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ESSAYS ON ENTREPRENEURIAL SPAWNING

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ABSTRACT

This dissertation is composed of three essays on entrepreneurial spawning. Using a mix of qualitative and quantitative approaches, each essay addresses a specific aspect related to the (i) formation, (ii) development, and (iii) performance outcomes of spinoffs or entrepreneurial ventures founded by former employees of incumbent firms. In particular, the first essay aims at providing a fine-grained understanding of the mechanisms that underlie parental imprinting, the contingencies, and its consequences within spinoff ventures. The organizational antecedent of different patterns of spinoff formation, when unexploited knowledge created by the industry incumbents spurs entrepreneurial spawning is subject of the second essay. Finally, the third essay explores the impact of knowledge relatedness with the incumbent parents on the performance of spinoff ventures. The results of these studies contribute to the literatures on genealogical perspective on firm formation, organizational imprinting, knowledge spillover theory of entrepreneurship, and entry by spinoff ventures.

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1. INTRODUCTION

This dissertation is composed of three essays on entrepreneurial spawning, where employees of industry incumbents leave their paid jobs to start their self-standing start-ups. Using a mix of qualitative and quantitative approaches, each essay addresses a specific aspect related to the (i) formation, (ii) development, and (iii) performance outcomes of ventures founded by ex-employees of incumbent firms.

The first essay aims at providing a finer-grained understanding of the mechanisms that underlie parental imprinting, the contingencies, and its consequences within spinoff ventures. Using grounded theory approach and building upon qualitative data collected from 14 spinoffs cases, I posit that the extent to which spinoffs founders draw on parental blueprints to set their ventures early structures is hinged on the historical origin and organizational antecedent of spinoffs (i.e. the ex-employees of incumbent firms' impetus for transition to entrepreneurship) since that reflects the pattern of spinoffs' entry (i.e. whether spinoffs spawn into a similar/different technological field or market sector as their parent firms), and the extent to which spinoffs' knowledge domains fit with those of their parent firms early after spawning. While genealogical lineage and parental heredity is beneficial to spinoffs at birth, too excessive reliance on parental knowledge inhibits spinoff ability to exploit new technological/market opportunities or respond to changes in their external environment. I posit that throughout spinoffs life cycle and during 'sensitive phase' in which spinoffs exhibit 'high receptivity' to the changes in their external environment, spinoffs founders strategically deviate from initial trajectory, modify parental blueprints, and combine them with knowledge available from external sources to overcome inertia and exploit unprecedented opportunities or to respond to major shift (e.g. new market regulation) in their external economic and institutional environment. The grounded model of organizational imprinting through entrepreneurial spawning in this study contributes to the entrepreneurship and organizational imprinting literatures.

The second essay sheds light on the underlying mechanisms triggering different patterns of spinoff formation. The theoretical framework in this study builds on two streams of the literature. First, in evolutionary theory firms undertake local search and 'path-dependent exploration to maintain their level of coherence. Drawing on this research line and the literature on employee startups resulting from their employers' project rejection, I argue that incumbents pursue and further exploit opportunities that have a level of similarity and synergy with their existing stock of knowledge and leave unfamiliar or less similar opportunities unexploited. Second, the knowledge spillover theory of entrepreneurship posits unexploited technological knowledge or unexploited market opportunities created in the incumbent firms may signal employees the existence of untapped entrepreneurial opportunities that can be leveraged for the purpose of venturing out. Building on this stream of research, I argue that the technological and market diversity of incumbent firms generate opportunities for the creation of spinoffs pursuing different types of opportunities. By integrating the two, I study how a spinoff's technological and market distance from (i.e. overlap with) the incumbent parent varies with different combinations of technological and market diversity of its parent firm. The analysis of 131 spinoffs from the biotech sector supported my hypotheses. The results of this study contribute to the growing literature on knowledge spillover theory of entrepreneurship and entry by spinoff ventures.

The third essay explores the impact of knowledge relatedness with the parent firms on the performance of spinoffs or entrepreneurial ventures founded by former employees of these industry incumbents. Building on current literature, I argue that the degree to which a spinoff's technological and market knowledge bae overlaps with its parent firm has a positive but declining impact on spinoffs innovativeness and survival. That is, while some level of knowledge relatedness is pleasant for spinoffs allowing them to reduce uncertainties at birth, excessive technological and market overlaps both hamper creation of valuable knowledge and spinoffs' survival. The former is because too much technological overlap impedes combination of underlying elements of knowledge with unfamiliar knowledge. The latter is because too much market overlap may spark parent hostile reaction as competing spinoffs may jeopardize parent firms' competitive positions in the market. Also, I argue that founders' hierarchical position within the incumbent parents moderates the relationship between level of knowledge relatedness and spinoffs performance. The results of analyses using a sample of 131 spinoffs spawned from 116 industry incumbents supported the hypotheses on the inverted U-shaped relationship between knowledge relatedness and spinoffs innovative performance and survival. The results of this study contribute to the literature on genealogical perspective on firm formation, knowledge inheritance, and spinoff performance.

2. ESSAY ONE

Does Genealogical Lineage Make Them Clones of The Industry Incumbents? Spinoffs and Organizational Imprinting

ABSTRACT

Extant literature has commonly hypothesized that spinoffs inherit considerable amount of blueprints in the forms of knowledge and capabilities from their parent organizations and that parental heredity stamps a long-lasting influence on spinoffs' structure, development trajectories, and subsequent performance. However, except for few anecdotal evidences supporting the imprinting theory, we still know little about how this process unfolds in practice. Using grounded theory approach and qualitative data collected from 14 spinoff cases, this paper aims at providing a finer-grained understanding of the mechanisms that underlie parental imprinting, the contingencies, and its consequences for the spinoffs' patterns of knowledge accumulation and the direction of business growth. I posit that the extent to which spinoffs founders draw on parental blueprints to set their ventures early structures is hinged on the historical origin and organizational antecedent of spinoffs (i.e. the ex-employees of incumbent firms' impetus for transition to entrepreneurship) since that reflects the pattern of spinoffs' entry (i.e. whether spinoffs spawn into a similar/different technological field or market sector as their parent firms), and the extent to which spinoffs' knowledge domains match with those of their parent firms early after spawning. While genealogical lineage and parental heredity is beneficial to spinoffs at birth, too excessive reliance on parental knowledge generates inertia and inhibits spinoff ability to exploit new technological/market opportunities or respond to changes in their external environment. I posit that throughout spinoffs life cycle and during 'sensitive phase' in which spinoffs exhibit 'high receptivity' to the changes in their external environment, spinoffs founders strategically deviate from initial trajectory, modify parental blueprints, and combine them with knowledge available from external sources to overcome inertia and exploit unprecedented opportunities or to respond to major shift (e.g. new market regulation) in their external economic and institutional environment. The grounded model of organizational imprinting through entrepreneurial spawning in this study contributes to the entrepreneurship and organizational imprinting literatures.

Keywords:
Organizational Imprinting; Genealogical Lineage; Employee Entrepreneurship

2.1. INTRODUCTION

Spinoffs – entrepreneurial ventures founded by former employees of incumbent firms in the same industry – by their very nature, benefit from their founders' pre-entry experiences and knowledge accumulated during the past courses of employment in the incumbent firms. When employees resign to create their own self-standing ventures, they carry with them routines, capabilities, and technological expertise developed by the parent firms to formulate their ventures' early strategies and structures (Agarwal et al. 2004; Boeker, 1997; Franco & Filson, 2006; Gompers et al., 2005; Klepper and Thompson, 2010; Phillips, 2002). In addition to this, spinoffs' founders may transfer non-technical knowledge related to marketing and regulatory strategy (Chatterji, 2009), contacts with suppliers and customers in the market (Shane & Stuart, 2002), and the best practices for complex processes such as R&D (Roberts, 1991) from parent organizations to their spinoff ventures.

Overall, the exposure of spinoffs' founders to the knowledge domains of the incumbent parents provides them with the opportunity to transfer considerable amount of "blueprints" (Klepper, 2001) in the forms of technological and market-related capabilities, which shape their founding process and exert an enduring life-time effect on their development trajectory and performance (Gompers et al., 2005). In this regard, many spinoffs are said to be "spawned with silver spoons" (Chatterji, 2009) since their founders' employment in the industry incumbents gives spinoffs access to industry knowledge not available to other de novo startups at the time of founding (Phillips, 2002; Sapienza et al., 2004).

During the last two decades, an increasing number of studies have compared the transfer of knowledge from the parent organization to the spinoff venture to the transmission of biological genes (Klepper and Sleeper, 2005; Phillips, 2002), and presumed that since spinoffs are spawned from incumbents with established routines and practices, their capabilities and competences are closely related to those of their parent organizations (Agarwal et al., 2004;

Gompers et al., 2005; Klepper and Sleeper, 2005). However, besides limited anecdotal evidence in support of the 'inheritance' and transfer of knowledge from parent organizations to their spinoff ventures, still we have a little understanding of how this process unfolds in practice. In other words, as noted by Chatterji (2009) and highlighted by Ferriani et al., (2012): "*while we know that many high-technology ventures are founded by former employees of incumbent firms in the same industry, we know little about… to what extent they incorporate knowledge from the parent firm", since "the existing literature...has hypothesized that spawns inherit technical knowledge from the parent but has rarely demonstrated it empirically*" (Chatterji, 2009: P. 201).

The main research questions driving my analysis are the following: To what extent spinoffs adopt and incorporate the same elements of knowledge and capabilities as their parent firms? What conditions lead to stronger or weaker use of parent knowledge in the spinoff firms? Is there any variation with regard to the extent to which spinoffs draw on parental blueprints across different spinoffs and if so, how such variation arises?

In this paper, I attempt to delineate more precisely the boundary conditions under which the imprinting process takes place. Using grounded theory approach and drawing upon qualitative data collected from 14 biotech spinoff cases, I found that throughout spinoff life cycle and during 'sensitive phase' of receptivity and changes, spinoffs' founders actively opt for and put in place only those fitted elements of knowledge inherited form their parent organizations and that parental blueprints stamped on the spinoff ventures persisted until the advent of subsequent sensitive phase. In particular, I found that the extent and the form of parental knowledge retained by founders to formulate their ventures' early strategies and structures varied across different spinoffs. Focusing on historical origin or organizational antecedent of spinoffs (i.e. the ex-employees of incumbent firms' impetus for transition to entrepreneurship) as a baseline for cross-case comparison, I found that spinoffs spurred following the industry incumbents' turbulence (for example internal restructuring such as director mobility, or external shock including bankruptcy or merger and acquisition) are more likely to remain in an overlapping technological fields and/or market-segments as their parent firms and as a result of better fit between their knowledge domain and that of their parent firms, they are better able to benefit from parental blueprints and are more likely to use that inherited knowledge to set their ventures' early routines and practices. In contrast, I found that spinoffs originated due to the industry incumbents' rigidity (for example strategic disagreement, lack of complementary capabilities, or information asymmetries) are more likely to spawn to a new technological field or a market segment distant from their parent organizations core businesses, and as a result of divergence in their trajectories, they are less able to benefit from technological market-related knowledge accumulated during their founders course of employment in the incumbent parents. While genealogical lineage to industry incumbents and parental legacy is beneficial to spinoffs and provide them with a comparative advantage not available to other de novo startups at the time of founding, excessive reliance on parental knowledge hampers spinoffs ability to exploit new technological opportunities, or respond to new demands in the market. Over the course of spinoffs' development, I found that spinoffs founders strategically deviate from their early structures and development trajectories, modify or discard parental blueprints, and combine them with elements of knowledge available from sources outside their existing knowledge domains to overcome inertia and respond to changes in the economic and institutional environment they belong to. Examples of these changes were major shift in institutional environment (e.g. new market regulations), scarcity of resources, development of new technologies in the industry, or emergence of new opportunities in the market.

The grounded model of organizational imprinting through entrepreneurial spawning in this study contributes to the literature on organizational imprinting by providing new insight on presence of other salient periods beyond the founding phase in which environmental forces exert a persistent – but not necessarily irreversible – influence on the focal organizations (Marquis and Tilcsik, 2013). By questioning the prevailing view that assumes organizational lineage makes spinoffs clones of their parent firms, this study highlights the important role played by spinoffs founders through the process of imprinting in which they strategically retain, modify, or combine elements of parental knowledge with knowledge available from external sources to find a balance between less technological/market uncertainties faced by new entrants and more inertia in responding to changes in their external environment.

The remainder of this paper is organized as follows. First, I provide a detailed definition of a spinoff firm to spell out this research boundary, and I build upon extant literature to state the theoretical background. Next section describes the research approach, data gathering strategy, analysis protocol, and presents the organizational antecedent of spinoffs constructs. Then I summarize the results of findings and present the grounded model of organizational imprinting within spinoff ventures. I conclude by discussing the expected contributions to the literature and I identify the direction for the future research.

2.2. THEORETICAL BACKGROUND

To this date, a number of different definitions and classifications have been proposed for spinoff ventures and as a result of that, sometimes we lack a clear understanding of what is meant by the use of this term. For instance, a number of studies have categorized the term between academic spinoffs (e.g. Perkmann et al., 2013) and corporate spinoffs (e.g. Parhankangas and Arenius, 2003). In relation to the later, some studies define spinoffs as independent and self-standing new ventures created by former employee/s of the established firms in the same industry (Agarwal et al, 2004[1]; Klepper, 2002; Franco and Filson, 2006),

[1] Agarwal et al. (2004) used the term "spinout" as entrepreneurial ventures formed by ex-employees of established firms in the same industry.

while the others define them as new ventures that use ideas developed within the established firms without emphasizing on the link between the two ventures (Chesbrough, 2003, Parhankangas and Arenius, 2003; Sapienza et al, 2004). Among others, Helfat and Lieberman (2002) proposed a distinction between "entrepreneurial-spinoff" and "parent-spinoff" in which in the later, parent firm often retain financial interests and representation on the board of directors, while in the former there is no direct support or sponsorship from the parent firm.

In this article, I follow the later classification and I focus my attention on entrepreneurial spinoffs or entrepreneurial ventures founded by ex-employee/s of incumbent firms in which there is no ownership or strategic link between spawning and spawned firms. However, for the sake of brevity, I constantly use the term "spinoff" in this manuscript.

The focus on genealogical lineage dates back to early studies on ethology science by Douglas Spalding (1873) and Oskar Heinroth (1911), who observed domestic chickens' tendency in following the first moving object that they see shortly after they were hatched. Later, Konrad Lorenz (1935) took over this terminology and analyzed thoroughly the phenomenon in study of nidifugous birds, calling it "Prägung" or imprinting. Lorenz (1935) demonstrated how greylag geeses imprinted on the seen first large moving objects (their mothers or Lorenz himself) during the early "critical period" or shortly after hatching. Further, he reported the effects of those early experiences persisted even after the geeses were exposed to other moving objects, reflecting animals' early experiences stamp a permanent influence on their subsequent behavior.

The concept of imprinting has received scholarly attention in various scientific disciplines from evolutionary biology to psychology and ethology. It has also been studied in organization literature following Stinchcombe's (1965) seminal essay on "Social Structure and Organizations" and has become a core concept for describing different phenomena at multiple levels of analysis (see a recent review by Marquis and Tilcsik, 2013). Stinchcombe (1965) posited that external environmental forces during the founding period shape organizations' early structures, and those structures persist beyond the founding phase as he observed a significant correlation between industries age and structure. While the focus of Stinchcombe was primarily at the industry-level, since then, organizational ecologists, management scholars, and entrepreneurship researchers have investigated on the relevance of the imprinting concept and importance of initial conditions in explaining current behavior across different level of analysis including industries or communities (e.g. Chandler, 1993), single organizations (e.g. Carroll and Hannan, 1989), organizational building blocks (e.g. Burton & Beckman, 2007), and individuals (e.g. Dokko et al., 2009). In particular, at the organization-level, researches have explored the impact of external environmental forces during founding period on organizations early structures, and demonstrated how organizations bear a lasting imprint of founding conditions due to inertia (Hannan and Freeman, 1984) and institutionalization (DiMaggio and Powell, 1983) over time. Inertia refers to organizations' persistence resistance to changing structure since as noted by Caroll and Hannan (2004) changes in organizations' core features expose them to high risk of mortality. Institutionalization also refers to persistence of stable organizational arrangements (e.g. rules, coordination mechanisms, and communication channels) produced through "self-activating social processes", as they become taken for granted (Selznick, 1957). This stream of literature also highlights the long-lasting stamps of three different "imprinting forces" on the organizations' characteristics: economic and technological conditions, institutional conditions, and individual founders (Marquis and Tilcsik, 2013). The first body of work has focused on the organizational capabilities and practices that are imprinted by economic and technological conditions during the founding period. For example, Zyglidopoulos (1999) posited that organizations follow technological practices available during their foundation. Tucker et al. (1990) demonstrated how founding conditions (e.g. organizational density, or resource availability) left enduring stamp on social service organizations. The second stream of researches has highlighted how institutional conditions during founding period leave imprints on organizations and shape their early structures. For example, in study of semiconductor industry, Boeker (1988) found that the type of financing opportunities during founding phase exerted a long-lasting impact on organization decisions about market entry and long-run strategic path. Carroll and Hannan (2004) found that social and political arrangements during founding period exerted an influence on organizations' design and those imprints are perpetuated even after founding phase. Marquis and Huang (2010) posited that organizations come to reflect the institutional conditions available during their founding phase, and those conditions could have different manifestation overtime. Finally, a number of studies have also focused on the role of entrepreneurs and organizations' managers and the enduring effects of their traits and decision on organizations subsequent strategy and behavior. For example, in a qualitative study of a medical school, Kimberly (1979) demonstrated the founders' early decisions left a long-lasting influential on subsequent organization's structure and actions. Also, in study of Paris Opera foundation, Johnson (2007) proposed the idea of "cultural entrepreneurship", and posited that the tension between founders' initiative (creativity) and environmental constraints constitute the organization's imprinting process. Further, she argued that the imprinting process involves two stages: "activation" or founders' active incorporation of elements of the founding environment, and "recombination" or reproduction of some of those elements beyond the founding phase.

To sum up, extant literature demonstrates how elements of founding environment and resources matter since new organizations often draw on practices that have proven to be effective in the past (Ding, 2011), and organization persist on those templates to preserve legitimacy (Ferriani et al., 2012) resulting in the enduring effect of founding conditions even after the environmental structure that triggered those elements has disappeared (Kimberly, 1979).

In the context of spinoffs, previous researches have highlighted the role of spinoffs' founders as conduit of technological and operational expertise, knowledge about market, and managerial capabilities from parent firms to the spinoff ventures (Agarwal et al., 2004; Klepper, 2002; Klepper and Sleeper, 2005). Evolutionary economic theory provides an explanation for this process based on the notion of transferability of organizational routines from old to new organizations through personnel migration (Aldrich and Pfeffer, 1976; Almeida and Kogut, 1999). This view conceptualizes an organization tacit knowledge not only as a socially construct embedded in its routines (Nelson and Winter, 1982), but also as know-how that resides in individual human capital (Berman, Down, and Hill, 2002; Lepak and Snell, 1999; Szulanski, 1996). When the former employees of incumbent firms resign and leave to found their own independent new ventures, they may leverage the blueprints of their parent organizations in the forms of routines, technological and market capabilities, and managerial practices to develop the starting core competences of their new ventures (Agarwal and Shah, 2014; Klepper and Sleeper, 2005). Technological and market-related knowledge transferred by departing employees can take the form of tacit know-how or codified information embodied in patent or routines. For example, in study of law firms in Silicon Valley, Phillips (2002) finds that the new law firms employ similar routines as those of their parent firms. In study of Disk drive industry, Franco and Filson (2006) find a positive correlation between the areal density of the disk drives of parents and their spinoffs. In a study of the same sector, Agarwal et al. (2004) demonstrate that parental technological and marketing know-how underlie the spinoffs' knowledge capabilities. Similarly, Chatterji (2009) finds that in addition to technological know-how, spinoffs also inherit non-technical knowledge related to marketing and regulatory strategy from their parents. In laser industry, Klepper and Sleeper (2005) find that nearly all spinoffs initially produced the same type of laser as their parent. Also, in the automobile industry, Klepper (2002; 2007) shows that cars initially produced by the spinoffs had many features in common with those produced by their parents, which points out the importance of knowledge inherited from parent firms. Moreover, Moore and Davis (2004) highlight the importance of managerial skills learned by Fairchild Semiconductor's technical employees in their decisions to spawn. Overall, it has often been assumed that since spinoffs are spawned from incumbents with established routines and practices, their capabilities and the technology are closely related to those of their parent firms (Agarwal et al., 2004; Gompers et al., 2005; Klepper and Sleeper, 2005). To put in a different way, conducted studies have largely assumed that knowledge transfers from parents to progeny occur almost genealogically, and progeny ventures by their very nature follow the practices of their parent firms. However, as emphasized by Basu et al. (2015), there has been little attention on the fact that spinoffs (i) might choose consciously or (ii) might become able to incorporate only certain elements of inherited knowledge as their core businesses might diverge from those of their parent organizations. Recently, few studies attempted to provide a more accurate picture of organizational imprinting process within spinoff ventures by allowing spinoffs to reconstitute the past influence and differentiate themselves from their parent firms to establish their own distinctive identity. For example, Ferriani et al., (2012) propose a model of intergenerational learning or a so-called "re-imprinting process" and posit that as a result of intense learning, improvisation and feedback from the market, spinoffs override early parental influence to develop their idiosyncratic capabilities. Basu et al., (2015) argue that offspring's founders may decide to deviate from their parents' existing technologies to create new knowledge by combining unfamiliar knowledge from distant sources. While these two studies have provided new insights on the tension between parental heredity and organizations' new trajectory, it's necessary to further investigate on the underpinning mechanisms that lead to incorporation of parental knowledge, as well as spinoffs deviation from that early parental influence.

In addition to this, spawned ventures from incumbent organizations differ from each other along various strategic dimensions including historical antecedents (impetus for employees' departure) or sources of entrepreneurial idea. In particular, extant theories on the genesis of spinoffs suggest that the employee decision to establish a new firm can be motivated by information asymmetry (Anton and Yao, 1995; Chatterjee and Rossi-Hansberg, 2012), limited organization capabilities (Cassiman and Ueda, 2006; Chesbrough, 2003), strategic disagreement (e.g. Klepper and Thompson, 2010; Thompson and Chen, 2011), or employee learning (e.g. Franco and Filson, 2006). For example, Agarwal et al. (2004) explored the relation between knowledge capabilities of industry incumbents and their likelihood of spawning. By distinguishing between technological know-how and market pioneering know-how, the authors find that increases in either technological or market pioneering know-how (a mismatch between the incumbents' focus on value creation and appropriation) enhance the likelihood of experience spawning. Gompers et al. (2005) tested two views of entrepreneurial spawning. In the first case, the employees learn the process of becoming entrepreneur and get access to important social and financial resources through working for young entrepreneurial firms. In the second case, large bureaucratic companies refuse to support the employees' ideas that are outside their core tasks. Klepper and his colleagues through series of articles proposed the theory of spinoff formation driven by strategic disagreement and argued that spinoff occurs when employees have "*different views about the best strategic direction of firms*", and this disagreement is of "*sufficient magnitude to justify costs of creating a new firm*" (Klepper and Thompson, 2010). Also, nascent entrepreneurs (ex-employees of incumbent firms) may discover or create new entrepreneurial opportunities through different entrepreneurial action to exploit them in their new ventures (Alvarez and Barney, 2007). Despite the significant scholarly attention to the entry by spinoff and importance of new firms' origin in explaining heterogeneities in their capabilities and subsequent performance, still we know little about how organizational antecedents of spinoffs or underlying mechanisms triggering former employees of incumbent organizations transition to entrepreneurship affect the micro-processes under which spinoffs founder transfer parental blueprints and incorporate them in their own ventures.

2.3. RESEARCH APPROACH

Given the exploratory nature of this study and the main research questions, grounded theory approach was chosen for its richness and potential for discovery through an iterative process of theory building and analysis within the wave of data collection (Gioia et al., 2013; Strauss and Corbin, 1998). Clearly to this end, I was forced to trade off concerns related to external validity of my findings against the possibility to gain a deeper understanding of the imprinting process and its boundary conditions (Ambos and Birkinshaw, 2010). I started by analyzing each case individually, and then I compared and contrasted similarities and differences across different cases to construct the grounded theoretical framework (Miles and Huberman, 1984).

2.3.1. Data Gathering Protocol

A sample of spinoff ventures was identified using the national survey of Italian biotech firms carried out by the Italian Association for the Development of Biotechnology (Assobiotec[2]), which was established in 1986 as a branch of the Italian Federation of the Chemical Industry (Federchimica). Since 2007 and in cooperation with Farmindustria, Assobiotc collects firm-level data by sending questionnaires to the companies in the sector. In particular two categories of companies are included in this survey; 1- "Pure biotech" companies, or the companies that "use modern biological techniques to develop products or services for the treatment of humans or animals, agricultural productivity, renewable resources, industrial production and environmental protection", and whose core business falls among these activities (according to

[2] http://assobiotec.federchimica.it/

the EY definition), and 2- Companies that use "at least one biotechnological method to produce goods or services, or research and development in the biotech field," and with a smaller share of their economic activities related to biotechnology, defined as "other biotech" (according to the OECD definition). The dataset contains the following information for approximately 400 firms over a 8-year period (2007-2014): 1- date of foundation; 2- information about the origin, 3- the field of application (market segment), 4- number of employees, 5- R&D investment, 6- total turnover, 7- revenues from biotech products/services, and etc.

To construct the sample, I started the analysis using an initial list of 119 firms identified as startup in this survey. First, using different sources including the companies' websites, AIDA (Bureau Van Dijk Italian companies' database), and NETVAL (Italian academic spinoffs database), I was able to identify 25 academic spinoffs, 9 multinational subsidiaries, 11 corporate spinoffs, and 1 joint venture, and I excluded them from the list.

Second, to make sure the remaining 73 startups are actually spinoffs, I used companies' websites as well as LinkedIn to collect information about the name of founders and their history of employment to identify their links to the incumbent firms. I succeeded in collecting this information for 52 firms. Yet, I excluded 18 firms founded by former employees of research centers, science parks, and hospitals, which didn't match to my pre-defined definition of a spinoff firm. These procedures resulted in a final sample of 34 spinoffs.

Third, I sent an invitation letter describing the purpose of this study and a request to participate in an interview both to the spinoffs as well as founders' personal email addresses and after one week, I gave a follow up phone call. 20 interviews were conducted with the founder/s of 14 spinoff firms. The interviews were conducted through Skype call and all were recorded following the interviewees' permission. Each interview lasted between one and two hours. I promised usual confidentiality and anonymity. Table 2.1 presents an overview of 14 spinoff cases.

Table 2.1: Details on Cases								
Spinoff Core Business	***Historical Origin***	***Entrepreneurial idea***	***Target Sector***	***Year of Foundation***	***N. Founder***	***N. Employee***	***N. Product***	***N. Patent***
Contract research organization dedicated to industrial microbiology	External shock (acquisition of parent)	Unexploited knowledge created at the parent	Environment - Industrial processing	2007	3	5	0	0
R&D Laboratory	External shock (bankruptcy of parent)	Existing customer's needs	Natural resources - Non-food waste	2013	4	6	0	0
Manufacturing company active in the fields of biomass and biofuel sector	External shock (acquisition of parent)	Family business	Environment - Natural resources	2011	2	8	4	1
Consulting and research company in the field of industrial exploitation of enzyme	Disagreement on strategic issues (further expansion)	Opportunity from the market	White sector - Industrial processing	2006	3	3	15	5
Service company active in the field of animal breeding	Disagreement about how to continue	Individual research outside working time	Animal health	2008	2	16	0	3
CRO and Manufacturing company based on Enzymes	External shock (structural changes within the parent)	Unexploited knowledge created at the parent	Health - Industrial processing	2002	4	10	2	2
Manufacturing company active in the field of natural ingredient (food ingredients) using fermentation by bacteria	Disagreement about how to continue	Unexploited knowledge created at the parent	Food industry	2011	2	3	2	0
Manufacturing and service company active in DNA sector	Disagreement about how to continue	Individual research outside working time	Nutritional supplements	2009	4	6	4	4
Manufacturing and research company active in the Industrial Biotechnology sector	Lack of support from CEO	Unmet needs of customers	Industrial processing	2007	2	16	0	1
Manufacturing and research company active in the fields of antibiotics and other bio active molecules	Personal conflicts - Lack of support as a result of information asymmetry with CEO	Unexploited knowledge created at the parent	Human health	2013	7	11	8	14
Manufacturing and research company active in the field of therapeutic antibody for human	Conflict with investor - Disagreement on the goal	Unexploited knowledge created at the parent	Human health	2008	6	6	2	3
Research company active in the fields of oncology and discovery chemistry	External shock (acquisition of parent)	Unexploited knowledge created before	Human and animal health	2003	2	4	2	5
Manufacturing and research company active in the field of anti-infective drugs	External shock (acquisition of parent)	Unmet needs of customers	Human health	2006	2	3	1	2
Manufacturing and research company focused on novel diagnostics for cancer	Information asymmetry with CEO	Serendipitous discovery	Human health	2001	4	10	2	6

Given to the importance of interviews as the primarily source of data collection, I paid great attention in crafting the initial interview protocol to make sure the questions are thoroughgoing and are not "leading-the-witness" (Gioia et al., 2013). The interviews were conducted in a semi-structured manner with both likert-scale and open-ended questions that have been found to provide a higher accuracy in retrospective report (Miller et al. 1997, Graebner and Eisenhardt 2004).

The interviews contained 5 different types of questions related to: (1) an overview of the main activities and core businesses of cases, (2) founders' career histories, (3) entrepreneurial opportunity and foundation process, (4) parental heredity and transfer of knowledge across organization boundaries, and (5) technological and market capabilities, products/services, and intellectual properties. In addition to the interviews, I collected complementary data using secondary sources including parent organizations and spinoff firms' websites, annual reports, two industry reports over 9-year period (BioinItaly 2011-2014, Blossom Associati 2006-2010) and three business directories (Bionity, Biocentury, Biowebspin) for purpose of both inferring the grounded findings as well as validating the informants' responses.

2.3.2. Data Analysis Protocol

To analyze the qualitative data from interviews and documents, I used the framework described by Strauss and Corbin (1998) to build a grounded model, and I followed a three-step coding process inspired by Gioia, Corley, and Hamilton (2013). As a number of researchers have noted, collecting the data and the analysis should proceed together in qualitative research (Gioia et al., 2013). As for that, along the wave of data collection, I went through the archrivals, and interviews to get an overview of collected data. In particular, first, I started the analysis by coding data through identifying original terms and phenomena in the data and grouping them into the "first-order concepts" (similar to Strauss and Corbin (1998) notion of open coding).

During this first-order analysis, I did my best to use the original language of the informants to avoid any unintended deviation. As the research progressed, I started seeking similarities and differences among the many concepts (similar to Strauss and Corbin's notion of axial coding), and I grouped and labeled the convergent first-order concepts into more abstract "second-order themes". Finally, once a workable set of themes and concepts was in hand, I distilled emerged second-order categories further into "aggregate dimensions" (similar to Strauss and Corbin's notion of selective coding), and I looked for the links between the first-order concepts and second-order themes, as well as between second-order themes and aggregate dimensions to build a grounded model (Strauss and Corbin, 1998).

Throughout the coding process, and coincident with the data collection, I adopted an iterative approach of data contrast and comparison (going back and forth between concepts, themes, aggregate dimensions and the relevant literature). This enabled me to check the differences or justify the presence or absence of a concept comparing to the extant literature (Gioia et al., 2013).

2.3.3. The Organizational Antecedent of Spinoffs Constructs

Following the first part of questions set for purpose of familiarity with the cases, informants (spinoffs founder) were asked to explain about their history of employment (e.g. Have you ever been employed by any companies before founding this firm? What was your last position, and for how long you were employed there?). This part of interview was followed with more detailed questions related to the entrepreneurial idea (e.g. When and how did you come up with this idea? Did you disclose this idea to your employer?), and the underlying reasons underpinning their decision to turn into entrepreneurship (e.g. why did you choose to leave your last place of employment? In your opinion, why your employer refused to develop this idea?)

Implementing three-step coding and analyzing qualitative data related to the origin of the spinoff firms, I identified two principal mechanisms spurring formation of spinoff ventures as described in the following subsections.

2.3.3.1. Organizational turbulence

Two clusters of firms are active in the health (Bio-Pharmaceutical) sector: traditional large pharmaceutical companies, and biotech firms, which they can be further classified into (i) core biotech companies, which are directly involved in production and/or commercialization of new product discoveries, and (ii) product/service suppliers, which provide complementary products (chemical ingredients) or services (e.g. consultancies) to the other firms.

Reviewing the history and development of the biotech industry in Europe and particularly in Italy, I noticed that following the introduction of biotechnology in pharmaceutical sector, big pharmaceutical companies have focused most of their resources and efforts on the production and commercialization of drug candidates, and have covered the discovery and sometimes the developments of drugs through licensing agreements, or acquisition of small biotech companies. I found that the large pharmaceutical companies' later strategy was of principal relevance also in our sample, triggering the former employees of the acquired firms transition to entrepreneurship.

"*Many of Biotech companies here in Italy are actually originated from previous companies, where a research center of a large Pharmaceutical company after acquisition become non-strategic by the headquarters and become an independent Biotech company*." (Interview 1; P. 2)

"*Because now big Pharmas are mostly financial companies than research companies. They do invest only in clinical trials and not in basic researches. And they get candidates for their pipelines from universities or small biotech firms*." (Interview 11; P. 48)

Almost similar mechanisms were at work in other biotech sectors including Agriculture, Industrial, and Environment. For example, the incumbent firms' dissolution either due to bankruptcy or acquisition by another firm obliged their employees to either look for new jobs within other existing companies or to start their own initiatives. In addition to above-mentioned external socks, some internal restructurings or major shifts within incumbent firms also found to be a key forcing mechanism in employees' decision to leave and to create their independent new ventures. For example, two entrepreneurs in the sample remarked that their decision to resign and create a new venture was directly motivated by their superiors' resignation. Similarly, I found that some spinoffs in the sample spawned following the incumbent firms' deliberate decision to stop some research activities either in purpose of focusing on their core activities or diversifying into a new business sector.

"*At the certain point, they decided to stop investment in R&D activities and close all the non-core business R&D labs*." (Interview 2; P. 6) – *"Boss of R&D that brought me there was leaving the company to start a new company, so he resigned and then I left."* (Interview 7; P. 36)

To sum up, organizational turbulence caused by incumbent organizations internal restructuring (e.g. director mobility, shift in the core business, etc.) or external shocks (e.g. merger and acquisition, bankruptcy, etc.) appeared as the first mechanism triggering the ex-employees of incumbent organizations' decision to set up their own independent firms.

2.3.3.2. Organizational rigidity

The second aggregate dimension spurring formation of spinoff ventures was related to organizational rigidity. In contrast to the spinoffs in organizational turbulence aggregate dimension, whose origin was motivated by former employees' response to either internally or externally originated organizational changes, I found that some spinoffs in the sample spawned following their founders' frustration, after their ideas were rejected and shelved within the incumbent firms. As pointed earlier, informants were asked about which factors impeded the development of the idea internally within the incumbent organizations. I found that, first, disagreements between employees and the decision-making hierarchies within the incumbent firms over strategic issues such as development of new technologies or entering into new markets triggered their transition to entrepreneurship. For example, a spinoff founder pointed to the effect of lack of support and interpersonal conflict with his co-founders (co-investors) on his decision to resign and to create his self-standing independent venture.

"*It was an error to go with an investor that is not, let's say aware of the field. After 3 years the guy started complaining the return is not rapid enough, and confusion about the goal, and conflict about project*." (Interview10; P. 42)

The second impetus was related to the incumbent organizations limited complementary capabilities and financial resources for developing the proposed idea internally or through breaking down a section. For example, two spinoff founders mentioned that after disclosing their idea with their ex-employer, the incumbents' management refused to further pursue and develop it since the idea 1) required additional financial resources, 2) was not align with their core businesses, or 3) simply they didn't want to change the status quo.

"*The argument was mostly of being conservative, and I think this is something typical in large organizations or even small organizations with people who worked for large organizations. You do not want change too much the status quo, because change requires a lot of effort to be managed. So, if people are, I'm not saying at the end of careers, but they want to have a quiet life, they do not like to change, rather leave them as they are*." (Interview 9; P.38)

"*They realize quite clearly that to sustain such new opportunity, would require additional funding, additional resources, that were not also available, because the company was fully concentrated on its core business*." (Interview 13; P. 62).

Similarly, the third impetus for initiating spinoff was related to different evaluation of an idea or asymmetric information problem between spinoff's founder/s (incumbent's ex-employee) and the decision-making hierarchies.

"*We were doing something that was not interesting anymore for the main company. At least for the management. That time, the person in charge or CEO changed, so they implemented a different policy, which didn't include my idea*" (Interview 4; P. 18).

To sum up, organizational rigidity whether related to strategic disagreement (e.g. conflict over goal), lack of complementary capabilities (e.g. lack of funding resources), or information asymmetries (e.g. different evaluation of new ideas) was found as the second mechanism triggering the ex-employees of incumbent organizations' decision to resign and initiate their own independent firms. Table 2.2 presents the result of implemented three-step coding.

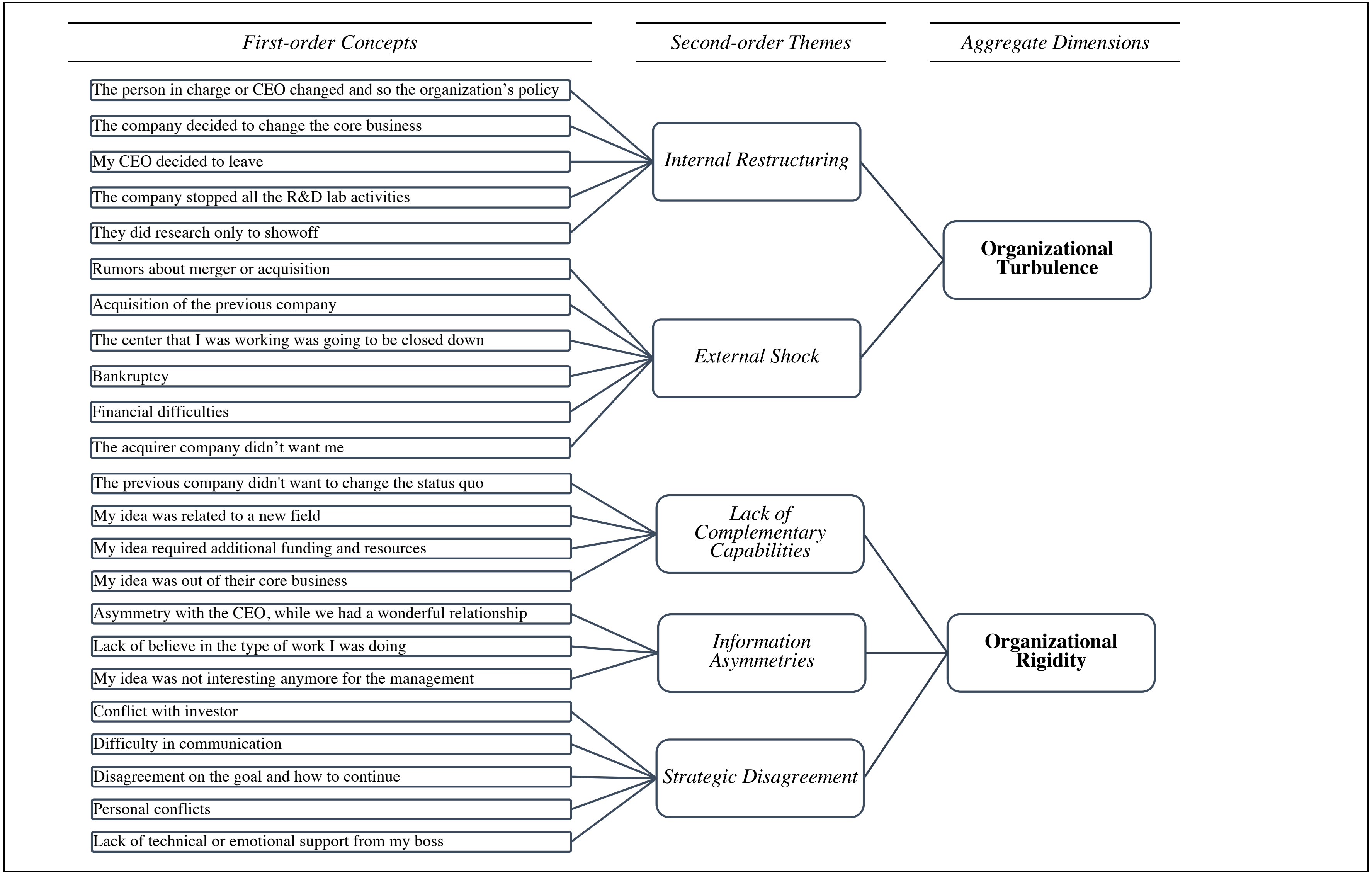


Table 2.2: Data structure related to organizational antecedents

2.4. RESULTS

2.4.1. Founding Phase and Historical Origin

The main part of the interviews included questions related to the relevance and importance of founders' earlier expenses (in particular those acquired from the parent organizations or the founders' last place of employment in the industry) for developing capabilities and technological/market-related expertise in their newly founded firms. Founders in particular were asked to explain about i) similarities and/or differences between their own companies and their parent organization core capabilities and competences (e.g. to what extent existing technologies or market capabilities in your company differ from the knowledge incorporated within your last place of employment?), ii) the importance of knowledge and recourse inherited from the parent organizations (e.g. in managing the main activities in your venture, how important were the capabilities you gained through working your last place of employment?), and iii) the extent to which they transfer and draw on parental blueprints in their spinoff ventures (e.g. to what extent you have incorporated the same elements of knowledge as those developed in your last place of employment?).

Along the waves of data collection and analysis, I noted a considerable heterogeneity across different spinoffs concerning the extent to which they initially incorporated the same elements of knowledge as their parent organizations. That is, while there was an overall emphasis among founders on the importance of parental heredity in managing uncertainties of newness and achieving fit with the new institutional context, the extent and the form of the parental knowledge, which they actually incorporated to formulate their spinoffs early capabilities, routines, and practices varied across the cases.

To inquire the mechanisms leading to variation among analyzed cases, I categorized spinoffs based on various strategic dimensions. More specifically, I compared and contrasted cases according to the nature and source of entrepreneurial ideas, founding team characteristics including number of founding members, founders' entrepreneurial experience measured by number of founded firms, founders' tenure, and historical origin or organizational antecedents of spinoff firms. When cases were sorted along the latter dimension, I observed that spinoffs spawned following 'organizational turbulences' (e.g. external shocks, or major internal restructuring within the parent organizations) often remained on a very similar strategic and technological path as their parent organizations. Hence, since spinoffs in this aggregate dimension early knowledge domain was closely connected to those of their parent organizations, their founders drew extensively on parental technological and market-related blueprints to shape their new ventures' early routines, practices, and capabilities.

"Now they have become a sort of research institute. They have changed a lot the technology and approach to discovery since acquisition. In terms of technology at that time, the technology in our company is just the same. Here we work on natural products as we did there… In terms of market capabilities, for example, when I built up the company and started to buy instrumentation, I called the suppliers we had there. I was vice president of chemist there, and we had purchasing department responsible for buying everything. So, I contacted several suppliers, and when I started the company I went back to them because I knew they were working in the same market." (Interview 11; P.50)

In contrast to the spinoff ventures categorized in 'organizational turbulence' aggregate dimension, I observed that spinoffs spurred on by 'organizational rigidity' (e.g. lack of complementary capabilities in parent organization, information asymmetries with employer, or strategic disagreement) often spawned to a new technological field or served a new market segment distant from their parent organizations' core businesses. Said that, I found that spinoffs categorized within this dimension initially incorporated at most only very suited elements of inherited knowledge from their parent organization since the relevant capabilities, practices and required know-how in those new sectors didn't correspond to the knowledge domains of their parent firms.

"We saw ways of translating the technology to other pieces, other markets, and so we saw that opportunity… I would say the technology is pretty much similar. We continued our mission as before. What we are doing is similar to them, maybe small change and a bit of shift." (Interview 4; P. 18)

"The technology was not a problem. But the market, and also the focus in the sense that they were mainly involved in research activities for other firms. They were working on bio pharmaceutical, and my idea was related to diagnostics. So, for them this was an entirely new field, as it was for me. From production level to regulatory issues, customers, marketing strategy, time to market. I mean if you have an expertise in Biotech, the diagnostic or the medical tech is completely new and different. So, you cannot use existing expertise for the new initiative. It's also very rare to find biotech companies with diagnostic department. Generally speaking there is sort of division between these areas because they require very, very specialized expertise, which cannot be shared very easily in the sense that if you are an expert in regulatory issues in biopharmaceutical, this expertise cannot be used for diagnostic. Of course, it's not like starting from zero but is not like knowing everything." (Interview 13; P. 62)

2.4.2. Environmental Changes and Trajectory Shift

In the previous section, I discussed how organizational antecedents of spinoffs affected the process through which spinoffs took on certain elements of parental knowledge early after spawning. Said that, over the course of time, I observed that spinoff ventures deviated from their early development trajectories and combined the underlying elements of knowledge inherited from the incumbent parent firms with knowledge available from sources outside their existing domains to exploit new opportunities or respond to new demands in the market.

"Just before setting up the company, we filed for the main patent, which was filed by our academic founder, and that was the beginning of the story because than clearly we filed for other patents and we improved the technology. We also shift from the initial patent and the initial technology moving to quite different field of investigation, because the original patents were only based on proteins, but now our core business is really this new protein IDM complex, which is something different than the original finding, and this has been developed totally during the first few years of the life the company." (Interview 13, P.61)

"My idea was not to go to a different technology, but to make the old technology far more efficient by using different approaches. By technology here I mean identifying bioactive molecules from microorganisms and the technology is still the same. The purpose is how you do it can substantially change… So, I learned a lot about the technology. The innovation was doing the same thing with different ways." (Interview 9; P. 39).

Apart from emergence of new opportunities in the market that unleashed the reframing of spinoffs development trajectory, I observed that major shift in spinoffs' institutional environment (e.g. new market regulations), or scarcity of resources necessitated spinoffs to deviate from their existing strategies, structures, and development path in order to respond to those changes in their institutional context.

"The initial idea has changed quite significantly from the beginning. At the beginning, we were focusing for 3 years on protein fraction. Then due to regulatory issues

(that took longer than expected), we decided to modify and work on industrial applications such as bio glue and it turn to be even more interesting." (Interview 3, P.13)

"At the beginning, we had some idea in the animal health, but we had no resources to develop the idea. They [parent firm] didn't pay the patent taxes for maintenance… I discovered the compounds. I re-patent the compound with formulation for animal health. This was my first idea when I started X, but then I changed and I went back to oncology. If I found the right resources, I will continue." (Interview 11, Page 51).

Overall, in addition to the early founding phase in which spinoffs founders' strategically opted for and retained only very suited elements of parental knowledge to set their ventures early knowledge and capabilities, over the course of time, I observed that changes in external economic and institutional environment necessitate spinoffs to break away from parental stamp that has caused inertia, search for external sources of knowledge to combine it with existing element of inherited knowledge, in order to exploit new technological/market-related opportunities or respond to changes in their external environment.

2.5. GROUNDED MODEL OF ORGANIZATIONAL IMPRINTING

In order to advance our grounded model of organizational imprinting, first, its necessary to have a clear understanding of what the imprinting term refers to. In his seminal essay, Stinchcombe introduced the concept of "structural imprinting" to the organization literature and posited that organizations reflect the elements of their external environment at the time of founding and because of *"traditionalizing forces"*, or the premise that those organizations' early structures might still be the most efficient form as organizations might not be in a competitive structure, those elements exert an enduring effect on organizations subsequent behaviors (Stinchcombe, 1965, P.169). Following this outlook, institutional theorists, organizations ecologists, and management scholars have often invoked on the concept of imprinting as a process in which organizations come to reflect the elements founding context and they have attempted to justify and explain organizations' certain traits and behaviors using environmental conditions available at the time of founding (e.g. Boeker, 1988; Johnson, 2007; Marquis and Huang, 2010; Tucker et al., 1990; Zyglidopoulos, 1999). While the primary focus in most of the imprinting research has been on the long-lasting effect of environmental context during the founding period, as noted by Pennings (1980) and highlighted by Marquis and Tilcsik (2013), "the creation of new organization is one of the most salient moments of its life cycle", but it's not necessarily the only period. Recently, Marquis and Tilcsik (2013) attempted to provide a more accurate picture of imprinting hypothesis in a way that it is general and comprehensive to be valid across different level of analysis (e.g. industry, single organization, job blocks, and individual), but at the same time it is specific and distinct from other concepts such as path dependence or cohort effect that describe how historical events influence present organizations' outcomes (Marquis and Tilcsik, 2013). The authors defined imprinting as "*a process whereby, during a brief period of susceptibility, a focal entity develops characteristics that reflect prominent features of the environment, and these characteristics continue to persist despite substantial environmental changes in subsequent periods.*" (Marquis and Tilcsik, 2013 P. 201).

I believe this definition is suitable for the purpose of my analysis and this study for two reasons. First, this definition accounts for presence of various "sensitive periods" beyond the founding phases, in which organizations exhibit "high receptivity" to the influence of their environmental context. For example, Carroll and Hannan (2004) posited that imprinting could also occur during "key development stages", pointing to the presence of multiple sensitive periods throughout organizations' lifecycle. Second, this definition emphasizes volatility – rather than permanence – of imprints, suggesting that some elements of imprints might fade away over spinoff course of development. For example, Boeker (1989) find that when the performance declines, organizations deviate from their initially imprinted strategies. Similarly, Marquis and Huang (2010) find that when organizations encounter new environmental context, they modify the imprinted coordination practices and capabilities.

The results of my analysis using qualitative data collected from a sample of 14 biotech spinoff ventures can be summarized as follows. First, I found that the effect of parental heredity on spinoff ventures' early capabilities and structures is hinged on organizational antecedents of spinoff as I observed significant variation with regard to the extent to which the same elements of knowledge as parent organization were incorporated across different spinoffs. More precisely, I found systematic differences between spinoffs spawned following either dissolution or internal restructuring of the incumbent firms (what I term as organizational turbulence) and spinoffs motivated by information asymmetries, strategic disagreement, or incumbents' lack of complementary capabilities (what I term as organizational rigidity) with regard to the extent to which their founders strategically retained and initially incorporated the same elements of knowledge as their parent organizations. Spinoffs motivated by organizational turbulence often stay very close to their parent organizations' technological and market domains and initially they inherit the majority of their capabilities and know-how from their parent organizations. In contrast, spinoffs spawned following the parent firm's organizational rigidity absorb only some elements of inherited knowledge from their parents and the extent of the latter depends on the type of entrepreneurial opportunity a spinoff pursues. For example, I observed that spinoffs spawned to exploit business opportunities in new markets distant from their parents' core business often imprint only the very suited technological know-how (and not market related knowledge) from their parent firms. This evidence contrasts the view according to which spinoff ventures always transfer parental blueprints so that their capabilities and the technologies are instinctively closely related to those of their parent firms (e.g. Agarwal et al, 2004; Chatterji, 2009; Franco and Filson, 2006).

Second, whilst parental legacy and knowledge endowment during the founding phase (and when spinoffs have limited resources) may help spinoffs to reduce technological and market-related uncertainties faced by new entrants, it may also generate more inertia and ultimately it may diminish their flexibility in responding to changes in the market (Ferriani et al., 2012; Hannan et al., 1996). Yet, spinoff founders may choose to diverge from parental knowledge domain, recombine the existing elements of inherited knowledge in new ways, or combine them with knowledge acquired from external sources to create novel and impactful knowledge (Basu et al., 2015; Kogut & Zander, 1992; Sapienza et al., 2004).

Therewith, throughout spinoff lifecycle, and when they encountered unprecedented opportunities or faced major changes in their institutional environment, I found that spinoff's founders chose to diverge from their ventures early development trajectories, modified or discarded those incorporated parental blueprints to become able to overcome inertia caused by parental stamp, and exploit new opportunities or respond to changes in their external environment by combining the underlying elements of parental knowledge with knowledge available from the external sources.

Drawing upon these findings and discoursed definition of imprinting (Marquis and Tilcsik, 2013), I propose the grounded model of organizational imprinting through entrepreneurial spawning as a process through which offspring founders selectively retain and adopt the very fitted elements of knowledge inherited from the incumbent parents to set their ventures early structures, and that parental heredity exert a lasting influence beyond the founding phase pending the advent of major changes in spinoffs' external economic and institutional environment that entails them to deviate from early development trajectories and discard or combine those retained elements of parental knowledge with new fields of knowledge.

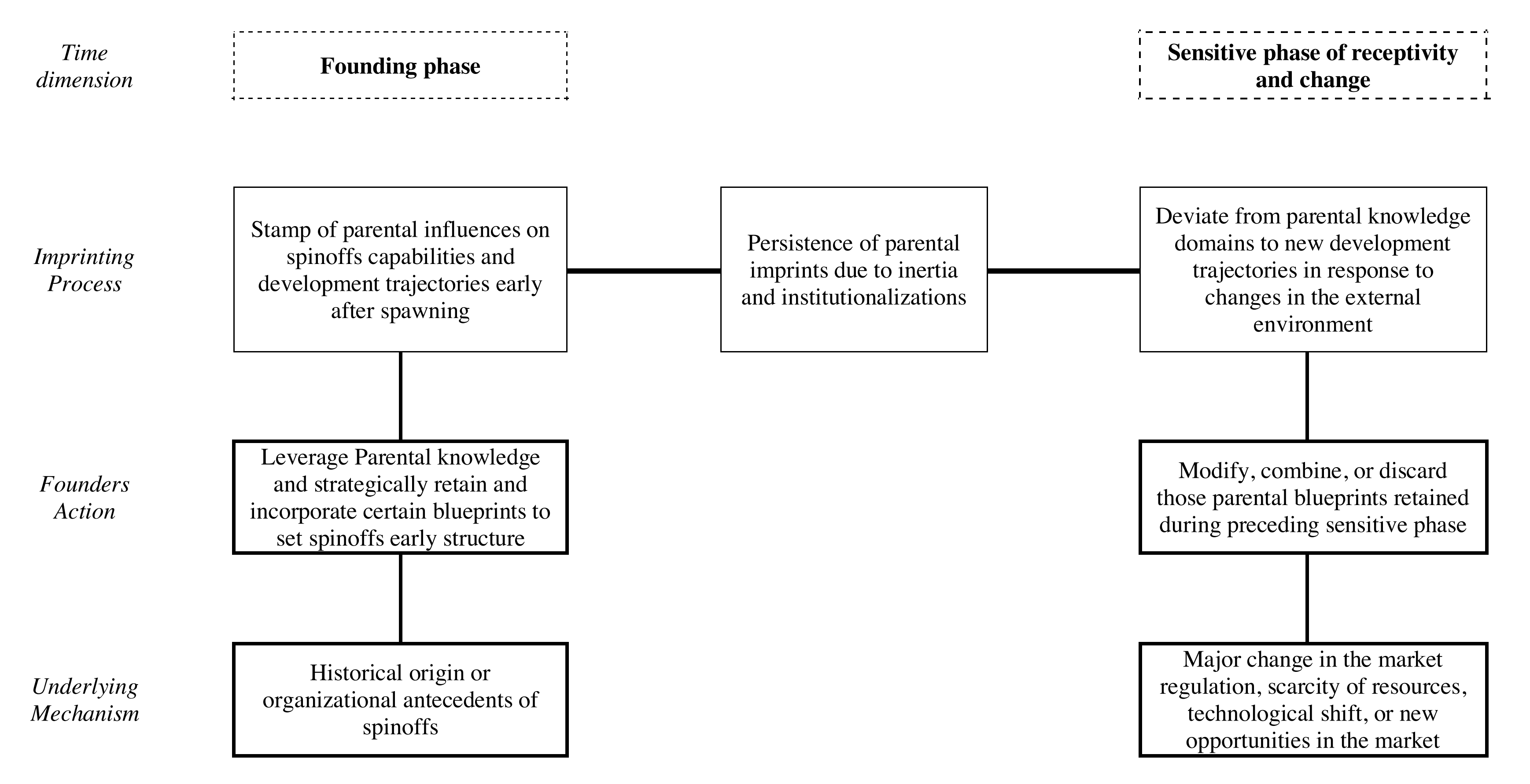
As depicted in figure 2.1, spinoffs ventures experience multiple sensitive phases of receptivity and change (e.g. early founding period or later over the spinoff course of development and when they face major changes in their institutional environment), and the stamp of that survived parental blueprint left on the spinoff ventures exert a persistent – but not necessarily irreversible – influence on spinoffs' structures, capabilities, and development path.

2.6. CONTRIBUTIONS AND DIRECTION FOR FUTURE RESEARCH

The main objective in this study was to gain a micro-level understanding of the mechanisms that underlie the creation of parental imprints, the contingencies, and the consequences for the spinoffs' patterns of knowledge accumulation and the direction of business growth. Organizational imprinting and genealogical view of new ventures formation suggest that spinoff founders inherit knowledge and capabilities in form of blueprints from the incumbent parent firms and that parental heredity stamp a lasting influence that makes spinoffs clones of the incumbent firms. Using grounded theory approach and building upon qualitative data collected from 14 biotech spinoffs, I show how and under which conditions spinoff founders choose to retain, abandon, or combine elements of knowledge inherited from their parent organization to find a balance between more organizational inertia and less technological/market uncertainties faced by new entrants. Below I discuss the expected contributions to different streams of literature.

First, the primary focus in most of the imprinting research has been on the long-lasting effect of environmental context during the founding period, suggesting that "*what an organization knows at its birth will determine what it searches for, what it experiences and how it interprets what it encounters*" (Huber, 1991: 91).

Figure 2.1: Grounded model of organizational imprinting through entrepreneurial spawning



However, alike founding period in which organizations are high receptive to their surrounding environment (e.g. Boeker, 1989; Kimberly, 1975), I showed that major changes in the external environment require organizations to modify their initial structures (i.e. break away from early environmental stamp), combine underlying knowledge with external knowledge in order to respond to external changes or exploit new opportunities encountered over time. Further, in contrast to the view that emphasizes on permanent and enduring influence of environmental conditions on organizations subsequent behaviors, I showed that the stamp of environmental forces on a focal entity during a specific period of transition (for example founding phase) persisted only until the advent of succeeding sensitive phase. Thus, our grounded findings contribute to the literature on organizational imprinting in two ways: first, by providing evidence on presence of other transition period beyond the founding phase in which environmental influences are at risk of at least modification, and second, by shedding more lights on the tension between 'persistence and decay' of imprinting effects (Marquis and Tilcsik, 2013; Marquis and Huang, 2010; Bamford et al., 2000).

Second, this study contributes to the growing literature on genealogical view of new ventures formation and spinoffs' parental heredity and knowledge endowments by identifying the boundary conditions under which founders leverage and incorporate the exact elements of knowledge as their parent firms to set their ventures strategies and structures. Current literature has often hypothesized an inevitable process of parent-spinoff knowledge transfer, and has rarely tested to what extent this process actually occurs in practice. Comparing and contrasting imprinted elements of parental knowledge across different spinoffs, I showed that the extent to which spinoffs initially incorporate the same elements of knowledge as their parent organizations depends on historical origin and the organizational antecedents of spinoffs and the extent to which the spawned ventures' knowledge domains conform with that knowledge available within the incumbent parent firms.

Third, this study also contributes to the literature on performance consequences of parental heredity for the spinoff ventures. Previous studies on firms' performance heterogeneity have demonstrated how historical antecedents affect new firms' resource heterogeneity and subsequently their market performance (Burton et al., 2002; Helfat and liberman, 2002; Shane and Stuart, 2002). In context of spinoffs, extant literature has often assumed that spinoff founders leverage parental knowledge and capabilities to avoid large upfront development costs by using routines and practices that have worked in the past (Winter et al., 2007) and as for that, it has been often argued that the capabilities and subsequent performance of spinoffs are in great extent determined by the quality of their parent firms (Klepper and Thompson, 2010). For example, Agarwal et al. (2004) find that spinoffs had a higher probability of survival than all other types of entrants (such as diversifying entrants and non-spinoff *de novo* entrants) in Disk drive industry. Chatterji (2009) finds that spinoffs that incorporated nontechnical knowledge related to regulatory, strategy, and marketing from their parent firms performed better than other spawns, and competitors. Franco and Filson (2006) show that a spinoff likelihood of survival (and in separate test expected lifetime) is increasing in its parent's know-how. Nevertheless, while there is an overall agreement on positive influence of parental heredity on the quality and survival of spinoff ventures, I found that spinoffs deflect parental stamp, deviate from their early trajectories, and combine parental blueprints with dispersed sources of knowledge in order to respond to major changes in their institutional environment. As for that, the grounded findings in this study suggest a less deterministic stance toward the monotonic positive effects of genealogical lineage on spinoff' performance as spinoffs may not necessarily adopt the same technological or market know-how developed by their parent firms. For example, Sapienza et al., (2004) argue that there is an inverted-U shape relationship between knowledge relatedness to the parent firms and spinoffs' learning and growth. The authors argue that too much and too little knowledge relatedness to parent firms both hamper spinoff' learning due to constraint for novel knowledge combinations and knowledge assimilation, respectively. Similarly, Basu et al. (2015) predicted a modest degree of divergence from parent firm's knowledge domain maximizes the knowledge impact created by the spinoff venture.

The findings in this study are grounded on qualitative analysis of multi-cases in the context of Italian spinoffs active in the biotech sector. Despite all merits of this type of approach for exploring poorly developed phenomenon in the literature, the external validity of these findings remains an issue. Although, I acknowledge the inherited difficulties in having access/collecting data on rare events like spinoffs, future researches using quantitative and variable-based approach based will result in a more representative understanding of this process and its consequences for recipient organization.

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3. ESSAY TWO

Knowledge Spillover Through Entrepreneurial Spawning;
Incumbents' Knowledge Profile and Spinoffs Patterns of Entry

ABSTRACT

The organizational antecedent of different patterns of spinoff entry, when unexploited knowledge created by incumbents spurs formation of spinoff ventures is subject of this paper. First, building on the corporate coherence argument, I claim that incumbents pursue and further exploit new ideas and opportunities that have a level of similarity and synergy with their existing stock of knowledge and leave unfamiliar or less similar opportunities unexploited. Second, drawing on knowledge spillover theory of entrepreneurship, I argue that while such underutilized knowledge created in the incumbents may signal employees the existence of untapped entrepreneurial opportunities, the employees' decision to leverage them for the purpose of venturing out is contingent on the presence of complementary capabilities within the incumbents' stock of knowledge. The analysis of 131 spinoffs from the biotech sector supported my hypotheses linking the incumbents' level of technological and market diversity to their spinoffs patterns of entry to the same (or different) technological fields or market segments as their parents' core businesses. The results of this study contribute to the growing literature on knowledge spillover and entry by spinoff ventures.

Keywords:
Employee Entrepreneurship; Knowledge Spillover; Corporate Coherence

3.1. INTRODUCTION

Spinoffs – entrepreneurial ventures founded by former employees of incumbent firms in the same industry – are a quintessential example of knowledge spillover as by very definition, they are created to exploit opportunities encountered by their founders through the past course of employment in the incumbent firms (Agarwal, Audretsch, & Sarkar, 2007; Phillips, 2002). In addition to this, when employees leave paid employments to become entrepreneur, they carry with them blueprints of the industry incumbents in the forms of routines, practices, and technologies to formulate their self-standing ventures' early capabilities and structures (Boeker, 1997; Chatterji, 2009; Gompers et al., 2005; Klepper, 2001, Klepper and Thompson, 2010). In this regard, industry incumbents are 'fonts of entrepreneurship' in the sense that they provide the necessary knowledge about opportunities, skills, complementary capabilities, and social capital that employees can rely upon for setting up their own ventures (Freeman, 1986; Romanelli, 1989; Sørenson and Audia, 2000; Sørensen and Fassiotto, 2011).

According to the knowledge spillover theory of entrepreneurship, "*…entrepreneurship is an endogenous response to opportunities generated by investments in new knowledge made by incumbent firms and organizations but which are unable to completely and exhaustively commercialize*" (Audretsch and Keilbach, 2007, P. 1244). In other words, by exploiting knowledge that otherwise would remain unexploited, through the start-up of a new venture, employee entrepreneurship serves as a conduit of knowledge spillover from the parent organization to the spinoff venture (Acs et al., 2009 & 2013; Agarwal et al., 2007 & 2010; Audretsch and Keilbach, 2007).

This stream of literature demonstrates that this is not an increase in stock of knowledge created within industry incumbents that trigger entrepreneurial spawning, rather formation of spinoffs is contingent on how incumbents efficiently exploit their knowledge. That is, in contrast to some evidence that incumbents with abundant knowledge are more prone to experience spawning (Burton et al., 2002; Franco & Filson, 2006; Garvin, 1983), the knowledge spillover view of spinoff formation emphasizes on endogenous creation of entrepreneurial opportunities, when incumbent firms fail to appropriate and exploit the value from their investment in knowledge creation. For example, by distinguishing between pioneering technological know-how (i.e. an incumbent's ability to create new scientific and breakthrough technologies) and market pioneering know-how (i.e. an incumbent's ability to commercialize those technologies ahead of its competitor), Agarwal et al. (2004) demonstrate that an increase in either pioneering technological know-how or market pioneering know-how enhances the likelihood of spinoffs entry. These authors posit that incumbents' unwillingness to pursue certain valuable opportunities related to new technological breakthroughs or emerging sub-markets might cause frustration among employees whose ideas or inventions are shelved and not pursued by the incumbent firms, and ultimately it may spur the formation of spinoff ventures. Moreover, abundant pioneering technological know-how not complemented by pioneering market know-how signals employees new market opportunities that the parent is not interested or able to pursue.

Overall, in the lens provided by knowledge spillover theory of entrepreneurship, potential opportunities generated by incumbent firms are not equally accessible to new firms in general; instead, spinoffs take advantage of 'knowledge corridors' that gives them access to know-how and tacit knowledge not freely available to other startups (Agarwal et al., 2004; Franco and Filson, 2006; Klepper, 2007; Klepper and Sleeper, 2005).

That said, while the primary focus of previous research has been on endogenous creation of entrepreneurial opportunities, little is known about the link between incumbents' knowledge profile (i.e. level of technological and market diversity) and the type of opportunities created by them. Specifically, an existing gap in our understanding of knowledge spillover theory of entrepreneurship is that how incumbent select among the pool of new ideas to appropriate the value of their investment in knowledge creation and under which conditions such created but remained unexploited knowledge spurs employees' transition to entrepreneurship?

Spinoffs might spawn into new technological sectors or new market segments distant from the incumbent parents' core businesses. For example, in a study of the laser industry, Klepper and Sleeper (2005) observed that spinoffs initially operated in an overlapping, but different product-market from their parent firms and differentiated over time. Franco and Filson (2006) in contrast observed that the new market segments transitioned from low market overlap to greater competition. The type of spinoff entry (the extent to which spinoffs initially spawn into the same technological sector or market segment as their parent firms) has important implication both for spinoffs and parent organizations. In particular, when a spinoff enters an overlapping market segment to exploit a new technological opportunity not commercialized by its parent firm, the spawning event poses a special threat to the parent organizations since the new entrant might end up attacking the market position of the incumbent (Campbell et al., 2012; Phillips, 2002; Wezel et al., 2006). In contrast, such competition effect is null-and-void when spinoff pursues a business opportunity outside its parent firm's core business. Nonetheless, despite the important consequences of different patterns of spinoff entry, still we know little about how knowledge profile of industry incumbents (i.e. the organizational antecedents of spinoffs) predict different patterns of spinoffs' entry. For example, Agarwal et al., (2016) predict the likelihood of a spinoff increases with the gap between the incumbent organizations' technological and market know-how, but do not tell about the type of spinoff – i.e. the degree of market or technological overlap with the incumbent parent firm. Moreover, unlike Agarwal et al, (2004) who focus on technological and market leadership of the parent, this paper looks at the parent's portfolio of technological and business activities as a predictor of different types of spinoffs.

My theoretical framework builds on two streams of the literature. First, I draw on the concept of corporate coherence (Teece et al., 1994) that links organizations' decision to pursue/shelve unprecedented opportunity to their existing stock of technological and market knowledge. Because of firms' tendencies toward local search and 'path-dependent exploration', I argue that incumbents pursue and further exploit opportunities that have a level of similarity and synergy with their existing stock of knowledge and leave other opportunities unexploited (March, 1991; Rosenkopf and Nerkar, 2001). Second, building on the knowledge spillover theory of entrepreneurship (Audretsch and Keilbach, 2007; Agarwal et al., 2007 & 2010; Acs et al., 2009 & 2013), I argue that, while such unexploited technological knowledge or unexploited market opportunities created in the incumbent firms may signal employees the existence of untapped entrepreneurial opportunities, the employees' decision to leverage them for the purpose of venturing out is contingent on the presence (absence) of complementary capabilities within the incumbents' stock of knowledge.

My unit of analysis in this study is the parent-spinoff dyad and I focus my attention on the determinants of the extent of technological and market overlap between a spinoff and its incumbent parent at the time of spawning. The results of my analyses based on a sample of 131 spinoffs in the Biotech industry can be summarized as follows. 1- new market serving spinoffs (spinoffs spawning into new market segments different from their parent firms) are more likely to spawn from incumbent parents with a low degree of market diversity. 2- new technology seeking spinoffs (spinoffs developing new technologies different from their parent firms) are more likely to spawn from incumbent parents with a low degree of technological diversity. 3- new markets serving but same technology seeking spinoffs are more likely to spawn from technologically diversified incumbent parents that are active in a few product-market segments. 4- in contrast, the incumbent' knowledge profile doesn't predict new technologies seeking spinoffs spawning into the same market segment as their parent firms. 5- spinoffs founders' tenure in the incumbent parent moderates the relation between the incumbent parent's level of market diversity and its spinoff's pattern of entry, such that the negative effect of parent's market diversity on new market serving type of spinoff entry is stronger, when the founder has shorter duration of employment in the parent firm. 6- spinoffs founders' former entrepreneurial experience moderates the relationship between the incumbent parent's level of technological diversity and its spinoff's pattern of entry, such that the negative effect of incumbent parents' technological diversity on new technology seeking type of spinoff entry is stronger for the novice entrepreneurs.

The remainder of this paper is organized as follows. Section 2 reviews the extant literature. Section 3 describes the two building blocks of my theoretical framework and presents the research hypotheses. Section 4, introduces the research context and describes sample, key variables, and estimation method. Sections 5 and 6 present the results of main and robust analysis. I conclude by discussion, a brief conclusion and expected contributions to the literature.

3.2. LITERATURE REVIEW

3.2.1. Definition of a Spinoff Firm

The literature has proposed a number of different definitions and classifications of spinoff ventures and, as a result, sometimes we lack a clear understanding of what is meant by the use of this term. For instance, a number of studies have distinguished between academic spinoffs (e.g. Perkmann et al., 2013) and corporate spinoffs (e.g. Parhankangas and Arenius, 2003). Some studies define corporate spinoffs as independent and self-standing new ventures created by former employee/s of established firms in the same industry (Agarwal et al, 2004[3]; Klepper,

[3] Agarwal et al. (2004) used the term "spinout" as entrepreneurial ventures formed by ex-employees of established firms in the same industry.

2002; Franco and Filson, 2006) while others define them as new ventures that use ideas developed within the established firms without emphasizing the link between the two organizations constituted by employee mobility (Chesbrough, 2003, Parhankangas and Arenius, 2003; Sapienza et al, 2004).

Among others, Helfat and Lieberman (2002) proposed a distinction between *"entrepreneurial-spinoff"* and *"parent-spinoff"*. In the latter, the parent firm often retains financial interests and representation on the board of directors while in the former there is no direct support or sponsorship from the parent firm. Following this classification, I focus my attention on entrepreneurial-spinoffs (i.e. entrepreneurial ventures of incumbents' ex-employees in which there is no strategic link to the incumbent parent) to make sure there is no influence on spinoffs' strategic decisions and interference from outside. However, for the sake of brevity, I constantly use the term 'spinoff' in this study. Further, following the popular terminology, I use 'incumbent parent' to refer to the spinoff founders' last place of employment in the industry.

3.2.2. Stylized Facts

Spinoffs have been studied in various industries including semiconductors (Braun and MacDonald, 1982; Brittain and Freeman, 1986; Klepper, 2001), disk drives (Agarwal et al., 2004; Christensen, 1993; Franco and Filson, 2006), lasers (Klepper and Sleeper, 2005; Sherer, 2006), automobile (Klepper, 2002; Klepper, 2007; Ioannou, 2014), tyres (Buenstorf and Klepper, 2009), biotechnology (Mitton, 1990; Stuart and Sorenson, 2003), and legal services (Phillips, 2002).

These studies demonstrate that spinoffs account for a high share of entrants in several fast-growing and knowledge-intensive industries (Christensen, 1993; Bhide, 2000; Burton et al., 2002; Gompers et al, 2005). For example, in a study of Silicon Valley start-ups, Burton et al. (2002) could identify at least one prior employer for 420 founders out of 527 in their sample.

Gompers et al. (2005) found that 45% of all venture capital backed startups in their sample were spawned by public companies. Bhide (1994) found that 71% of the founders in 1989 Inc. 500 fastest growing private companies had replicated or modified an idea encountered through previous employment. In a study of the U.S. disk drive industry, Christensen (1993) found that spinoffs had a market leadership position in the industry and contributed to 99.4 percent of start-ups total revenue. Evidence suggests that in the vast majority of cases, the decision to found a new venture is made while an individual is working for an incumbent firm in the same industry (Freeman, 1986).

Empirical studies have also highlighted several "stylized facts" or "empirical regularities" concerning the generation and performance of this type of ventures (Klepper, 2001).

First, the probability of a spinoff increases when the established firms are acquired or when there is a change in the firm CEO (Klepper and Thompson, 2010). Second, the rate of spinoff increases when the established firm's performance declines (Gompers et al., 2005). Third, there is an inverted U-shape relation between the probability of spinoffs and the established firms' age (Klepper and Thompson, 2010). Fourth, established firms with more and better know-how (Franco and Filson, 2006), and more patents generate spinoffs at a higher rate (Klepper and Sleeper, 2005). Fifth, the probability of spinoff increases not only with the amount of know-how per se, but when established firms underutilize the knowledge they create (Agarwal et al., 2004; Agarwal et al., 2007; Audrestch and Keilbach, 2007; Klepper, 2007; Shane and Stuart, 2002). Sixth, the probability of a spinoff increases when the parent firm follows more focused business strategy (Gompers et al., 2005). Seventh, better performing firms spawn better performing spinoffs (Agarwal et al., 2004; Franco and Filson, 2006). Finally, spinoffs have a superior performance in comparison with other *de novo* startups and almost the same performance as diversifying entrants (Agarwal et al., 2004).

3.2.3. Theories of Spinoffs Formation

Extant theories on the genesis of spinoffs suggest three possible classes of explanations. The *first* one, focuses on organizational capabilities and suggests that incumbent firms deliberately refuse to develop valuable, but remote opportunities, not only because of constrains in the exploitation process (e.g. lack of complementary assets), but also because the exploitation might challenge their current competences and rents (Cassiman and Ueda, 2006; Chesbrough, 2003; Hellmann, 2007; Gompers et al., 2005; Lewis and Yao, 2001; Pakes and Nitzan, 1983). In this line of thought, for instance, Pakes and Nitzan (1983) in a cost-benefit analysis of cannibalization propose that an employee leaves the parent only if leaving is the efficient decision. Similarly, Cassiman and Ueda (2006) propose that the incumbent firm trades off the returns of new opportunity exploitation not only against cannibalization, but also against the option value of waiting for better opportunities in the future. In their dynamic model, based on the assumption that the firm has a limited commercialization capacity, the incumbent may optimally refuse to support a seemingly valuable opportunity and wait for a future opportunity that has a higher fit with its commercialization resources. The authors claim that such prediction is due to the benefits that arising from pursuing new opportunities that make use of internal underutilized resources. Gompers et al. (2005) tested two views of entrepreneurial spawning. In the first case, the employees learn the process of becoming entrepreneur and get access to important social and financial resources through working for young entrepreneurial firms. In the second case, large bureaucratic companies refuse to support the employees' ideas that fall outside their core business. From this perspective, Hellmann (2007) develops a multitask model where the incentives (and benefits) for employees to innovate may interfere with the incentives (and benefits) to carry out core tasks. Hellman's model suggests that a spinoff can be the outcome of efficient ex-ante policies (when discouraging employees' inventions is a part of an optimal policy that promote greater focus on core tasks) or ex-post inefficient policies (when refusing to develop an invention whose internal development would have been more efficient than external development by a start-up). In his view, the way that incumbent designs its incentive structure affects the employee's decision to become entrepreneur.

The *second* class of theories posit that asymmetric information between employees and employers hampers the writing of efficient contract between employees and employers and may persuade employees to remain silent (when the discovery is private information) and leave the parent firm to develop the opportunity by founding a spinoff, even though the joint profit would be higher if the opportunity were developed by the parent firm (Anton and Yao, 1995; Bankman and Gilson, 1999; Chatterjee and Rossi-Hansberg, 2012; Gromb and Scharfstein, 2002). In this class of explanations, for example, Anton and Yao (1995) focus on contracting problems between employees and incumbent firms and argue that in a setting in which starting up a new firm requires little capital or when property rights are missing, employees remain silent and leave the incumbent firms to exploit the opportunity by setting up a spinoff to reduce the risk of rent expropriation (Anton and Yao, 1995). Chatterjee and Rossi-Hansberg (2012) confirm that employees have private information regarding the quality of their idea, however adverse selection prevents them to disclose the idea to the incumbent firm, or employees reveals those ideas of moderate quality to incumbents, but exploit the very best ideas by setting up a spinoff.

The *third* class of theories, focuses on employee learning and suggests that employees learn from their parents how to operate effectively; by "*blue printing*" their parents' know-how they set up their own independent firms (Acs et al., 2009; Agarwal et al., 2004; Audretsch et al., 2007; Franco and Filson, 2006; Klepper and Sleeper, 2005; Klepper and Thompson, 2010; Thompson and Chen, 2011). Employees of established firm learn from their parent and might decide to exploit abundant knowledge to create their own firms. In this line of thought, for instance Agarwal et al. (2004) explore the impact of the incumbent firm's know-how on the likelihood of spinoff spawning. By distinguishing between technological and market pioneering know-how, the authors find that firms that are expert in both types of know-how generate fewer external ventures than those that invest mostly in one. While Agarwal et al. (2004) focus on the opportunities created by the mismatch between technological and market capabilities of the incumbent firms, other works propose the theory of spinoff formation underpinned by strategic disagreement and argue that as a result of contrasting incentives or asymmetric information (i.e. what underlies the second stream of theories), spinoffs are created when employees and employers have "*different views about the best strategic direction of firms*" (Klepper, 2002 and 2007; Klepper and Sleeper, 2005; Klepper and Thompson, 2010). Overall, the proposed theories on the genesis of spinoffs suggest that spinoffs are motivated by unexploited knowledge (e.g. Agarwal et al., 2004), strategic disagreement (e.g. Klepper, 2007; Thompson and Chen, 2011) or employee learning (e.g. Franco and Filson, 2006) and can be understood as the outcome of either efficient, or inefficient policies by the parent firms (Hellmann, 2007).

3.3. THEORETICAL DEVELOPMENT AND RESEARCH HYPOTHESES

Extant research in the entrepreneurship has typically revolved around the nexus of "*lucrative opportunities*" and "*enterprising-individuals*", aiming to understand what makes some individuals more likely to identify opportunities, act upon them, and start a new venture (Shane and Venkataraman, 2000). As for that, the prevailing theories of entrepreneurship have typically assumed entrepreneurial opportunities are exogenously being available to the entrepreneurs, thus the source of entrepreneurial opportunities and prominent effect of social context in which individuals identify opportunities implicitly have been overlooked and taken for granted. Said that, past anecdotal evidences suggest that in several fast growing and knowledge-intensive industries, individuals encounter valuable opportunities and enter to entrepreneurship from employment in the incumbent firms (Dobrev and Barnett, 2005; Freeman, 1986; Sorensen and Audia, 2000; Sorensen and Fassiotto, 2011; Stinchcombe, 1965; Corsino, Giuri and Torrisi, 2018). Specifically, as reviewed in the previous section, among other factors, an employee's decision to leave and found a spinoff may be motivated by unexploited knowledge created by the incumbent firms. Drawing from the view that entrepreneurial opportunities become available to individuals, when incumbent firms fail to appropriate all rents from their investment in new knowledge creation, I attempt to shed light on the underlying mechanisms triggering different patterns of spinoffs formation.

My theoretical framework builds on two streams of the literature. First, in evolutionary theory firms undertake local search and 'path-dependent exploration', i.e. their search that builds on previous search outcomes (March, 1991; Rosenkopf and Nerkar, 2001) to maintain coherence (Teece et al., 1994). Drawing on this research line and the literature on employee startups resulting from their employers' project rejection (e.g., Cassiman and Ueda, 2006), I argue that incumbents pursue and further exploit opportunities that have a level of similarity and synergy with their existing stock of knowledge and leave unfamiliar or less similar opportunities unexploited. Second, the knowledge spillover theory of entrepreneurship (Audretsch and Keilbach, 2007; Agarwal et al., 2007 & 2010; Acs et al., 2009 & 2013) posits unexploited technological knowledge or unexploited market opportunities created in the incumbent firms may signal employees the existence of untapped entrepreneurial opportunities that can be leveraged for the purpose of venturing out (Spence, 2002). Building on this stream of research, I argue that the technological and market diversity of incumbent firms generate opportunities for the creation of spinoffs pursuing different types of opportunities. By integrating the two, I study how a spinoff's distance from (i.e. overlap with) the incumbent parent's core market and technological field varies with different combinations of the latter technological and market diversity.

3.3.1. Technological and Market Diversifications and Corporate Coherence

Attention to corporates diversification dates back to Penrose's resource-based theory of firm growth, according to which firms diversify in related industries to exploit tangible or intangible underutilized resources accumulated over time (Penrose, 1995). This view acknowledges the importance of the resource profile in shaping the diversification patterns of firms, and suggests that the coordination of firms' interrelated assets and activities is a key mechanism behind the direction of growth (Montgomery and Wernerfelt, 1988; Montgomery and Hariharan, 1991) and generation of economies of scope (Panzar and Willig, 1981; Teece, 1980).

While the resource-based theory of firm often focuses on product/market determinants of corporate diversification, the evolutionary concept of 'coherence' developed by Teece et al. (1994), emphasizes on ability of the incumbents in pursuing related diversification strategies by exploring synergies and relatedness across common technological resources and competencies and not merely their existing products and markets (Valvano and Vannoni, 2003; Nesta and Saviotti, 2005). The authors introduce the cognitive concept of 'corporate coherence' as they observed firms' products portfolios are not distributed randomly and are relatively stable over long run. According to Teece et al. (1994), a firm can be thought of as "*integrated clusters of core competencies*" and "*supporting complementary assets*" that can grow more diverse, while it maintains a "*constant level of (local) coherence between neighboring activities*" (p.296). They argue that, the degree of a firm's coherence can be explained as an interaction between organization learning dynamic, path dependencies characteristics, the selection environment, the firm's complementary assets, and the technological opportunities neighboring organization current activities. Similarly, Foss and Christensen (2001) define corporate coherence as *"the corporate capacity to generate and exploit complementarities among diverse stock of dispersed knowledge and localized learning processes"*, and argue that path-dependency and organizational learning dynamics that occur within an organization could determine corporate's diversifying strategy (Foss and Christensen, 2001).

The notion of path dependencies emphasizes the lasting effects of a firm's history, and suggests that what a firm can do in future is significantly related to its past experiences. Additionally, the nature of corporate learning defined by firm's existing technologies and markets also determines the range of activities a firm can pursue in the future (Dosi, 1982; Dosi et al., 1992; Teece et al., 1994). In other words, what a firm can do in the future is significantly related to its stock of routines (history), and previous investments, thus the firm future new developments will be close to previous activities and will be transaction and product specific.

Earlier research on technological and business diversification demonstrate that related diversification strategies are often more effective than unrelated ones (Wernerfelt, 1984; Barney, 1991; Markides and Williamson, 1994; Robins and Wiersema, 1995). For instance, Rumelt (1974) confirms that firms with related diversification strategies on average outperform those with unrelated diversification strategy. Such findings can be explained in relation to the increase in both managerial and technological complexity generated by diversifying into unrelated markets and technologies. Moreover, building new marketing capabilities to enter new markets might be more difficult than building new technological competences (Pavitt, 1998). In addition, firms diversify their technological portfolios to develop increasingly complex products and production processes and monitor externally generated technologies (Granstrand et al., 1997; Patel and Pavitt, 1997). This may explain why firms' technological diversification is often larger than market diversification. For instance, through study of 32 electronic companies, Gambardella and Torrisi (1998) find substantial differences between technological and market diversification. Moreover, technological diversification has a positive effect on firms' performance while market diversification has a negative effect.

While related market and technological diversification strategies provide new opportunities for incumbents to access niche markets and to develop new technologies, they also help the incumbents to maintain corporate coherence. Thus, incumbents often select only those created opportunities that share a level of similarity and synergy with their existing stock of technological and market competences, and tend to leave other opportunities unexploited. This is due to two reasons. First, dissimilar opportunities may activate inertial forces, constrain firms' learning processes, disarrange corporate coherence and, ultimately, weaken firm's long-run performance. For instance, Capron and Mitchell (2009) argue that established firms attempts in creating capabilities that depart from or compete with the existing ones often cause organizational resistance and system disruption. Second, pursuing opportunities that require new technological and marketed-related capabilities may destroy the established firm's existing competences since they draw scarce resources from the firms' core business (Teece et al., 1994).

In order to maintain corporate coherence, firms tend to pursue and further exploit new opportunities (i.e., by entering a new businesses) that share similar technological and market-related capabilities with their core business. However, firms differ in their past diversification strategy. As the literature on search and organizational learning clarifies, firms face a trade-off between distant and local learning (March, 1991; McGrath, 2001). To avoid the negative effects of excessive local search and foster innovativeness firms undertake explorative learning by searching far from their current activities (McGrath, 2001) . Firms that have explored and diversified more in the past have probably developed greater capabilities needed to manage diverse businesses and become more willing to pursue a wider set of new opportunities compared to firms with a limited diversification experience.

The ability and willingness of firms with different levels of technological or market diversification to pursue new opportunities has implications for the likelihood of a spin-off and, conditional on a spinoff, for the type of spinoff entry. For example, a firm active in a limited number of product-market segments will probably not pursue an opportunity that requires of new market capabilities that would reduce corporate coherence. Similarly, a firm with a focused set of technological competences will likely shelve an opportunity whose exploitation requires new technological capabilities with a low fit with its existing core technological competences. Not exploiting a new business opportunity by the incumbent organization offers employees the possibility to pursue the business opportunities outside the firm. Thus, conditional on observing a spinoff, I posit that:

Hypothesis 1: *'new market serving spinoffs'* (spinoffs entering a new market segment distant from their parent organizations' core businesses) are less likely to spawn from incumbent parents with a high degree of market diversity.

Hypothesis 2: *'new technology seeking spinoffs'* (spinoffs developing new technologies distant from their parent organizations' core technologies) are less likely to spawn from incumbent parents with a high degree of technological diversity.

3.3.2. Incumbents' Knowledge Profile and Types of Created Opportunities

According to the knowledge spillover theory of entrepreneurship, entrepreneurial opportunities endogenously become available to the incumbents' employees, when incumbents do not want to (or cannot) internalize the outcome of their investment in new knowledge creation (Acs et al., 2009; Agarwal et al., 2007; Audretsch and Keilbach, 2007). Such conceptualization of entrepreneurial opportunities not only undermines the classical theories of entrepreneurship, which have typically treated entrepreneurial opportunities as exogenous to entrepreneurs (e.g. Schumpeter, 1934; Aghion and Howitt, 1992), but it also points to the implications of investments that incumbents make in exploring new knowledge. That said, according to the lens provided by the knowledge spillover theory of entrepreneurship, the gap between technological and market know-how in incumbent organizations may be due to "knowledge filters" such as uncertainty, information asymmetry and high transaction costs that may generate a different perception of (and incentives to pursue) opportunities between the incumbent organization and its employees (Acs et al. 2013; Audretsch and Keilbach, 2007).

Yet, building up on the concept of corporate coherence, I hypothesized that when industry incumbents create new knowledge distant from their existing stock of technologies or discover emerging markets that call for resources distant from their market-related knowledge, they choose not to pursue those opportunities to maintain their coherence. Due to the nature of knowledge, firms cannot easily prevent knowledge expropriation even when knowledge is protected (Arrow, 1962; Cohen et al., 2002). Moreover, incentive mechanisms that firms typically adopt for employee retention (e.g. through deferred rewards like stock options, pension plans with delayed vesting and other "golden handcuffs" (Liebeskind, 1996), are subject to agency costs. Further, moral hazard (Wiggins, 1995) and information asymmetry (Anton & Yao, 1995) hampers the design of efficient contracts between employees and the parent firms. Hence, when the industry incumbent does not have efficient means to fight expropriation or when an employee owns the IP (Hellmann, 2007), the employee may resign the paid job and exploit that unexploited knowledge through venturing out. Such non-excludability and transferability nature of knowledge across organizational boundaries also hold for technological or market related competences and complementary resources required for successful commercialization of underutilized knowledge created in the incumbent firms. I argue that, while that unexploited technological or market knowledge created in the incumbent firms may signal employees untapped entrepreneurial opportunities, the employees' transition to entrepreneurship is contingent on the employer's combination of technological or market-related knowledge.

So far, I have discussed the relationship between the industry incumbents' technological and market diversification on the one hand and the patterns of spinoff formation on the other hand. Yet, to gain a deeper understanding of the relationship between the parent's profile and the type of opportunities generated by the parent and pursued by the spinoff we need to look at different combinations of the parent's technological and market diversification,

Suppose an industry incumbent with a wide range of technological capabilities (i.e. high degree of technological diversity) active in a few product-market segments (i.e. low degree of market diversity). I argue that the incumbent's technological competences that can be leveraged to pursue unexploited opportunity in a new market segment distant from the incumbent's core businesses offer employees the possibility to pursue the business opportunities outside the incumbent firm. That is, the applicability of the incumbent's core technological competences in new market segments foster the employee decision to pursue that created but left unexploited opportunity through setting up a new firm.

In contrast, consider an industry incumbent with a limited range of technological capabilities (i.e. low degree of technological diversity) active in various product-market segments (i.e. high degree of market diversity). I argue that, the incumbent's market-related know-how that can be leveraged to exploit business opportunities that require new technologies distant from the incumbent firm's core technological competences offer employees the possibility to pursue that business opportunities through venturing out. In other words, similarities between required capabilities for entering into the market and available marketing competences within the incumbent's stock of knowledge enhance employees' confidence about starting a new firm. Thus, conditional on observing a spinoff, I posit that:

Hypothesis 3: *"new market serving but same technology seeking spinoffs"* (spinoffs developing technologies similar to their parent firms while spawning into new market segments) are more likely to spawn from technologically diversified parent organizations active in a few product-market segments.

Hypothesis 4: *"new technologies seeking but same market serving spinoffs"* (spinoffs developing new technologies while remaining in the same market as their parent firms s) are more likely to spawn from technologically focused parent organizations active in various market segments.

3.3.3. Founders' Tenure and Former Entrepreneurial Experiences

The successful commercialization of untapped opportunities requires entrepreneurs to be "jacks-of-all-trades" who are competent in a wide set of skills, from technical capabilities to marketing strategies, but do not necessarily excel in any one of them (Lazear, 2004). Employees can acquire these skills by taking on a variety of jobs in their overall career or while they work in the parent firm before entering entrepreneurship. In fact, spinoffs are said to be "spawned with silver spoons" (Chatterji, 2009) since their founders walk out with 'blueprints' of former employers' routines, technological expertise, and market related know-how to set their new ventures early resources, capabilities and structures (Klepper, 2001).

Said that, as noted by Phillips (2002, P. 476), "*the volume of resources and routines transferred to the new entity is likely to be a function of the founder's position in the parent organization*". The amount of time an employee has spent within the incumbent firm determines to what extent the employee has accessed and obtained valuable resources, complementary capabilities, and social capitals. This is due to the fact that, since organization knowledge is socially embedded in its operational and administrative routines (Nelson and Winter, 1982), it takes some time for employees to comprehensively understand and acquire this knowledge.

In developing the hypotheses linking incumbents' level of technological/market diversity and spinoffs' patterns of entry to the same/different technological field or market segment as their parent firms, I posited that since incumbents with a high degree of market diversity are in possession of experience advantages (corporate capabilities) needed to manage diverse businesses, they are more willing and able to pursue a wider set of opportunities in emerging submarkets, and as for that, they are less likely to spawn new market serving spinoffs. It follows then that since the volume of resources accessed and acquired by employees is likely to be correlated with their duration of employment within the incumbent firms, conditional on observing a spawning event, employees with longer tenure are better able to accumulate and transfer parental blueprints in the forms of market-related know-how and exploit them in new markets.

Moreover, spinoffs' founders often possess varied career histories before turning into entrepreneurship (Mosey and Wright, 2007). Among their past working experiences, spinoff founders might have the experience of founding a new venture prior to joining the incumbent parents. Said that, as noted by Dew, Velamuri and Venkataraman (2004), whether an opportunity is exploited internally or through a spinoff depends on the degree of "*intersubjective agreement*" on the value of an opportunity within the firm and outside in the factors market, due to the opportunity uncertainty and novelty. Hence, since a more experienced entrepreneur may be better able to leverage external resources when entering a new market or technology (Hyytinen and Ilmakunnas 2007; Ronstadt, 1988), the probability that this employee exploits the untapped opportunities through venturing out is higher than employees without any earlier entrepreneurial experience.

Thus, I argue that due to prior entrepreneurial aspirations, expertise, and ability to perceive the value of new opportunities related to technological fields outside the parent's set of technologies, spinoff founders with entrepreneurial experience are more prone to pursue those unexploited technological opportunities created in parent firms than other employees without any earlier entrepreneurial experience. Thus, conditional on observing a spinoff, I posit that:

Hypothesis 5: founders' tenure within the incumbent firms positively moderates the negative effect of incumbents' market diversity on *"new market serving spinoffs"* type of entry.

Hypothesis 6: founders' former entrepreneurial experience positively moderates the negative effect of incumbents' technological diversity on *"new technology seeking spinoffs"* type of entry.

3.4. METHODOLOGY

3.4.1. Context: The Biotech Industry

Biotechnology is the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services (OECD, 2005). Included in this definition, there are companies that use at least one modern biological technique, to develop products or services for human and animal treatment, agricultural productivity, renewable resources, industrial production and environmental protection. As for that, biotechnology is not a separate science but rather a mix of disciplines coming together in purpose of serving different product-markets from human and animal treatment to agricultural to industrial biotech products.

I believe this is an appropriate context to study formation of spinoffs for at least three reasons. First, biotechnology is one of the high-tech industries in which the industry development is largely based on the creation of new knowledge by small and medium enterprises (Mangematin et al., 2003). In contrast to some industries in which the knowledge needed for developing a market is already mature (e.g. pharmaceutical industry), biotech companies have to place a significant emphasis on creation of new knowledge since there is a small body of existing know-how that they can rely upon (Pisano, 1994). In the year 2013, almost 23% of the industry revenue (4,834 million USD) was allocated to research and development activities by European biotech firms (EY, 2014).

Second, the biotech industry has historically been characterized by a large number of start-ups (Rothaermel and Deeds, 2004), in which many of them are spawned from industry incumbents (Stuart and Sørenson, 2003). In addition, other entrepreneurs enter industry directly from universities or science parks to develop new products or services in the field. This variation in prior employment is central to this type of studies.

Third, patenting is a common practice by industry incumbents as there are more than 20000 patents granted by European Patent Office during 10-year period from 2004 to 2013 (European IPR Helpdesk, 2014). Patent data is very central for the purpose of my study as it contains fruitful information about technological capabilities of incumbent firms (e.g. Gompers et al., 2005).

3.4.2. Data & Sample

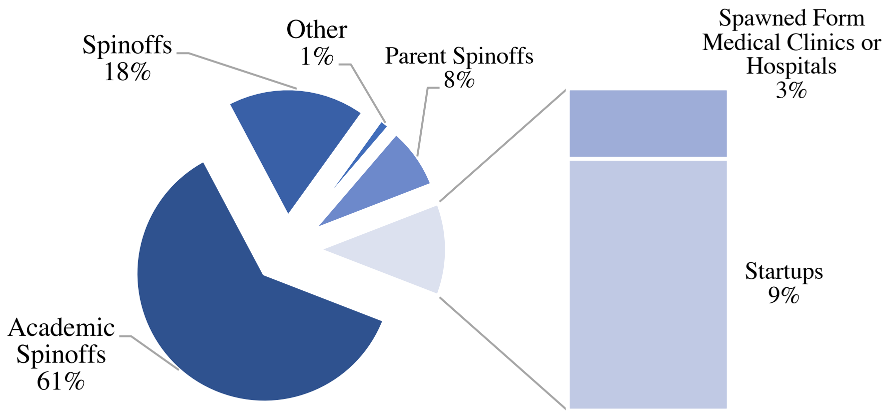
Data was collected using five major sources. 1- ThomsonOne database (a unit of Thomson Reuters), 2- ORBIS database (a unit of Bureau van Dijk), 3- WIPO patent database (PATENTSCOPE), 4- Companies' websites and annual reports, and 5- Three business directories (Bionity, Biocentury, and Biowebspin).

The core data in this study comes from ThomsonOne database. ThomsonOne and similar databases (e.g. Venture Expert, and VentureOne) have been used widely in the literature to investigate different aspects of venture capital financing. Yet, in studies of spinoff formation by Gompers (2005) and Chatterji (2009) these databases have been used as the primary source of data. ThomsonOne database provides financial information covering ventures, buyouts, private equity funds, firms, executives, portfolio companies and limited partners around the world (Kaplan and Lerner, 2015). More specifically, this database contains firm-level information (e.g. funding date, financing rounds, investors, etc.) covering approximately 1,180 European biotech startups that received at least one round of venture capital financing over the period 1986 to 2015.

To create the sample of spinoffs, I implemented following three steps. First, to identify spinoffs and link the spinoff ventures to their incumbent parent firms, it was necessary to collect information about (i) start-up's founders, (ii) their history of employments, and (iii) start-up's initial shareholders. Among the 1,180 startups selected initially, ThomsonOne includes information about the key executive officers of only 874 start-ups. However, this information was not exhaustively practical for my purpose in the sense that except 352 startups in which the founders' name was available, the database doesn't explicitly indicate whether other start-ups' current executive officers were among the initial founders or not. Thus, I re-collected the founders' name for the remaining 522 start-ups using the companies' website and two business directories, Bloomberg and RelScience. Second, I collected information about startup founders' employment history including their last place of employment in the industry, duration of employment, and hierarchical position by searching their names using LinkedIn. Finally, using Orbis database, I collected information about startups' history of ownership to include only those spinoffs in which parent firms have no ownership or control over the spawned ventures.

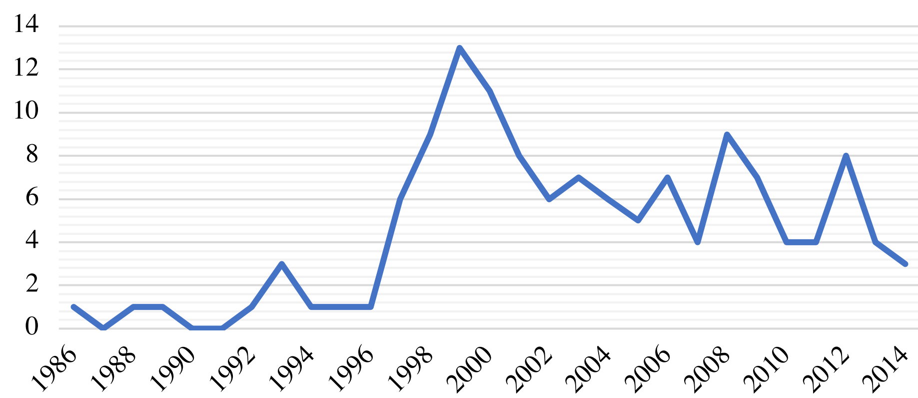
Overall, I was able to identify the origin of 740 startups. As displayed in figure 3.1, 131 startups (approximately 18%) in my sample were identified as spinoff ventures spawned by 116 industry incumbents. The sample is built over a long period of time (1986-2014), in which there was a regime switch in the year 2000 (See Figure 3.2). It was around this time in which the biotech boom reached its first major peak. The large pharma companies perceived the new demands in the market, and soon the drug candidates developed by start-ups took over many tasks formerly located within established large pharmaceutical firms.

Figure 3.1: Startups Analysis by Origin



After creating the sample of spinoffs, I collected information about spinoffs and parent firms' core businesses, projects, and products using companies' websites and three business directories: Bionity, Biocentury, and Biowebspin. Also, spinoffs and parent firms' patent data was collected using PATENTSCOPE to construct the main explanatory variables. Further, I hand-matched the name of parent firms and their spinoffs from ThomsonOne database with the company names from Orbis database to collect other firm-level information such as date of incorporation, current status, 4-digit primary and secondary SIC codes, sales by market segments, and number of employees.

Figure 3.2: Spinoffs Entry by Year



3.4.3. Measures

3.4.3.1. Dependent variable

Spinoffs Type of Entry: For the purpose of this study, I define a spinoff as a new venture, founded by one or more former employees of an incumbent firm. I included only those spinoffs created within 2-years from the date of founders' departure from the incumbent firms. For example, if an employee or employees leave an incumbent firm in year 2000, and then they create a new venture in year 2003, I did not consider this new venture as a spinoff firm.

To identify a spinoff type of entry, I compared the extent of technological and market overlap within parent-spinoff dyads after the spawning event using patent data and 4-digit SIC codes, respectively. I used the PATENTSCOPE database and compared the IPC codes (7-digit level of aggregation) of the spinoff's first patent (according to the priory date) with the technological classes in its parent firm's patent portfolio (only patents whose priority date is before the spinoff's date of incorporation).

A spinoff was defined as a new technology seeking spinoff, when its first patent IPC codes were different from the IPC codes assigned to the patents in its parent firm's patent portfolio, and same technology seeking spinoff, when at least one of its first patent IPC codes was the same as the parent firm's patents' technological classes.

Further, to compare the extent of market overlap between a spinoff and its parent firm, I compared the 4-digit SIC primary and secondary classes of a spinoff with its parent firm using Orbis database. A spinoff was defined as a same market serving spinoff, when at least one of its primary or secondary 4-digit SIC classes was also found in its parent firm product portfolio, and new market serving otherwise. This classification gives rise to a 2×2 pattern of spinoffs entry as depicted in figure 3.3.

<table>
<tr><td colspan="2"></td><td colspan="2">Figure 3.3: 2×2 taxonomy of spinoff entry</td></tr>
<tr><td colspan="2"></td><td colspan="2">Technological Comparison</td></tr>
<tr><td colspan="2"></td><td>Same Technological Field</td><td>New Technological Field</td></tr>
<tr><td rowspan="2">Market Comparison</td><td>New Market Segment</td><td>New Market Serving & Same Technology Seeking Spinoffs
$n = 53$</td><td>New Market Serving & New Technology Seeking Spinoffs
$n = 19$</td></tr>
<tr><td>Same Market Segment</td><td>Same Market Serving & Same Technology Seeking Spinoffs
$n = 19$</td><td>Same Market Serving & New Technology Seeking Spinoffs
$n = 10$</td></tr>
</table>

Note: n presents the number of spinoffs in each cell

3.4.3.2. Independent variables

Market diversification: Biotech industry encompasses several sub-markets or fields of application. As an example of multiple applications, recombinant DNA technology can be used to produce large molecule medicines in the pharmaceutical sector, create new crop varieties in the agricultural sector, or micro-organisms that produce industrial enzymes for the chemical sector (OECD, 2005). As for that, within this broad industry, Biotech firms may serve various product-segments using almost identical sets of technological skills. To measure parent firm's level of market diversification, I used two non-categorical constructs, weighted-average product-count entropy measure, and unweighted segment-count.

The entropy measures of diversification (Jacquemin & Berry, 1979; Palepu, 1985) have been used widely in the literature and they have been found to generate estimates of product diversification with strong correspondence with those based on Rumelt's (1974) subjective categorization methods (Montgomery , 1982).

The entropy measure of diversification is defined as:

$$\sum_i [p_i \times \ln(1/p_i)]$$

, where p_i is the share of segment i sales and $\ln(1/p_i)$ or the natural logarithm of the inverse of segment i sales share is the weight given to each segment. I collected the segments' sales data using companies' annual reports corresponding to the year the incumbent experienced spawning. In their annual reports, Pharmaceutical and Biotech firms are entailed to adopt IFRS 8 "Operating Segments", which requires them to report financial and descriptive information about their reportable segments. In particular, a reportable segment is an operating segment or aggregations of operating segments whose revenue (and the absolute measure of its reported profit) accounts for 10 percent or more of the firm's combined revenue (reported profit), or its assets account for 10 percent or more of the combined assets of all operating segments (International Accounting Standards Board, 2006). Further, I drew on a three-level classification system for Biotechnology application developed by OECD (2005) to construct unweighted segment-count measure of parent firms' market diversification. This classification provides a three-level (Broad, Intermediate, and Detailed) application of biotechnology across various market areas including human health, Veterinary health, Agriculture, Natural resources, Environment, and Industrial processing (See Appendix 1). To construct this measure, I text analyzed the parent firms' businesses description, and I counted the number of distinct detailed-level application areas matched with the parent firms' core activities. Although, it has been argued that weighted SIC-based measures of market diversification are superior to unweighted product-count measures (Montgomery , 1982), the latter measures are adequate for the purpose of this study as we are interested to estimate the breadth of available marketing know-how rather than the importance of different segments in which the parent firm is involved to.

Technological diversification: To measure the technological diversification of the parent firms in the sample, I used information reported in patent documents. A patent document contains detailed technical information, including claims, citations, and technical classes to which the invention belongs assigned by patent examiners. In relation to the biotechnology sector, the majority of patents are classified in the IPC sub-classes C12M to C12C. However, since the biotech industry encompasses various technologies from different fields, I collected data at a lower level of aggregation. As for that, I used two different definitions to identify biotechnology patent classes. First, I used the "Provisional Definition of Biotechnology Patent" proposed by the OECD (2005). This definition includes 70 IPC classes for biotechnology patents, chosen through scanning the patent classification in a top-down approach (See appendix 2).

Second, I used a more aggregate classification of biotechnology patents developed by Italian Patent and Trademarks Office, which include 22 IPC classes[4]. Also, since the objective of this study is to test how technological diversity of the parent firms predicts the type of spinoffs entry, I included only parent firms' patents filled before their spinoffs' date of incorporation. I measured technological diversification using above-mentioned entropy measure of diversification, where p_i is the share of patents in IPC class i and $\ln({}^{1}/_{p_i})$ or the natural logarithm of the inverse of IPC class i share is the weight given to each class.

3.4.3.3. Control Variables

I included a number of variables to control for other factors that might affect the spinoffs type of entry. The data for constructing these variables comes mainly from the Orbis database.

First, I controlled for parent firms' innovativeness by computing the *total number of patents before spinoff event*, since some studies show that knowledge-rich firms tend to be "entrepreneurial hotbeds" and more prone to experience spawning (Franco and Filson, 2006; Garvin, 1983).

Second, I included various controls for the effects the founding team characteristics. These variables include *total number of founders, number of founders from the same parent firm,*

[4] These technological fields are A01H, A01K, A01N, A01P, A21D, A23B, A23C, A23L, A61K, A61L, C02F, C05F, C07H, C07J, C07K, C12M, C12N, C12P, C12Q, C12R, G01N, and G06N.

main founder's position within the parent firm, main founder experience, and a dummy variable for *serial entrepreneur*.

Finally, I included parent-related controls including the firm's *status at the spawning event (active, failed), the number of products, the number of active 4-digit SIC primary and secondary classes,* and *number of reportable segments* in their annual reports.

Nonetheless, while the theory suggests to reasonably include a set of controls, results show that some of these controls were not relevant in my case. Tables 3.1 and 3.2 present the summary of descriptive statistics and correlation matrix.

Table 3.1: Summary Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Technological Diversity I (Constructed using 70 IPC classes)	131	1.203191	0.94265	0	2.51246
Technological Diversity II (Constructed using 22 IPC macro classes)	131	1.081372	0 .77408	0	2.205578
Parent Market Diversity I (Constructed using entropy & segments sale)	131	0.14243	0.34648	0	1.33240
Parent Market Diversity II (Constructed using matched areas)	129	1.2093	0.4271	1	3
Number of Active SICs	129	1.85271	1.81616	0	14
Number of Reportable Segments in Annual Reports	129	1.91473	1.54632	1	8
Number of Products	107	18.94393	56.74601	0	397
Total Number of Patents	131	6406.473	15477.25	0	69501
Total Number of Patents Before Spawning Event	131	3618.053	8362.384	0	38677
Spinoffs' Number of Founders	131	1.69466	0.82175	1	4
Spinoffs' Number of Founders from the Same Parent	131	1.30534	0.53913	1	3
Spinoffs' Any Founders from Academia (yes=1; No=0)	131	0.06107	0.24038	0	1
Serial Entrepreneur (yes=1; No=0)	130	0.25385	0.43689	0	1
Main Founder Position (Directors, Unit managers=1; Others=0)	130	0.83969	0.36830	0	1
Main Founder Experience in Parent Firm	129	6.52713	3.99233	2	21
Parent Status at the Spawning Event (Active=1; Dissolved=0)	128	0.83594	0.37179	0	1
New Technology Seeking Spinoff (yes=1; No=0)	113	0.28319	0.45255	0	1
New Market Serving Spinoff (yes=1; No=0)	115	0.69565	0.46214	0	1

	Table 3.2: Correlation Matrix															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Technological Diversity I (Constructed using 70 IPC codes)	1.000															
2. Technological Diversity II (Constructed using 22 IPC codes)	0.862	1.000														
3. Parent Market Diversity I (Constructed using segments sale)	0.269	0.206	1.000													
4. Parent Market Diversity II (Constructed using matched areas)	0.187	0.253	0.173	1.000												
5. Number of Active SICs	0.036	0.043	0.076	-0.011	1.000											
6. Number of Reportable Segments in Annual Reports	0.340	0.281	0.535	0.302	0.115	1.000										
7. Number of Products	0.242	0.049	0.151	0.188	0.068	0.113	1.000									
8. Total Number of Patents	0.394	0.311	0.626	0.215	0.090	0.600	0.279	1.000								
9. Total Number of Patents Before Spawning Event	0.421	0.340	0.584	0.210	0.087	0.628	0.217	0.948	1.000							
10. Spinoffs' Number of Founders	0.054	0.036	0.280	0.126	-0.003	0.240	-0.057	0.253	0.230	1.000						
11. Spinoffs' Number of Founders from the Same Parent	0.095	0.081	0.155	0.095	-0.044	0.303	-0.065	0.118	0.155	0.682	1.000					
12. Spinoffs' Any Founders from Academia (yes=1; No=0)	0.014	0.003	-0.077	-0.113	-0.125	-0.123	-0.064	-0.071	-0.081	0.218	-0.009	1.000				
13. Serial Entrepreneur (yes=1; No=0)	-0.106	-0.118	0.041	-0.231	-0.119	-0.133	-0.148	-0.104	-0.127	0.125	0.067	0.120	1.000			
14. Main Founder Position (Directors, Unit managers=1; Others=0)	-0.107	-0.120	-0.209	-0.096	-0.073	-0.286	0.039	-0.110	-0.157	-0.145	-0.103	0.100	0.251	1.000		
15. Main Founder Experience in Parent Firm	0.107	0.170	0.098	-0.006	-0.031	0.007	0.057	0.171	0.176	0.062	0.095	0.106	0.078	0.140	1.000	
16. Parent Status at the Spawning Event (Active=1; Dissolved=0)	-0.002	0.079	-0.069	0.094	0.119	-0.062	-0.071	0.063	0.019	-0.014	-0.101	0.013	-0.089	-0.118	0.050	1.000

3.4.4. Estimation Method

The main research question in this study relates to the likelihood of different spinoffs' entry. To estimate the effect of the critical variables of interest (technological diversity and market diversity of parent firms) on the type of spinoff entry, I used Penalized Likelihood Logistic regression to control for small-sample bias. The choice of this technique can be justified as follows. First, in logistic regression, Maximum Likelihood Estimates are consistent but they can be biased when events are rare (Leitgöb, 2013). Second, Penalized Maximum Likelihood Estimates in logistic regression produces finite, consistent estimates of regression parameters when the maximum likelihood estimates do not exist (Williams, 2016). Third, unlike other corrections for small-sample bias like exact logistic regression penalized likelihood doesn't require to have discrete covariates (Leitgöb, 2013).

3.5. RESULTS

3.5.1. Two-sample Comparison of Means

Table 3.3 presents the results of the mean values comparison of the incumbent parents' technological diversity by new and same technology seeking spinoff groups (upper panel) and between new and same market serving spinoffs (bottom panel). I found a statistically significant difference in mean values of "*Technological Diversity I*" and "*Technological Diversity II*" constructs between the two groups. Similarly, I found a statistically significant difference in mean values of parent firms' *"Market Diversity II"* variable constructed using count of active 3rd level application area by new and same market serving spinoff groups. Nevertheless, the t-test cannot reject the null hypothesis of no significant difference between new and same market serving spinoffs, when the two groups were compared by the parent firms' level of market diversity variable constructed using segments sale data.

Table 3.3: Two-Sample Comparison of Means					
	New Technology Seeking Spinoffs (n=32)		Same Technology Seeking Spinoffs (n=81)		
	Mean	*Std. Err.*	*Mean*	*Std. Err.*	T stat.
Technological Diversity I	0.6370	0.1407	1.6719	0.0813	6.606***
Technological Diversity II	0.7289	0.1287	1.4421	0.0644	5.469***
Market Diversity I	0.0480	0.0366	0.2054	0.0451	2.0837**
Market Diversity II	1.1562	0.0652	1.2469	0.0513	0.992
Number of Patent Before Spinoff Event	253.13	187.50	5748.85	1117.46	3.076***
Number of Products	21.931	13.158	21.540	7.075	-0.028
Number of Active Main & Secondary SICs	1.7812	0.2569	1.9747	0.2264	0.493
Parent Status at Spinoff Event	0.75	0.0778	0.875	0.0372	1.632*
	New Market Serving Spinoffs (n=80)		Same Market Serving Spinoffs (n=35)		
	Mean	*Std. Err.*	*Mean*	*Std. Err.*	T stat.
Technological Diversity I	1.2070	0.1068	1.1511	0.1549	-0.292
Technological Diversity II	1.0711	0.0859	1.0803	0.1296	0.059
Market Diversity I	0.1411	0.0382	0.2106	0.0704	0.937
Market Diversity II	1.225	0.0470	1.1143	0.0546	-1.388*
Number of Patent Before Spinoff Event	3828.46	959.76	3831.49	1550.64	0.001
Number of Products	19.548	6.947	14.381	6.177	0.513
Number of Active Main & Secondary SICs	2.075	0.2177	1.8858	0.2681	-0.506
Parent Status at Spawning Event	0.85	0.0402	0.8	0.0686	-0.660
***p < 0.01; **p < 0.05; *p < 0.10					

3.5.2. Penalized Logistic regression

Table 3.4 presents the results of logistic regression related to the first two hypotheses. Our two dichotomous dependent variables take value one when the new venture is classified as (i) a new technology seeking spinoff, and (ii) a new market serving spinoff, respectively and 0 otherwise. 'Model I' includes only the control variables. The main explanatory variables - parent firms' level of technological diversity (constructed using 70 IPC codes) and market diversity (constructed using segments sales), were added in Model II and Model III one at a time. Model IV includes both main independent and control variables.

The estimated coefficient for the incumbent firms' level of market diversity was statistically significant and the estimated sign was in line with hypothesis 1, suggesting that the probability of new market serving spinoffs entry decreases with increase in the parent firms' level of market diversity. The results were robust to alternative model specifications, i.e. when measuring parent firms' level of technological diversity (constructed using 22 IPC codes) and market diversity (constructed using count of 3rd level application area). Similarly, the estimated coefficient for the parent firms' level of technological diversity related to hypothesis 2 suggests that increases in parent firms' level of technological diversity decreases the probability of new technology seeking type of spinoffs entry. However, the founders' related control variables were all insignificant in the Model IV.

Tables 3.5 presents the results of panelized logistic regression related to hypotheses 3 and 4. The two hypotheses explore the relation between incumbents' level of technological and market diversity and the probability of observing (i) same technology spinoff in new market, and (ii) new technology spinoff in the same market, respectively.

The dichotomous dependent variables take value equal to 1 for spinoffs classified in respective entry cell depicted in figure 3.3, and 0 otherwise. In particular, the dependent variable in hypothesis 3 is a dichotomous variable taking a value of 1 for new market serving but same technology seeking spinoffs, and 0 otherwise. Similarly, in hypothesis 4, the dependent variable gets value equal to 1 for same market serving but new technology seeking spinoffs, and 0 for other types of spinoff entry.

'Model I' includes only the controls. The two main explanatory variables, i.e. parent firms' technological diversity and market diversity were added in Model II and Model III one at a time. The interaction term between the two was constructed using a dummy variable, such that it took value equal to 1 for incumbents with a high level of technological diversity (i.e. incumbents with technological diversity equal or greater than the sample median), and a low level of market diversity (i.e. incumbents with market diversity equal or smaller than the sample median), and 0 otherwise. This variable was included in Model IV.

Table 3.4: Penalized Logistic Regression Related to Hypotheses 1&2

	Model 1		Model II		Model III		Model IV	
	New Market Serving Spinoff	New Technology Seeking Spinoff	New Market Serving Spinoff	New Technology Seeking Spinoff	New Market Serving Spinoff	New Technology Seeking Spinoff	New Market Serving Spinoff	New Technology Seeking Spinoff
Technological Diversity I (Using 70 IPC codes)			-0.157 (0.347)	-1.098*** (0.421)			-0.254 (0.360)	-1.098*** (0.424)
Market Diversity I (Using segments sale)					-1.804* (1.089)	0.286 (1.313)	-1.871* (1.090)	-0.464 (1.654)
Marginal Effects			-0.0329 (0.072)	-0.180* (0.071)			-0.052 (0.073)	-0.184* (0.072)
					-0.369* (0.215)	0.049 (0.226)	-0.383* (0.215)	-0.078 (0.273)
Log Number of Patents Before Spinoff	-0.027 (0.108)	-0.603*** (0.149)	0.013 (0.140)	-0.345** (0.171)	0.017 (0.113)	-0.594*** (0.151)	0.082 (0.147)	-0.318* (0.176)
Log Number of Active Sub Markets	0.321 (0.510)	0.501 (0.679)	0.296 (0.514)	0.445 (0.756)	1.076 (0.777	0.477 (0.745)	1.075 (0.782)	0.589 (0.792)
Log Number of Founders	0.119 (0.666)	0.614 (0.818)	0.108 (0.664)	0.340 (0.833)	0.042 (0.671)	0.626 (0.814)	0.015 (0.671)	0.315 (0.831)
Log N. Founders from Same Parent	0.783 (0.878)	-1.580 (1.091)	0.774 (0.872)	-2.014 (1.228)	0.702 (0.913)	-1.548 (1.081)	0.715 (0.908)	-1.942 (1.203)
Spinoffs' Founders from Academia	0.456 (1.013)	-0.722 (1.101)	0.477 (1.014)	-0.216 (1.173)	0.301 (1.022)	-0.733 (1.099)	0.340 (1.027)	-0.213 (1.164)
Serial Entrepreneur	-0.501 (0.524)	-0.031 (0.593)	-0.513 (0.522)	-0.131 (0.619)	-0.318 (0.530)	-0.031 (0.597)	-0.329 (0.530)	-0.097 (0.620)
Main Founder Position in Parent	1.101 (0.673)	-1.201 (0.874)	1.121 (0.678)	-1.358 (0.989)	0.978 (0.696)	-1.144 (0.864)	1.030 (0.702)	-1.318 (0.975)
Main Founder Log Experience in Parent	-0.227 (0.420)	0.701 (0.536)	-0.254 (0.426)	0.565 (0.551)	-0.295 (0.429)	0.679 (0.532)	-0.363 (0.444)	0.519 (0.549)
Parent Status before Spinoff	0.471 (0.554)	-1.503** (0.659)	0.481 (0.552)	-1.549** (0.691)	0.557 (0.568)	-1.503** (0.674)	0.580 (0.566)	-1.469** (0.697)
Cons.	-0.169 (1.019)	2.844 (1.316)	-0.134 (1.020)	3.592** (1.551)	-0.193 (1.029)	2.791** (1.310)	-0.120 (1.034)	3.459** (1.523)
N. Observation	101	107	101	107	101	107	101	107
Wald chi2	4.22 (0.8967)	20.18 (0.0168)	4.36 (0.929)	22.49 (0.0128)	6.16 (0.8013)	20.25 (0.0270)	6.45 (0.8416)	22.21 (0.0228)

Standard errors are in parentheses.
***$p < 0.01$; **$p < 0.05$; *$p < 0.10$

Table 3.5: Penalized Logistic Regression Related to Hypotheses 3&4								
	Model I		Model II				Model III	
	Same Tech. New Market Spinoff	New Tech. Same Market Spinoff	Same Tech. New Market Spinoff	New Tech. Same Market Spinoff	Same Tech. New Market Spinoff	New Tech. Same Market Spinoff	Same Tech. New Market Spinoff	New Tech. Same Market Spinoff
Technological Diversity I (Using 70 IPC codes)			0.593	-0.118	0.592	-0.093	1.783**	1.043
			(0.393)	(0.505)	(0.419)	(0.498)	(0.839)	(1.037)
Market Diversity I (Using segments sale)					-2.963**	0.633	-4.580***	-1.403
					(1.358)	(1.836)	(1.723)	(2.434)
Marginal Effects			0.147	-0.013	0.148	-0.011	0.445**	0.114
			(0.097)	(0.055)	(0.105)	(0.058)	(0.209)	(0.106)
					-0.741**	0.073	-1.143***	-0.153
					(0.340)	(0.210)	(0.432)	(0.264)
Interaction (High Tech. Diversity × Low Market Diversity)							-2.120*	-2.177
							(1.209)	(1.760)
Log Number of Patents Before Spinoff	0.340***	-0.390**	0.212	-0.353	0.353**	-0.343	0.358*	-0.377
	(0.127)	(0.196)	(0.150)	(0.223)	(0.174)	(0.238)	(0.187)	(0.242)
Log Number of Active SICs	0.067	-0.248	0.073	-0.290	0.001	-0.251	0.011	-0.275
	(0.402)	(0.667)	(0.401)	(0.681)	(0.435)	(0.651)	(0.453)	(0.624)
Log Number of Products	-0.022**	0.004	-0.023**	0.004	-0.008	0.004	-0.020*	0.005
	(0.010)	(0.004)	(0.010)	(0.005)	(0.010)	(0.005)	(0.012)	(0.005)
Log Number of Founders	0.251	0.399	0.386	0.354	0.389	0.375	0.507	0.271
	(0.791)	(1.064)	(0.791)	(1.053)	(0.797)	(1.028)	(0.845)	(1.052)
Log N. Founders from Same Parent	1.284	-0.932	1.303	-0.913	1.811	-0.858	1.973	-0.695
	(1.031)	(1.369)	(1.068)	(1.356)	(1.197)	(1.336)	(1.257)	(1.346)
Spinoffs' Founders from Academia	0.030	-0.731	-0.256	-0.730	-0.321	-0.753	-0.442	-1.136
	(1.323)	(1.636)	(1.389)	(1.644)	(1.345)	(1.639)	(1.212)	(1.931)
Serial Entrepreneur	-1.174**	0.238	-1.256**	0.262	-0.945	0.277	-0.841	0.668
	(0.597)	(0.756)	(0.608)	(0.748)	(0.623)	(0.740)	(0.643)	(0.860)
Main Founder Position in Parent	2.848***	-1.276	2.919***	-1.234	2.806**	-1.153	2.847**	-1.473
	(1.018)	(1.222)	(1.050)	(1.212)	(1.092)	(1.172)	(1.122)	(1.259)
Main Founder Log Experience in Parent	-0.608	0.761	-0.458	0.707	-0.524	0.663	-0.572	0.539
	(0.510)	(0.737)	(0.520)	(0.735)	(0.544)	(0.717)	(0.565)	(0.739)
Parent Status before Spinoff	1.726**	-0.770	1.674**	-0.718	1.293*	-0.734	1.250	-0.922
	(0.791)	(0.869)	(0.807)	(0.869)	(0.749)	(0.859)	(0.790)	(0.899)
Cons.	-4.265***	0.313	-4.675***	0.358	-4.811***	0.284	-5.085***	0.684
	(1.543)	(1.703)	(1.627)	(1.696)	(1.659)	(1.680)	(1.764)	(1.749)
N. Observation	78	78	78	78	78	78	78	78
Wald chi2	13.54	5.05	14.12	4.99	15.7	4.8	16.87	5.47

Standard errors are in parentheses.
***$p < 0.01$; **$p < 0.05$; *$p < 0.10$

The estimated coefficients for the two explanatory variables in hypothesis 3 were statistically significant with expected signs, suggesting that parent firms' level of technological diversity positively, and market diversity negatively affect the likelihood of their spinoffs' entry into new market segments by developing similar technologies as their parent firms. However, the estimated coefficient for the interaction between incumbents' level of technological and market diversity was negative, suggesting that in contrast to hypothesis 3, incumbent parents with a high level of technological diversity but a low level of market diversity are less likely to observe new market serving spinoffs that develop similar technologies as their parent firms. Also, the results did not show any significant effects of parent firms' level of technological and market diversity on new technology seeking but same market serving type of spinoffs entry in hypothesis 4.

Table 6 presents the results of logistic regressions related to hypotheses 5 and 6. Hypothesis 5 relates to the moderating effect of founders' tenure within the incumbent parent on the relation between parent firms' market diversity and spinoffs entry to a new market. A dummy variable was constructed such that it took value equal to 1 for spinoff founders with a duration of employment within their parent firms greater than average duration of employment of all founders in the sample (mean= 6.52), and 0 otherwise.

The estimated coefficient for the interaction term between parent firm's level of market diversity and founders' tenure within the parent firm was statistically significant, confirming a positive moderating effect of spinoffs founders' seniority within the parent firm on the negative relation between parent market diversity and spinoffs entry into the new market. Similarly, the results of logistic regression related to hypothesis 6 confirms a positive moderating effect of spinoffs founders prior experience in founding a new venture on the relation between technological diversity of parent firms and spinoffs entry into new technological fields.

Figure 3.4 displays the average marginal effects of founders' tenure and prior entrepreneurial experience on probability of new market serving and new technology seeking patterns of spinoffs entry, respectively.

Table 3.6: Logistic Regression Related to Hypotheses 5&6

	Model I		Model II	
	New Market Serving Spinoff	New Technology Seeking Spinoff	New Market Serving Spinoff	New Technology Seeking Spinoff
Technological Diversity (Using 70 IPC codes)	-0.408 (0.405)	-1.867*** (0.413)	-0.467 (0.416)	-2.329*** (0.532)
Market Diversity (Using segments sale)	-2.545** (1.267)	-1.530 (1.657)	-3.937*** (1.496)	-1.612 (1.782)
Market Div. × Founder Tenure			2.286* (1.269)	
Tech. Div. × Serial Entrepreneur				1.418* (0.798)
Marginal Effects			0.409* (0.226)	0.197* (0.115)
Log Number of Patents Before Spinoff	0.117 (0.159)		0.135 (0.161)	
Log Number of Active SICs	1.573* (0.919)	0.040 (0.773)	1.630* (0.916)	0.263 (0.842)
Log Number of Founders	-0.029 (0.727)	0.102 (0.897)	-0.021 (0.758)	0.259 (0.912)
Log N. Founders from Same Parent	0.983 (0.987)	-2.308* (1.294)	1.170 (1.019)	-2.527* (1.307)
Spinoffs' Founders from Academia	0.529 (1.224)	-0.213 (1.339)	0.492 (1.249)	-0.445 (1.423)
Serial Entrepreneur	-0.233 (0.579)	-0.146 (0.700)	-0.081 (0.597)	-1.305 (0.971)
Main Founder Position in Parent Firm	1.214 (0.765)	-1.543 (0.987)	1.349* (0.797)	-1.662 (1.076)
Founder Tenure within Parent (New Hire=0; Senior=1)	-0.922* (0.539)	0.519 (0.575)	-1.489** (0.639)	0.698 (0.606)
Parent Status before Spinoff	0.750 (0.624)	-1.704** (0.764)	0.846 (0.636)	-1.791** (0.782)
Cons.	-0.519 (1.039)	4.177*** (1.495)	-0.472 (1.063)	4.711*** (1.615)
N. Observation	102	110	102	110
Pseudo R2	0.1102	0.3539	0.139	0.3778
LR chi2	13.42	46.3	16.93	49.43

Standard errors are in parentheses.
***$p < 0.01$; **$p < 0.05$; *$p < 0.10$

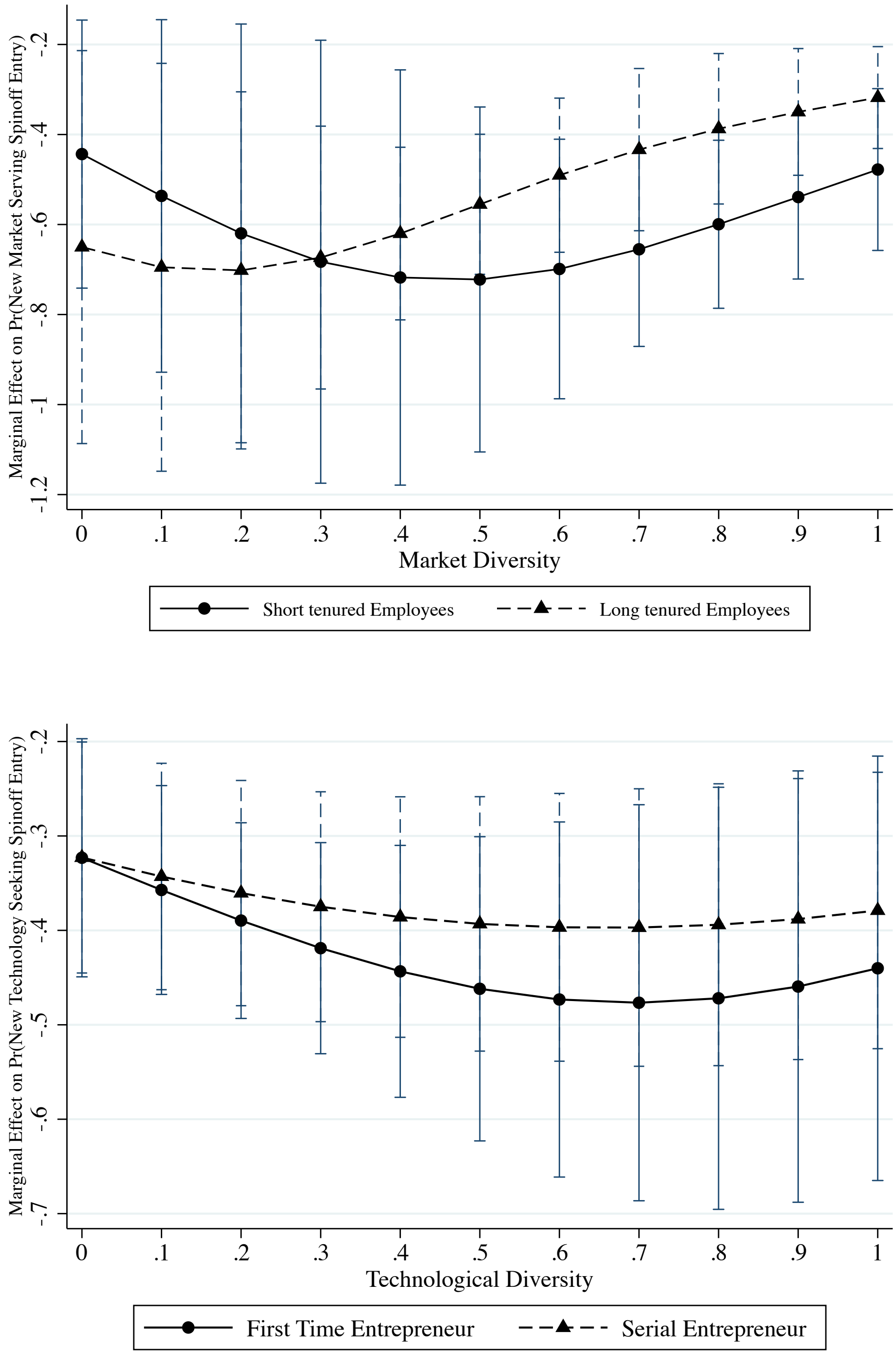


Figure 3.4: Average marginal effects of founders' tenure and prior entrepreneurial experience

3.6. ROBUSTNESS TEST

The third and fourth hypotheses in this study relate to the effects of incumbent parents' level of technological and market diversity and the probability of observing (i) same technology spinoff in new market, and (ii) new technology spinoff in the same market, respectively. As presented in the previous section, the results of panelized logistic regression were not in line with my hypotheses. In particular, despite the significant effects of incumbents' technological and market diversity with expected signs on the probability of observing same technology seeking but new market serving spinoff entry in hypothesis 3, the estimated coefficient for the interaction between the two variables (High Tech. Diversity × Low Market Diversity) was negative.

Although the panelized logistic regression allows to control for small-sample bias, one may suggest the use of multinomial logistic regression. I believe the multinomial logit model is not adequate for testing the third and fourth hypotheses, given that we cannot assume the dependent variables in our data are mutually exclusive. Said that, to check whether the results from the previous section are robust to alternative specifications of the model and the dependent variable, I ran the following two logistic regressions.

Model I in table 3.7 includes only the controls. The corresponding variable for incumbent parents' level of technological diversity was added in Model II. To examine the effect of incumbent parents' level of market diversity on spinoffs patterns of entry to the same or a different market, I included an interaction term between parents' level of technological diversity and market diversity into the model III. In addition to effect of technological diversity, the interaction variable measures whether the probability of observing new technology seeking but same market serving (H3), and same technology seeking but new market serving spinoff entry (H4) also depends on incumbent parents' level of market diversity.

Table 3.7: Robust Analysis (I) Related to Hypotheses 3&4

	Model I		Model II		Model III	
	Same Technology Seeking in New Market Spinoff	New Technology Seeking in Same Market Spinoff	Same Technology Seeking in New Market Spinoff	New Technology Seeking in Same Market Spinoff	Same Technology Seeking in New Market Spinoff	New Technology Seeking in Same Market Spinoff
Technological Diversity I (Using 70 IPC codes)			0.789* (0.414)	-0.201 (0.488)	0.865** (0.426)	-0.184 (0.485)
Interaction (Tech Div. × Market Div.)					-1.570** (0.695)	0.410 (0.798)
Marginal Effects			0.196* (0.103)	-0.023 (0.056)	0.216** (0.107)	-0.022 (0.059)
					-0.392** (0.174)	0.050 (0.095)
Log Number of Patents Before Spinoff	0.330** (0.128)	-0.347* (0.186)	0.158 (0.154)	-0.296 (0.210)	0.258 (0.163)	-0.296 (0.219)
Log Number of Active SICs	0.046 (0.406)	-0.223 (0.621)	0.088 (0.412)	-0.268 (0.629)	0.139 (0.453)	-0.240 (0.614)
Log Number of Products	-0.021* (0.012)	0.003 (0.005)	-0.022* (0.012)	0.003 (0.005)	-0.003 (0.010)	0.003 (0.005)
Log Number of Founders	-0.205 (0.787)	0.459 (1.031)	0.017 (0.809)	0.397 (1.020)	0.387 (0.845)	0.374 (1.009)
Log N. Founders from Same Parent	0.832 (0.995)	-0.591 (1.297)	0.789 (1.031)	-0.602 (1.290)	1.144 (1.129)	-0.548 (1.249)
Spinoffs' Founders From Academia	-0.363 (1.326)	-0.685 (1.627)	-0.764 (1.459)	-0.646 (1.637)	-0.950 (1.453)	-0.639 (1.640)
Serial Entrepreneur	-1.681** (0.656)	0.235 (0.809)	-1.784*** (0.666)	0.282 (0.810)	-1.513** (0.666)	0.305 (0.803)
Main Founder Position in Parent	2.126*** (0.709)	-0.350 (0.858)	2.321*** (0.741)	-0.372 (0.853)	2.437*** (0.773)	-0.379 (0.847)
Main Founder Log Experience in Parent	0.221 (0.494)	0.501 (0.678)	0.447 (0.514)	0.450 (0.673)	0.253 (0.558)	0.408 (0.661)
Parent Status before Spinoff	0.234 (0.581)	-0.162 (0.787)	0.282 (0.610)	-0.152 (0.773)	0.291 (0.639)	-0.170 (0.765)
Cons.	-2.761** (1.229)	-0.858 (1.454)	-3.513** (1.389)	-0.708 (1.422)	-4.120*** (1.521)	-0.651 (1.421)
N. Observation	77	77	77	77	77	77
Wald chi2	13.69	4.31	15.66	4.32	18.27	4.09

Standard errors are in parentheses.
***$p < 0.01$; **$p < 0.05$; *$p < 0.10$

The estimated coefficient for the effect of parent firms' level of technological diversity in Model II & III were again both statistically significant with expected positive signs, suggesting that increase in parent firms' level of technological diversity increases the likelihood of observing same technology seeking in new market patterns of spinoffs entry.

Moreover, the estimated coefficient for the interaction term between technological diversity and market diversity was also in line with hypothesis 3 and statistically significant with a negative sign, suggesting that, high levels of both technological and market diversity, negatively affect the probability of new market serving, but same technology seeking pattern of spinoffs entry. Again, the results did not show any significant effects of parent firms' level of technological and market diversity on new technology seeking but same market serving type of spinoffs entry in in hypothesis 4.

Table 3.8 presents the results of analysis with an alternative specification of dependent variable. In particular, to estimate the effects of variables of interest – i.e. parent firms' level of technological and market diversity on spinoffs type of entry in hypotheses 3 and 4, the dependent variables took the value 1 for same technology seeking spinoffs in markets not covered by their parent company (hypothesis 3) and new technology seeking spinoffs in the same market as their parent firms (hypothesis 4), respectively. This specification may give rise to heterogeneity problems because the 'DV=0' category pools together different types of spinoffs. For instance, the '0' category of the variable "Same Technology Seeking in New Market Spinoff" contains two different cases – "New Technology Seeking in New Market" and "Same Technology Seeking in Same Market". To account for this source of heterogeneity, a two-step analysis was implemented as follows.

First, within spinoffs classified as new technology (or the same technology) seeking type of entry, I estimated the effects of parent firms' technological and market diversity on spinoffs spawning into the same market as their parents versus spinoffs entering new markets distant from their parents' core businesses. Second, within spinoffs classified as new market (or the same market) serving type of entry, I estimated the effects of the parent firms' technological and market diversity on spinoffs developing similar technologies as their parent firms versus spinoffs seeking new technological fields. The estimated coefficients for the effect of parents' technological and market diversity in hypothesis 3 were in line with the earlier findings, supporting the third hypothesis. However, again, I did not find any significant results related to hypothesis 4.

Table 3.8: Robust Analysis (II) Related to Hypotheses 3&4

	Pr (Same Tech. | New Market)	Pr (New Market | Same Tech.)	Pr (Same Market | New Tech.)	Pr (New Tech. | Same Market)
Technological Diversity I (Using 70 IPC codes)	1.074** (0.510)	-0.055 (0.527)	0.321 (0.557)	0.227 (1.010)
Market Diversity I (Using segments sale)	-1.255 (1.892)	-1.609* (0.954)	-1.176 (1.892)	-1.175 (3.051)
Log Number of Patents Before Spinoff	0.316 (0.223)	0.188 (0.199)	-0.144 (0.246)	-0.601 (0.494)
Log Number of Active SICs	-0.001 (0.565)	-0.187 (0.452)	-0.404 (0.797)	0.184 (0.941)
Log Number of Founders	-0.541 (1.086)	-0.458 (0.853)	-0.707 (1.180)	-0.871 (1.808)
Log N. Founders from Same Parent	2.463 (1.575)	1.264 (1.132)]	0.670 (1.519)	3.161 (4.268)
Spinoffs' Founders from Academia	-1.048 (1.862)	-0.485 (1.213)	-0.276 (1.911)	-0.189 (2.358)
Serial Entrepreneur	-1.023 (0.936)	-1.033 (0.820)	-0.052 (1.052)	-2.574 (2.625)
Main Founder Position in Parent	1.862* (0.957)	1.160 (0.729)	0.109 (1.120)	1.513 (1.984)
Main Founder Log Experience in Parent	-0.185 (0.807)	-0.131 (0.539)	0.403 (0.857)	0.066 (0.863)
Parent Status before Spinoff	1.697* (0.978)	0.517 (0.881)	0.504 (0.940)	-1.731 (2.063)
Cons.	-3.702** (1.845)	-0.203 (1.625)	-0.819 (1.482)	3.419 (3.228)
N. Observation	69	68	28	28
Wald chi2	13.22	7.06	2.13	3.31

Standard errors are in parentheses.
***$p < 0.01$; **$p < 0.05$; *$p < 0.10$

3.7. DISCUSSIONS AND CONCLUSION

The main research question driving my analysis in this study was, conditional on observing a spinoff venture, how knowledge profile of the incumbent firms (i.e. level of technological and market diversity) shape different patterns of spinoffs entry?

According to the knowledge spillover theory of entrepreneurship (Audretsch and Keilbach, 2007), unexploited knowledge created by incumbent firms endogenously provides entrepreneurial opportunities for employees to pursue them by creating independent ventures. First, drawing from the notion of corporate coherence (Teece, et al. 1994), I claimed that one reason incumbent firms are unable or not willing to exhaustively internalize the outcome of their investment in new knowledge creation is to maintain their extant level of coherence. That is, industry incumbents opt and further exploit opportunities that fall within their existing learning domains and have a level of similarity and synergies with their ongoing activities.

Using a sample of 131 spinoff ventures active in the Biotech industry, I hypothesized and empirically showed that, conditional on observing a spawning event, incumbent parents active in a few product-market segments (i.e. with a low degree of market diversity) are more likely to spawn spinoffs serving new market distant from their core businesses, since the incumbent firms with a limited market-related know-how are more likely to shelve opportunities that have a low fit with their existing core businesses (Hypothesis 1). Also, I found that new technology seeking spinoffs are more likely to spawn from technologically specialized incumbent firms, since the incumbent firms with a focused set of technological competences are more likely to shelve opportunities that have a low fit with their existing core technological competences as those opportunities might require specific investments that take resources away from the core technological capabilities (Hypothesis 2).

That being said, one can argue that these results could be simply statistical artifacts, since for example if the number of technologies available for exploration is limited, even a small increase in the technological diversification of the parent firm greatly reduce the likelihood of a spinoff exploring a technological niche not already ‘occupied’ by the parent firm. However, this is not the case since the maximum number of technological niches actually occupied by incumbent firms in our sample was only 23 out of 70 available 'niches', which were considered for constructing the measure of incumbent parents' technological diversity.

Second, I argued that those created but left unexploited opportunities that had a low fit with the incumbents' technological or marketing capabilities are more likely to be pursued externally, when employees are able to deploy the required complementary capabilities for successful commercialization of those opportunities using the parent firms' stock of knowledge. In other words, similarities in terms of required complementary marketing or technological capabilities give rise to two types of entrepreneurial opportunities for employees and enhance their confidence about venturing out. These two opportunities are:

1. The incumbent firm's technological competences that can be leveraged to pursue unexploited opportunities in new markets distant from the incumbent firm's core businesses.
2. The incumbent firm's market-related know-how that can be leveraged to exploit business opportunities that require new technologies different from those developed by the incumbent firms.

I found that, spinoff ventures developing similar technologies to their parent organizations in non-overlapping market segments are more likely to spawn from technologically diversified incumbent firms with a low degree of market diversity (Hypothesis 3). However, I found no significant effects of incumbent parents' level of technological and market diversity on new technology seeking but same market serving spinoffs type of entry (Hypothesis 4). I believe this is attributable to the incumbent firm's hostile reaction since the spawning event poses a special threat to the incumbent firm's market position, when the spinoff enters an overlapping market segment to exploit a new technological opportunity not commercialized by the incumbent firm (Walter et al., 2014). That is, while incumbent firms might deliberately shelve and choose to leave opportunities related to emerging submarkets or unmet customers' needs, it is less likely that they reluctantly dismiss new technological opportunities that can be exploited for sustaining their competitive positions in their existing markets.

In contrast to nascent entrepreneurs, spinoffs founders often carry different employment experiences and on top of that, they may have the experience of founding more than one startup (Mosey and Wright, 2007). Moreover, there is a significant heterogeneity with respect to the hierarchical position and the amount of time spent in the incumbent parents across spinoffs founders. To further explore how prior experiences possessed by spinoff founders trigger different patterns of spinoffs entry, I examined the moderation effects of founders' seniority within the incumbent parents and former entrepreneurial experiences on the relation between incumbents' technological and market diversity and spinoffs entry to new (same) technological field or market segment as their parent firms. I found that, spinoffs founders' seniority within the parent firms positively moderate the negative effect incumbents market diversity on new market serving spinoffs entry, since the amount of resources and 'blueprints' transferred by departing employee from the parent firm to its spinoff ventures correlates with the amount of time an employee has spent with the incumbent firm (Hypothesis 5).

Also, I found that spinoffs founders' former entrepreneurial experience positively moderates the negative effect incumbents' technological diversity on new technology seeking spinoffs entry since employees, who are in possession of past entrepreneurial experiences are more willing to/better able to accumulate resources and start a new venture to exploit untapped opportunities than employees with no such experiences (Hypothesis 6).

3.8. EXPECTED CONTRIBUTIONS AND DIRECTION FOR FUTURE RESEARCH

Exploring both the determinants of, as well as the impact from, breakthrough and valuable inventions has been the focus of scholarly attention in the fields of strategy and entrepreneurship (e.g., Ahuja and Lampert, 2001). By creating new knowledge, industry incumbents may build or improve their existing competencies and production processes, or identify opportunities for future growth (Zahra et al., 1999; Zhang and Li, 2010). However, given the inherent uncertainties and asymmetries, not all new knowledge created by incumbents' knowledge investment gets accumulated and exploited for commercialization purpose (Arrow, 1962; Alvarez and Barney, 2005). Divergence in beliefs about the expected value of ideas about new technologies or new markets between employees and their employers exposes the latter to the risk of expropriation since employees may choose to capture the value of these ideas in a spinoff (Audretsch and Keilbach, 2007; Agarwal et al., 2007 & 2010; Acs et al., 2009 & 2013). The risk of expropriation raises the question how incumbent firms select among the pool of new ideas to appropriate the value of their investment in knowledge creation. New idea selection has consequences for spinoffs and it is important to understand under which conditions the ideas and knowledge unexploited by incumbent firms spurs employees' transition to entrepreneurship.

Two papers have particularly dealt with this topic; Agarwal et al. (2004), and Gompers et al. (2005). Agarwal et al. (2004) argue that when incumbents do not simultaneously develop their technological and marketing know-how (i.e. when there is a mismatch between incumbents' level of technological and market pioneering know-how), frustrated employees perceive abundant entrepreneurial opportunities and become confident about venturing out. Gompers et al., (2005), in on view of entrepreneurial spawning, propose that employees learn valuable skills and get access to necessary resources for venturing out by working for entrepreneurial firms, and conclude that diversified firms are less likely to spawn, since diversified firms are less entrepreneurial and thus their employees are less likely to have the ability or skills for venturing out.

While these two studies provide both theoretical and empirical evidence in support of the genesis of spinoff ventures motivated by created but remained unexploited knowledge in the incumbent firms, still we know little about the link between industry incumbents' knowledge profile and the type of opportunities created by them as well as the underlying mechanisms triggering different patterns of spinoffs entry. This paper responds to the call by Agarwal, Audrestch and sarkar (2007) about the "*linkages from knowledge generation and spillovers in the form of new venture formation, and the strategic decisions in established firms*". I argued that one reason incumbent firms are unable or not willing to exhaustively internalize the outcome of their investment in new knowledge creation is to maintain their extant level of coherence. Building on this premise, I claimed that since diversified organizations are in possession of experience and capabilities needed to manage diverse businesses, they are more willing to pursue a wider set of new opportunities compared to firms with a limited diversification experience. Thus, diversified firms are less prone to spawn not because they're less entrepreneurial and attract employees with little entrepreneurial aspiration (Gompers et al., (2005), but rather because they're more able/willing to internalize the benefits from their investment in new knowledge creation.

Notwithstanding that, one can argue that if coherence is a strategic consideration by industry incumbents and if diversification implies learning to enter to new markets/technological fields, two contrasting effects are at work. That is, up to a point, the learning effect associated with incumbents' diversification reduces the likelihood of spinoff (vs. internal exploitation), while beyond that point, coherence effect may exercise control over the learning effect, and thus increases the likelihood of spinoff entry. These contrary mechanisms may lead to a U-shaped relationship between incumbents' level of technological and market diversification and likelihood of spawning event or employee entrepreneurship. Having said that, the results did not show a significant effect, when a squared term for the incumbents' level of diversification was included in the logistic regression. Future research may delineate more precisely the unfolding of these two contrasting effects.

Spinoffs entry mode is a new topic in the entrepreneurship literature. Except for few anecdotal evidences on the relationship between spinoffs and the parent firms (for example Klepper and Sleeper (2005) observed that spinoffs initially produced a type of laser similar to their parent firms), still we know little about the antecedents and consequences of different spinoffs type of entry. In this study, I explored how knowledge profile of incumbent parents (i.e. level of technological and market diversity) underlies spinoff patterns of entry to the same (or new) technological fields and market domains as their parent firms. Specifically, focusing on the extent of diversifications of incumbents' technology/market base within the biotech sector, I posited similarities between required complementary capabilities for successful commercialization of untapped opportunists, and those available within incumbents' stock of knowledge enhance employees' confidence about turning to entrepreneurship. Nonetheless, one may argue that solitary focus on the breadth of incumbents' technological and market knowledge base within the biotech sector implies the assumption that spinoffs are endowed only with biotech-related know-how and disregards the effects of knowledge from overlapping fields (e.g. chemical or pharmaceutical) available within the incumbent parents. Although, I believe the two measures of diversification employed in this study account for the spread of incumbents' technological and market knowledge base over biotech as well as other related industries (e.g. measure of technological diversity used in this study accounts for the spread of incumbents' patents over 70 micro IPC codes), future researches may directly consider the effects of knowledge available from the other fields. Further, future research may go deeper and explore how different patterns of entry (i.e. different levels of business relatedness within parent-spinoff dyads) affects the performance of spinoff ventures.

One implication of our results is that the diversification strategy undertaken by industry incumbents may affect involuntary spinoffs and spillover of knowledge across organizational boundaries through the employees' transition to entrepreneurship. In addition to theoretical contribution, our findings can also help incumbent firms to make more efficient decisions when they face unprecedented but often breakthrough and valuable opportunities, who confront two alternatives; 1- to opt in a new opportunity and exploit it internally (e.g. through a division of labor) or externally (e.g. through a corporate spinoff) or 2- to shelve the opportunity and wait for more fitted opportunities, but take the risk of expropriation. Since a firm with a limited past technological (market) exploration experience may find it more difficult to explore new technologies (market niche) in the future, incumbent firms often pursue and exploit new opportunities that fall within their learning domain that is composed by their existing stock of technological and market-related knowledge and give up other opportunities. Whether this choice may prove to be ex post inefficient (e.g., the firm gives up developing a new technology that could become crucial for its future competitive advantage) it is an issue that falls outside the scope of this paper. Future research, however, could explore the consequences of different types of spinoffs entry for the subsequent technological and commercial performance of their parents.

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4. ESSAY THREE

Too Little and Too Much of A Good Thing:
Parental Knowledge and Spinoffs Performance

ABSTRACT

This study explores the impact of knowledge relatedness with the parent firms on the performance of spinoffs or entrepreneurial ventures founded by former employees of these industry incumbents. Building on current literature, I argue that the degree to which a spinoff's technological and market knowledge base overlaps with its parent firm has a positive but declining impact on spinoffs innovativeness and survival. That is, while some level of knowledge relatedness is pleasant for spinoffs allowing them to reduce uncertainties at birth, excessive technological and market overlaps both hamper creation of breakthrough knowledge and spinoffs' likelihood of survival. The former is because too much technological overlap impedes combination of underlying elements of knowledge with unfamiliar knowledge. The latter is because too much market overlap may spark parent hostile reaction as competing spinoffs may jeopardize parent firms' competitive positions in the market. Also, I argue that founders' hierarchical position within incumbent parents moderates the relationship between level of knowledge relatedness and spinoffs performance. The results of analyses using a sample of 131 spinoffs spawned from 116 industry incumbents supported the hypotheses on the inverse U-shape relationship between knowledge relatedness and spinoffs innovativeness and survival. The results of this study contribute to the literature on genealogical perspective on firm formation, knowledge inheritance, and spinoff performance.

Keywords:

Genealogical Lineage; Knowledge Relatedness; Spinoffs Performance

4.1. INTRODUCTION

Genealogical perspective on new firm formation posits that offspring originated from industry incumbents inherit their knowledge and capabilities from their parent firms and that parental heredity stamps a long-lasting influence on the new ventures' structures, capabilities and long-run performance (Agarwal et al., 2004; Phillips, 2002). Spinoffs – entrepreneurial ventures founded by former employees of incumbent firms - by their very definition benefit from knowledge accumulated during their founders past course of employment in the incumbent firms. When employees leave their paid jobs to create their own self-standing new ventures, they transfer considerable 'blueprints' (Klepper, 2001) in the forms of organizational routines, technological expertise, and market related know-how developed by the incumbent parents to set their ventures early resources, capabilities and structures (Boeker, 1997; Gompers et al., 2005; Klepper and Thompson, 2010). In addition to this, spinoffs' founders may bring with them colleagues (Agarwal et al., 2016), knowledge about customers and suppliers demand (Shane and Stuart, 2002), and the best practices for complex processes such as R&D (Roberts, 1991) to leverage in their new ventures. In this regard, spinoffs are said to be 'spawned with silver spoons' (Chatterji, 2009) since their founders' employment in the incumbent firms gives spinoffs access to industry knowledge not available to other de novo startups at the time of founding (Phillips, 2002; Sapienza et al., 2004).

During the last two decades, a large body of theoretical and empirical studies has drawn on biological metaphor to describe the process through which spinoffs inherit knowledge from their parent organizations and has acknowledged the benefits and endowments accrued to spinoff venture as a result of this process. For example, in study of law firms in Silicon Valley, Phillips (2002) showed that the new law firms employ similar routines as those of their parent firms and found that spinoffs likelihood of failure decreases with the greater the extent of parent-spinoff knowledge transfer. In study of the disk drive industry, Agarwal et al. (2004)

demonstrated that incumbent parents' technological and market pioneering know-how underlie the spawned ventures' knowledge capabilities and spinoffs have a higher probability of survival than other types of entrants (e.g. diversifying entrants and non-spinoff de novo entrants). Using data from the medical device sector, Chatterji (2009) showed that spinoffs secure funding more quickly than non-spawns, and those that incorporated non-technical knowledge related to marketing and regulatory strategy from their parents outperformed the others.

Said that, previous studies have often presumed that knowledge transfers from incumbent parents to spinoff ventures in a manner similar to transition of biological genes, and since spinoffs are spawned from incumbents with established routines and practices, their capabilities and technologies are closely related to those of their parent firms. However, little attention has been paid to the noteworthiness extent of knowledge relatedness between incumbent parents and their spinoffs ventures as few recent studies suggest that as a result of learning, spinoffs may 'deprint' parental knowledge and deviate to new development trajectory to establish their idiosyncratic competitive identity (Ferriani et al. 2012), or combine distinct pieces of knowledge in meaningful new ways (Sapienza et al. 2004; Basu et al., 2015).

This study explores the impact of knowledge relatedness with the incumbent parents on the performance of spinoff ventures. More specifically, I examine the effects of level of (a) technological and (b) market overlap with the incumbent parent on spinoff's (a') innovativeness and (b') likelihood of survival.

Building on current literature, I argue that while some level of knowledge relatedness is pleasant for spinoff ventures, too little and too much technological and market overlap with incumbent parent both hamper spinoffs' innovativeness and survival. The former because limited technological and market overlap prevents assimilation of familiar knowledge and hampers spinoffs' ability to deploy parental knowledge to reduce technological and market uncertainty faced by new entrants (Sapienza et al., 2004; Winter et al., 2007). The latter because excessive technological and market overlap not only hampers spinoff's ability to combine existing knowledge with unfamiliar knowledge available from external sources (Ahuja and Lampert, 2001; Fleming and Sorenson, 2001; Kogut and Zander, 1992; Basu et al. 2015), but it may spark parent hostile reaction as competing spinoffs may jeopardize parent firms' competitive position in the same market, respectively (Walter et al. 2014). Further, I hypothesize that spinoffs founders' hierarchical position within the incumbent parents moderates the relationship between the level of knowledge relatedness and spinoff's performance since the amount of knowledge and resources accessed and leveraged by employees is associated with their position within the incumbent firms.

The results of my analysis using a sample of 131 spinoffs from the Biotech sector can be summarized as follows: 1- the degree to which spinoff technological domain overlaps with the incumbent parent has positive but diminishing effect on spinoffs' innovative performance or breath of knowledge created by them. 2- the degree to which spinoff operating market segment overlaps with the incumbent parent has positive but diminishing effect on spinoffs' survival. 3- spinoff founder's hierarchical position within the parent firm moderates the curvilinear relation between technological overlap with the parent and the breadth of knowledge created by spinoff venture such that the inverted U-shaped curve becomes flatter for spinoffs founded by former manager or senior employees of the incumbent firms. 4- spinoff founder's hierarchical position within the parent firm moderates the curvilinear relation between market overlap with the parent and spinoff's likelihood of survival such that that the inverted U-shaped curve becomes flatter for spinoffs founded by former manager or senior employees of the incumbent firms. These results add to the received literature on genealogical perspective on firm formation, knowledge inheritance, and spinoff performance.

The remainder of this paper is organized as follows. Next section is devoted to theory and hypotheses development. Section 3 introduces the research context, describes sample, key variables, and methods. In section 4, the results of econometric analyses are presented. Section 5 presents the results of robustness checks. I conclude by discussion, a brief conclusion and expected contributions to the literature.

4.2. THEORY AND HYPOTHESES

The focus on genealogical lineage within organization literature dates back to Stinchcombe's seminal essay on "Social Structure and Organizations", in which he posited that organizations reflect the elements of their external environment at the time of founding (Stinchcombe, 1965, P.169). Following Stinchcombe (1965), organizational ecologists, management scholars, and entrepreneurship researchers have investigated on the relevance of imprinting and importance of initial conditions in explaining current behavior across different level of analysis including industries, organizations, and individuals (Marquis and Tilcsik, 2013). In particular, genealogical perspective on new firm formation posits that offspring originated from industry incumbents inherit their knowledge and capabilities from their parent firms and that parental heredity stamps a long-lasting influence on the new ventures' structures, capabilities and long-run performance (Phillips, 2002). As pointed out by Freeman (1986) and highlighted by Phillips (2002, P. 475), this is due to the fact that "*organizational founders… are constrained by their organizational experiences, and, consequently, the new organizational forms are constrained by the characteristics of the founders' previous organization, population, and employment*.

In the context of spinoffs, previous researches have highlighted the role of spinoffs' founders as conduit of technological and operational expertise, knowledge about market, and managerial capabilities from parent firms to the spinoff ventures (Agarwal et al., 2004; Klepper, 2002;

Klepper and Sleeper, 2005). For example, in a study of law firms in Silicon Valley, Phillips (2002) showed that the new law firms employ similar routines as those of their parent firms. Using data from the disk drive industry, Franco and Filson (2006) find a positive correlation between the areal density of the disk drives of parents and their spinoffs. In a study of the same sector, Agarwal et al. (2004) demonstrate that parental technological and marketing know-how underlie the knowledge capabilities of spinoff ventures. Chatterji (2009) find that in addition to technological know-how, spinoffs also inherit non-technical knowledge related to marketing and regulatory strategy from their parents. In the laser industry, Klepper and Sleeper (2005) observed that nearly all spinoffs initially produced the same type of laser as their parent firms. In the automobile industry, Klepper (2002; 2007) found that cars initially produced by spinoffs had many features in common with those produced by their parent firms. Also, Moore and Davis (2004) highlighted the importance of managerial skills learned by Fairchild Semiconductor's technical employees in their decisions to spawn.

Previous studies have also demonstrated that spinoffs endowed with parental knowledge perform better than other de novo entrants. For example, Agarwal et al. (2004) found that spinoffs had a higher probability of survival than all other types of entrants (such as diversifying entrants and non-spinoff de novo entrants). Chatterji (2009) demonstrated that spinoffs secured funding more quickly than non-spawns, and those spawns that incorporated nontechnical knowledge related to regulatory, strategy, and marketing from their parent firms outperformed the others. Franco and Filson (2006) show that a spinoff likelihood of survival increases with its parent firm's know-how. Eriksson and Kuhn (2006) showed that spinoffs survived longer than other startups. Dahlstrand (1997) found that spinoffs grow more rapidly than non-spinoffs.

Overall, current literature has highlighted the role of spinoffs' founders as conduit of technological, operational, and market-related know-how from parent firms to the spinoff ventures and demonstrated that the capabilities and subsequent performance of spinoff ventures are determined to a great extent by the quality of their parent firms (Klepper and Thompson, 2010).

Said that, it has been often presumed that parental knowledge spillovers to spinoff ventures in a manner similar to 'transition of biological genes', and since spinoffs are spawned from incumbents with established routines and practices, their capabilities and the technology are closely related to those of their parent firms (Phillips, 2002; Agarwal et al., 2004; Gompers et al., 2005; Klepper and Sleeper, 2005). That is, while much attention has been paid to the benefits of overlap with parent firms accrue to spinoffs; relatively few studies have questioned how 'de-printing' parental knowledge provides benefits to the spinoff ventures?

For example, Ferriani et al., (2012) propose a model of intergenerational learning or a so-called "re-imprinting process" and posit that as a result of intense learning, improvisation and feedback from the market, spinoffs override early parental influence to develop their idiosyncratic capabilities and form their distinct identity. Basu et al. (2015) study how the breadth of available knowledge to a progeny from its parent and individual founders affect its own creation of impactful knowledge. The authors argue that a venture's divergence from its parents' knowledge domains, as well as its founder personal knowledge enables spinoffs to combine more new and unfamiliar knowledge from distant sources. Using a sample of 54 industrial spinoffs, Sapienza et al. (2004) demonstrate that the relationship between knowledge relatedness (technological and production but not marketing knowledge) with the parent firms and spinoffs growth in sales is inverse U-shape. They argue that too much and too little knowledge relatedness to parent firms both hamper spinoff' learning due to constraint for novel knowledge combinations and knowledge assimilation, respectively.

Unlike Basu et al. (2015) and Sapienza et al., (2004), who focused on the effects of knowledge relatedness with the parent firm on impact of knowledge created by spinoffs and their growth in sales, respectively, this paper adds to this stream of literature by exploring the relationship between the level of technological and market overlaps with the incumbent parents and spinoffs' innovative performance and survival.

4.2.1. Technological Overlap with Parent and Spinoffs' Innovativeness

Exploring the determinants of breakthrough inventions has been the focus of scholarly attention in the fields of strategy and entrepreneurship (e.g. Ahuja and Lampert, 2001). By creating breakthrough and innovative knowledge, entrepreneurial ventures or established firms may sustain their competitive positions, or identify opportunities for future growth (Shane, 2003).

Prior research has shown creating breakthrough knowledge involves recombination of familiar knowledge in novel ways, and combining the underlying knowledge elements with unfamiliar knowledge available from external sources (Kogut and Zander, 1992; Cohen & levinthal, 2000; Fleming and Sorenson, 2001; Ahuja and Lampert, 2001; Ahuja and Katila, 2004; Yayavaram and Ahuja, 2008). By tapping into knowledge resource which spinoffs have inherited some familiarity with through their founders, they become able to search for and ultimately identify opportunities for recombining the existing knowledge components in new ways (Kogut and Zander, 1992; Fleming and Sorenson, 2001). Also, assimilating parental technological knowledge may help spinoffs to reduce technological uncertainty and upfront development costs faced by new entrants (Phillips, 2002).

Yet, excessive focus on the local search and reliance on familiar knowledge inherited from the incumbent parent firms (i.e. high degree of technological overlap with the parent firms' knowledge domains) diminishes spinoffs ability to create breakthrough inventions through combining existing elements of knowledge with unfamiliar knowledge available from external sources (March, 1991; Levinthal and March, 1993; McGrath, 2001). As noted by Ahuja and

Lampert (2001), by experimenting with novel and unfamiliar knowledge, established firms can overcome "*familiarity trap*" and they can successfully create breakthrough inventions. Accordingly, both too little and too much knowledge relatedness with the incumbent parents' technological knowledge domains diminishes the innovative performance of spinoff ventures. The former because little knowledge relatedness with the incumbent parents hampers "*local search*" and spinoff's ability to exploit familiar knowledge available from the parent firm (Rosenkopf and Almeida, 2003), and the latter because high level of technological overlap also hampers "*explorative search*" and spinoff's ability to combine heterogeneous knowledge available from external sources in distinct new ways (Fleming and Sorenson, 2001).

Hypothesis 1*: The relationship between technological overlap with the incumbent parent and spinoffs' innovativeness will be inverse U-shaped.*

4.2.2. Market Overlap with Parent and Spinoffs Survival

As pointed earlier, in addition to narrow technological expertise, spinoffs' founders carry with them blueprints of parent firms' routines, practices and very suited market related know-how. In fact, Chatterji (2009) demonstrated that spinoffs acquire their superior performance not by inheritance of technological knowledge from their parent firms, but rather by regulatory strategy and marketing related know-how. While the current literature has recently begun to explore the determinants and performance implications of technological knowledge relatedness between industry incumbents and spawned ventures (e.g. see Basu et al., 2015), except for few anecdotal evidences, still we know little about the antecedents and performance consequences of market overlap between the parent and spinoff ventures. For example, in study of the laser industry, Klepper and Sleeper (2005) observed that spinoffs initially operated in an overlapping product-market segment similar to their parent firms, but later they differentiated from their parents and focused on different, albeit related markets. Franco and Filson (2006) in contrast observed that the new market segments transitioned from low market overlap to greater competition.

Market overlap (the extent to which spinoffs spawn into the same market segment as their parent firms) is the critical of importance for the survival of newly founded venture as well as the incumbent parent post-spinoff performance as it determines to what extent the two ventures compete in an overlapping market segment. When a spinoff spawns to an overlapping market segment to exploit an opportunity not commercialized by the parent firm, the 'spawning event' poses a special threat to the parent firm since besides the loss of important human capitals and disruption of ongoing organizational routines, the spawned venture may jeopardize the parent firm market position as the two ventures compete within the same product-market (Campbell et al., 2012; Phillips, 2002; Wezel et al., 2006)[5].

For example, Wlater et al. (2014) argue that parent hostility, defined as "*the degree to which an incumbent firm disapproves of the spawning of a spin-out from within its ranks*" hinders spinoff performance through impeding spinoff's transaction with parent's partners, denial of any support, and intellectual property litigation, specifically when spinoff focuses on the same product-market as the parent firm. In fact, the names 'traitorous eight' and 'dirty dozen' were given to the former employees of Shockley Semiconductor Laboratory and IBM respectively, who ended up competing with their parent firms in the semiconductor and disk drive industries, respectively (McKendrick et al., 2009; Klepper, 2009).

5 Phillips (2002) found that the Silicon Valley law firms that experienced spinoff activity had lower survival rates compared with those that did not. He attributed this to the disruption of the general social organization at the parent firm and to the loss of firm-specific resources (human and social capital) that are costly for the parent firm to replace. Wezel et al. (2006) found that parent firm failure is more likely when the exiting employees set up their own ventures than when they join another firm in the same industry. They argued that leveraging knowledge originally generated at the parent firm and also replicating routines within the newly formed firms make them their parent direct competitor. Campbell et al. (2012) demonstrated that spinoffs had larger negative impact on parent's performance compared with when employees move to other firms. They argue that this is due to the fact that complementary assets and opportunities (e.g. relationship with customers or parent reputation) are easier to transfer to spinoff than to other existing firms in the same industry.

Nonetheless, ceteris paribus, such competition effect is null-and-void when there is a little degree of market overlap between the parent and its spinoff firm. Further, from the parent point of view, the development of parent technology in a new market might be beneficial and leveraged back to the parent firm. In fact, Agarwal et al., (2016), argue that when spinoffs occupy *"complementary"* rather than *"competitive"* positions, there will be potential for learning and even future acquisition of the spawned firm. Thus, while some level of market overlap with the parent firms may help spinoffs to avoid large upfront costs by using market-related know-how and routines that have proven effectiveness in the past (Winter et al., 2007), too much market overlap impedes spinoff survival due to direct competition and plausible hostile reaction by parent firm.

Hypothesis 2*: The relationship between market overlap with the incumbent parent and spinoff's survival will be inverse U-shaped.*

4.2.3. Founder's Hierarchical Position Within the Parent

Prior to their transition, spinoffs founders hold different position and status within the incumbent firms. As highlighted by Phillips (2002, P. 476), "*the volume of resources and routines transferred to the new entity is likely to be a function of founder's position in the parent organization"*. The employees' hierarchical positions within the incumbent firms determine to what extent they have accessed and obtained valuable resources, complementary capabilities, and social capitals. As for that, employees with higher position are better able to transfer parental blueprints in the forms of technological and marketing knowledge and replicate them within their own independent ventures (Wezel et al., 2006).

Said that, as noted by (Agarwal et al., 2016) an extensive amount of knowledge and organizational experiences accumulated by founders through the course of employment within the incumbent parent might be associated with a 'downside', and it might diminish the positive effect of knowledge relatedness with parent firm. High ranked founders within the incumbent parent may suffer from more inertia and a limited heterogeneous knowledge (Fleming and Sorenson, 2001). Moreover, potential threat to the parent firm market position and the hostile reaction by parent firms toward competing spinoff increases with the amount of knowledge transfer from parent to the spinoff venture and the founders' hierarchical position within the parent firm. For example, Ioannou (2014) found that the position of departing employee moderates the relation between the spawning event following a severe disagreement at the parent firm and parent's performance.

In developing the hypotheses on the relation between parent-spinoff knowledge relatedness and spinoff's innovative performance and survival, I posited that an intermediate degree of technological and market overlap with the incumbent parents is the sweet spot for the spinoff ventures as it enables them to assimilate parental technological and market-related knowledge, while at the same time reduces the risk associated with excessive focus on the "*local search*" and "*familiarity trap*" (March, 1991; Ahuja and Lampert, 2001; McGrath, 2001) and mitigates the negative effect of parent hostility (Walter et al., 2014). It follows then that since the volume of resources transferred from incumbent parent to spinoff venture is likely to be correlated with the founders' position within the parent firm, the positive effect of low to intermediate, and negative effect of intermediate to high level of technological and market overlap with the parent on spinoffs innovative performance become neutralized (i.e. the slopes of curve become flatter), when spinoffs are founded by senior managers or high ranked employees within the incumbent parents. In other words, founders' position within incumbent parent (i) negatively moderates the positive effect of low to medium level of knowledge overlap, and (ii) positively moderates the negative effect of medium to high level of knowledge overlap on spinoffs' likelihood of creating breakthrough inventions and survival.

Hypothesis 3*: Spinoff founder's hierarchical position within the parent firms moderates the curvilinear relation between technological overlap with parent and spinoffs' innovative performance, such that the positive and negative slopes of the inverted U-shaped curve become flatter for spinoffs founded by senior managers or high ranked employees within the incumbent parents.*

Hypothesis 4*: Spinoff founder's hierarchical position within the parent firms moderates the curvilinear relation between market overlap with parent and spinoffs' survival, such that the positive and negative slopes of the inverted U-shaped curve become flatter for spinoffs founded by senior managers or high ranked employees within the incumbent parents.*

4.3. METHODOLOGY

4.3.1. Context: The Biotech Industry

Biotechnology is the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services (OECD, 2005). As an interdisciplinary field of science, Biotechnology is a blend of various technological fields and their application goes beyond a single product-market. In fact, included in this definition, there are companies that use modern biological techniques to serve different product-segments including human and veterinary health, agriculture, natural resources, environment, and industrial processing. This variation in terms of different technological fields and co-existing product-market segments makes the Biotech industry an appropriate context to investigate on research questions similar to one we are analyzing in this study. Moreover, the biotech industry has historically been characterized by a large number of start-ups (Rothaermel and Deeds, 2004), in which many of them are spawned from industry incumbents (Stuart and Sørenson, 2003).

4.3.2. Data & Sample

Data was collected using five major sources: 1- ThomsonOne database (a unit of Thomson Reuters), 2- ORBIS database (a unit of Bureau van Dijk), 3- WIPO patent database (PATENTSCOPE), 4- Companies' websites and annual reports, and 5- Three business directories (Bionity, Biocentury, and Biowebspin).

The core data in this study comes from ThomsonOne database. ThomsonOne and similar databases (e.g. Venture Expert, and VentureOne) have been used widely in the literature to investigate different aspects of venture capital financing. Yet, in studies of spinoff formation by Gompers (2005) and Chatterji (2009) these databases have been used as the primary source of data collection. ThomsonOne database delivers a comprehensive and deep range of financial information covering ventures, buyouts, private equity funds, firms, executives, portfolio companies and limited partners around the world (Kaplan and Lerner, 2015). More specifically, this database contains firm-level information (e.g. funding date, financing rounds, investors, etc.) covering approximately 1180 European biotech start-ups that received at least one round of venture capital financing over the period 1986 to 2015.

To create the sample of spinoff ventures (i.e. to identify spinoffs and link them to their incumbent parent firms), three steps were implemented as following: First, among above-mentioned population of 1180 VC-backed European biotech start-ups, ThomsonOne includes information about the key executive officers of only 874 start-ups. Nonetheless, this information was not exhaustively practical for my purpose in the sense that except 352 startups in which the founders' names were available, the database doesn't explicitly indicate whether other start-ups' current executive officers were among the initial founders or not. Thus, I collected the names of founders for the remaining 522 start-ups using companies' website and two business directories, Bloomberg and RelScience.

Second, I collected information about founders' history of employments including their last place of employment in the industry, duration of employment, and hierarchical position by searching their names using LinkedIn and through companies' website.

Third, using Orbis database, I collected information about startups' history of ownership to include only those spinoffs in which incumbent parents have no ownership or control over the spawned ventures. Overall, these procedures enabled me to identify the historical origins of 740 startups, in which 131 startups (approximately 18% of initial population) were identified as spinoff ventures, which were spawned from 116 incumbent parents (see figure 4.1).

Parents and spinoff ventures' patent data including IPC codes, priority dates, claims, and citations was collected using PATENTSCOPE. Also, I collected information about parents and spinoff firms' core businesses pipeline projects, and products using companies' websites and three business directories; Bionity, Biocentury, and Biowebspin.

Finally, I hand-matched the name of parent firms and their spinoffs from ThomsonOne database with the name of companies available in Orbis database to collect other firm-level information such as date of incorporation, current status, and 4-digit primary and secondary SIC codes. Figures 4.2 & 4.3 display the spinoffs entry by year, and main operating segments, respectively.

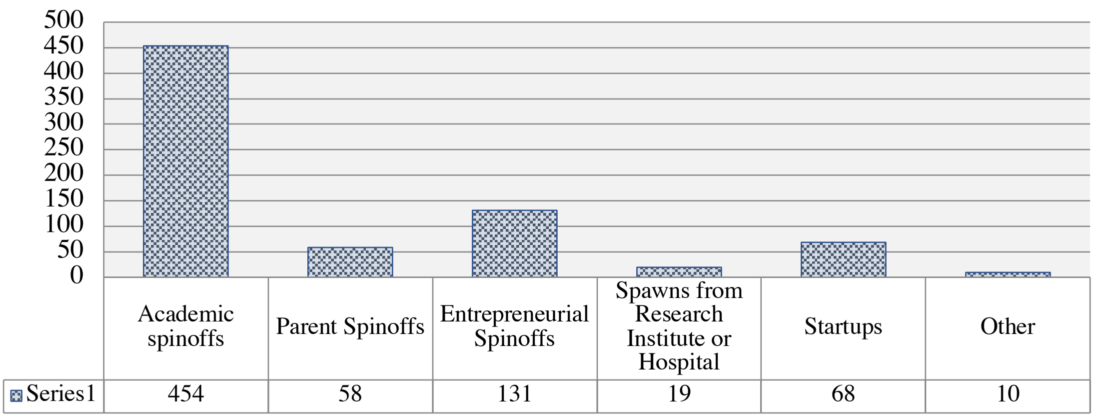


Figure 4.1: Startups Analysis by Origin

Figure 4.2: Spinouts Entry by Year

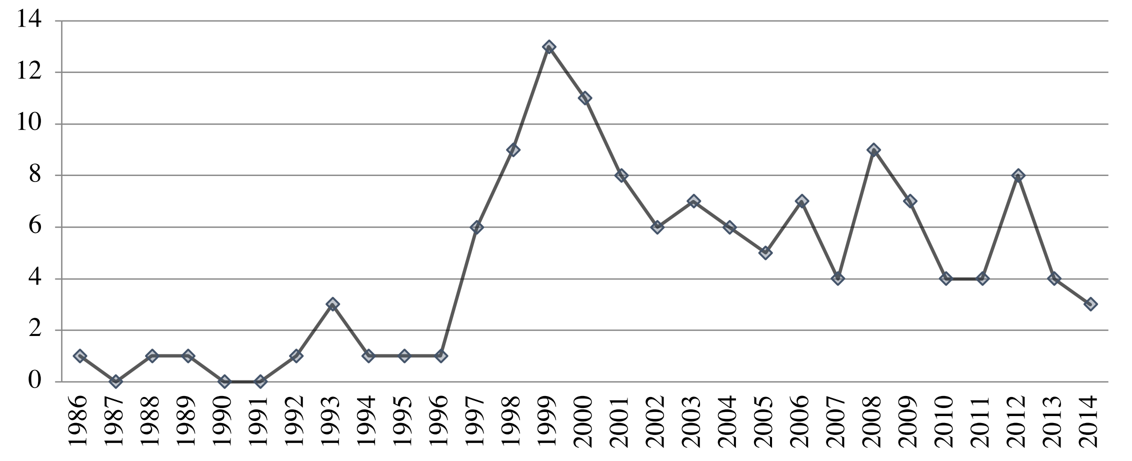
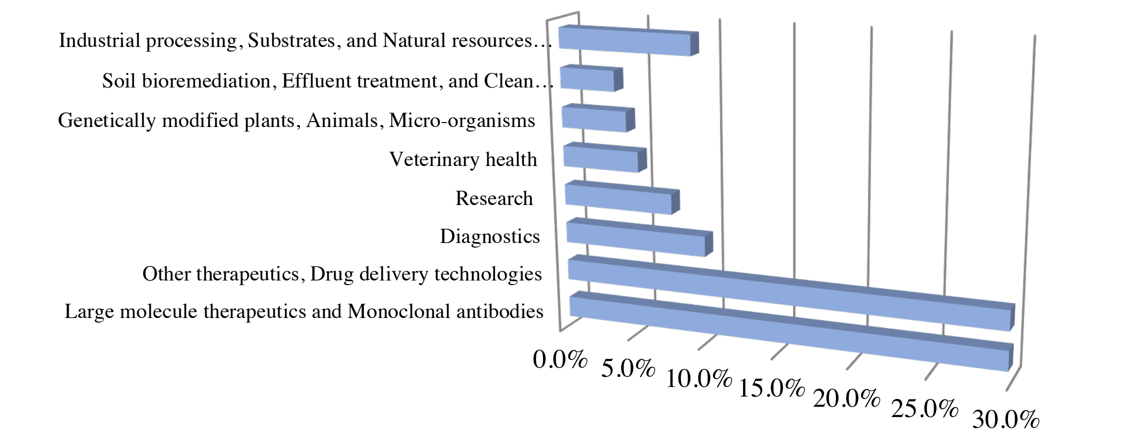


Figure 4.3: Spinoffs Analysis by Market Area



4.3.3. Measures

4.3.3.1. Dependent variable

Spinoff Innovativeness. Previous studies demonstrate that the breadth (scope) of knowledge available within a firm’s boundaries is associated with its innovative performance (e.g. Cohen and Levinthal, 1990). For example, Henderson and Cockburn (1994) posit that firms with ability to span their boundaries and integrate extensive flow of knowledge will have more innovative research outputs. Similarly, Leiponen and Helfat (2010) demonstrate that established firms with a greater breadth of knowledge sources tend to have greater innovation success. As highlighted by Kogut and zander (1992), this is due to fact that established firms’ ability to integrate knowledge from different fields enable them to combine the underlying knowledge in more complex and creative new ways (Schumpeter, 1934).

A typical measure of breadth is the number of technical (sub)-classes in which the patent was assigned by the patent examiners, which has been shown to be correlated with other indicators of patent value like the number of forward citations (Lerner, 1994; Hall, Thoma, and Torrisi, 2009; Akcigit et al. 2016).

Consistent with definition of breadth of knowledge as the range of fields over which a firm is familiar with (Laursen and Salter, 2006), I measured the breadth of knowledge created by a spinoff venture using the total number of technical classes (4-digit IPCs) assigned by WIPO patent examiners to the spinoff's patents filled in 3-year window from its date of foundation.

Spinoff Survival. Since it is quite difficult to measure market performance in privately held small ventures, many studies have used lifespan as measure of spinoffs' performance as it's the primary objective of newly founded ventures (Agarwal et al., 2004; Franco and Filson, 2006; Phillips, 2002; Wezel et al., 2006). Moreover, other measures of market performance such as sales or revenue per employee bias my estimation on better surviving ventures (Agarwal et al., 2016). I constructed a dummy variable for "failure" that takes the value equal to 1 for spinoffs exited from the market in a respective year. Further, I right censored observations that dissolved due to merger or acquisition by other firms. Overall, my survival analysis includes 1503 year-observation at the risk of failure in which 19 events (Failure=1) recorded.

4.3. 3.2. Independent variables

Technological overlap. To measure technological overlap between a spinoff and its parent firm, I compared the early technological knowledge base of spinoff ventures to that of their parent firms before the spawning date. Consistent with definition of a firm's knowledge base as the set of knowledge with which the firm has "*demonstrated familiarity with, or mastery of*" (Ahuja and Katila, 2001), and following previous studies (e.g. Cahtterji, 2009; Sears and Hoetker, 2013), I collected parent firms' patents filled prior to the spawning event (the spinoff founding date) to construct the incumbent parents' patent stock. Then, I collected the spinoff's patents filled within 1-year window from its date of foundation.[6] Technological overlap between a spinoff and its parent firm was measured by counting the number of patents with the same 6-digit IPC in the knowledge base of the two ventures divided by the total number of spinoff's patents 1 year after spawning. The calculated measure ranges from 0 to 1, with higher values indicating greater technological overlap between spinoff and its parent firm.

Market overlap. Business relatedness has been traditionally measured in the literature in three ways; i. application of SIC codes or different indices (e.g. Amit & Livnat, 1988), ii. assessments by researchers (e.g. Rumelt, 1974), and iii. managerial perceptions (e.g. Pehrsson, 2006).

To measure the extent of market overlap between a spinoff and its parent firm, following (Pehrsson, 2006), I text analyzed all spinoffs and parent firms core businesses descriptions (including the operating segments, product pipelines, and undergoing research projects), and I hand-matched according to the classification system for Biotechnology Application developed by OECD (2005), which provides a three-level (Broad, Intermediate, and Detailed) grouping of biotechnology market application areas. The broader level of classification encompasses six areas, i.e. human health, Veterinary health, Agriculture, Natural resources, Environment, and Industrial processing (see appendix I). The intermediate level encompasses nine sub-areas while the detailed level comprises twenty-six finer-grained application areas.

[6] Gompers et al. (2005) observed spinoffs first 5 patents. In an alternative specification, I measured technological overlap using spinoff 1st 5 patents and the results were robust to my main findings.

The market overlap variable was recorded equal to 1, for parent-spinoff dyad assigned to the same 3rd (detailed) level application area using above-mentioned procedure. The variable was recorded 0.66 when a spinoff and its parent firm assigned to the same 2nd (intermediate) level application area, but they were placed in different 3rd level segments. Similarly, 0.33 for parent-spinoff dyad assigned to the same 1st (broad) level, and 0 when the two firms assigned to completely different 1st level application areas.

To illustrate this coding procedure, let's consider the following example. A spinoff company in the sample was a biopharmaceutical company engaged in developing drug candidates for the treatment of the cancer and other life-threatening diseases. The company had a number of drug candidates in late stage clinical development designed to strengthen human body's immune response to cancerous antigens and prevent tumor recurrence (source: company's website). Through tracing back the history of employments of its founders, I found that this spinoff was spawned from an incumbent firm active in the field of in-vitro diagnostics. More precisely, the parent firm had a number of clinical diagnostics products in the areas of sepsis, infections, tuberculosis, biomarkers, and cardiovascular diseases. After analyzing the description of the core businesses, products or drug candidates, and the undergoing research projects, I hand-matched the extracted information with the description of different application areas available within proposed classification system for Biotechnology Application (OECD, 2005), and assigned the incumbent parent and the spinoff venture to at least one 3rd (detailed) level application field. In this example, the spinoff venture and the incumbent parent were matched and assigned to 'other therapeutics, drug delivery technologies' and 'diagnostics' respectively (see appendix I). Since the spinoff venture was involved in a non-overlapping 3rd (detailed) level application area with respect to the incumbent parent, the market overlap was recorded 0.66, given that the two ventures operated in the same 2nd (intermediate) and 1st (broad) level application area.

4.3.3.3. Control Variables

Controls used in this study can be categorized in four classes of variables; *spinoff and founding team characteristics, parent-related controls, financing controls, and industry controls*. First, I included number of variables to control for the effect of spinoffs' founding team characteristics including *total number of founders, number of founders from the same parent, main founder's hierarchical position and tenure within the parent* (related to *H1&H2*), and two dummy variables for *serial entrepreneur* and *founder from academia*. Also, three variables were included to control for *spinoffs number of patents filled in 3-year window from founding, spinoff number of products*, and *spinoff number of active primary and secondary 4-digit SIC codes*.Second, a number of variables were included to control for the effects of the incumbent parents' characteristics on the performance of spinoff ventures.

In particular, I controlled for parent firms' innovativeness by computing the *total number of patents before the spawning event*, and *parent tech. diversity* (measured using the entropy measure of diversification and spread of parent firms' patents over 22 IPC classes[7]). Also, I controlled for *parent market diversity* (measured using the entropy measure of diversification and spread of parent firms' sales over 8 different operating segments), *parent number of active 4-digit SIC primary and secondary classes,* and a dummy variable to control for *the status of the parent firm* (whether active or dissolved) at the time of spawning. Third, related to VC financing, I controlled for spinoffs' *time to 1st financing, total amount of funding, number of funding rounds,* and the *number of VC firms* throughout all the financing rounds. Finally, I included controls for *country, year,* and *industry segment*. Tables 4.1 & 4.2 present the summary of descriptive statistics and correlation matrix.

[7] These technological fields are A01H, A01K, A01N, A01P, A21D, A23B, A23C, A23L, A61K, A61L, C02F, C05F, C07H, C07J, C07K, C12M, C12N, C12P, C12Q, C12R, G01N, and G06N.

Table 4.1: Descriptive Statistics					
List of Variables	Obs.	Mean	Std. Dev.	Min	Max
Spinoff Total Number of Patents	131	12.573	14.847	0	89
Number of Patents Filled Within 1-*year* From Spinoff Founding	131	2.069	2.160	0	11
Spinoff *1st year* Patents Share in the Same Tech. Class as Parent Firm	122	0.643	0.442	0	1
Spinoff *1st five* Patents Share in the Same Tech. Class as Parent Firm	122	0.626	0.414	0	1
Number of Patents Filled Within *3-year* from Spinoff Founding	131	5.221	5.529	0	32
Total Number of Forward Citation	131	16.886	34.987	0	229
Forward Citations in *3-year* Window from the Application Date	131	10.886	21.388	0	135
Citation Per Patent	131	1.670	3.064	0	21
Breadth of Knowledge Created Within *3-year* From Spinoff Founding	130	4.846	3.354	0	22
Spinoff Market Overlap with the Parent Firm	129	0.500	0.425	0	1
Spinoff Current Status (Active=0; Dissolved=1)	131	0.412	0.494	0	1
Spinoff Time to Dissolution	131	11.473	4.892	3	27
Spinoff Time to 1st Financing	129	31.209	30.632	0	180
Spinoff Total Funding	118	24.767	39.839	0.12	260.32
Total Number of Rounds	131	3.504	2.821	1	16
Spinoff Number of Founders	131	1.695	0.822	1	4
Spinoff Number of Founders from the Same Parent	131	1.305	0.539	1	3
Spinoff Any Founder from Academia (Yes=1; No=0)	131	0.061	0.240	0	1
Serial Entrepreneur (Yes=1; No=0)	130	0.254	0.437	0	1
Main Founder Tenure with Parent	129	6.527	3.992	2	21
Founder Position in Parent (Senior managers=1; Others=0)	131	0.546	0.500	0	1
Spinoffs Number of Products	131	2.595	2.420	0	11
Spinoff Number of Primary & Secondary Active SICs	121	1.438	0.836	1	5
Parent Number of Primary & Secondary Active SICs	129	1.853	1.816	0	14
Parent Number of Patent before Spawning Event	131	3618.053	8362.384	0	38677
Parent Tech. Diversity (Constructed using 22 macro IPC classes)	131	1.081	0 .77408	0	2.2056
Parent Market Diversity (Constructed using segments sale)	131	0.142	0.346	0	1.3324
Parent Status at the Spawning Event (Active=1; Dissolved=0)	128	0.836	0.372	0	1

Table 4.2: Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1. Spinoff Total Number of Patents	1.00																							
2. Spinoff *1st year* Patents share in the same Tech. Class as Parent	0.10	1.00																						
3. Spinoff *1st five* Patents Share in the same Tech. Class as Parent	0.23	0.88	1.00																					
4. Spinoff Market Overlap with the Parent	0.10	0.04	0.03	1.00																				
5. Spinoff Number of Patents Filled in *3-year* From Founding	0.65	0.21	0.27	-0.07	1.00																			
6. Forward Citations in *3-year* Window from the Publication Date	0.41	0.13	0.15	-0.13	0.43	1.00																		
7. Breadth of Knowledge Created in *3-year* From Spinoff Founding	0.43	0.14	0.20	-0.10	0.58	0.61	1.00																	
8. Spinoff Current Status (Active=0; Dissolved=1)	-0.10	0.08	0.02	-0.16	-0.03	0.25	0.10	1.00																
9. Spinoff Time to Dissolution	0.42	0.07	0.19	0.02	0.22	0.15	0.29	-0.12	1.00															
10. Spinoff Time to 1st Financing	-0.18	-0.06	-0.07	0.16	-0.22	-0.05	0.05	-0.14	0.23	1.00														
11. Spinoff Total Funding	0.31	0.27	0.26	0.09	0.19	0.09	0.02	-0.21	0.10	-0.17	1.00													
12. Spinoff Number of Founders	0.13	0.13	0.15	0.07	0.25	-0.04	0.02	-0.14	-0.06	-0.27	0.24	1.00												
13. Spinoff Number of Founders from the Same Parent	0.14	0.20	0.25	0.01	0.22	0.06	0.22	-0.07	-0.03	-0.10	0.08	0.68	1.00											
14. Spinoff Founder form Academia (Yes=1; No=0)	0.00	0.12	0.07	-0.07	-0.03	-0.01	-0.12	0.02	-0.01	-0.16	0.42	0.31	0.04	1.00										
15. Serial Entrepreneur (Yes=1; No=0)	-0.11	-0.12	-0.26	0.22	-0.13	-0.06	-0.15	-0.20	-0.18	0.08	-0.03	0.16	0.11	0.00	1.00									
16. Founder Tenure with Parent	0.05	0.25	0.30	0.16	-0.04	-0.19	-0.09	0.05	0.15	0.00	-0.04	0.06	0.09	-0.07	-0.01	1.00								
17. Founder Position in Parent (Directors, Managers=1; Others=0	0.08	0.03	-0.02	0.10	0.11	0.00	-0.01	-0.16	-0.09	-0.05	-0.04	0.09	0.01	0.08	0.49	-0.02	1.00							
18. Spinoffs Number of Products	0.20	0.14	0.14	0.11	0.21	0.04	0.20	-0.35	0.24	0.12	0.17	0.07	0.03	0.17	0.08	0.05	0.09	1.00						
19. Spinoff Number of Primary & Secondary Active SICs	0.06	-0.04	0.00	-0.14	0.04	0.08	0.18	-0.01	0.15	0.08	-0.10	0.05	0.13	-0.15	-0.11	0.05	-0.04	-0.18	1.00					
20. Parent Number of Primary & Secondary Active SICs	0.02	0.05	0.06	-0.07	-0.01	0.00	-0.05	-0.21	0.13	-0.03	-0.05	0.00	-0.02	-0.13	-0.06	-0.07	0.06	0.02	0.11	1.00				
21. Parent Number of Patent before Spawning Event	0.07	0.31	0.34	-0.10	0.11	0.00	-0.02	0.13	-0.14	-0.11	0.24	0.15	0.09	0.06	-0.22	0.18	-0.20	-0.14	-0.04	0.02	1.00			
22. Parent Tech. Diversity at the Spawning Event	0.09	0.60	0.58	-0.14	0.20	0.08	0.09	0.12	0.08	-0.12	0.15	0.07	0.02	0.08	-0.15	0.16	-0.02	-0.02	0.01	-0.04	0.37	1.00		
23. Parent Market Diversity at the Spawning Event	0.03	0.25	0.27	-0.01	0.03	0.12	-0.05	0.12	-0.03	-0.10	0.12	0.16	0.08	-0.05	-0.07	0.07	-0.08	-0.10	-0.07	0.06	0.63	0.32	1.00	
24. Parent Status at the Spawning Event (Active=1; Dissolved=0)	-0.07	-0.01	-0.05	-0.28	-0.11	0.03	0.08	0.23	0.04	0.07	-0.08	-0.04	-0.03	0.01	-0.12	0.16	-0.09	-0.11	-0.08	0.08	0.16	0.03	0.07	1.00

4.3.4. Estimation Methods

The first hypothesis in this study assesses the impact of knowledge overlap with the incumbent parent on spinoff's breadth (scope) of created knowledge. Dealing with non-negative integers, which are skewed to the left as the dependent variables in this hypothesis, I used negative binomial regression in preference to Poisson regression since the null hypothesis (likelihood-ratio alpha-test) for the equality of mean and standard deviation was rejected.

Second hypothesis relates to the survival of spinoff ventures. Since the time to failure was measured (in years) by the difference between a spinoff date of dissolution and the date of foundation, survival analysis with Log-logistic specification was chosen, since it is suitable for modeling non-monotonic survival functions (Bennett, 1983). The survival model and its hazard function can be parameterized as follow (Cleves et al., 2008):

$$S(t) = {}^{1}\!/_{1 + (\gamma t)^{p}} \qquad\qquad H(t) = \frac{\gamma p(\gamma t)^{p-1}}{1 + (\gamma t)^{p}}$$

, where γ is a constant term, and $p = {}^{1}\!/_{-\log\gamma}$.

One advantage of the log-logistic model over other specification about the hazard shape (e.g. Exponential, Gompertz or Weibull) is that the log-logistic model assumes that depending on the value of γ, the hazard shape is monotone decreasing (when $\gamma \geq 1$), or it increases and then it decreases with the time (when $\gamma < 1$).

Also, I estimated the moderating effects of spinoff founder's hierarchical position on the relation between technological and market overlap with the parent and spinoff's breadth of created knowledge and survival (hypotheses 3&4) using negative binomial regression and survival analysis, respectively.

4.4. RESULTS

Table 4.3 presents the result of negative binomial regression analysis related to the first hypothesis. The dependent variable measures spinoffs' innovativeness using the breadth (scope) of knowledge created by spinoff ventures.

'Model I' includes only the controls. The main variables of interest (technological overlap with the incumbent parent) and the squared term were added into Model II and Model III one at a time. The estimated coefficients for the variable *technological overlap* and the squared term are both statistically significant in Model III, and the positive and negative signs respectively are in conformity with hypothesis 1, suggesting an inverted U-shaped relationship between level of technological overlap and spinoff's breadth of created knowledge and number of external forward citations. In an alternative specification, I measured technological overlap between a spinoff and its parent firm by observing only the 1^{st} five patents filled by the spinoff firm and the results were robust to the main findings.

Table 4.4 presents the result of survival analysis related to hypothesis 2. 'Model I' includes only the controls. The variable *market overlap* and the squared term were included in Model II and Model III one at a time. The estimated coefficient for the linear form of *market overlap* is positive $(exp(+1.722) = 5.596)$ in Model III, while the coefficient for the squared term is negative $(exp(-2.257) = 0.105)$ and both statistically significant, suggesting the relation between level of market overlap with the incumbent parent and spinoff's survival is curvilinear, such that the likelihood of a spinoff's failure is lowest at moderate levels of market overlap.

For example, spinoffs operating in an overlapping 3rd (detailed) level application area with respect to their parent firms (i.e. *market overlap = 1)* have a 70.56% lower survival time relative to spinoff assigned to the same 2nd (intermediate) level application area, but different 3rd level segments (i.e. *market overlap = 0.66)* with respect to their parent firms.

The results also suggest that the higher the parent firm level of market diversity, the higher the survival of spinoff ventures, supporting the transfer of market related know-how from incumbent parents to the spinoff ventures.

Table 4.3: Negative Binomial Regression (H1)			
	DV: Knowledge Breadth		
	Model I	Model II	Model III
Parent-Spinoff Tech. Overlap		0.037 (0.159)	2.062*** (0.622)
Parent-Spinoff Tech. Overlap^2			-1.942*** (0.574)
Parent-Spinoff Market Overlap	0.045*** (0.009)	-0.178 (0.136)	-0.213 (0.135)
Spinoff N. Patents Filled in 3-year from Founding	-0.176 (0.136)	0.044*** (0.009)	0.040*** (0.009)
Spinoff N. Founder	-0.172* (0.097)	-0.169* (0.098)	-0.137 (0.098)
Spinoff N. Founder from the Same Parent	0.262** (0.121)	0.259** (0.122)	0.229* (0.122)
Any Founder form Academia (Yes=1; No=0)	-0.188 (0.232)	-0.193 (0.234)	-0.213 (0.234)
Serial Entrepreneur (Yes=1; No=0)	-0.036 (0.137)	-0.040 (0.138)	0.019 (0.138)
Main Founder Tenure with Parent	0.001 (0.014)	0.001 (0.014)	0.010 (0.014)
Founder Hierarchical Position (Director/Manager=1; Other=0)	0.026 (0.117)	0.027 (0.117)	0.050 (0.116)
Spinoff N. Active SICs	0.070 (0.058)	0.071 (0.058)	0.026 (0.061)
Log Parent N. Patent at Spawning Event	-0.011 (0.025)	-0.013 (0.026)	0.003 (0.027)
Parent Tech. Diversity at Spawning Event	-0.095 (0.097)	-0.102 (0.102)	-0.114 (0.101)
Parent Status at Spawning Event (Active=1; Dissolved=0)	0.104 (0.171)	0.105 (0.171)	0.152 (0.170)
Industry Segment Control	*Included*	*Included*	*Included*
Cons.	1.316*** (0.506)	1.325*** (0.508)	1.314*** (0.504)
Sample Size	101	101	101
Pseudo R2	0.1595	0.1596	0.1827
Standard errors are in parentheses. ***p < 0.01; **p < 0.05; *p < 0.10			

Table 4.4: Parametric Estimation of Survival Function with Log-logistic specification (H2)			
	DV: Spinoff Survival		
	Model I	Model II	Model III
Parent-Spinoff Market Overlap		-0.482*** (0.110)	1.722*** (0.429)
Parent-Spinoff Market Overlap^2			-2.257*** (0.426)
Parent-Spinoff Tech. Overlap	-0.148 (0.141)	-0.054 (0.097)	0.059 (0.060)
Spinoff N. Founder	0.154 (0.160)	0.156* (0.094)	0.055 (0.067)
Spinoff N. Founder from the Same Parent	-0.456** (0.220)	-0.298* (0.158)	-0.196** (0.087)
Founder Hierarchical Position (Director/Manager=1; Other=0)	0.050 (0.188)	0.026 (0.140)	0.024 (0.084)
Main Founder Tenure with Parent	0.042* (0.024)	0.039** (0.018)	0.042*** (0.013)
Serial Entrepreneur (Yes=1; No=0)	-0.020 (0.155)	0.031 (0.096)	-0.012 (0.059)
Spinoff Time to 1st Financing	0.004 (0.004)	0.006* (0.003)	0.003 (0.003)
Number of VC Rounds	-0.035 (0.024)	0.020 (0.024)	0.029* (0.018)
Number of VC Firms	-0.071* (0.038)	-0.103*** (0.030)	-0.177*** (0.037)
Total Funding	0.008 (0.006)	0.008** (0.003)	0.013*** (0.004)
Spinoff Number of Patents	0.039*** (0.014)	0.032*** (0.010)	0.034*** (0.010)
Spinoff Number of Products	0.067 (0.047)	0.110*** (0.035)	0.194*** (0.029)
Parent Market Diversity at Spawning Event	0.151 (0.254)	0.358* (0.196)	0.525*** (0.127)
Parent Status at Spawning Event (Active=1; Dissolved=0)	0.052 (0.297)	-0.243 (0.213)	-0.137 (0.131)
Industry Segment Control	*Included*	*Included*	*Included*
Cons.	2.74	2.614	2.083
/ln_gam	-2.13*** (0.212)	-2.56*** (0.236)	-3.16*** (0.254)
Sample Size	97	97	97
LR chi2	67.46***	78.86***	96.53***

Standard errors are in parentheses.
***$p < 0.01$; **$p < 0.05$; *$p < 0.10$

Table 4.5 presents the results of analysis related to hypotheses 3&4. The two hypotheses explore the moderating effect of founder's hierarchical position within the parent firm on the relation between technological and market overlap with the incumbent parent and spinoff's breadth of created knowledge and their survival. The variable *position* is a dichotomous variable, which takes a value equal to 1 for spinoff ventures founded by former senior managers or unit directors of the incumbent firms, and 0 for other employees.

Table 4.5: Moderation Tests Related to Hypotheses 3&4 (Standard errors are in parentheses. ***$p < 0.01$; **$p < 0.05$; *$p < 0.10$)

	Model I		Model II		Model II	
	D.V. = Knowledge Breadth	*D.V. = Spinoff Survival*	*D.V. = Knowledge Breadth*	*D.V. = Spinoff Survival*	*D.V. = Knowledge Breadth*	*D.V. = Spinoff Survival*
Parent-Spinoff Tech. Overlap	1.688***	-1.842**	1.592***	-1.812**	3.147***	-1.059
	(0.554)	(0.901)	(0.572)	(0.913)	(0.858)	(0.841)
Parent-Spinoff Tech. Overlap^2	-1.657***	1.773**	-1.663***	1.755**	-3.114***	1.020
	(0.521)	(0.816)	(0.522)	(0.829)	(0.780)	(0.790)
Parent-Spinoff Market Overlap	-0.926*	1.861*	-0.915*	1.777	-0.829	2.818**
	(0.530)	(1.114)	(0.530)	(1.147)	(0.535)	(1.353)
Parent-Spinoff Market Overlap^2	0.830	-2.057*	0.828	-2.034*	0.789	-2.991**
	(0.509)	(1.116)	(0.509)	(1.124)	(0.510)	(1.311)
Spinoff N. Founder	-0.214**	-0.079	-0.213**	-0.061	-0.234**	-0.098
	(0.090)	(0.162)	(0.090)	(0.174)	(0.091)	(0.160)
Spinoff N. Founder from the Same Parent	0.298***	0.184	0.300***	0.183	0.284**	0.262
	(0.114)	(0.284)	(0.114)	(0.288)	(0.114)	(0.281)
Any Founder form Academia (Yes=1; No=0)	-0.002	0.263	-0.003	0.295	-0.051	0.272
	(0.224)	(0.302)	(0.225)	(0.324)	(0.226)	(0.294)
Serial Entrepreneur (Yes=1; No=0)	0.042	-0.483**	0.047	-0.506**	0.024	-0.337
	(0.128)	(0.230)	(0.128)	(0.246)	(0.129)	(0.229)
Founder Tenure with Parent	-0.021	0.056**	-0.014	0.057**	-0.019	0.044**
	(0.094)	(0.023)	(0.094)	(0.023)	(0.093)	(0.020)
Founder Hierarchical Position (Director/Manager=1; Other=0)	-0.075	0.646***	-0.185	0.607**	0.100	0.556***
	(0.108)	(0.210)	(0.199)	(0.242)	(0.236)	(0.213)
Parent-Spinoff Tech. Overlap × Founder Position			0.161		-2.537**	
			(0.245)		(1.122)	
Parent-Spinoff Tech. Overlap^2 × Founder Position					2.541***	
					(1.026)	
Parent-Spinoff Market Overlap × Founder Position				0.121		-3.204*
				(0.361)		(1.924)
Parent-Spinoff Market Overlap^2 × Founder Position						3.317*
						(1.904)
Spinoff N. Patents Filled in 3-year from Founding	0.048***		0.048***		0.047***	
	(0.008)		(0.008)		(0.008)	
Spinoff Total N. Patents		0.040***		0.039***		0.032**
		(0.014)		(0.014)		(0.013)
Spinoff N. Active SICs	0.052		0.048		0.054	
	(0.056)		(0.057)		(0.057)	
Log N. Parent Patents at Spawning Event	-0.011		-0.009		-0.003	
	(0.024)		(0.024)		(0.024)	
Parent Tech. Diversity at Spawning Event	0.065	0.091	0.068	0.093	0.086	0.065
	(0.094)	(0.157)	(0.094)	(0.155)	(0.093)	(0.143)
Parent Status at Spawning Event (Active=1; Dissolved=0)	0.240	0.001	0.238	0.018	0.218	0.133
	(0.148)	(0.243)	(0.147)	(0.247)	(0.147)	(0.232)
Spinoff Time to 1st Financing		0.007		0.007		0.007*
		(0.004)		(0.004)		(0.004)
Number of VC Rounds		0.063		0.067		0.043
		(0.045)		(0.049)		(0.045)
Number of VC Firms		-0.134***		-0.129**		-0.086*
		(0.050)		(0.051)		(0.046)
Total Funding		0.018**		0.017*		0.014
		(0.009)		(0.010)		(0.008)
Cons.	1.010***	1.963***	1.057***	1.916***	0.887***	1.698***
	(0.259)	(0.442)	(0.267)	(0.468)	(0.283)	(0.464)
Sample Size	101	100	101	100	101	100
Pseudo R2/LR chi2	0.1378***	48.68***	0.1387***	48.80***	0.1515***	51.22***

‘Model I’ includes the corresponding main explanatory variable (*technological overlap* in H1 and *market overlap* in H2), the squared term, and all the controls. The interactions between the moderator and the linear term and the moderator and the squared term were included in Model II and Model III in a hierarchical order. The estimated coefficients for the linear interactions between founder’s *hierarchical position* and *technological overlap* in hypothesis 3, and founder’s *hierarchical position* and *market overlap* in hypothesis 4 were both statistically significant with expected negative signs (-2.537 for $Position \times Tech.Overlap$, and -3.204 for $Position \times Market\,Overlap$). Also, the estimated coefficients for the interactions between the two moderators and the squared terms (2.541 for $Position \times Tech.Overlap^2$, and 3.317 for $Position \times Market\,Overlap^2$) were positive and significant, supporting hypotheses 3 and 4. To facilitate the interpretation of these numbers and the results of analyses related to H1&H2, Figures 4.4 & 4.5 display the predicted breadth of knowledge and spinoffs survival by level of technological and market overlap with the incumbent parent, and founders’ hierarchical position within the parent firm, respectively.

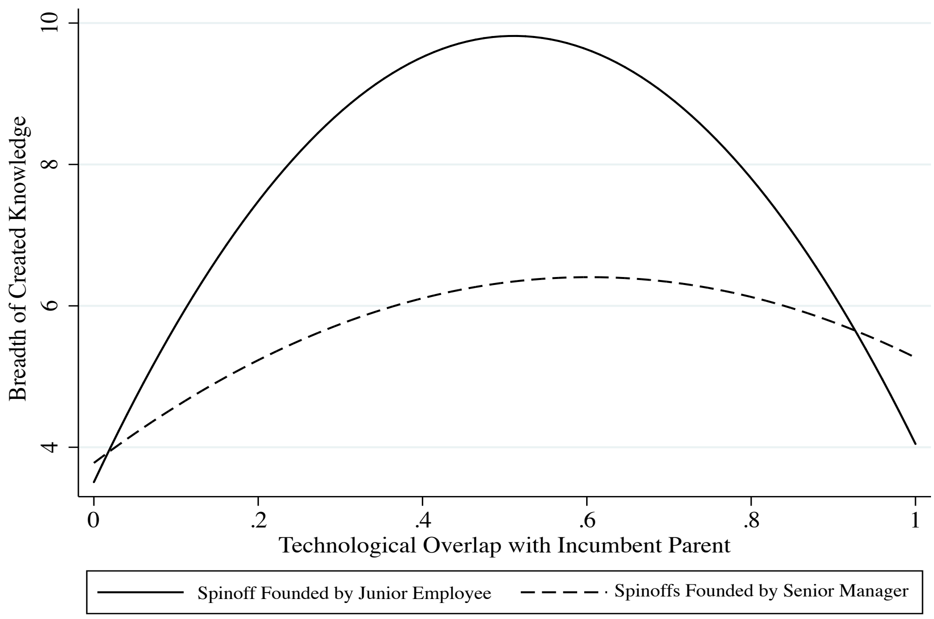


Figure 4.4: Predicted breadth of spinoffs’ knowledge by technological overlap

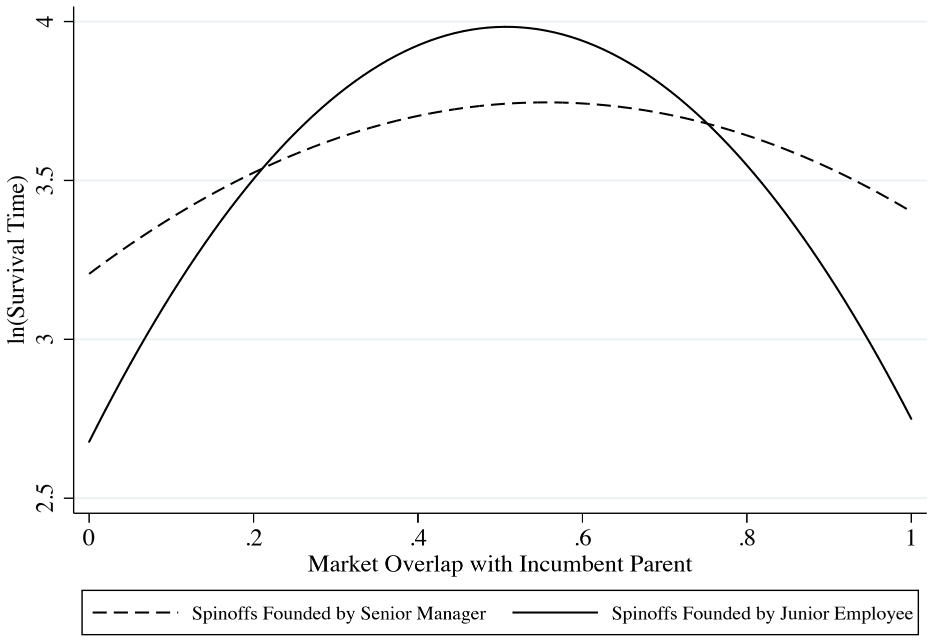


Figure 4.5: Predicted spinoffs' survival by market overlap

4.5. ROBUSTNESS TEST

In studying the impact of technological overlap with the incumbent parent on spinoffs' innovativeness in hypothesis 1, I measured the breadth (scope) of knowledge created by a spinoff venture as a proxy of spinoffs' innovative performance. Though, forward citations (i.e. number of citations that a patent receives in subsequent patents) is another proxy for the economic value and technological importance of an invention claimed in a patent (Trajtenberg, 1990; Lerner, 1994; Harhoff et al. 1999; Hall, Jaffe, and Trajtenberg, 2005). In fact, in a study of the effect of knowledge available from parent firms on creation of impactful knowledge by spinoff ventures, Basu et al. (2015) used the number of external forward citations as a measure of spinoffs' knowledge impact.

Following previous studies, I measured a spinoff's innovative performance using the number of forward citations of a spinoff's patents filed to WIPO in 3-year window from its date of foundation (Basu et al., 2015; Yayavaram & Ahuja, 2008). Further, to reduce a source of heterogeneity and allocate the exact same time for dissemination of a spinoff's created knowledge into knowledge base of other firms, I recorded forward citations of a given patent over 3year period from the date of application (Basu et al., 2015). That is, for a spinoff venture founded in year 2002, I observed the total number of patents filed until 2005, and then I recorded the number of forward citations of each patent for another 3 year after the patent date of application. I excluded self-citation, i.e. forward citations by patents assigned to the same spinoff venture. Table 4.6 presents the results of negative binomial regression related to hypothesis 1, in which the dependent variable was measured using the number of forward citations received by spinoffs patents. The estimated coefficients for the effects of Tech. overlap with the parent and the squared term on spinoffs patent citation are in line with the main findings and the positive and negative signs, respectively, support the first hypothesis.

Table 4.6: Negative Binomial Regression (H1) (Standard errors are in parentheses. ***$p < 0.01$; **$p < 0.05$; *$p < 0.10$)

	DV: Patent Citation		
	Model I	Model II	Model III
Parent-Spinoff Tech. Overlap		0.098 (0.696)	3.736* (2.225)
Parent-Spinoff Tech. Overlap^2			-3.381* (1.988)
Spinoff N. Patents Filled in 3-year from Founding	0.241*** (0.043)	0.239*** (0.046)	0.213*** (0.044)
Spinoff N. Founder	-0.314 (0.325)	-0.302 (0.335)	-0.206 (0.332)
Spinoff N. Founder from the Same Parent	0.190 (0.447)	0.170 (0.470)	-0.094 (0.472)
Any Founder form Academia (Yes=1; No=0)	0.489 (0.682)	0.482 (0.683)	0.484 (0.657)
Serial Entrepreneur (Yes=1; No=0)	0.406 (0.466)	0.427 (0.490)	0.384 (0.471)
Main Founder Tenure with Parent	-0.177*** (0.053)	-0.178*** (0.054)	-0.150*** (0.054)
Founder Hierarchical Position (Director/Manager=1; Other=0)	-0.296 (0.410)	-0.307 (0.419)	-0.236 (0.408)
Spinoff N. Active SICs	0.381 (0.242)	0.385 (0.246)	0.292 (0.231)
Log Parent N. Patent at Spawning Event	0.089 (0.077)	0.085 (0.081)	0.102 (0.077)
Parent Tech. Diversity at Spawning Event	0.590* (0.318)	0.566 (0.363)	0.430 (0.359)
Parent Status at Spawning Event (Active=1; Dissolved=0)	-0.110 (0.612)	-0.107 (0.611)	-0.161 (0.590)
Industry Segment Control	*Included*	*Included*	*Included*
Cons.	1.932	1.992	2.498
Sample Size	101	101	101
Pseudo R2	0.1123	0.1123	0.1171

In addition, to estimate the effect of level of market overlap with the incumbent parent on spinoff's survival in hypothesis 2, I employed survival analysis with Log-logistic specification. Although the Log-logistic parameterization of survival function allows for both monotone decreasing or non-monotone survival shape, one may argue that semi-parametric models of survival analysis are superior to parametric estimations since they make no assumptions about the distribution of failure times, allowing the covariates to shift the baseline hazard function. Table 4.7 presents the results of analysis using cox proportional hazard model (Mata and Portugal, 1994; Audretsch & Mahmood, 1995). The estimated coefficients for the effects of market overlap with the parent firm and the squared term on spinoffs hazard rate are in line with the main findings and the negative and positive signs support the second hypothesis.

Table 4.7: Cox Proportional Hazard Model (H2)

	DV: Log Hazard Ratio		
	Model I	Model II	Model III
Parent-Spinoff Market Overlap		0.602 (0.466)	-4.112* (2.383)
Parent-Spinoff Market Overlap^2			4.622** (2.313)
Spinoff N. Founder	-0.776* (0.456)	-0.847* (0.449)	-0.882** (0.443)
Spinoff N. Founder from the Same Parent	1.263** (0.637)	1.430** (0.651)	1.569** (0.701)
Founder Hierarchical Position (Director/Manager=1; Other=0)	-0.235 (0.404)	-0.169 (0.418)	-0.405 (0.434)
Main Founder Tenure with Parent	-0.101* (0.052)	-0.101** (0.050)	-0.107** (0.051)
Any Founder From Academia (Yes=1; No=0)	0.642 (0.803)	0.675 (0.804)	0.801 (0.828)
Serial Entrepreneur (Yes=1; No=0)	-0.475 (0.581)	-0.482 (0.577)	-0.623 (0.590)
Spinoff Time to 1st Financing	-0.020*** (0.008)	-0.024*** (0.009)	-0.028*** (0.009)
Total Funding	-0.014 (0.009)	-0.014 (0.009)	-0.012 (0.009)
Log Spinoff Number of Patents	-0.410** (0.209)	-0.454** (0.214)	-0.560** (0.234)
Parent N. Primary & Secondary SICs	-0.389** (0.194)	-0.392** (0.197)	-0.406** (0.195)
Parent Tech. Diversity at Spawning Event	0.393 (0.268)	0.385 (0.270)	0.519* (0.278)
Parent Market Diversity at Spawning Event	-0.235 (0.664)	-0.219 (0.651)	-0.070 (0.665)
Industry Segment Control	*Included*	*Included*	*Included*
Sample Size	104	104	104
LR chi2	57.74***	59.41***	63.89***

Standard errors are in parentheses.
***$p < 0.01$; **$p < 0.05$; *$p < 0.10$

For newly founded ventures, a critical factor to success is to obtain financial resources (Hsu, 2004; Chatterji, 2009). In contrast to nascent entrepreneurs who face some difficulties in raising capital for their newly founded ventures, prior employment in the industry incumbents provides opportunity for spinoffs founders to accumulate social capital, build a network of relation with investors, and ultimately acquire financial resources for their own ventures. Affiliation to incumbent firms also spreads positive signal about the quality of spinoff ventures and diminishes uncertainties faced by external investors in financing the newly founded ventures, which have not yet proven their credibility in the market (Stuart et al., 1999; Chatterji, 2009). For example, in a study of young biotech firms, Higgins & Gulati (2003) demonstrate that new ventures signal their credibility through connections with scientists, hiring industry experienced managers, or linking to the incumbent pharmaceutical companies. In study of Silicon Valley start-ups, Burton et al. (2002) find that spawns from prominent parent firms obtain external financing more quickly. Similarly, in study of Medical Device industry, Chatterji (2009) finds that entrepreneurial ventures spawned by industry incumbents are funded more quickly than other entrants including serial entrepreneurs.

In the previous sections, I hypothesized and tested how the level of technological and market overlap with the incumbent parent affects a spinoff's innovativeness and survival. I claimed that while a moderate level of knowledge relatedness is beneficial for spinoff ventures, too little and too much technological and market overlap both may hinder breadth of knowledge created by spinoffs as well as their survival. In addition to creation of breakthrough knowledge and survival, what is the impact of knowledge relatedness with the incumbent parent and spinoff's ability to obtain external financing?

One can think of this relation in two ways. On one hand, technological and market overlap with the parent firms may increase external investors' confidence in financing the spinoff ventures, given spinoff's access to the knowledge available from the parent firms. On the other hand, as argued in the previous section, a high market overlap may spark the incumbent parent's hostile reaction toward competing spinoff, diminish external investor confidence in financing the new venture, and hinder the spinoff ability to secure external funding until the spinoff establishes its legitimacy.

Table 4.8 presents the results of analysis on the impact of between technological and market overlap with the incumbent parents on (1) spinoffs' time to the 1st financing, and (2) spinoffs' total funding. Controlling for the founding team (e.g. *number of founders, number of founders from the same parent, founders' position and status with the parent, serial entrepreneur and if from academia*) and the incumbent parent (e.g. *number of patents, technological and market diversity, and status*) characteristics, 'Model I' includes both *tech. overlap*, and *market overlap* variables. The results of negative binomial regression demonstrate a negative effect of technological overlap on spinoffs' time to obtain financing, suggesting that spinoffs active in the similar technological fields as the incumbent parents obtain funding more quickly than spinoffs developing new technologies different from their parent firms. This finding is in line with the view in which technological knowledge overlap with the incumbent parent spreads the positive signal about the quality of knowledge available within the spinoff venture and thus, reduces uncertainty and investment risk faced by external investors.

Contrarily, high market overlap with the incumbent parent was found to defer spinoff 1st financing, while increase the total amount of funding. This result supports the argument in which a high degree of market overlaps with the parent firm and plausible parent hostile reaction toward spinoff competing in the same market increases the investment risk, diminishes external investor confidence in financing the new venture, and hinders time to obtain funding until the point in which spinoff establishes its legitimate identity. The squared terms were included in Model II. No significant effect was found for the variable *technological overlap* with incumbent parent and the two dependent variables. However, the positive coefficient for the market overlap and the negative coefficient of the squared term suggest an inverse U-shape relation between the level of market overlap with the parent and spinoffs' time to 1st financing and total funding.

Table 4.8: Spinoffs' Financing

	Model I		Model II	
	D.V. = Time to 1st Financing	*D.V. = Total Funding*	*D.V. = Time to 1st Financing*	*D.V. = Total Funding*
Parent-Spinoff Tech. Overlap	-0.655** (0.315)	0.630 (0.399)	0.516 (1.248)	0.429 (1.675)
Parent-Spinoff Tech. Overlap^2			-1.173 (1.168)	0.216 (1.585)
Parent-Spinoff Market Overlap	0.640** (0.264)	0.636* (0.330)	2.954** (1.265)	3.908*** (1.313)
Parent-Spinoff Market Overlap^2			-2.190* (1.168)	-3.091** (1.198)
Spinoff N. Founder	-0.596*** (0.201)	0.112 (0.227)	-0.658*** (0.198)	0.051 (0.213)
Spinoff N. Founder from the Same Parent	-0.001 (0.243)	0.302 (0.301)	0.030 (0.243)	0.333 (0.305)
Any Founder form Academia (Yes=1; No=0)	0.246 (0.422)	1.496*** (0.451)	0.379 (0.420)	1.587*** (0.445)
Serial Entrepreneur (Yes=1; No=0)	0.656*** (0.231)	-0.412 (0.316)	0.743*** (0.231)	-0.372 (0.310)
Founder Tenure with Parent	-0.070** (0.031)	0.115*** (0.039)	-0.064* (0.033)	0.110*** (0.041)
Founder Hierarchical Position (Director/ Manager=1; Other=0)	0.597 (0.372)	0.029 (0.391)	0.645* (0.379)	0.121 (0.414)
Spinoff N. Patents	-0.010 (0.008)	0.041 (0.009)	-0.013 (0.008)	0.039*** (0.009)
Log N. Parent Patent at Spawning Event	0.322*** (0.074)	-0.155* (0.088)	0.310*** (0.072)	-0.170** (0.086)
Parent Tech. Diversity at Spawning Event	-0.278 (0.212)	0.283 (0.252)	-0.280 (0.207)	0.193 (0.247)
Parent Market Diversity at Spawning Event	-1.607*** (0.360)	1.049** (0.485)	-1.753*** (0.382)	0.924* (0.501)
Parent Status at Spawning Event (Active=1; Dissolved=0)	0.589* (0.316)	-1.027*** (0.328)	0.609** (0.308)	-0.963*** (0.323)
Founding Year Control	*Included*	*Included*	*Included*	*Included*
Industry Segment Control	*Included*	*Included*	*Included*	*Included*
Cons.	4.837***	-5.967**	5.236***	-5.573**
Sample Size	103	93	103	93
LR chi2	100.02***	117.84***	104.4***	124.54***

Standard errors are in parentheses.
***$p < 0.01$; **$p < 0.05$; *$p < 0.10$

4.6. DISCUSSIONS AND CONCLUSION

Previous studies on firms' performance heterogeneity have demonstrated that historical origins affect new firms' early resources and their subsequent performance (Burton et al., 2002; Helfat and liberman, 2002; Shane and Stuart, 2002). As pointed by Huber (1991), this is due to the fact that "*what an organization knows at its birth will determine what it searches for, what it experiences, and how it interprets what it encounters*" (p. 91). Specifically, in the context of spinoffs, extant literature has highlighted the role of founders as conduit of organizational routines, technological expertise, and market related know-how from incumbent parents to the spinoff ventures.

In this paper, I examine the impact of knowledge overlap with the incumbent parent on spinoff's innovativeness and survival. More specifically, I examined the relationships between level of (a) technological and (b) market overlap with the incumbent parents and spinoffs' (a') innovativeness and (b') likelihood of survival.

Using a sample of 131 spinoffs from the biotech sector, I found that the degree to which spinoffs' technological and market knowledge overlap with the incumbent parent has a positive but declining effect on spinoffs performance. That is, while some level of knowledge relatedness with the incumbent parents is pleasant to spinoff ventures, too little and too much of this good thing both hamper creation of breakthrough knowledge and spinoffs' survival. The former is because limited knowledge relatedness hampers spinoffs ability to alleviate technological and market uncertainties by using familiar knowledge available from the incumbent parent firms. The latter is because extensive knowledge relatedness hinders combination of existing knowledge with unfamiliar knowledge available from external sources and it may evoke parent hostile reaction as a result of direct competition between the two ventures. Further, I found that founders' hierarchical position within the incumbent parents moderates the relationship between level of knowledge relatedness and spinoffs performance, given that the amount of knowledge and resources accessed and leveraged by spinoff founders is a function of their previous position within the industry incumbents.

The main part of this research was devoted to the impact of knowledge relatedness with the incumbent parent on spinoff' performance - i.e. creation of breakthrough knowledge and likelihood of survival. Besides that, I also examined the effects of technological and market overlap with the incumbent parents on spinoffs' ability to obtain external financing. I find that spinoffs, which maintain a high degree of technological overlap with the incumbent parents spread a positive signal about the quality of their knowledge and as for that they obtain funding more quickly than spinoffs spawning to a different technological field. In contrast, I find that the extent to which spinoffs' operating markets overlap with the incumbent parents has a positive effect on spinoffs' time to the first financing. This is due to the fact that since parent hostile reaction against competing spinoff increases investment risk, diminishes external investor confidence in financing the new venture, and defers spinoff time to obtain funding.

Overall, the results of my analysis complement earlier studies on the association between genealogical lineage and knowledge relatedness with the parents and spinoffs performance (Agarwal et al. 2004; Franco and Filson, 2006; Chatterji, 2009). Thus, this study responds to the call by Agarwal et al. (2010), where the authors ask for further research on consequences of knowledge spillovers on subsequent recipient organization performance (Q4; P.277).

In addition to adding to the current literature, the result of this study has important managerial implications for spinoff ventures. Early after spawning, spinoffs founders face a decision about the extent to which draw on (or abandon) elements of knowledge inherited from their parent organizations to formulate their ventures early resources, capabilities and development path. In this research, I hypothesized and demonstrated that while remaining on the same technological fields and/or market domains similar to the incumbent parents provides a comparative advantage to spinoffs not available to other de novo entrants, it may trap spinoffs on the local search and excessive focus on familiar knowledge (March, 1991; Levinthal and March, 1993; Ahuja and Lampert, 2001; McGrath, 2001) and it may expose them to the risk of direct competition with their parent firms. As for that, spinoffs founders need to find a right balance between less technological/market uncertainties and more organizational inertia and higher risk of a hostile reaction the incumbent parent.

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5. APPENDICES

Proposed Classification for Biotechnology Applications (Source: A Framework for Biotechnology Statistics. OECD, 2005)		
Broad	*Intermediate*	*Detailed*
Human Health	Large molecule therapeutics and monoclonal antibodies (MABs) produced using rDNA technology	-
	Other therapeutics, artificial substrates, diagnostics and drug delivery technologies, etc.	Other therapeutics, drug delivery technologies, etc.
		Substrates (artificial bone, skin etc.)
		Diagnostics
Veterinary health	As above, for veterinary uses	As above
Agriculture	New varieties of genetically modified (GM) plants, animals, and micro- organisms for use in agriculture, aquaculture, and silviculture	GM plants, including fruit trees, flowers, horticultural crops, grains, etc.
		GM animals for agriculture
		GM fish
		GM tree varieties for forestry
		GM micro-organisms for agriculture (including bio pest control)
	New varieties of non-GM plants, animals, and micro-organisms for use in agriculture, aquaculture, silviculture, bio pest control and diagnostics **developed using biotechnology techniques** (DNA markers, tissue culture, etc.)	Non-GM plants, including fruit trees, flowers, horticultural crops, grains, etc.
		Non-GM animals for agriculture
		Non-GM fish
		Non-GM tree varieties for forestry
		Non-GM micro-organisms for agriculture (including bio pest control)
		Diagnostics
Natural resources	Applications for mining, petroleum/energy extraction, etc.	Mining: extraction using micro-organisms, etc.
		Petroleum/energy: extraction using micro-organisms
		Other resource applications
Environment	Diagnostics, soil bioremediation, treatment of water, air, and industrial effluents using micro-organisms, clean production processes	Diagnostics
		Soil bioremediation, including phytoremediation
		Effluent treatment
		Clean production processes
Industrial processing	Bioreactors to produce new products (chemicals, food, ethanol, plastics, etc.), biotechnologies to transform inputs (bioleaching, biopulping, etc.)	Detailed list of specific biotechnologies that are relevant to the firm's sector of activity3
Non-specific applications/Others	Research tools, etc.	-

Provisional Definition of Biotechnology Patents (Source: A Framework for Biotechnology Statistics. OECD, 2005)	
IPC codes	Description of Technological Class
A01H 1/00	Processes for modifying genotypes
A01H 4/00	Plant reproduction by tissue culture techniques
A61K 38/00	Medicinal preparations containing peptides
A61K 39/00	Medicinal preparations containing antigens or antibodies
A61K 48/00	Medicinal preparations containing genetic material which is inserted into cells of the living body to treat genetic diseases; Gene therapy
C02F 3/34	Biological treatment of water, waste water, or sewage: characterized by the micro-organisms used
C07G 11/00	Compounds of unknown constitution: antibiotics
C07G 13/00	Compounds of unknown constitution: vitamins
C07G 15/00	Compounds of unknown constitution: hormones
C07K 4/00	Peptides having up to 20 amino acids in an undefined or only partially defined sequence; Derivatives thereof
C07K 14/00	Peptides having more than 20 amino acids; Gastrins; Somatostatins; Melanotropins; Derivatives thereof
C07K 16/00	Immunoglobulins, *e.g.* monoclonal or polyclonal antibodies
C07K 17/00	Carrier-bound or immobilized peptides; Preparation thereof
C07K 19/00	Hybrid peptides
C12M	Apparatus for enzymology or microbiology
C12N	Micro-organisms or enzymes; compositions thereof
C12P	Fermentation or enzyme-using processes to synthesize a desired chemical compound or composition or to separate optical isomers from a racemic mixture
C12Q	Measuring or testing processes involving enzymes or micro-organisms; compositions or test papers therefor; processes of preparing such compositions; condition-responsive control in microbiological or enzymological processes
C12S	Processes using enzymes or micro-organisms to liberate, separate or purify a pre-existing compound or composition processes using enzymes or micro-organisms to treat textiles or to clean solid surfaces of materials
G01N 27/327	Investigating or analyzing materials by the use of electric, electro-chemical, or magnetic means: biochemical electrodes
G01N 33/53*	Investigating or analyzing materials by specific methods not covered by the preceding groups: immunoassay; biospecific binding assay; materials therefore
G01N 33/54*	Investigating or analyzing materials by specific methods not covered by the preceding groups: double or second antibody: with steric inhibition or signal modification: with an insoluble carrier for immobilising immunochemicals: the carrier being organic: synthetic resin: as water suspendable particles: with antigen or antibody attached to the carrier via a bridging agent: Carbohydrates: with antigen or antibody entrapped within the carrier
G01N 33/55*	Investigating or analyzing materials by specific methods not covered by the preceding groups: the carrier being inorganic: Glass or silica: Metal or metal coated: the carrier being a biological cell or cell fragment: Red blood cell: Fixed or stabilized red blood cell: using kinetic measurement: using diffusion or migration of antigen or antibody: through a gel
G01N 33/57*	Investigating or analyzing materials by specific methods not covered by the preceding groups: for venereal disease: for enzymes or isoenzymes: for cancer: for hepatitis: involving monoclonal antibodies: involving limulus lysate
G01N 33/68	Investigating or analyzing materials by specific methods not covered by the preceding groups: involving proteins, peptides or amino acids
G01N 33/74	Investigating or analyzing materials by specific methods not covered by the preceding groups: involving hormones
G01N 33/76	Investigating or analyzing materials by specific methods not covered by the preceding groups: human chorionic gonadotropin
G01N 33/78	Investigating or analyzing materials by specific methods not covered by the preceding groups: thyroid gland hormones
G01N 33/88	Investigating or analyzing materials by specific methods not covered by the preceding groups: involving prostaglandins
G01N 33/92	Investigating or analyzing materials by specific methods not covered by the preceding groups: involving lipids, *e.g.* cholesterol
* Those IPC codes also include subgroups up to one digit (0 or 1 digit). For example, in addition to the code G01N 33/53, the codes G01N 33/531, GO1N 33/532, etc. are included.	

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