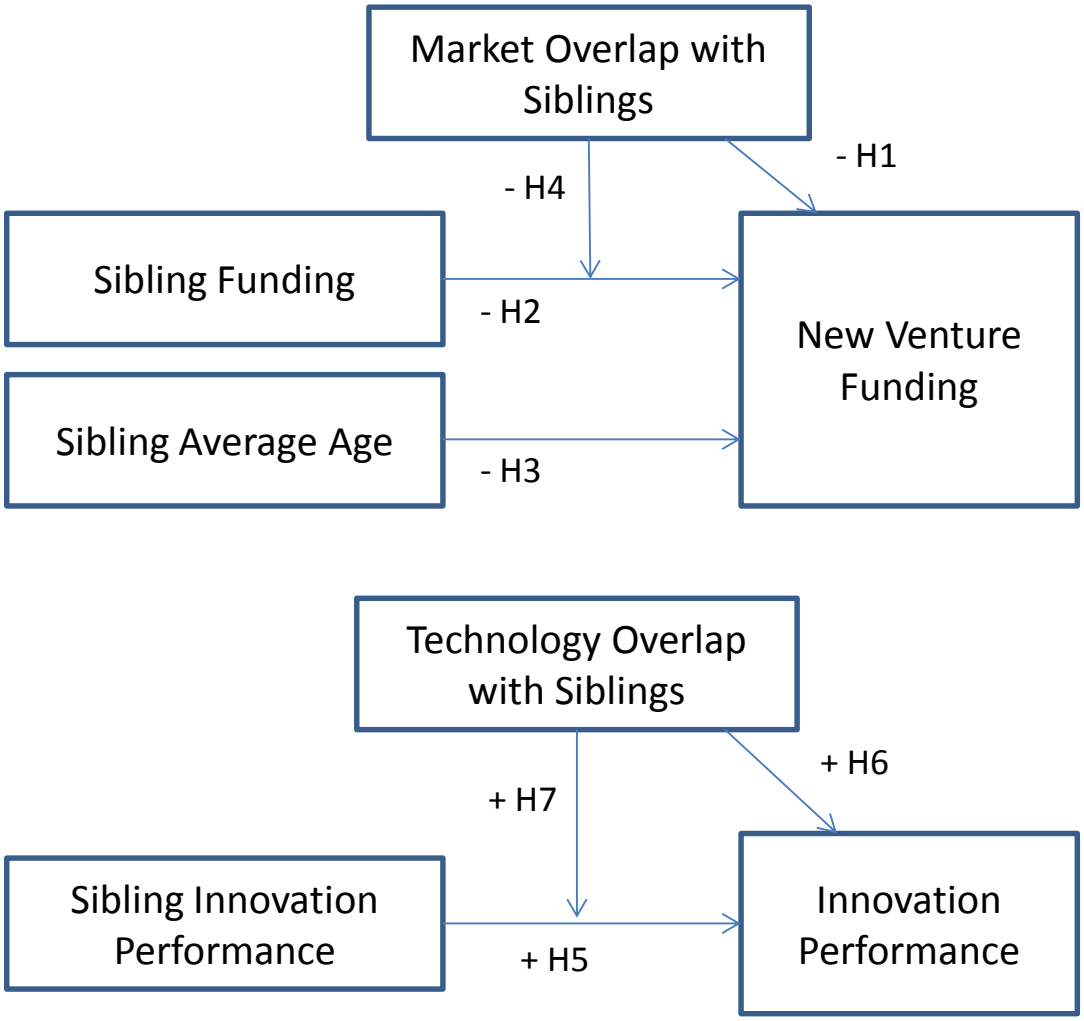
> **Hypothesis 6:** Greater technological overlap with genealogical siblings will increase the innovation performance of the focal firm.

The combination of stronger innovation performance in a sibling organization and greater overlap of its technologies with the focal firm is likely to enhance the opportunities for knowledge spillover. Not only would such a sibling generate more ideas that might be exploited through spillover, but these ideas will also occupy a more familiar position in the knowledge base of the new venture. It will be easier for the focal venture to adapt the broader offering of sibling innovations to its own purposes, leading to new market applications from more closely related extensions of the original parent technologies.

> **Hypothesis 7:** Greater sibling innovation performance and greater technological overlap will have an increasing, interactive effect on the innovation performance of the focal firm.

The hypothesized relationships in the study are summarized in Figure 3-2.

Figure 3-2: Hypothesized Relationships



METHODS

Sample and Data Sources

This study focuses on new ventures created in the biotech industry. The biotech industry offers a strong patent appropriability regime (Cohen et al., 2000; Shane, 2001), which allows the observation of new innovations through archival data sources. It also provides a dynamic competitive environment in which the founding of genealogical ventures is a relatively common practice (Stuart and Sorenson, 2003). Many of these genealogical ventures emerge from common parent organizations, large biotechnology or pharmaceutical companies with established market and financial positions within the industry (Bower, 2003).

The study employs a panel design with a 5 year observation window, tracking the financial and innovation performance of all new ventures founded in the biotech industry from the years 1990 to 2000 that received venture capital funding. Prior research has shown that venture capital investment is a common route for new venture financing in this industry (Hand, 2007); the favorable patent protections enable start-ups to quickly leverage new inventions and technology trajectories to obtain VC investment. An initial search was conducted in the Dow Jones VentureOne database, a proprietary resource that collects information on entrepreneurial firms, their founders, and the history of their funding for all U.S. venture capital investments. This search yielded a baseline data sample of 392 VC-backed biotech firms established by one or more biotech industry founders. With the 5 year observation window, this results in a total of 1,960 firm-year observations in the base sample.

Prior research has defined genealogical, or parent – progeny relationships through the employment history of the new venture founders. Using the VentureOne dataset, the names of all

founders were mapped to the unique individual ID codes established in the disambiguated Harvard inventor data (Lai, D'Amour, and Fleming, 2009). For each patent that 1) has the focal founder listed as an inventor and 2) most recently pre-dates the founding date of the new venture, the firm listed as the assignee on the patent is considered to be a "technology parent" organization. This method of establishing genealogical links draws on the comprehensive work history of founders in all prior firms where he or she has been active in patenting inventions over the course of his or her career, as far back as 1975. Since the relevance of a founder's past experiences may diminish over time, technology links to parent organizations that occurred ten years or more prior to the founding of the new venture are excluded from the sample. Using this process, a total of 93 parent-progeny relationships are observed within the initial sample of 392 firms.

A central element in the design of the study is the empirical definition of sibling organizations. The theoretical foundations laid out in this paper rest on the assumption that founders of sibling organizations share common experiences from their work at the parent firm. It is possible that changes over time in strategy, leadership, or financial performance of the parent organization can alter the experiences of prospective founders. Thus, the results of the study may be sensitive to longer lags between the time periods of sibling founder tenure. To address this issue, the definition of siblings is restricted to a +/- 5 year window, i.e., the focal firm is recognized to have a sibling organization when an employee of the founder's parent firm leaves to start his or her own organization during any time from five years prior to five years after the founding of the focal venture. This ensures that sibling founders will be at most five years distant in terms of the timing of their exposure to business practices, routines, and technologies of the parent organization. Using these criteria, a total of 66 sample firms are

identified as siblings, sharing 152 familial relationships during the period of observation. Note that once an organization is defined as a sibling, it is tracked for the duration of the observation window; the study hypotheses rest on the logic that organizations founded from a common heritage will continue to compete and develop in an interactive fashion over time.

Dependent Variables

Hypotheses 1 through 4 examine the effects and dynamics of sibling organizations in shaping the focal firm's access to funding. New ventures in technology industries are often closely held concerns that do not publish information on assets, sales, profits, or return on investment. However, it is possible to gain insight into the performance of these firms by observing the decisions of third party venture capitalists to provide initial funding or to offer continuing investments in the organization (Shane and Stuart, 2002). Funding decisions of venture capitalists provide the market with valuable information on the performance and viability of new technology firms (Fried and Hisrich, 1994; Baum and Silverman, 2004). The dependent variable, *New Venture Funding* is thus measured as the total venture capital funding received by the new venture in the year of observation. This information is obtained through VentureXpert, a proprietary database of Thompson Financial that tracks U.S. venture capital investments.

Hypotheses 5 through 7 propose relationships between siblings and the innovation performance of the focal firm. To capture this outcome, *innovation performance* is measured as the number of patents successfully filed by the focal venture in each year of the five year observation window. Patents have been shown to be an effective measure of innovation performance in the biotech industry (Ahuja, 2002; Baum and Silverman, 2004). Greater patent activity is associated with the development of new innovations and represents extensions of the

knowledge base of the firm (Acs et al., 2002; Schilling and Phelps, 2007). Patenting can lead to greater market opportunities and competitive success (Lanjouw and Schankerman, 2004). New patent applications require time for the U.S. Patent and Trademark Office to reach a decision in terms of granting or rejecting the patent. The data collection window for this study extends through 2010; with 2004 as the final year of observation in the study, this allows a minimum of six years of time to elapse for patent applications to be resolved. Prior research demonstrates that the mean lag time between patent application and grant decisions in the United States is 1.8 years, and 99.5% of all patent applications are resolved within a six year window (Hall et al., 2001). Patent data for the study is obtained through the National Bureau of Economic Research (Hall et al., 2001) and the Harvard Business School patent network website (Lai, D'Amour, and Fleming, 2009), with supplemental information through the search engine website of the U.S. Patent and Trademark Office.

Independent Variables

In each firm-year of the panel data, the *Average Sibling Age* is calculated among all firms that meet the criteria of sibling organizations. Older siblings have more time to establish themselves in the industry, increasing the competitive threat for the focal new venture.

Sibling Funding is operationalized using the same measure as the funding of the focal venture. It is captured as the total amount of venture capital investment awarded to a focal firm's sibling organizations in each year of observation.

In the regression models analyzing effects on new venture funding, the level of overlap between the focal firm and its siblings is evaluated by comparing the market segments in which they are established. Siblings operating in the same market segment may increase the level of

competition or knowledge spillover to a greater extent than siblings in different areas within the biotech industry. The VentureOne database captures four different industry segments for VC-backed biotech firms founded between 1990 and 2000: biotechnology therapeutics, drug delivery, drug development technologies, and pharmaceuticals. Each sibling organization is categorized as either matching or not matching the industry sector of the new venture. The variable, *Ratio of Siblings in the Same Industry Segment*, is then calculated as the number of siblings in the focal firm's segment divided by the total number of siblings for each year of observation.

Sibling Innovation Performance is measured in the same fashion as the dependent variable for the innovation performance of the new venture. The total number of successful patent applications across all sibling firms in the year of observation is recorded, again obtained through the NBER (Hall et al., 2001) and the U.S. Patent and Trademark Office.

It is hypothesized that common technological focus with its sibling organizations may influence the financial and innovation performance of the new venture. *Technology Overlap with Siblings* measures the proportion of common primary international patent classification (IPC) codes on patents held by the sibling and the focal venture (Rosenkopf & Alameida, 2003; Colombo, 2003). The result of this calculation ranges from 0 for firms that have no common primary patent classification codes to 1 for firms that develop patents in completely overlapping primary patent classification code areas. In cases where the focal firm has more than one sibling, the average value of technology overlap across all dyadic relationships is recorded.

Control Variables

Several controls are included in the study to address endogeneity or potential bias due to omitted variables that may confound the results (Hamilton and Nickerson, 2003; Shaver, 1998). While the use of fixed effects models in all tests of study hypotheses excludes the possibility of time-invariant enodogenous effects, it is necessary to anticipate and control for a number of time-varying factors. Control variables to address potential confounding effects at the firm, market segment, and industry levels are identified.

Nascent firms may benefit from greater human capital through the hiring or deployment of new scientists. Expanding the R&D team may provide an opportunity to enhance or replenish knowledge stocks (Al-Laham et al., 2011), potentially allowing a genealogical organization to extend its technologies beyond the endowment received from the parent firm. Thus, *R&D Human Capital* captures the cumulative count of unique inventors listed in focal firm patents over the period of observation.

Cumulative rounds of VC funding is included as a firm-level control variable to address the potential advantage to organizations that have successfully obtained prior rounds of venture capital investment. The completion of such milestones may indicate a track record of performance that could lead venture capital firms to increase their subsequent level of investment in the focal firm. Such firms may also demonstrate greater productivity in developing new knowledge. Information on cumulative rounds of funding for each firm in the sample is collected through the VentureXpert database and recorded for each year of observation.

In the innovation performance models, *Cumulative Amount of VC Funding* is included as a control. Access to greater financial resources may have a direct beneficial effect on the efforts of a new venture to conduct research and development into new technologies. Conversely, the

dependent variable, *Innovation Performance*, is included as a firm-level control in the financial performance models. Success in developing new innovations may improve the chances of the new venture to gain additional VC investment. The independent variables, *Average Sibling Age* and *Ratio of Siblings in the Same Industry Segment* are also applied as controls in the innovation performance regression models.

At the industry segment level, new technology breakthroughs from non-sibling competitors may have an impact on the innovation performance of the venture. *Industry Segment Patents* controls for this potential effect. It is measured as the total number of successful patent applications within the segment in the year of observation.

Several effects at the broader biotech industry level are controlled in the study. *Industry Patents* measures the number of successful patent applications launched across all biotech firms in each observation year. *Industry VC Deals* and *Industry VC Funds* capture the number of venture capital deals and amount of venture capital funding invested in each year of the study. These variables account for potential industry environmental effects of munificence and innovation that may contribute to firm-level outcomes.

Finally, other general macroeconomic effects may impact the performance of firms. To broadly capture such potential influences, observation year dummy variables are included in all econometric models. These variables are coded as 1 or 0, based on whether or not the control variable year coincides with the corresponding year of observation.

Modeling and Study Design

The performance of each organization in the dataset is tracked over 5 years from the year of founding, allowing the use of panel data econometric techniques. New venture funding takes

on a continuous distribution which is suited to panel OLS regression modeling. The innovation performance variable takes on a discrete distribution and is analyzed through panel-based negative binomial regression models. Normally, a Poisson distribution model is appropriate for discrete outcomes, but the patent data exhibits overdispersion, a skewed incidence of zero-valued observations, in the distribution of the variable. As a result, the negative binomial model is appropriate (Hilbe, 2007).

In the financial performance analysis, firms that fail, are acquired, or successfully complete the IPO process are no longer in a position to seek or require venture capital funding. Panel observations for these firms would necessarily record zero values for the financial performance dependent variable, thus biasing the results of the analysis. For this reason, all such observations are dropped from the sample. A total of 201 observations are omitted from the models analyzing financial performance, leaving a net sample of 1,759 firm-year observations arrayed in an unbalanced panel.

RESULTS

Descriptive statistics and bivariate correlations of all study variables are shown in Table 3-1. Among the correlations of independent variables listed in Table 3-1, the correlation value between the ratio of siblings in the same industry and average sibling age is relatively high, at .693. However, a variance inflation factor (VIF) analysis confirms that multicollinearity is not an issue for this or any other relationships between study covariates. All independent variables score 2.25 or lower, well below the general rule of thumb threshold of 5.0 (Dielman, 1991).

The results of the regression models testing hypotheses associated with financial performance are presented in Table 3-2.

Table 3-1: Descriptive Statistics and Correlations

	Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13
1	New Venture Funding	4.57	12.43													
2	Innovation Performance	1.34	4.93	.090**												
3	Average Sibling Age	0.34	1.11	.082**	.115**											
4	Sibling Funding	0.86	7.37	.027	.002	.312**										
5	Sibling Innovation Performance	0.67	4.22	.073**	.013	.340**	.200**									
6	Technology Overlap with Siblings	0.04	0.17	.046	.044	.401**	.140**	.246**								
7	Ratio of Siblings in Same Industry Segment	0.05	0.14	.065**	.088**	.693**	.142**	.352**	.404**							
8	R&D Human Capital	3.52	10.55	.121**	.833**	.188**	.025	.039	.087**	.121**						
9	Cumulative Rounds of VC Funding	1.60	1.71	.312**	.102**	.136**	.035	.063**	.096**	.092**	.178**					
10	Cumulative Amount of VC Funding	10.32	23.75	.781**	.117**	.136**	.050*	.097**	.071**	.084**	.178**	.466**				
11	Industry Segment Patents	164.70	126.84	.087**	.111**	.166**	.087**	.053*	.067**	.157**	.123**	.170**	.102**			
12	Industry Patents	3526.84	851.14	.130**	.056*	.125**	.070**	.095**	.052*	.112**	.094**	.265**	.181**	.561**		
13	Industry VC Deals	480.71	178.89	.199**	.089**	.193**	.054*	.123**	.080**	.140**	.135**	.314**	.256**	.649**	.703**	
14	Industry VC Funding	2712.70	1598.73	.199**	.095**	.184**	.059**	.141**	.081**	.144**	.131**	.307**	.255**	.684**	.688**	.964**

*. Correlation is significant at the 0.05 level

**. Correlation is significant at the 0.01 level

Table 3-2: Venture Funding Regression Models

Model Type	OLS Panel Regression		
Dependent Variable	New Venture Funding		
	Model 1	Model 2	Model 3
Independent Variables			
Ratio of Siblings in Same Industry Segment (H1)		1.761	4.705
		(4.246)	(3.580)
Sibling Funding (H2)		-0.042+	-0.050+
		(0.027)	(0.028)
Average Sibling Age (H3)		-0.833*	0.229
		(0.458)	(0.810)
Sibling Age X Ratio of Siblings in Same Industry Segment (H4)			-3.552*
			(2.135)
Control Variables			
R&D Human Capital	0.059	0.069	0.066
	(0.083)	(0.084)	(0.084)
Innovation Performance	0.304+	0.298	0.300
	(0.182)	(0.186)	(0.186)
Cumulative Rounds of VC Funding	3.400***	3.462***	3.469***
	(0.431)	(0.449)	(0.449)
Industry Segment Patents	-1.65E-05	4.86E-04	0.001
	(0.005)	(0.005)	(0.005)
Industry Patents	-0.002*	-0.002*	-0.002+
	(0.001)	(0.001)	(0.001)
Industry VC Deals	0.002	0.002	0.001
	(0.009)	(0.009)	(0.009)
Industry VC Funding	-0.002+	-0.002+	-0.001+
	(0.001)	(0.001)	(0.001)
Observation Year Dummy Variables	included	included	included
Constant	7.843***	8.277***	8.274***
	(2.002)	(2.100)	(2.099)
Model F-Value	14.31***	12.10***	11.73***

+p<.1 *p<.05 **p<.01 ***p<.001

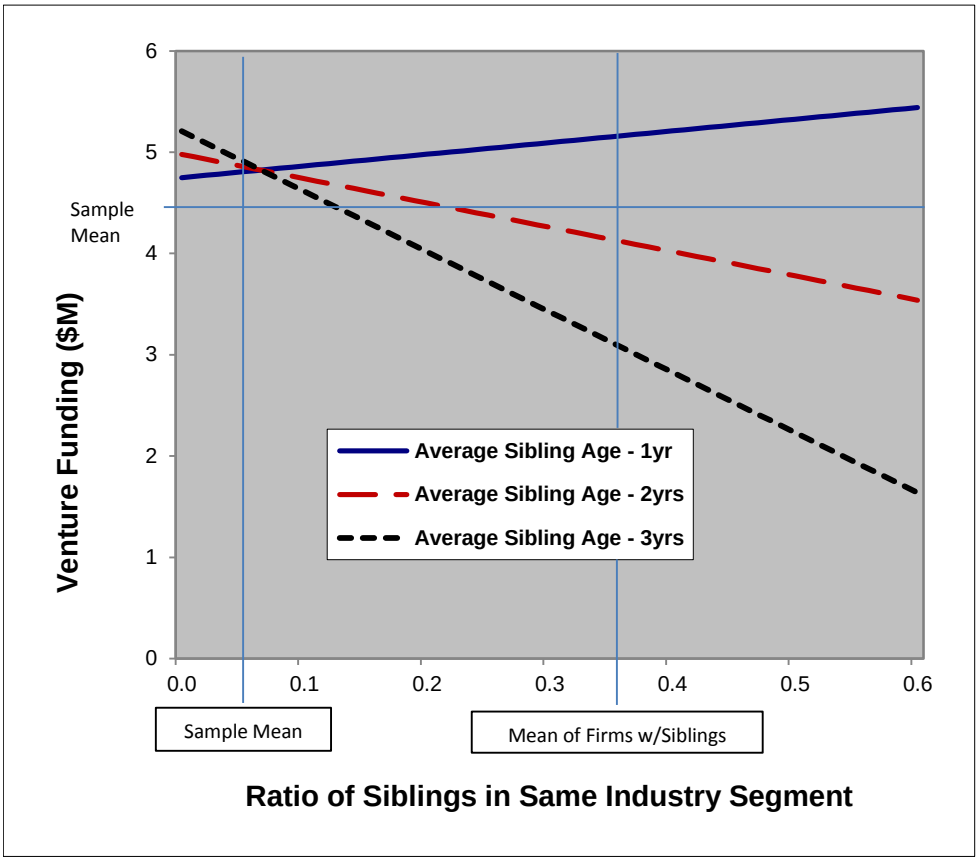
(robust standard errors in parentheses)

Model 1 of Table 3-2 loads the control variables for the regression analysis assessing new venture funding. It is not surprising that this model reveals a positive, significant relationship between the cumulative rounds of venture capital investment and venture capital funding. There is a negative and significant relationship between industry patent activity and new venture funding, perhaps suggesting that competition for venture capital resources in the biotech industry intensifies during periods with generally higher levels of innovation.

Model 2 in Table 3-2 adds the tests of direct effects of the independent variables on new venture funding. The test of hypothesis 1, that having siblings that compete in the same market segment reduces funding for the focal firm is not supported. The regression coefficient associated with the ratio of siblings in the same market segment is not significant in predicting funding. The coefficient for sibling funding is negative and weakly significant ($p<.1$). Thus, the model fails to fully support hypothesis 2, the notion that having siblings that receive greater VC funding negatively impacts funding prospects for the focal firm. The coefficient for average sibling age is negative and significant ($p<.05$). This supports the relationship proposed in hypothesis 3. The presence of siblings that are more established in the industry leads to reduced funding for the focal firm.

In model 3, the interaction between sibling age and the ratio of siblings in the same industry segment is added. The coefficient for this term is negative and significant ($p<.05$), providing support for hypothesis 4. To fully understand the implications of this result, it is necessary to plot this interactive relationship. Figure 3-3 provides a graphical illustration of the relationship between ratio of siblings in the same industry segment and the impact on new venture funding, plotted for three different values of average sibling age: 1, 2, and 3 years. All other covariates are held at their mean values.

Figure 3-3: Interaction between Sibling Age and Industry Segment Overlap



Interestingly, the presence of sibling firms that are 1 year of age or lower provides a slightly positive effect on new venture funding with increasing levels of industry segment overlap. Perhaps this is due to beneficial signaling effects for the focal venture; VC investors may observe the recent launch of other new companies from the same parent organization and interpret this as a good sign for the performance or market acceptance of the focal firm. When sibling firms are older, this trend quickly reverses. At average sibling ages of 2 years and higher, there is a clear negative trend between industry segment ratio and new venture funding. These results may shed also light on the insignificant findings in the test of hypothesis 3. The relationship between sibling market overlap and focal firm funding is clearly dependent on

sibling age, and direct effects are masked by this positive to negative slope transition that occurs with siblings between one and two years of age. At the same time, the observations depicted in Figure 3-3 are fully consistent with the theoretical relationship proposed in hypothesis 4; sibling firms that are both more established and operating in the same segment as the new venture have a negative impact in its effort to obtain funding.

Table 3-3 reports the results of the negative binomial panel regression models used to test hypotheses associated with new venture innovation performance.

Table 3-3: Innovation Performance Regression Models

Model Type	Negative Binomial Panel Regression		
Dependent Variable	Innovation Performance		
	Model 1	Model 2	Model 3
Independent Variables			
Sibling Innovation Performance (H5)		0.054**	0.069***
		(0.018)	(0.017)
Technology Overlap with Siblings (H6)		1.403***	1.654***
		(0.220)	(0.246)
Sibling Innovation X Technology Overlap (H7)			-0.163*
			(0.074)
Control Variables			
Average Sibling Age	0.012	-0.059	-0.050
	(0.048)	(0.052)	(0.052)
Ratio of Siblings in Same Industry Segment	0.222	0.174	0.223
	(0.513)	(0.507)	(0.508)
R&D Human Capital	0.010***	0.011***	0.010***
	(0.002)	(0.002)	(0.002)
Cumulative Rounds of VC Funding	0.087*	0.086*	0.080*
	(0.039)	(0.039)	(0.040)
Cumulative Amount of VC Funding	0.002	0.001	0.001
	(0.003)	(0.003)	(0.003)
Industry Segment Patents	-6.83E-04	-4.74E-04	-3.70E-04
	(0.001)	(0.001)	(0.001)
Industry Patents	-3.66E-04	3.05E-04	-8.43E-04
	(0.001)	(2.23E-04)	(0.001)
Industry VC Deals	-0.002	-0.001	-0.003
	(0.002)	(0.001)	(0.002)
Industry VC Funding	2.76E-04	1.79E-04	2.11E-04
	(1.70E-04)	(1.72E-04)	(1.72E-04)
Observation Year Dummy Variables	included	included	included
Constant	2.763	-0.755	5.372
	(4.192)	(1.508)	(4.230)
Model Wald Chi Squared	234.83***	270.38***	274.91***

+p<.1 *p<.05 **p<.01 ***p<.001

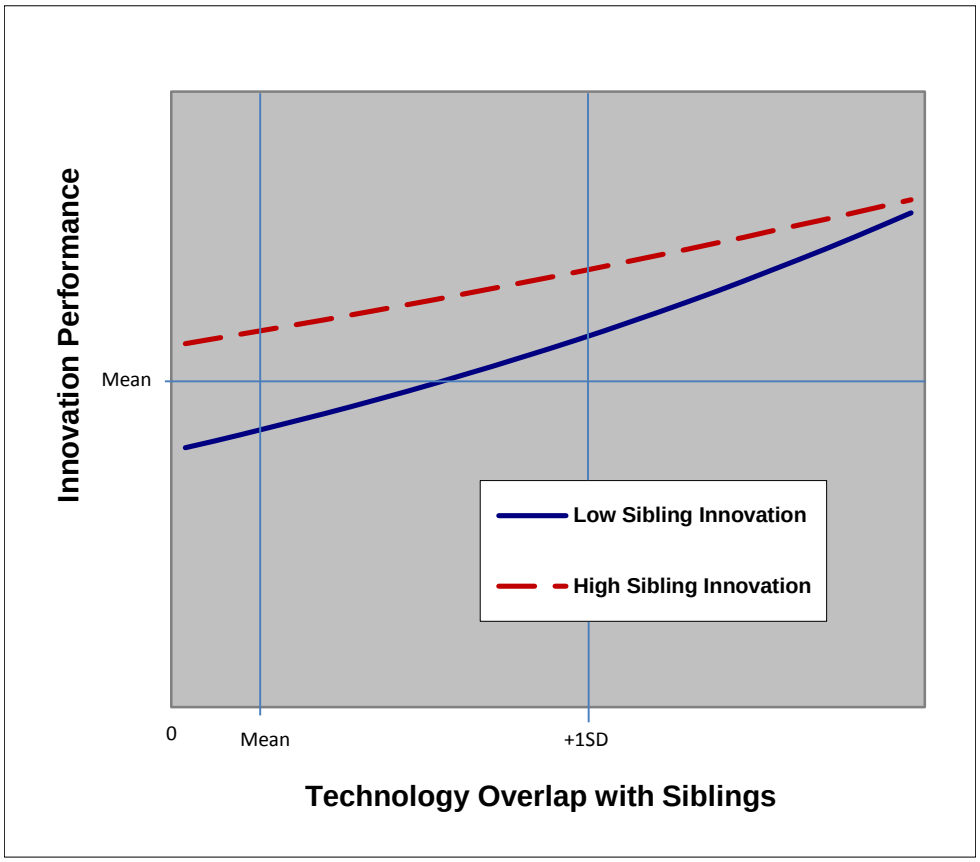
(robust standard errors in parentheses)

In Model 1, all control variables are loaded into the regression. Among these variables, the coefficient for the level of R&D human capital is highly significant. Perhaps not surprisingly, firms that increase the number of new inventors that participate in the R&D process tend to boost their innovative output.

Model 2 in Table 3-3 incorporates the direct effects of the independent variables. The innovation performance of siblings is shown to have a positive, significant effect on venture innovation performance ($p<.01$), thus supporting hypothesis 5 and the notion that sibling firms that develop more knowledge provide a beneficial spillover effect to the focal venture. As predicted in hypothesis 6, siblings that patent in technology areas more closely aligned with the new venture also provide a greater increase in innovation performance. The coefficient of technological overlap with siblings is positive and highly significant ($p<.001$), strongly supporting hypothesis 6.

Model 3 in Table 3-3 tests the interaction between sibling innovation performance and technology overlap. The coefficient for the interaction term is significant ($p<.01$) and, interestingly, has a negative value. Once again, it is useful to plot the relationships among sibling innovation, overlap, and new venture innovation to examine whether the interaction effect is consistent with the hypothesized outcome. The results of this effort are shown in Figure 3-4.

Figure 3-4: Interaction between Sibling Innovation and Technology Overlap



The figure depicts the effects of sibling technology overlap on new venture innovation performance at high and low levels of sibling innovation. The two curves are plotted using +1 and -1 standard deviation from the mean of sibling innovation. All other covariates are held at their mean values. As shown, both curves reveal increasing effects of overlap on firm innovation, with the curve associated with high sibling innovation yielding consistently greater levels for the dependent variable. This fully supports hypothesis 7, that sibling innovation and technology overlap have a compounding beneficial effect on innovation performance. Note: the negative value of the interaction term coefficient reflects the fact that the two curves eventually cross,

though this occurs at a value of sibling overlap that is not readily observed in the data, well beyond +2 standard deviations.

DISCUSSION AND CONCLUSION

The central finding of the study is that siblings make a difference; the capabilities and strategies of firms launched from common familial origins have an influence on access to financial resources and innovation. Further, this influence is dynamic in nature. Controlling and excluding firm-specific factors that are set at the time of their founding, an entrepreneurial venture's siblings have an impact that is felt over many years of observation.

Theoretical Contribution and Implications

This work extends the theoretical framework of organizational genealogy to explain the dynamics of progeny ventures emerging from a common parent. Results from prior research into the market niche advantages enjoyed by genealogical new ventures provide a coarse understanding of this phenomenon. This study adds further insight by addressing the broader ecological system of genealogical firms and illustrating the intriguing dual love/hate relationship between organizational siblings. It contributes to the resource and knowledge based theories of the firm by probing the nature and limits of the resources that are transferred across organizations.

The revealed impact of organizational siblings also holds implications for practitioners. Managers, investors, and industry analysts can better gauge the potential benefits and detriments to progeny entrepreneurial ventures that follow in the footsteps of prior firms spawned from common organizational parents. Technology managers can improve their R&D strategies by

focusing attention on new breakthroughs developed by sibling firms, while at the same time avoiding direct overlap and competition in narrow niche markets.

Limitations

Though the focused sample for this study provides a successful, conservative test of the core hypothesized relationships, future research may benefit from examining the sibling phenomenon through other strategic actions with broader measures of success. Beyond the measurement of the patent history of the sibling firm, other factors such as product launch or successful industry alliances may be beneficial in fully exploring the effects of siblings. Given the data challenges of studying closely held firms, this may require longer time horizons, subset analysis of publicly traded firms, or examining different industry domains.

Future research is necessary to explore the temporal effects of sibling influence. While this study establishes relationships between sibling actions and their consequences to the focal firm, it raises other questions about the persistence and strength of these effects. Perhaps disruptive technologies or paradigm shifts push an organization beyond its prior base of experience. The effects of familial relationships may diminish over time as the knowledge legacy of the parent becomes outmoded through such technological developments. Shifting consumer preferences may change the market resource landscape, altering the strategies of sibling firms and impacting their prospects for success. Finally, the parent and offspring genealogical ecosystem suggested in this paper addresses progeny firms in their early stages, when they are likely to adopt the role of specialists in the resource partitioning model. With greater success and the passage of time, such firms may choose to expand their market strategy and broaden their focal niche, adopting the role of generalist.

Conclusion

Prior research in organizational genealogy has focused on the relationship and beneficial transfer between organizational parents and their progeny. This study proposes a new extension for genealogical research in the form of organizational siblings, those entrepreneurial firms whose founders share a common heritage from their experiences within the same parent organization. Consistent with the theory of resource partitioning and concepts of simultaneous competition and mutualism from the community ecology literature, the findings reveal an interesting dual relationship in which genealogical ventures tend to decrease financial performance while boosting the innovation performance of their siblings. The hypothesized relationships were tested through a panel-based analysis of VC-funded genealogical ventures in the U.S. biotech industry founded in the years 1990 through 2000, examining their subsequent performance over a total of 1,960 firm-year observations. The results point to the importance of taking sibling actions into consideration for decisions of investment, technology development, and market strategy.

CONCLUSIONS AND FINAL THOUGHTS

In this dissertation, I have attempted to make the case for organizational genealogy as an important theoretical tool for understanding the nature and origins of firms. The great promise of this approach to theory development in organizational research lies in its ability to describe and explain how beneficial routines and characteristics are passed across generations of firms through both conscious (i.e. Lamarckian) and inadvertent (i.e. Mendelian) actions of founders. Arguably, no current or classic theory of the firm has the same ability to account for inter-generational links between organizations. Even population ecology, a theory closely related to organizational genealogy, fails to recognize differences between individual "organisms," preferring to observe outcomes at a species level. Consequently, organizational genealogy represents a useful emerging theoretical lens that has a great deal more to offer to the broader fields of entrepreneurship and management strategy.

I have proposed a research roadmap describing how the biological metaphor of genealogical heritage may be organized and expanded through future research. As described in the chapter 1 review of prior literature, early research in organizational genealogy and complementary work in adjacent fields has addressed several important aspects of the genealogical model. Revisiting the framework of Figure 1-1, this prior work has helped to explain the "New Venture," or the basic logic for genealogical firm formation; "What is Transferred," the role of routines and practices that span generations of firms; and "Outcomes," the nature and extent of the performance advantage enjoyed by genealogical entrepreneurial ventures. Beyond this important work, there are several other destinations on the roadmap that may lend greater insight into organizational genealogy. Two of the most interesting avenues for new research in this field involve: 1) delving deeper into the prior generational history of

genealogical firms and 2) understanding the environmental context of the genealogical entrepreneurial venture.

Examining the roadmap categories of "Parent Organization" and "The Founding Team" may provide insight into how the transfer of routines to the new ventures is influenced by characteristics of the source, the parent firm. Chapter 2 provided a modest first step into this area, studying how differences in organizational background at parent firms may inhibit innovation and performance in the new venture. The empirical findings support the notion that divisions in backgrounds among founding team members may undermine new venture innovation and growth. This suggests that differences in parent firms transferred through founders into the management team of the new venture may lead to suboptimal outcomes for the genealogical entrepreneurial firm.

At the same time, genealogical firms form and exist in a broader context and are subject to external influences. This notion is represented as the Figure 1-1 categories of "The Environment," as well as dynamic interactions with their genealogical cohort peers, represented in the category, "Siblings." Chapter 3 presented an empirical test of the benefits and detriments that accrue to firms with genealogical peers launched from common organizational parents. My results provide initial support for the broad notion that context matters in genealogical organizations. In this case, findings point to the importance of taking sibling actions into consideration for decisions of investment, technology development, and market strategy. Future work will be helpful in expanding this theme, lending greater insight into the effects of other contextual factors on the transfer of beneficial routines to progeny ventures. Changes in technology, economic conditions, or the nature of market competition within an industry may greatly enhance or undermine this established benefit of genealogical ventures.

Organizational research continuously builds on new findings and approaches as we seek to understand the emergence of and competition among firms. We cannot fully anticipate where future developments may lead the study of organizational genealogy. Through this dissertation, I have tried to capture the current state of the art in this area of research, outline a framework through which the field may advance, and take some modest first steps in contributing to the theoretical and empirical understanding of organizations spawned through genealogical processes.

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