Essays on the Creation and Development of Organizations

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M.Sc. Caren Klingbeil
aus
Dortmund

Referent: Prof. Dr. Thorsten Semrau
Korreferent: Prof. Dr. Detlef Buschfeld
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1 Introduction

This thesis adopts a stage perspective and seeks to expand our knowledge on the creation and development of organizations. The purpose of this first chapter is to integrate the studies included in this thesis, which will be presented in the following three chapters, into a wider research picture and to introduce the specific research questions that will be addressed by those studies.

The study presented in Chapter 2 is authored by me and coauthored by Thorsten Semrau and Mark Ebers. The data collection and analysis of this study were solely conducted by me, and the manuscript was prepared by all three authors. This study was presented at international conferences such as the 30th European Group of Organizational Studies Colloquium 2014 in Rotterdam, Netherlands and the 75th Annual Meeting of the Academy of Management 2015 in Vancouver, Canada. A previous version was also published in the *Academy of Management Proceedings* (Vol. 2015, No. 1). Currently, the paper is in the revise and resubmit status with the *Journal of Management Studies.*

The study presented in Chapter 3 is authored by me and coauthored by Thorsten Semrau. Both authors contributed to the data collection and preparation of the manuscript, and all analyses were solely performed by me. It was accepted for presentation at the 20th Annual Interdisciplinary Conference on Entrepreneurship and Innovation and SMEs (G-Forum) 2016 in Leipzig, Germany and is currently in the second round of peer review at the *Industry and Innovation* journal.

The last study, which is presented in Chapter 4, is a single-author paper and prepared for submission to *Research Policy*. Guidance and comments were provided by Thorsten Semrau.

1.1 The Creation and Development of Organizations – A Stage Perspective

The creation and development of organizations can be divided into stages (Moroz & Hindle, 2012). Each stage encompasses certain activities, processes and outcomes, which are influenced and shaped by various factors (Baron, 2014; Shane, 2003). Building on research by Frese (2009) and Baron (2014), for the purpose of this thesis the formation and development of a new venture into an established organization is divided into four stages: *Pre-launch, Launch, New Venture and Established Organization*. The characteristics of each stage as well as exemplary factors that may affect the stages' activities, processes and outcomes are presented in the following.

Major Stages

Stage 1. – Pre-Launch. The *pre-launch stage* encompasses the process of opportunity recognition and evaluation (Ardichvili, Cardozo, & Ray, 2003; Baron, 2006; Keh, Foo, & Lim, 2002) as well as the formation of entrepreneurial intentions by potential founders (Krueger, Reilly, & Carsrud, 2000; Thompson, 2009). The recognition of a business opportunity as well as the decision to start a business may both constitute the beginning of the pre-launch stage (Hills & Singh, 2004). However, whether it is the detection or development of an idea or the decision to found an organization that happens first, at the end of this stage the future entrepreneurs have discovered problems to solve or needs to fulfill and have decided to engage in an entrepreneurial endeavor.

Stage 2. – Launch. The *launch stage* begins when the founding individuals proceed from thinking about starting a new organization to engaging in activities that are directed at reaching the objective of founding (Hoang & Antoncic, 2003). Thus, this stage encompasses all activities and efforts to assemble the resources necessary to actually start

a new venture (Baron & Shane, 2008; Hoang & Antoncic, 2003), such as organizing a founding team, consulting with attorneys, applying for copyright, patent or trademark or preparing a business plan (Carter, Gartner, & Reynolds, 1996; Reynolds & Miller, 1992; Van Auken & Neeley, 2000). The birth of the new venture constitutes the end of this stage and the start of the next one.

Stage 3. – New Venture. At this stage, the newly founded venture faces unique challenges and difficulties (Bøllingtoft & Ulhøi, 2005). For instance, unlike established organizations, due to their small size, new ventures typically are resource-poor (Carroll, 1983) in terms of physical (e.g., products, components), technological (e.g., research and development knowledge), financial (capital) and intangible (e.g., specialized knowledge) resources (Aldrich, 1999; Hoang & Antoncic, 2003). Because of challenges such as resource deficits, a positive development of newly founded ventures is not the norm. Most businesses start small, live small and die small or young, and thus never embark a significant growth trajectory (Aldrich, 1999; Reynolds & White, 1997). Accordingly, this stage encompasses new venture's activities that are directed at achieving organizational growth and survival. Those ventures that grow large and prosper well enter Stage 4.

Stage 4. – Established Organization. As an organization moves into the *established organization stage*, it begins to seek long-term survival and success (Gilbert, McDougall, & Audretsch, 2006). Scholars have argued that in order to reach that goal, organizations need to constantly adapt to the changing environmental conditions and expectations (Dodgson, 1993; Williams, 1992). Especially in dynamic environments, long-term success cannot be achieved by only doing more of the same or tinkering with the familiar (Ahuja & Morris Lampert, 2001). Thus, this stage encompasses organizational processes and activities such as incremental learning (Argote & Miron-Spektor, 2011) or conducting radical innovation projects (Tushman, 1997) that are associated with adaption

and change and, thus, long-term success. At the end of this stage, organizational decline begins to take place; however, some organizations will not reach their end for decades.

Antecedents

Many researchers have devoted their efforts toward analyzing how a multitude of factors may affect the processes, activities and outcomes of the stages outlined above (Baron, 2014; Shane, 2003). Most scholars have primarily focused on factors that belong to one of the following three groups: a) *individual factors* – factors relating to characteristics of the potential or actual founder(s) or the top management team (TMT); b) *organizational factors* – factors at the level of the organization, which is or was created; and c) *environmental factors* – factors relating to the surroundings of the founder(s) or the created organization.

With regard to the first group, *individual factors*, research has explored the impact of the entrepreneurs' personality, background and experiences. There are, for example, several studies providing evidence for the notion that work experience, entrepreneurial experience, and years of education foster new venture survival and growth (Brüderl, Preisendörfer, & Ziegler, 1992; Colombo & Grilli, 2005). Moreover, research on TMTs has revealed that TMT education has an impact on strategic change in organizations (Wiersema & Bantel, 1992).

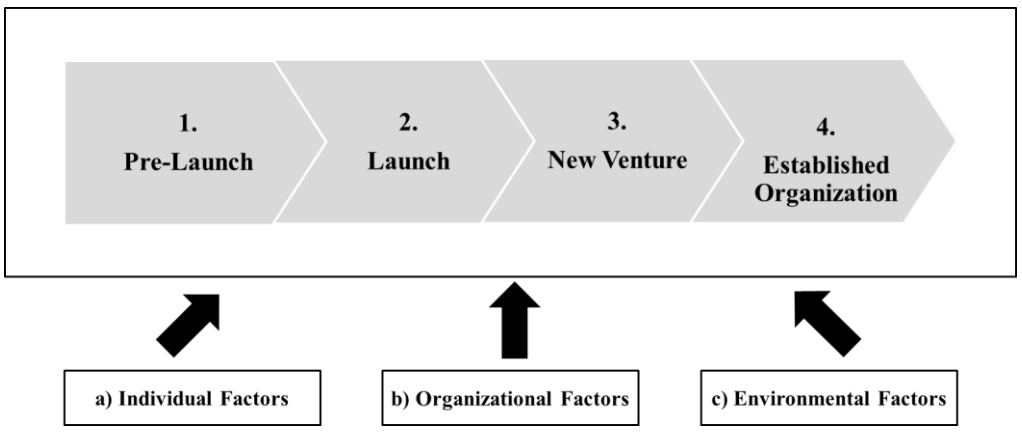
Scholars have also examined how certain *organizational factors* such as the type of venture, strategic focus or organizational structures affect venture creation and organizational development. Liao and Welsch (2008), for example, found that the venture creation processes of nascent entrepreneurs setting up either a technology-based or a non-technology-based venture differ significantly, and that it takes considerably longer to set up a technology-based business. In the field of new ventures, Chandler and Hanks (1994)

showed that strategic differences, such as differentiation on quality versus cost leadership, influence the performance of new ventures. Also, research by Cannon and Edmondson (2005) points to the importance of organizational values with regard to organizational learning from failures for improved subsequent performance.

Acknowledging that the creation and development of organizations does not take place in isolation, researchers have also examined how *environmental factors* impact pre-launch processes and organizational development. Mueller (2006), for example, has shown that the regional entrepreneurial environments in Germany have a significant impact on the decision of individuals to start a business. Research has also revealed that the contexts within research organizations shape scientists' entrepreneurial intentions and behaviour (e.g. Di Gregorio & Shane, 2003; Haeussler & Colyvas, 2011). In the field of new ventures, for example, the technology transfer office at a university that supports the founding process has been shown to positively impact the formation of spin-off companies (Lockett, Siegel, Wright, & Ensley, 2005; Slavtchev & Göktepe-Hultén, 2016). In a similar vein, research has revealed that business incubators influence the development of new ventures (Colombo & Delmastro, 2002; Schwartz, 2011).

Figure 1.1 illustrates the stages and antecedents of organization creation and development.

Figure 1.1: Stages and Antecedents of the Creation and Development of Organizations



1.2 Prior Research and Thesis Outline

This thesis as a whole seeks to expand our knowledge on the creation and development of organizations. However, each one of the studies, which will be presented in the following three chapters, addresses specific research questions and thus especially contributes to a certain field of research.

The study presented in **Chapter 2** addresses how characteristics of the context within research organizations impact the inclinations of researchers to engage in founding activities. Therefore, this study belongs to the field of research examining how *environmental factors* (c) impact activities and processes that are characteristic of the *pre-launch stage* (Stage 1.).

The founding activity of researchers is of particular interest, as it represents an important channel for the commercialization of scientific knowledge, and thus significantly contributes to societies' economic and social welfare (Di Gregorio & Shane, 2003; Feldman, 2003; Nicolaou & Birley, 2003; Pérez Pérez & Sánchez, 2003; Roberts & Malonet, 1996; Shane, 2004). The field of research examining how characteristics of the context within research organizations such as organizational policies and values or the supervisor and work peers impact researchers' entrepreneurial intentions and behavior has grown strongly over the last decade (e.g. Di Gregorio & Shane, 2003; Haeussler & Colyvas, 2011; Huyghe & Knockaert, 2015; Krabel & Schacht, 2014).

One organizational-level factor that has received much attention in the literature so far are the organizations' policies, procedures and incentives that should motivate organizational members to establish a start-up company. Di Gregorio and Shane (2003), for example, found that the university's willingness to take an equity stake in future start-ups in exchange for paying patenting, marketing or other up-front costs facilitate the formation of start-up companies. They, as well as Markman, Phan, Balkin, and Gianiodis

(2005), also provided empirical evidence for the notion that maintaining a low inventor share of royalties may increase new firm formation activity. Di Gregorio and Shane (2003) attributed this effect to the higher opportunity costs associated with founding a new venture relative to licensing the new technology to an existing organization. Recent research by Muscio, Quaglione, and Ramaciotti (2016) found that the availability of entrepreneurial support in the form of guidelines for business plan preparations and the existence of a minimum limit on university staff participation in spin-off capital positively influence start-up activity. They argue, that a minimum limit on participation in spin-off capital forces potential founders to make a stronger commitment, but also serves as a monetary incentive. Finally, Huyghe and Knockaert (2015) showed that an explicit reward for academic entrepreneurship offered by the university also fosters spin-off creation due to its positive impact on academics' entrepreneurial intentions.

Scholars also have studied if technology transfer offices at research organizations (Lockett & Wright, 2005; Siegel, Waldman, & Link, 2003) drive scientist entrepreneurial activity. TTOs manage patenting, licensing and consulting activities, contract research and support the spin-off creation process of the organization' members (Huyghe, Knockaert, Piva, & Wright, 2016). A more recent study by Fini, Fu, Mathisen, Rasmussen, and Wright (2016), for example, revealed that the establishment of a TTO at the university level has a positive effect on the number of spin-offs created. However, they also noted that the quality of these ventures decreased compared to universities without a TTO. Additionally, Clarysse, Tartari, and Salter (2011) found earlier that the existence of TTOs to play only a marginal role in inspiring academics to engage in an entrepreneurial endeavor.

Moreover, a few studies pointed out that besides organizational policies or tangible organizational units such as the TTO, prevailing organizational norms and values

may act as important drivers of spin-off creation (Clark, 2001; O'Shea, Allen, Morse, O'Gorman, & Roche, 2007). O'Shea et al. (2007), for example, argued that cultural norms supportive of commercialization activities played a crucial role for academic entrepreneurship at MIT. Also, the seminal study by Louis, Blumenthal, Gluck, and Stoto (1989a) showed that local group norms significantly influenced the entrepreneurial behavior of organization members.

Prior research has also shown that it is fruitful to look at the local social context in terms of work peers or the supervisor as an explanation for academics' entrepreneurial activities (Bercovitz & Feldman, 2008; Clarysse et al., 2011; Moog, Werner, Houweling, & Backes-Gellner, 2015; Stuart & Ding, 2006). Haeussler and Colyvas (2011) found, for example, that the extent to which scientists perceive that their peers value patenting acts as strong predictor for their own start-up activity. A more recent study by Moog et al. (2015) also highlighted the importance of peers, finding that academics with more diverse and balanced skills are more likely to have higher entrepreneurial intentions, but only if they are in contact with entrepreneurial work peers. Prodan and Drnovsek (2010) and Huyghe and Knockaert (2015) provided evidence on the positive link between perceived role models of spin-off creation in the work context and scientists' intentions to found a company themselves. Similarly, Bercovitz and Feldman (2008) and Krabel and Schacht (2014) were able to provide confirming evidence for the notion that supervisors' role model behaviour can be a driver of academics' entrepreneurship-related activities, and thus represents an important driver of academics' entrepreneurial behaviour.

The study presented in the second chapter of this thesis complements the research outlined in the previous paragraphs by examining how and under what conditions an organizational-level institutional logic drives researchers' entrepreneurial intentions. Based on data from 254 researchers nested in 85 research groups within 49 research

institutes in Germany, we specifically analyze how two distinct facets of leader behaviour—their own entrepreneurial behaviour and their support for researchers' entrepreneurial activities—help to explain the transmission of an organizational-level institutional logic to the individual level. Additionally, the moderating role of these two facets of leader behaviour for the relationship between organizational-level entrepreneurial logic and researchers' entrepreneurial intentions is analyzed.

The study presented in **Chapter 3** addresses the overall research question, how do incubator characteristics impact the development of ventures hosted in incubator facilities. Due to addressing this research question, the study can be assigned to the field of research examining how *environmental factors* (c) affect activities, processes and outcomes that are characteristic of the *new venture stage* (Stage 3).

Through the provision of a favourable business environment, all incubators focus on the compensation of new ventures early-stage resource deficits to assure economic growth and survival (Mian, 1997; Smilor & Gill, 1986). Scholars have argued that, although all incubators share the same goal, some incubators may be better able to facilitate ventures' development than others, depending on their characteristics (Schwartz, 2012). So far, prior research examining the impact of incubator characteristics, such as age, sponsorship, specialization strategy or size on new venture development have investigated direct effects and often found inconclusive results.

Prior research by Schwartz (2012), for example, found a negative relationship between age of the incubator and firm survival after graduation, while Allen and McCluskey (1990) observed a positive impact of incubator age. According to Schwartz (2012), the older the incubator, the higher the pressure to achieve and sustain high occupancy rates, which requires time-intensive marketing and management activities and results in less available time to support the tenants. Scholars have also examined how

incubator specialization impacts new venture development. Aerts, Matthyssens, and Vandenbempt (2007) were unable to identify incubators who are specialized with regard to their support mechanisms in one or a limited number of industry sectors to be better for tenant development than their counterparts. Similarly, Schwartz and Hornych (2010) did not find that tenants profited from being located in a specialized incubator. Furthermore, an analysis by Peters, Rice, and Sundararajan (2004) on the impact of incubators' sponsorship structure on ventures' development revealed a significant difference in the number of companies graduating among incubators with different governance structures. The highest number of graduates was observed to be among incubators sponsored by public institutions, such as regional or national governments. Another incubator characteristic that has been linked to tenant development is its size. So far, existing research has revealed ambiguous results (Aerts et al., 2007; Allen & McCluskey, 1990). While Allen and McCluskey (1990) found that larger incubators lead to the highest tenant performance, Aerts et al. (2007) analysis conversely revealed that tenants may not necessarily profit from larger incubators.

Shedding more light on the relationship between incubator size and tenant development, the study presented in Chapter 3 of this thesis seeks to complement prior research outlined above. In particular, we adopt a multi-level "fit" perspective that takes the interplay between incubator and tenant characteristics into account, and, by employing a multilevel analysis of data from 276 tenants from 67 incubators in Germany, we analyze how a) the size of a tenant's venture team and b) whether the tenant is active in a high-tech industry, impact the relationship between incubator size and tenant growth.

The study presented in **Chapter 4** of this thesis addresses the research question, how do top management team characteristics help to explain how effective organizations learn from their failures for improved future performance. Thus, the study is part of the field of

research addressing the impact of *individual factors* (a) on activities, processes and outcomes that are characteristic of the *established organization stage* (Stage 4).

Organizational learning is especially central to established organizations due to its role with regard to adaption and change and, thus, long-term success (Chuang & Baum, 2003; Kim & Miner, 2007; Madsen & Desai, 2010). According to organizational learning theory, organizations may obtain knowledge from their experience, and organizational change and adaption occurs as they incorporate this knowledge into strategies, routines or operating practices (Argote & Miron-Spektor, 2011; Levitt & March, 1988). While research on organizational learning from past experiences has a relatively long tradition, only recently have scholars begun to examine whether and especially under what conditions organizations may learn from failures (Desai, 2016) as this form of experience tends to yield richer knowledge compared to that generated by many other forms of experience (Baum & Dahlin, 2007; Cyert & March, 1963; Levitt & March, 1988; Madsen & Desai, 2010; Sitkin, 1992).

Prior research addressing contingencies of organizational learning from failure so far have highlighted the role of failure characteristics, such as the magnitude or importance of the failure (Khanna, Guler, & Nerkar, 2016; Madsen & Desai, 2010), the type of failure (voluntary or involuntary) (Haunschild & Rhee, 2004; Kim & Rhee, 2017) or the heterogeneity in the causes of the failure (Haunschild & Sullivan, 2002). Madsen and Desai (2010), for example, studied organizational learning from failure in the context of orbital launch attempts and found that organizations learn more from large failures than small ones. They argued that in the case of small failures, as they do not have large negative consequences, organization members may redefine them as successes (Dillon & Tinsley, 2008; Morris & Moore, 2000). Further, while organizational self-enhancement may influence organizational members to ignore small failures, large failures, due to their

magnitude and visibility, are less likely be ignored or manipulated into successes (Madsen & Desai, 2010). A similar result is provided by Khanna et al. (2016), as they found that small failures of higher importance in experimentation result in more effective learning processes compared to failures of lower importance to the firm. Furthermore, two studies point to the relevance of volition in learning from failure. Voluntary recalls have been found to result in more effective learning than involuntary recalls (Haunschild & Rhee, 2004). A more shallow learning process in the case of involuntary failures as compared to mandated failures has been argued to be at least partly responsible for that result. A recent study by Kim and Rhee (2017) confirmed this finding, as their analysis revealed that the greater the proportion of internally attributed causes, the more likely it is that an airline will learn from its failures, thus experiencing a lower subsequent failure rate. With regard to heterogeneity in the causes of the failure, Haunschild and Sullivan (2002) showed that failures with heterogeneous causes engender better learning among airlines, because those causes led to a deeper, broader and more intense search for causality than failures with homogeneous causes.

However, failure-related characteristics were not the only factors identified by prior research that significantly influence organizational learning from failure. Research has shown that an organization's operating experience (Desai, 2016) or the concentration of failures within an organization (Desai, 2015b) also have an impact on learning. With regard to operating experience, Desai (2016), for example, tested his hypothesis on a panel of railroad companies and found that as those organizations gained operating experience, they were increasingly able to learn from their failures. He argued that operating experiences lead to a base level of knowledge that in turn helped the companies to access relevant knowledge through failures. Finally, another recent study by Desai (2015b) highlighted the importance of the concentration of failures within an organization

for learning effectiveness. Specifically, that study revealed that organizations learn more effectively from failures when they are more broadly dispersed, compared to when failures are relatively concentrated in origin, and thus typically involve a specific unit or particular individual. He argued that in the case of concentrated failures, decision makers may ignore or undervalue any contributing situational factors, and overweight the importance of individual or dispositional characteristics, which leads to simplified explanations for the cause of failure and superficial learning.

The study presented in Chapter 4 extends the research outlined in the previous paragraphs by adding TMT characteristics to the debate on contingencies for organizational learning from failure. Based on longitudinal data comprising 550 organization-year observations from 39 research institutes, I examine how two TMT characteristics—TMT founding experience and TMT exposure to US culture—help to explain whether organizations seize the learning opportunities inherent in their failures to improve subsequent performance.

2 Fissuring the Ivory Tower: Organizational-Level Entrepreneurial Logic, Leader Behaviour, and Researchers' Entrepreneurial Intentions

2.1 Introduction

Recognizing academic entrepreneurship as a channel for commercializing scientific knowledge that significantly contributes to societies' economic and social welfare (Di Gregorio & Shane, 2003; Nicolaou & Birley, 2003; Shane, 2004), policy makers all over the world have made considerable efforts to supplement the logic of open-science with an entrepreneurial logic, i.e. a logic that fosters a commercialization of research results and facilitates researchers' engagement in entrepreneurial actions (Lehrer & Asakawa, 2004; Perkmann et al., 2013; Rasmussen, 2008; Rasmussen & Gulbrandsen, 2012). However, when a new institutional logic is introduced and promoted in a field, it is not uniformly embraced and adopted by organizations (Kraatz & Block, 2008; Lounsbury, 2007; Pache & Santos, 2010; Reay & Hinings, 2009). Rather, some organizations will readily accede to newly established expectations, others may resist to adopting the new logic completely, and still others will only partially adopt the newly emerging expectations (see, e.g. Lander, Koene, & Linssen, 2013; Marquis & Lounsbury, 2007; Zilber, 2002). While this phenomenon is widely recognized among institutional theorists (Dacin, Goodstein, & Richard Scott, 2002), our knowledge concerning the adoption of new institutional logics among organization members is sparse, both in general (Luo, 2007; Zilber, 2002) and with regard to the individual embracing of an entrepreneurial logic by researchers in academia (yet see Fini & Lacetera, 2010). Given the significant role of individuals in giving life and meaning to institutions (Dacin et al., 2002), this is a significant shortcoming. Moreover, Kim, Wennberg and Croidieu (2016) suggest that the

meso-level structures and processes linking institutional logics and individual attitudes and behaviours offer untapped riches for enhancing our understanding of multilevel entrepreneurial mechanisms. Similarly, in their reviews of entrepreneurship research informed by institutional theory, Bruton, Ahlstrom and Li (2010) as well as Tolbert, David and Sine (2011) call for research that examines the macro–micro (institutional–individual mindset) link. Following these suggestions, the present study examines cross-level mechanisms that might help to explain variations in organization members' accordance with the institutional logic of entrepreneurship in the field of academia.

For a long time, the field of academia has been dominated by the Mertonian logic of open science (Stuart & Ding, 2006), which legitimizes an open dissemination of discoveries in exchange for being rewarded through citations and academic merits (Merton, 1957, 1973). Despite major efforts by policy makers to promote the commercialization of scientific research, entrepreneurial activity has caught on very unevenly in academia (Haeussler & Colyvas, 2011). Whereas some researchers have found to display considerable inclinations towards entrepreneurship and the commercialization of research results (Colyvas & Powell, 2007), others have been found to consider such actions as a serious threat to the basic values and ideals of academia (Stuart & Ding, 2006). In a large cross-national study, Fini et al. (2016) find that changes in the institutional framework conditions at the national- and university-level aimed at encouraging the commercialization of research results indeed increase entrepreneurial activity in terms of the number of university spin-offs, yet in varying quantity and quality.

Taking these observations as a point of departure, we suggest as a baseline model that researchers' entrepreneurial intentions correspond with the extent to which the research organisation in which they are embedded has adopted an entrepreneurial logic within its normative, cognitive, and regulative institutional elements. We focus on

researchers' entrepreneurial intentions, because the intention to commercialize research results constitutes a crucial precondition for any form of academic entrepreneurship (Goethner, Obschonka, Silbereisen, & Cantner, 2012). Portraying supervisors as important carriers of institutional legitimation and change (Dacin et al., 2002), we further submit that research group leaders play a significant role in explaining why and to what extent researchers' entrepreneurial intentions reflect an organizational-level entrepreneurial logic. Specifically, we posit that two distinct facets of research group leaders' behaviour—their own entrepreneurial behaviour as well as their support for their researchers' entrepreneurial activities—convey an entrepreneurial logic from the organizational to the individual level. Furthermore, we suggest that these two facets of leader behaviour contribute to explaining variations in the entrepreneurial intentions of researchers within research organizations, as they, respectively, weaken and strengthen the link between an organizational-level entrepreneurial logic and researchers' entrepreneurial intentions.

This paper makes two main contributions that inform both the literature on the commercialization of academic research and institutional theory. First, it shows that heterogeneity in researchers' entrepreneurial intentions can be traced back to the extent to which an entrepreneurial logic is reflected in the normative, regulative and cognitive institutions of research organizations. Second, by highlighting two facets of leadership behaviour, this paper identifies meso-level mechanisms that shape how an organizational-level institutional logic influences individuals' mindsets.

2.2 Theory and Hypotheses

According to institutional theory, social behaviour is prescribed and proscribed by institutional logics, i.e. historical patterns of practices, assumptions, values, and rules that provide a coherent set of organizing principles for a particular societal domain (Friedland

& Alford, 1991; Greenwood, Oliver, Sahlin-Andersson, & Suddaby, 2007; Thornton, Ocasio, & Lounsbury, 2012). Institutional logics are reflected in normative, cognitive and regulative elements (Ahuja & Galvin, 2003; Scott, 2014). The normative elements include values and norms indicating what is preferred and desired, and how things should be done in a particular context. They thus direct actors' behaviour based on appropriateness considerations (March & Olsen, 2008). Representing the social knowledge shared among actors, cognitive elements indicate what is considered normal and taken for granted within a particular context, thus affecting how individuals select and interpret information that guide their actions (Markus & Zajonc, 1985). The regulative elements comprise formal rules, policies and regulations that influence actions based on conformity (Scott, 2014).

For decades, the field of academia has been dominated by the Mertonian logic of open science (Stuart & Ding, 2006). According to this logic, it is legitimate, appropriate and normal that researchers expand the existing stock of human knowledge in a communal way, such that they openly disseminate their discoveries within the scientific community in exchange for being rewarded through citations and academic merits (Merton, 1957, 1973). Yet to this established logic, an entrepreneurial logic that aims at fostering recognizing and exploiting business opportunities by means of commercializing research results has been recently added. Governments, funding bodies, and research institutions around the world have introduced policies that promote the commercialization of research results (Lehrer & Asakawa, 2004; Perkmann et al., 2013; Rasmussen, 2008; Rasmussen & Gulbrandsen, 2012). Governments devised policies such as the Bayh-Dole Act in the USA that increased incentives for academic entrepreneurship and a commercialization of scientific inventions (Färnstrand Damsgaard & Thursby, 2013; Grimaldi, Kenney, Siegel, & Wright, 2011). Moreover, policies identified as hindering commercialization activities were abolished, such as the so-called 'professor's privilege'

in European countries (Mowery & Sampat, 2005; Sampat, Mowery, & Ziedonis, 2003). Public and private bodies also provided an increasing number of grants and public funding opportunities for commercializing research results (Meyer, 2003). Finally, funding bodies, such as the Research Councils in the United Kingdom, for instance, now require that researchers receiving funding "exploit results where appropriate, in order to secure social and economic return to the UK" (ESRC, 2015, p. 19).

Even within a particular national context, however, it is unlikely that the introduction and promotion of a new institutional logic, such as the entrepreneurial logic in academia, will be uniformly embraced by organizations (Kraatz & Block, 2008; Lounsbury, 2007; Pache & Santos, 2010; Reay & Hinings, 2009). Organizations in academia exposed to the exact same institutional logics on the field-level thus often differ with respect to the degree to which they have adopted an entrepreneurial logic that emphasizes other goals, values, and practices and/or those entailed by the logic of open science (Kenney & Richard Goe, 2004; Perkmann et al., 2013). We suggest that differences in organizational-level institutions (Besharov & Smith, 2014; Spicer & Sewell, 2010) contribute to explaining differences in researchers' inclinations for academic entrepreneurship, i.e. their entrepreneurial intentions.

2.2.1 Entrepreneurial Logic and Researchers' Entrepreneurial Intentions

Entrepreneurship is a planned, individual-level behaviour that is inherently intentional (Bird, 1988; Katz & Gartner, 1988). Without the intention to commercially exploit their research methods and results, researchers will not engage in any form of academic entrepreneurship. Prior research accordingly considers entrepreneurial intentions as the most proximal and important predictor of individuals' engagement in entrepreneurial activity in general (Bird, 1988; Dutta & Thornhill, 2008; Fishbein & Ajzen, 1975; Lee,

Wong, Foo, & Leung, 2011) and in academic entrepreneurship in particular (Prodan & Drnovsek, 2010).

Actors develop entrepreneurial intentions based on whether they perceive entrepreneurial activities as desirable and feasible (Krueger, 1993; Krueger et al., 2000). Entrepreneurial activities are perceived as desirable by individuals when they fit with personal needs and are considered legitimate in the context in which they are embedded. The degree to which an individual feels capable of exerting entrepreneurial behaviour determines whether she perceives such activities as feasible (Krueger et al., 2000). Based on these notions, we propose as our baseline model that researchers' entrepreneurial intentions correspond with the extent to which the normative, cognitive, and regulative elements of a research organization's institutions reflect an entrepreneurial logic.

To the extent that normative elements of research organization's institutions reflect an entrepreneurial logic, activities, such as filing a patent, being engaged in industry cooperation, or founding a business (Abreu & Grinevich, 2013; Louis, Blumenthal, Gluck, & Stoto, 1989b; Renault, 2006), are appreciated, considered normal, and reinforced within an organization. According to the person-environment fit literature (Edwards, 2008; Kristof, 1996), individuals' values and attitudes tend to match those prevalent in the organization in which they are embedded. Supporting this notion in the context of academic entrepreneurship, Fini and Toschi (2016) find that academic entrepreneurs implement their entrepreneurial intentions in accordance with their particular academic institutional environment. Two main processes jointly foster a fit between an organization and organization members' values and desirability perceptions: Selection-attrition-retention and socialization processes. Based on applicant's job choice behaviour and hiring decisions, organizations attract and select individuals whose preferences and desirability perceptions fit in with what is appreciated within the

organization (Schneider, Goldstiein, & Smith, 1995). At the same time, individuals whose attitudes do not fit with the normative, cognitive and regulative organizational context will tend to either leave voluntarily or involuntarily. Additionally, individuals' attitudes and values and are shaped through organizational socialization processes (De Cooman et al., 2009). Due to organizational socialization, individuals over time thus adopt the preferences and beliefs needed to participate and succeed as organization members (Chao, O'Leary-Kelly, Wolf, Klein, & Gardner, 1994).

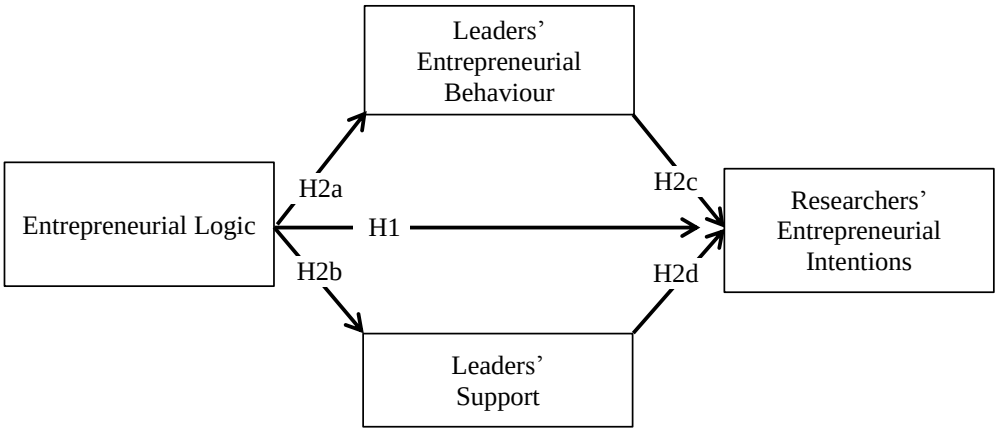
Based on these arguments, we derive the following baseline notion:

Hypothesis 1: *The extent to which an entrepreneurial logic is embodied within a research organization's institutional elements positively relates to the entrepreneurial intentions of researchers within that research organization.*

2.2.2 The Role of Leader Behaviour

Above, we suggested the entrepreneurial intentions of researchers to correspond with the extent to which an entrepreneurial logic is prevalent within their research organizations. However, we know little about the processes that link organization-level institutional logics with individual-level constructs (Bruton et al., 2010). Shedding more light on the question of how an organizational-level entrepreneurial logic affects individual-level entrepreneurial intentions, we extend the baseline model and submit that research group leaders—who fulfil the role of supervisors within research organizations, as they fund, steer, review, and evaluate the work of their researchers (Bercovitz & Feldman, 2008)—play a significant role in conveying an organizational-level entrepreneurial logic to the individual level. Specifically, as displayed in Figure 2.1, we expect that through a) their entrepreneurial behaviour and b) their support for their researchers' entrepreneurial activities, research group leaders serve as carriers of institutions (Dacin et al., 2002).

Figure 2.1: Mediation Hypotheses



2.2.2.1 Leader Behaviour as a Transmission Channel

With organizations being the context in which leader behaviour is enacted (Porter & McLaughlin, 2006), we first of all expect leader behaviour to typically correspond with the organizational-level institutions in which it is embedded.

Within organizations, attitudes and behaviours that fit with what is considered appropriate and legitimate typically increase individuals' status and reputation (Göktepe-Hulten & Mahagaonkar, 2010) and are rewarded with the support of organization members and systems (Bretz & Judge, 1994). Based on forces driving promotion decisions, higher job-levels within organizations are thus likely achieved by individuals who correspond with their organization's normative, cognitive, and regulative institutional set-up. Learning their supervisory role within an organization, leaders also further adjust to their organizational context (Chao et al., 1994), which results in leader behaviour that even more closely aligns with what is appreciated, considered normal, and rewarded within an organization.

Based on these notions, we expect that research group leaders' entrepreneurial behaviour, as well as their support for the entrepreneurial activities of researchers in their

group, to be positively related to the extent to which an entrepreneurial logic is embodied within their research organization.

Hypothesis 2a: *The extent to which an entrepreneurial logic is embodied within a research organization is positively related to leaders' entrepreneurial behaviour.*

Hypothesis 2b: *The extent to which the entrepreneurial logic is embodied within a research organization is positively related to leaders' support for the entrepreneurial activities of their researchers.*

Complementing the expectation that research group leaders' behaviour aligns with the organizational-level institutions in which they are embedded, we suggest that differences in leaders' entrepreneurship-related behaviour will be reflected in their researchers' entrepreneurial intentions.

Supervisors tend to favour individuals who are similar to themselves (Schaubroeck & Lam, 2002), a tendency that results in selecting applicants with similar attitudes (Jansen & Kristof-Brown, 2006). Social-cognitive learning theory (Bandura, 1977, 1986) further suggests that supervisors influence the attitudes and behaviour of their subordinates in different ways. Generally, individuals vicariously learn by observing and imitating the behaviour of others who function as role models (Bandura, 1977, 1986). Being high in status, leaders act as such role models within organizations displaying desirable attitudes and behaviours. Through their leadership actions, leaders signal what kind of behaviour is appreciated and rewarded in an organizational context, thus also influencing what is considered desirable by their subordinates (Bandura, 1986; Schein, 1985).

Based on these lines of reasoning we suggest that affecting researchers' perceptions related to the desirability and feasibility of entrepreneurial activities, research group leaders' entrepreneurial behaviour will be positively related to their researchers' entrepreneurial intentions. Thus, we propose:

Hypothesis 2c: *Leaders' entrepreneurial behaviour positively relates to their researchers' entrepreneurial intentions.*

While research-group leaders' entrepreneurial behaviour may correspond to their researchers' perceptions of whether entrepreneurial activity is desirable and feasible, we posit that by more pointed actions suited to drive researchers' perceptions of whether it is feasible to engage in entrepreneurial activities, research groups leaders may further stimulate researchers' entrepreneurial intentions. Within research organizations, research group leaders are the most qualified persons and experts in their respective fields (Krabel & Schacht, 2014). They can thus facilitate researchers' entrepreneurship-related feasibility perceptions when they actively support them with their expert knowledge as well as by providing other necessary resources (Rasmussen, Mosey, & Wright, 2014). Typically, entrepreneurial endeavours emerging from research organizations heavily depend on laboratory capacity, e. g. for analysing compounds or building a prototype, but have a limited budget (Ndonzuau, Pirnay, & Surlemont, 2002). Research group leaders can thus, for instance, facilitate entrepreneurial endeavours by providing access to laboratory capacities and equipment. As leaders are typically well connected internally and externally (Mehra, Dixon, Brass, & Robertson, 2006), they can also provide access to contacts who can provide additional knowledge and resources that are helpful for researchers' entrepreneurial activities (Rasmussen, Mosey, & Wright, 2011). Reducing

feasibility concerns, we thus expect leaders' support for their researchers' entrepreneurial endeavours to foster their entrepreneurial intentions. We thus propose:

Hypothesis 2d: *Leaders' support for their researchers' entrepreneurial activities is positively related to the entrepreneurial intentions of their researchers.*

Summing up, the lines of reasoning leading to Hypotheses 2a, 2b, 2c, and 2d suggest that leaders' entrepreneurial behaviour and their support for the entrepreneurial activities of their researchers are important transmission channels through which a research organization's institutions shape researchers' entrepreneurial intentions. Hence, we propose:

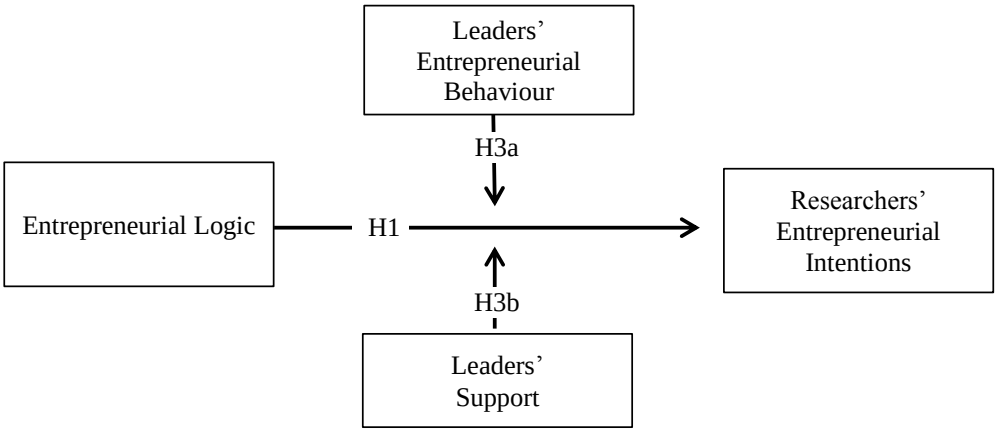
Hypothesis 2: *Leaders' entrepreneurial behaviour and their support for their researchers' entrepreneurial activities mediate the relationship between an organizational-level entrepreneurial logic and researchers' entrepreneurial intentions.*

2.2.2.2 Leader Behaviour as a Contingency

The arguments delineated above suggest leader behaviour to link a research organization's institutions with the individual level and thus mediate the relationship between an organizational-level entrepreneurial logic and researchers' entrepreneurial intentions. Complementing these lines of reasoning, we further submit that the two facets of leader behaviour also serve as contingencies for, and thus moderate, the correspondence between the organizational-level logic and individual-level attitudes. Specifically, as depicted in Figure 2.2, we will subsequently outline in detail why we expect a) leaders' entrepreneurial behaviour to weaken, whereas b) leaders' support for

their researchers' entrepreneurial activities strengthens the congruence between an organizational-level entrepreneurial logic and researchers' entrepreneurial intentions.

Figure 2.2: Moderation Hypotheses



Generally, two variables interact in a compensatory way and thus weaken each other's influence (i.e. negatively interact) when their effects rest on the same mechanism, and they are thus partially redundant in bringing about a particular outcome (Côté & Miners, 2006; Johnson, Groff, & Taing, 2009; Menges, Tussing, Wihler, & Grant, 2016). In line with this general reasoning, we expect the relationship between an organizational-level entrepreneurial logic and researchers' entrepreneurial intentions to be negatively moderated by leaders' entrepreneurial behaviour.

We suggested above that the extent to which a research organization embraces an entrepreneurial logic will correspond with researchers' entrepreneurial intentions. This is because attraction-selection-attrition as well as socialization processes (De Cooman et al., 2009) jointly operate to shape whether individuals within an organization perceive entrepreneurial activities as desirable. We further proposed that as supervisors tend to favour hiring individuals that hold similar desirability perceptions as they do themselves (Jansen & Kristof-Brown, 2006; Schaubroeck & Lam, 2002), leaders' entrepreneurial

behaviour will be associated with the perception among their researchers that entrepreneurial activity is desirable. These lines of reasoning suggest that both variables exert their influence via the same mechanism and are thus in part redundant in facilitating researchers' entrepreneurial intentions.

When a research group leader does not represent a role model (Bandura, 1977, 1986) for entrepreneurial activities, researchers may lack cues from their immediate social context as to whether or not entrepreneurial activities are considered legitimate and desirable. In such a situation, researchers' perceptions of whether it is desirable to engage in entrepreneurial endeavours, and thus their entrepreneurial intentions (Krueger et al., 2000), will strongly hinge on whether cognitive, normative and regulative institutional elements within an organization signal legitimacy for entrepreneurial activities. A research group leader who is heavily engaged in entrepreneurial activity, in contrast, may be sufficient to assure researchers that related activities are appropriate and legitimate in their organizational context. As a result, organizational-level signals pointing in the same direction will be less consequential for researchers' entrepreneurial intentions. In line with this reasoning, we propose:

Hypothesis 3a: *Leaders' entrepreneurial behaviour negatively moderates the link between an organizational-level entrepreneurial logic and researchers' entrepreneurial intentions.*

In contrast with Hypothesis 3a, we suggest that leaders' support for researchers' entrepreneurial activities will re-inforce, that is positively moderate, the link between an organizational-level entrepreneurial logic and researchers' entrepreneurial intentions. Generally, two variables that complement each other in bringing about a particular

outcome tend to strengthen each other's influence, i.e. interact in a positive way (Johnson et al., 2009).

When an entrepreneurial logic is strongly institutionalized within a research organization, it will facilitate perceptions of the desirability of entrepreneurial behaviour among researchers. Leaders' support for entrepreneurial activities enhances individual perceptions related to the feasibility of entrepreneurial activities, as it provides researchers with valuable resources, such as expert knowledge, contacts, or other resources (Mehra et al., 2006; Rasmussen et al., 2014). Therefore, we suggest that an entrepreneurial logic and leader support complement one another in fostering researchers' inclinations to engage in entrepreneurship.

When leader support for entrepreneurial activities is low, an entrepreneurial logic reflected in the normative, cognitive, and regulative institutions within a research organization may facilitate researchers' perceptions that entrepreneurial activities are legitimate and thus desirable. Yet, due to weak support with needed resources, researchers may still lack the conviction that pursuing an entrepreneurial endeavour is actually feasible (Krueger et al., 2000). In contrast, when leaders' support for entrepreneurial activities is high and researchers are thus provided with the expert knowledge and access to other needed resources, the extent to which entrepreneurial endeavours are legitimate within the institutional set-up of an organization will be much more crucial for the development of entrepreneurial intentions by researchers.

Accordingly, we expect that when leader support for academic entrepreneurship is strong rather than weak, the congruence between an organizational-level entrepreneurial logic and researchers' entrepreneurial intentions increases. We thus propose:

Hypothesis 3b: *Leaders' support for their researchers' entrepreneurial activities positively moderates the link between an organizational-level entrepreneurial logic and researchers' entrepreneurial intentions.*

2.3 Method

2.3.1 Sample

Our hypotheses address three levels of analysis—researchers (L1) supervised by research group leaders (L2) within research organizations (L3). To reflect this structure, we collected data from scientists working for research group leaders in research institutes belonging to two of the most important and prestigious research associations in Germany, the Max-Planck-Society (MPS) and the Helmholtz Association (HA). The two research associations comprise 299 research institutes that conduct basic as well as applied research. Of these research institutes, which autonomously set and pursue their research agendas, receive their own publicly/federally funded budgets, and can thus rightfully be considered as independent organizations, 74% belong to the HA and 26% to MPS. About 56% perform research in the natural sciences, 38% conduct research in the life sciences, and about 7% in social and human sciences (Helmholtz Association, 2015; Max Planck Society, 2015).

This setting is particularly appropriate for testing our arguments, because all MPI and HA institutes are geared towards, and represent excellence in, scientific research. MPS research institutes have been home to 11 Nobel laureates and produce more than 15,000 international publications each year, many of which are among the most-cited publications in their respective field (Max Planck Society, 2015). HA research institutes provide cutting-edge research that contributes substantially to solving the grand challenges of science, society, and industry (Helmholtz Association, 2015) and have produced two Nobel laureates. At the same time, both research organizations also seek to

accommodate the transfer of promising research findings to potential commercial applications that improve human living conditions. Moreover, they are exposed to the exact same institutional logics on a national-level aimed at strengthening the entrepreneurial of research results. The Federal Ministry for Education and Research, the main contributor to the two research organizations' budgets, in its High-Tech Strategy 2020 initiative for example stipulates that "Germany once again has to become a land of founders and needs an increase in founding dynamism. We thus aspire to strengthen the entrepreneurial spirit and founding culture in universities and research organizations and to support spin-offs in research and scientific institutions by means of better counsel and aid." (Federal Ministry of Education and Research, 2010, p. 10).

For our study, we collected data from MPS and HA institutes located in three regions in Germany—Cologne, Goettingen, and Magdeburg. We focused on these three regions for two reasons: First, we decided to personally administer the questionnaire in order to increase response rates and ensure that we could obtain sufficient data for conducting a multilevel analysis from research group leaders and researchers at the same institute. Second, secondary data analysis revealed that focusing on these three regions allows us to obtain a fairly representative sample of the full population of the MPS and HA research institutes in Germany. Similar to the distribution for the overall population of research institutes, 76% of the research institutes in our sample belong to the HA and 24% to the MPS. Additionally, 59% are active in natural sciences, 37% in life sciences, and 4% in the field of social and human sciences.

In the three regions, as a first step we contacted by telephone a random sample of 250 research group leaders from 89 research institutes whose contact data were publicly available and asked them to participate in our study. In a second step, we personally administered questionnaires to 201 research group leaders as well as to 805 researchers

working in these leaders' research groups. In total, we received 110 leader questionnaires (54%), and 339 researcher questionnaires (42%) from 66 research institutes (74%). After dropping unmatched responses, our data set comprises data for 254 researchers working for 85 research group leaders in 49 research institutes.

On average, researchers and research group leaders in our sample are 36, respectively 52, years of age. Similar to the percentage of male and female researchers working in public research institutes in Germany (Federal Ministry of Education and Research, 2012), 70% of the researchers in our sample are male. With 93%, this rate is even higher among the research group leaders in our sample. Further, 72% of the researchers and 84% of the research group leaders hold German citizenship.

2.3.2 Measures

As our study is based on data obtained from different sources, we are confident that common source variance is not a significant concern (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Research group leaders provided information on their entrepreneurial behaviour and support for the entrepreneurial activities of their researchers, as well as the leader-related control variables. Researchers made data available on the dependent variable of our study, i.e. their entrepreneurial intentions, and the researcher-related controls. Research group leaders and researchers both reported on our independent variable, i.e. the extent to which the institutional environment within their research organization embodied an entrepreneurial logic.

To further ensure the validity of our data, when possible we employed established scales that were validated in prior research. All English survey items were translated to German and back-translated following the procedures described by Brislin (1980). Prior to the main study, we pre-tested our questionnaires with academics whose responses were not included in the study. This pre-test consisted of a think-aloud protocol to receive

structured feedback on the validity and comprehensibility of the items used (Sudman, Bradburn, & Schwarz, 2010).

Dependent Variable (Researcher-Level, L1). To capture *researchers' entrepreneurial intentions*, we relied on a six-item scale developed by Thompson (2009) that has proven its reliability and validity in prior research (De Jong, Parker, Wennekers, & Wu, 2015; Mathieu & St-Jean, 2013; Swail, Down, & Kautonen, 2013). The six items formed a single scale (Cronbach's alpha = .85).

Independent Variable (Organization-Level, L3). To capture the extent to which research organizations embodies an *entrepreneurial logic*, we developed a scale based on Scott's (2014) conceptualization of the elements of institutions and five activities that earlier research (Abreu & Grinevich, 2013; Louis et al., 1989b; Renault, 2006) identified as entrepreneurial: patenting, licensing, founding activities, industry co-operations, and membership of firm advisory boards or boards of directors. Specifically, we constructed 15 items. For each of the five activities, respondents were asked to indicate with regard to their research institute the extent to which (a) the respective activity is appreciated (normative), (b) it is taken for granted/considered to be normal that researchers pursue the respective activity (cognitive), and (c) individuals are encouraged and rewarded for aforementioned activities based on formal rules and policies (regulative). The response scales ranged from 1, "not at all" to 7 "to a very large extent". In line with the notion that an institutional logic is coherently reflected by cognitive, normative and regulative elements within a societal domain (Friedland & Alford, 1991; Greenwood et al., 2007; Thornton et al., 2012), the 15 items formed a single scale (Cronbach's alpha = .91).

To establish whether the measure reflects an organizational-level construct, we assessed the level of inter-rater agreement among the individuals within the same research institutes and tested for significant between-institute variance (Bliese, 2000; James,

Demaree, & Wolf, 1984; Lindell, Brandt, & Whitney, 1999). Median $r_{wg(j)}$ tests (James et al., 1984; LeBreton & Senter, 2008) revealed strong within-institute agreement ($r_{wg(j)}$ = .88). One-way ANOVA further established significant between-institute-variance (F = 1.73, p = .00), which was confirmed by intra-class correlation analyses. Specifically, we find an ICC1 value (ICC1 = .11) that exceeds the commonly applied threshold of .05 (Bliese, 2000), and an ICC2 value (ICC2 = .46) that further suggests the appropriateness of aggregating the data (Černe, Nerstad, Dysvik, & Škerlavaj, 2014; Cole, Bruch, & Vogel, 2012).

Mediators (Research Group Leader-Level, L2). To capture leaders' *entrepreneurial behaviour*, we formed an additive index comprising research group leaders' entrepreneurial activities in the past and the extent to which leaders are currently inclined to entrepreneurship. We used the number of businesses a research group leader had established as an indicator of his/her past entrepreneurial activities (Krabel & Mueller, 2009). For measuring research group leaders' current inclination towards entrepreneurial activities, we used the same scale as for measuring researchers' entrepreneurial intentions (Cronbach's Alpha = .80). To eliminate variance based on different scales, we followed earlier research (Gulati & Sytch, 2007) and standardized the two measures before adding them to a single index.

To capture leaders' support for their researchers' entrepreneurial activities, we adapted a scale used in earlier research on support for innovation (Gemünden, Salomo, & Hölzle, 2007; Rost, Hölzle, & Gemuenden, 2007; Walter & Gemünden, 2000). The scale comprises 16-items capturing the extent to which a leader supports entrepreneurial activities through providing physical resources, knowledge and expertise, and referrals. Answers were provided on a scale ranging from 1 "not at all" to 7 "completely". The items combine to a single scale (Cronbach's Alpha = .94).

Controls. We included several control variables at the three different levels of analysis. At the organizational level, we took into account that the inclinations of researchers for academic entrepreneurship may differ across disciplines (D'Este, Mahdi, Neely, & Rentocchini, 2012) by controlling whether the respective institutes were active in the *life sciences*, *natural sciences*, or *social and human sciences*. Further, we controlled for the different *regions* in which we collected our data as well as the two different research associations (*MPS* and *HA*) to which the research institutes belong. Following earlier research (D'Este et al., 2012; Krabel & Schacht, 2014), we also controlled for the *size* of the research institutes in terms of the number of research groups. We further accounted for the potential impact of the extent to which the research institutes embodied the *open science logic*. Analogous to our measure reflecting the entrepreneurial logic, we captured the open science logic based on 12-items reflecting to what degree it is appreciated (normative), taken for granted (cognitive), and formally encouraged and rewarded (regulative) within an organization that researchers engage in activities related to the logic of open science, i.e. publishing articles, conference participations, scientific awards, and striving for research grants from public institutions (Lam, 2011; Siegel, Veugelers, & Wright, 2007). The 12 items formed a single scale (Cronbach's alpha = .82) and median $r_{wg(j)}$ tests revealed strong within-institute agreement ($r_{wg(j)}$ = .86). However, one-way ANOVA revealed no significant between institute-variance (F = 0.90, p = .66). This result indicates that in contrast to the entrepreneurial logic, the logic of open science is very similarly reflected across the research institutes in our sample.

At the level of research group leaders, we controlled for leaders' *age*, *gender* and *citizenship*, and included a dummy variable indicating whether leaders also were the *heads* of their respective research institutes.

At the researcher-level, we accounted for person-related characteristics that may affect entrepreneurial intentions (Caliendo, Fossen, & Kritikos, 2009; Fritsch & Krabel, 2010; Haeussler & Colyvas, 2011) by controlling for researchers' *age*, *gender*, *citizenship* as well as *risk-taking propensity*. To capture researchers' risk-taking propensity, we relied on seven items that previous research has shown to validly capture an individual's general tendency to take risks (Meertens & Lion, 2008; Zhao, Seibert, & Hills, 2005). Items formed a single scale (Cronbach's alpha = .83). Additionally, we controlled for whether researchers had a *PhD* and whether they had an *indefinite work contract*.

2.3.3 Analytical Approach

As our data comprise three levels of analysis, we relied on a multilevel model (Hofmann, 1997; Klein & Kozlowski, 2000) and used HLM 7 (Bryk & Raudenbush, 1992) to test our hypotheses. A multilevel model accounts for nested data and allows to estimate, simultaneously and without biases, effects at different levels of analysis (Arnold, 1992; Gavin & Hofmann, 2002; Klein & Kozlowski, 2000). Consequently, it serves us to examine the effects of organization-level (L3) and leader-level (L2) variables on a researcher-level (L1) outcome as well as cross-level mediation and moderation effects.

In multilevel models, centring decisions need particular attention, as lower-level variables may be centred either at the grand mean (CGM) or within clusters (CWC). Which approach is appropriate depends on the research question addressed (Enders & Tofighi, 2007; Mathieu & Taylor, 2007). CWC implies that case values are centred at the mean of the cluster to which they belong. CWC thus removes all between-cluster variation and results in lower-level variables that are uncorrelated with higher-level variables. This centring approach is thus particularly appropriate for analysing cross-level interactions (Aguinis, Gottfredson, & Culpepper, 2013; Enders & Tofighi, 2007). When modelling cross-level mediation effects, however, one has to avoid CWC, as it scales

away potential correlations between variables at different levels of analysis (Hofmann & Gavin, 1998; Mathieu & Taylor, 2007). For our leader behaviour variables, we consequently applied a CGM approach when testing Hypothesis 2a, 2b, 2c, and 2d but resorted to CWC for testing Hypotheses 3a and 3b.

2.4 Results

Table 2.1 displays descriptive statistics and correlations of our study variables.

Table 2.1: Descriptive Statistics and Correlations

N = 254 (L1), 85 (L2), 49 (L3)		**Mean**	**SD**	**1.**	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**
Level 3 (Organization)										
1.	Entrepreneurial Logic	2.97	.59							
2.	Open Science Logic	5.18	.41	.121						
3.	Association (0=MPS; 1=HA)	.76	.43	.211	.023					
4.	Life Science	.37	.49	.160	.243	.139				
5.	Social and Human Science	.04	.20	-.320*	.00	-.362*	-.157*			
6.	Cologne Region	.69	.47	-.367**	-.098	.240	-.045	.137		
7.	Goettingen Region	.27	.45	.369**	.065	-.303*	-.074	-.124	-.905**	
8.	Size	6.59	6.88	.159	.210	-.055	.475**	-.139	-.105	.104
Level 2 (Leader)										
1.	Entrepreneurial Behaviour	-.02	.86							
2.	Support	3.94	1.37	.456**						
3.	Age	52.06	8.32	.089	.203					
4.	Gender (1=Female)	.07	.26	.004	.033	-.057				
5.	German Citizenship	.84	.37	-.071	.016	.028	-.122			
6.	Head of Institute	.26	.44	.116	.168	.207	-.163	.045		
Level 1 (Researcher)										
1.	Entrepreneurial Intention	2.59	1.39							
2.	Age	35.79	9.11	-.030						
3.	Gender (1=Female)	.31	.46	-.194**	-.226**					
4.	German Citizenship	.72	.45	-.217**	.197**	-.099				
5.	Permanent Contract	.26	.44	-.064	.621**	-.161*	.229**			
6.	PhD	.61	.49	.240**	-.009	-.100	-.115	-.090		
7.	Risk-Taking Propensity	3.61	1.05	-.054	.547**	-.121	-.097	.211**	.003	

Notes: *p < .05, **p <.01.

In line with existing research on the person-related characteristics predicting entrepreneurial activity (Caliendo et al., 2009), correlation analyses reveal a significant positive link (r = .240, p < .01) between researchers' risk-taking propensity and their entrepreneurial intentions. Correlation analyses further show that our two mediator variables—leaders' entrepreneurial behaviour and their support for their researchers' entrepreneurial activities—are moderately but significantly interrelated (r = .456, p < .01). This result implies that leaders who had founded a venture in the past or are currently inclined to entrepreneurial activity are also more willing to provide support for entrepreneurial activities to their researchers. This interrelation further suggests that it may be necessary to control for leaders' entrepreneurial behaviour when testing for the relation between their support for their researchers' entrepreneurial activities, and vice versa (Atinc, Simmering, & Kroll, 2012; Spector & Brannick, 2011).

2.4.1 Hypotheses Testing

Table 2.2 depicts the results of our multilevel analyses.

Table 2.2: Results from Multilevel-Analyses

N = 254 (L1), 85 (L2), 49 (L3)	**Model 1: Entrepreneurial Intention (Researcher)**		**Model 2: Entrepreneurial Intention (Researcher)**		**Model 3: Entrepreneurial Behaviour (Leader)**		**Model 4: Support (Leader)**		**Model 5: Entrepreneurial Intention (Researcher)**		**Model 6: Entrepreneurial Intention (Researcher)**	
Level 3 (Organization)												
Intercept	2.51	(.09)**	2.54	(.08)**	-.08	(.07)	3.89	(.13)**	2.57	(.07)**	2.54	(.08)**
Entrepreneurial Logic	.45	(.20)*			.70	(.20)**	.65	(.30)*	.04	(.14)	.45	(.20)*
Open Science Logic	-.25	(.21)			-.33	(.14)*	-.38	(.39)	.01	(.17)	-.21	(.21)
Association (0=MPS; 1=HA)	-.49	(.18)**			-.32	(.14)*	-.01	(.30)	-.32	(.20)	-.48	(.20)*
Life Science	-.38	(.20)$^{+}$			.55	(.20)**	-.11	(.25)	-.70	(.19)**	-.53	(.22)*
Social and Human Science	-.55	(.31)*			.81	(.37)*	-2.04	(.45)**	-.73	(.46)	-.73	(.39)$^{+}$
Cologne Region	-1.11	(.40)**			.30	(.22)	-.17	(.50)	-1.14	(.38)**	-1.08	(.50)*
Goettingen Region	-1.36	(.41)**			.34	(.25)	-.42	(.54)	-1.50	(.39)**	-1.43	(.49)**
Size	.02	(.01)*			-.01	(.01)	.01	(.01)	.02	(.01)**	.02	(.01)**
Level 2 (Leader)												
Entrepreneurial Behaviour			.29	(.09)**					.40	(.08)**	.73	(.11)**
Support			.22	(.07)**					.18	(.07)*	.03	(.10)
Age			-.02	(.01)	.01	(.01)	.02	(.01)	-.02	(.01)$^{+}$	-.01	(.01)
Gender (1=Female)			-.08	(.28)	-.20	(.22)	.88	(.40)*	.17	(.27)	.10	(.31)
German Citizenship			-.28	(.22)	-.17	(.28)	.28	(.46)	-.13	(.22)	-.13	(.23)
Head of Institute			-.22	(.22)	.29	(.24)	.41	(.32)	-.24	(.23)	-.03	(.22)
Entrepreneurial Behaviour x Entre. Logic											-.90	(.16)**
Support x Entre. Logic											.60	(.10)**
Level 1 (Researcher)												
Age	-.00	(.01)	.00	(.01)					-.00	(.01)	-.00	(.01)
Gender (1=Female)	-.52	(.15)**	-.58	(.16)**					-.50	(.17)**	-.52	(.16)**
German Citizenship	-.59	(.17)**	-.68	(.18)**					-.56	(.18)**	-.62	(.19)**
Permanent Contract	-.02	(.24)	-.05	(.25)					-.03	(.23)	-.07	(.23)
PhD	-.40	(.23)$^{+}$	-.30	(.22)					-.31	(.21)	-.36	(.21)
Risk-Taking Propensity	.24	(.08)**	.24	(.08)**					.22	(.08)**	.22	(.08)*
Deviance	821.76		812.17		212.87		283.37		793.75		798.83	
Akaike Information Criterion (AIC)	857.76		844.17		216.87		287.37		841.75		860.83	

Notes: Reported are average gamma coefficients with robust standard errors; standard errors in parentheses; $^{+}$ $p \leq .10$, *$p \leq .05$, **$p \leq .01$, (two-tailed).

Model 1 provides support for our baseline Hypothesis 1 suggesting that the extent to which an entrepreneurial logic is embodied within a research organization's institutions is positively related to the entrepreneurial intentions of researchers within that research organization ($\gamma = .45$, $p < .05$).

Hypothesis 2 suggested that leaders' entrepreneurial behaviour and their support for their researchers' entrepreneurial activities mediate the relationship between the organizational-level entrepreneurial logic and researchers' entrepreneurial intentions. To test this hypothesis, we examined whether our data meet the three criteria for a mediation effect established by Baron and Kenny (1986), as described by Mathieu and Taylor (2007) for testing mediation in multilevel models. The first criterion demands that, the independent variable must be significantly related to our two mediators (Hypothesis 2a and 2b). As Models 3 and 4 reveal, this criterion is met by our data. Specifically, we observe significant positive relationships between the organizational-level entrepreneurial logic and leaders' entrepreneurial behaviour ($\gamma = .70$, $p < .01$, Model 3) and leaders' support ($\gamma = .65$, $p < .05$, Model 4). To meet the second criterion, the mediator must be significantly related to the dependent variable (Hypotheses 2c and 2d). Model 2 reveals significant positive links between researchers' entrepreneurial intentions and their leaders' entrepreneurial behaviour ($\gamma = .29$, $p < .01$) and support for researchers' entrepreneurial activities ($\gamma = .22$, $p < .01$), respectively. The third criterion demands that the relationship between the independent and dependent variable must substantially decrease in magnitude when the mediators are included in the equation. A comparison of Models 1 and 5 reveals that the third criterion for mediation is also met by our data. Specifically, including the studied mediators in the equation considerably reduces the effect of the entrepreneurial logic embodied within research organizations on researchers' entrepreneurial intentions (from $\gamma = .45$; $p < .05$, Model 1; to $\gamma = .04$; $p > .10$, Model 5).

This result is further confirmed by (Sobel, 1982) tests, which show significant indirect effects of the entrepreneurial logic mediated by leaders' entrepreneurial behaviour ($Z = 2.87$, $p < .01$) and leaders' support ($Z = 1.66$, $p < .10$). Summing up, our data thus support Hypothesis 2.

Hypotheses 3a and 3b suggest that leader behaviour also moderates the effect of an entrepreneurial logic within a research organization on researchers' entrepreneurial intentions. As shown in Model 6, both hypotheses find empirical support. The data uphold Hypothesis 3a proposing that leaders' entrepreneurial behaviour negatively moderates the relationship between the extent to which a research organization embodies an entrepreneurial logic and researchers' entrepreneurial intentions ($\gamma = -.90$, $p < .01$, Model 6). Hypothesis 3b also finds supporting evidence, as leaders' support for their researchers entrepreneurial activity positively moderates the relationship between the organizational-level entrepreneurial logic and researchers' entrepreneurial intentions ($\gamma = .60$, $p < .01$, Model 6). To illustrate the results for Hypotheses 3a and 3b, we plotted the effects of an organizational-level entrepreneurial logic at one standard deviation above and one standard deviation below the means of the two moderators (see Figures 2.3 and 2.4).

Figure 2.3: The Interaction between Entrepreneurial Logic and Leaders' Entrepreneurial Behaviour

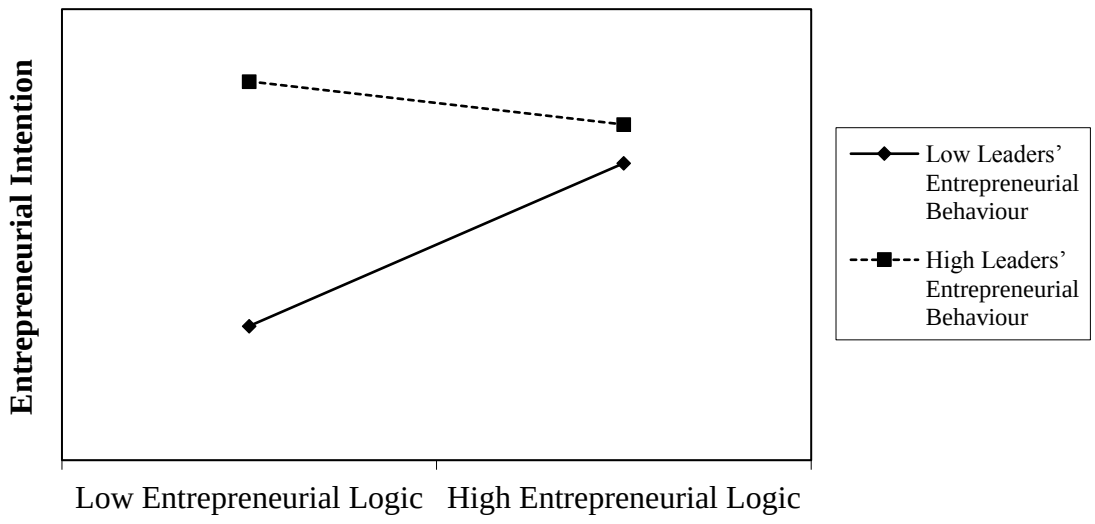
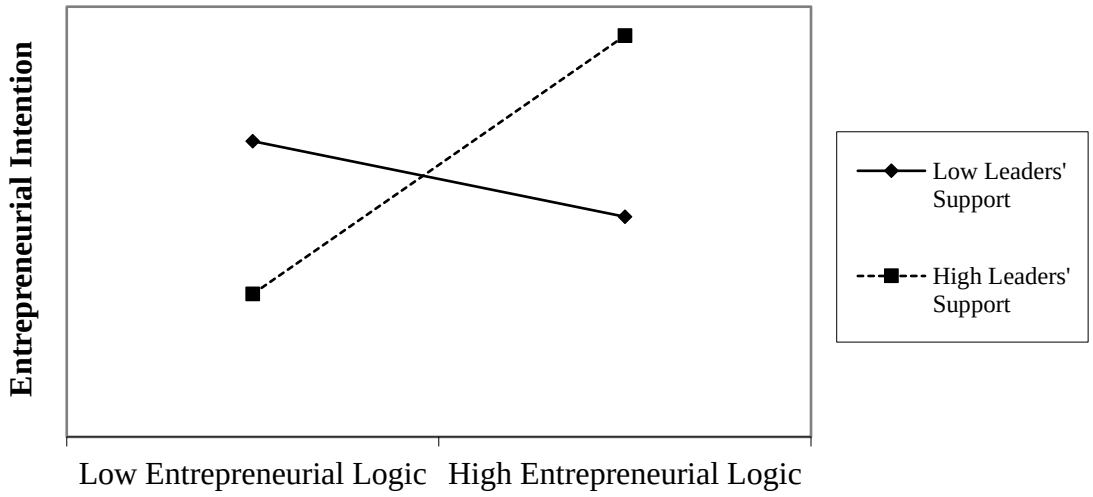


Figure 2.4: The Interaction between Entrepreneurial Logic and Leaders' Support



2.4.2 Additional Analyses

To illuminate to which extent observed relationships between researchers' entrepreneurial intentions and their research group leaders' behaviour as well as an organizational-level entrepreneurial logic rest, as we argued, on processes of attraction-selection-attrition and socialization, we reran our analyses including additional variables that reflect researchers' entrepreneurial activities prior to entering their respective research organizations. Specifically, we included researchers' *prior industry experience* in terms of the number of years researchers worked in industry before entering their current research organizations, as well as their *prior patenting experience* in terms of the number of patents a researcher filed prior to entering their current research organizations. The latter information was obtained from DEPATIS, the database of the German Patent and Trade Mark Office. We further accounted for researchers' *prior entrepreneurial experience*, in terms of the number of ventures founded, and their prior years of *self-employment*. Further, we accounted for *parental founding experience* by including a dummy variable indicating whether or not their parents ever started or took over a business. When including these variables in our models, we found all our hypothesized

relationships to remain significant, even though some of them were reduced in magnitude. Specifically, we observed that whereas including the aforementioned variables did not change the effect of leaders' support for researchers' entrepreneurial activities ($\gamma = .22$, $p < .01$), it slightly reduced the effects of an organizational-level entrepreneurial logic (from $\gamma = .45$; $p < .05$ to $\gamma = .40$; $p < .05$) and leaders' entrepreneurial behaviour (from $\gamma = .29$; $p < .01$ to $\gamma = .23$; $p < .05$). Similarly, the inclusion of the additional variables also reduced the interaction effects between an organizational-level entrepreneurial logic and leaders' entrepreneurial behaviour (from $\gamma = -.90$; $p < .01$ to $\gamma = -.75$; $p < .01$) as well as an organizational-level entrepreneurial logic and leaders' support (from $\gamma = .60$; $p < .01$ to $\gamma = .57$; $p < .01$). As indicated by prior research (De Cooman et al., 2009), these additional analyses suggest that attraction-selection-attrition processes may contribute to explaining the effects in our main analyses. However, as the values of the coefficients of the main, moderating and mediating effects we postulated only slightly diminish and retain their direction of influence and significance, we conclude that the core explanations we suggested for researchers' entrepreneurial intentions remain valid nevertheless.

Even though higher-level factors generally have a larger impact on lower-level factors than the reverse (Mathieu, Maynard, Rapp, & Gilson, 2008), and previous research found leaders in academia to not have a long-term imprinting effect on their organizations (Krabel & Schacht, 2014), we conducted additional analyses to rule out that our results are distorted by potential reverse causality. Specifically, we followed earlier research in applying a recursive structural equation modelling approach (Li, Poppo, & Zhou, 2010; Wong & Law, 1999; Zhou & Wu, 2010) to assess the possibility of reverse causal relationships between a) the organizational-level entrepreneurial logic and researchers' entrepreneurial intentions, b) the organizational-level entrepreneurial logic and research group leaders' behaviour as well as c) research group leaders' behaviour and researchers'

entrepreneurial intentions. To do so, we aggregated our data to the highest level involved and in the relationship addressed (i.e. the leader- or the organization-level) and compared three models: Model A, which comprises the hypothesized effects (hypothesized model); Model B, which comprises the proposed effects as well as potential effects with reversed causality (bi-directional model); and Model C, which comprises just the reversed causal effects (reversed-effect model). All three models additionally contained the effects of control variables that are expected to directly affect one of the variables considered, such as researchers' risk propensity and age.

Table 2.3: Results from Recursive Structural Equation Modeling

Relationships	**Model A (Hypothesized Model)**	**Model B (Bi-directional Model)**	**Model C (Reversed-effect Model)**	**Nested Model Comparison between Models A and B**
Entrepreneurial Logic & Researchers' Entrepreneurial Intentions	CFI = .904	CFI = .880	CFI = .733	$\Delta\chi^2$ (Δdf = 1, N = 49) = .58, p = .44
Entrepreneurial Logic & Leaders' Entrepreneurial Behaviour/Leaders' Support	CFI = .957	CFI = .920	CFI = .916	$\Delta\chi^2$ (Δdf = 2, N = 49) = .54, p = .76
Leaders' Entrepreneurial Behaviour/Leaders' Support & Researchers' Entrepreneurial Intentions	CFI = .982	CFI = .973	CFI = .872	$\Delta\chi^2$ (Δdf = 2, N = 85) = 1.26, p = .53

As depicted in Table 2.3, comparative fit index (CFI) comparisons (Hu & Bentler, 1999) reveal that our hypothesized models (Models A) demonstrate a very good overall fit with our data and show a better fit with our data than Models B and C. Nested model comparisons further indicate that additionally including possible reverse causal effects does not significantly increase the fit with our data. We are thus confident that reverse causality is not a significant issue in our study.

To further rule out potential endogeneity concerns, we followed earlier research (Colombo & Grilli, 2005; Cui, Wong, & Lui, 2006) and applied a control function approach (Gourieroux, Monfort, Renault, & Trognon, 1987; Vella & Verbeek, 1999). To do so, we first computed the generalized residuals for each of our explanatory variables from regressions that included related control variables and additional exogenous variables. When adding the computed residuals into our main analyses, we found our results confirmed.

Based on these additional test, we are confident that our empirical findings are robust.

2.5 Discussion

While it is widely recognized among institutional theorists that new institutional logics are not uniformly embraced and adopted by organizations (Kraatz & Block, 2008; Lounsbury, 2007; Pache & Santos, 2010; Reay & Hinings, 2009), much less is known about the adoption of new institutional logics by individual organization members, in general (Luo, 2007; Zilber, 2002), and with regard to the individual embracing of an entrepreneurial logic by researchers in academia, in particular. Examining how a complex interplay between an organizational-level entrepreneurial logic and two distinct facets of leader behaviour relates to the entrepreneurial intentions of researchers in academia, the present study contributes to illuminating when and how an organization-level institutional logic translates into individual-level mindsets. Responding to the call from Kim et al. (2016), the present study specifically highlights meso-level processes that can help us understand when and how an entrepreneurial institutional logic translates to individual-level entrepreneurial intentions, an essential condition and precursor of academic entrepreneurial activities.

We first of all observed that the extent to which research organizations adopt and institutionalize an entrepreneurial logic has effects for researchers' inclinations towards entrepreneurial activity. This result supports the idea that due to selection-attrition-retention as well as socialization processes (De Cooman et al., 2009), the attitudes and behaviours of organization members are shaped by organizational-level institutions. While institutionalized structures aimed at fostering and supporting the commercialization of academic research results, such as technology transfer offices, have been found to be of limited effectiveness (Siegel & Wright, 2015), the social and cognitive processes we studied seem to exert a significant influence on the extent to which researchers within academia display entrepreneurial intentions.

Our study further elucidates how the relationship between organizational-level institutions and individual mindsets might be explained. First, our study identifies organizational-level institutions as a crucial driver for leader behaviour that stimulates individual-level entrepreneurial intentions. Our study thus provides empirical evidence underscoring the idea that leaders serve as agents of legitimacy within organizations (Dacin et al., 2002) and are thus crucial for conveying the effects of an organizational-level logic to the individual level (Jarzabkowski & Sillince, 2007). Highlighting the mediating role of two distinct facets of leader behaviour for the link between organizational-level institutions and individual researchers' entrepreneurial intentions, our study complements prior research on academic entrepreneurship (Bercovitz & Feldman, 2008; Krabel & Schacht, 2014). First, our study substantiates the notion that leaders' role model behaviour can be an important driver for researchers' entrepreneurial intentions (Bercovitz & Feldman, 2008; Krabel & Schacht, 2014). Second, with regard to leader support our study extends previous research by Rasmussen, Mosey and Wright (2014). Based on a case study in the context of university departments, the authors

conclude that support from management and senior academics importantly shapes the subsequent development of university spin-offs. In extension of these findings, our study indicates that leader behaviour already importantly influences an earlier stage of academic entrepreneurship, the formation of entrepreneurial intentions among researchers.

The present study also points out that leader behaviour does not just help to transmit organizational-level institutions to the individual level. Rather, we also find that through their behaviour leaders moderate the relationship between organizational-level institutions and individual attitudes. Specifically, we observe that leaders' entrepreneurial behaviour weakens the link between an organizational-level entrepreneurial logic and organization members' entrepreneurial intentions, while leaders' support for researchers' entrepreneurial activities strengthens it. We argued that the reason for these effects is that different facets of leader behaviour exert their influence through different pathways. Organizational-level institutions legitimize behaviour (Besharov & Smith, 2014; Spicer & Sewell, 2010) and thus primarily shape the desirability perceptions of organization members. Signalling what kind of behaviour is appropriate and will likely be rewarded in an organizational context (Bandura, 1986; Schein, 1985), some facets of leader behaviour—such as their entrepreneurial behaviour—exert their influence via a similar mechanism, thus serving as a substitute for organizational-level institutions. In contrast, other facets of leader behaviour—such as their direct support for their subordinates' activities—complement organizational-level institutions in shaping organization members' attitudes and behaviour, as they primarily affect individuals' perceptions of feasibility. Considering that the effects of leader support for researchers' entrepreneurial intentions rest on the provision of resources, this latter finding also complements earlier research on how organizations in academia can foster academic entrepreneurship.

Specifically, prior research suggests that by providing slack time or enhancing the entrepreneurial knowledge (Lockett et al., 2005) and competencies of their researchers (Rasmussen et al., 2011, 2014), organizations may facilitate academic entrepreneurship. Our study suggests that such initiatives will much more likely succeed when complemented by the normative, cognitive and regulative elements reflecting an entrepreneurial logic on the organizational level.

Pointing to the significant role of organizational-level institutions and leader behaviour for establishing an entrepreneurial logic in the field of academia, our study also has clear practical implications. First, in order to foster entrepreneurial activities among academic researchers, it is not sufficient that policy makers propagate an entrepreneurial logic at the field-level, e.g. through national policies or sector-specific educational programs. Rather, the challenge lies in convincing research organizations to adopt and embody this logic and research group leaders to transmit them to the individual level. To fully exploit the potential of an organizational-level entrepreneurial logic for promoting academic entrepreneurship, it is further crucial that academic research group leaders can access resources to support their researchers in pursuing entrepreneurial activities, which complements organizational-level signals of legitimacy with perceptions of the feasibility of entrepreneurial activities.

2.6 Limitations and Future Research

Some limitations of our study provide opportunities for future research. First, our study focuses on the entrepreneurial intentions of researchers. Even though these intentions are recognized as the most proximal and important predictor of engaging in entrepreneurial behaviour (Dutta & Thornhill, 2008; Lee et al., 2011; Prodan & Drnovsek, 2010), we have to leave it to further research to address how an organizational-level entrepreneurial logic and the facets of leader behaviour addressed in our study ultimately contribute to

explaining researchers' entrepreneurial behaviour. Further, our study did not explain variance in the adoption of an entrepreneurial logic across research organizations. Future research might thus fruitfully address whether the same factors as in other fields (see, e.g. Lander et al., 2013; Marquis & Lounsbury, 2007; Zilber, 2002) contribute to explaining why research organizations vary with respect to the extent to which they accede to a new field-level logic. Finally, our study rests on data from a single national context. Consequentially, it was beyond the scope of the present paper to examine how potential societal-level differences may affect the correspondence between individual attitudes, organizational-level institutions and different facets of leader behaviour.

3 For Whom Size Matters – The Interplay between Incubator Size, Tenant Characteristics and Tenant Growth[1]

3.1 Introduction

Business incubators are property-based organizations with identifiable administrative centers, which provide their tenants with infrastructure, business support, and network resources (Phan, Siegel, & Wright, 2005). Incubation theory suggests that business incubators can facilitate the creation and successful development of new businesses, as they help tenants to overcome early-stage resource deficits (Bøllingtoft & Ulhøi, 2005; Hackett & Dilts, 2004b). While the general potential of business incubators to facilitate venture development has long been recognized (Allen & Rahman, 1985; Udell, 1990), scholars have more recently begun to discuss what incubators are best suited to facilitate their tenants' development (Schwartz, 2012; Schwartz & Hornych, 2010). Specifically, researchers have examined the performance implications of incubator characteristics such as age (Link & Scott, 2003; Peters et al., 2004; Schwartz, 2012), size (Aerts et al., 2007; Allen & McCluskey, 1990), specialization strategy (Aerts et al., 2007; Schwartz & Hornych, 2008, 2010), and sponsorship structure (Allen & McCluskey, 1990; Peters et al., 2004). However, the results generated by this stream of research are largely inconclusive (Schwartz, 2012).

In order to help resolve these inconclusive findings, the present study introduces a multilevel "fit" perspective to business incubation research (Hackett & Dilts, 2004a; Tavoletti, 2013). Specifically, we build on contingency theory (Drazin & Van de Ven, 1985) to provide theoretical arguments and empirical evidence, thus suggesting that it is

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not necessarily incubator characteristics per se but rather the cross-level interplay between incubator and tenant characteristics that is crucial for explaining tenant development. In detailing our theoretical reasoning, we focus on business incubator size, which seems fruitful for several reasons. First, incubator size is expected to affect tenant development (Aerts et al., 2007; Allen & McCluskey, 1990). However, prior research results on the consequences of incubator size for relevant outcomes are ambiguous. While Allen and McCluskey (1990) observe positive implications of incubator size, Aerts et al. (2007) reach a different conclusion.[2] Second, incubator size is a discretionary design feature related to the investments involved in establishing an incubator facility (Tavoletti, 2013). Policy makers and private investors alike thus need guidance on whether establishing larger business incubators may pay off.

Multilevel analyses of data from 276 tenants nested in 67 incubators in Germany provide evidence in support of our theoretical reasoning. In line with our hypotheses, we find that the effect of incubator size on tenant growth is contingent upon the size of the tenants' venture team and whether tenants are operating in a high-tech industry—two characteristics driving a venture's need for a larger quantity and variety of resources. Through these findings, the present study contributes to establishing a multilevel perspective in business incubation research (Hackett & Dilts, 2004a; Tavoletti, 2013). Specifically, our study provides theoretical arguments and empirical evidence suggesting that it is not necessarily incubator characteristics per se but rather the cross-level interplay between incubator and tenant characteristics that is crucial for incubation outcomes. Highlighting that a "one-size-fits-all approach" to incubator design may be inappropriate, our study also has clear practical implications.

[2] Please note that Allen and McCluskey (1990) rely on the number of tenants to indicate incubator size, while Aerts et al. (2007) capture incubator size by means of the space an incubator provides to its tenants. As described in more detail later in our manuscript, we find the two measures to be significantly interrelated.

3.2 Theory and Hypotheses

Business incubators all over the world share the common goal of supporting venture development, and they aim to reach this objective through the provision of infrastructure, business support, and networks (Allen & McCluskey, 1990; Bergek & Norrman, 2008; Bruneel, Ratinho, Clarysse, & Groen, 2012; Ferguson & Olofsson, 2004; Schwartz, 2013). However, there is considerable variance among the population of business incubators with respect to characteristics such as size, age, specialization strategy, and sponsorship structure (Aerts et al., 2007; Peters et al., 2004). Based on this observation, scholars have recently begun to argue which types of incubators are better able to facilitate venture development (Link & Scott, 2003; Peters et al., 2004; Schwartz, 2012; Schwartz & Hornych, 2010).

Due to organizational learning and the accumulation of expertise, for instance, scholars have argued that older rather than younger incubators are better able to provide the support needed for superior tenant development (Link & Scott, 2003; Peters et al., 2004; Schwartz, 2012). Empirical research addressing the performance implications of incubator age, however, has yielded controversial results. While Allen and McCluskey (1990) found a positive impact of incubator age, Schwartz (2012) observed a negative relationship between incubator age and firm survival after graduation. According to Schwartz (2012), the latter result may be explained by the fact that older incubators are under higher pressure to achieve high occupancy rates, which requires them to invest in time-intensive marketing and management activities and can result in less time available for supporting the development of their tenants.

Researchers also have argued that incubator specialization (i.e., focus on hosting tenants from particular industries) may be beneficial (Aerts et al., 2007; Schwartz & Hornych, 2010). However, neither Aerts et al. (2007) nor Schwartz and Hornych (2010)

found that tenants profited from being located in a specialized incubator. In contrast, the incubator sponsorship structure was found to be consequential for tenant development. Specifically, Peters et al. (2004) observed that, compared with their private or university counterparts, incubators sponsored by public institutions have more graduating ventures on average.

Another discretionary design characteristic in which incubators vary considerably is size (Aerts et al., 2007; Allen & McCluskey, 1990). While some incubators host up to 100 tenants and employ more than 10 staff members on a full-time basis, others are rather small, hosting 10 or fewer tenants and being run by just one full-time employee (Isabelle, 2013; Schwartz & Hornych, 2010). Subsequently, we will detail why such differences in incubator size might be consequential for tenant development. Building on contingency theory (Drazin & Van de Ven, 1985), we will then develop a multilevel "fit" perspective on business incubation to derive detailed hypotheses on why we expect the effect of incubator size on tenant growth to be contingent upon the size of tenants' venture team and whether tenants are operating in a high-tech industry.

3.2.1 Incubator Size and Tenant Growth

Incubation theory suggests that, by providing access to needed infrastructure, business support, and network contacts, business incubators facilitate the development of their tenants (Bøllingtoft & Ulhøi, 2005; Hackett & Dilts, 2004b). Based on this fundamental premise, some arguments suggest that tenants can profit from being located in a larger incubator (Aerts et al., 2007; Allen & McCluskey, 1990).

Due to economies of scale and scope, larger incubators can provide their tenants with a larger quantity of resources in terms of infrastructure and business support. The infrastructure that incubators typically offer to their tenants includes office space (Bergek & Norrman, 2008), production facilities (Grimaldi & Grandi, 2005), meeting and

conference rooms, and reception and clerical services (McAdam & McAdam, 2008). The availability of a greater quantity of such resources can be beneficial for tenant development, as tenant ventures typically lack resources in substantial quantities (Schwartz, 2013). Similarly, a greater quantity of support services offered in areas such as planning, marketing, accounting, and taxes (Bøllingtoft & Ulhøi, 2005; Bruneel et al., 2012; Hansen, Chesbrough, Nohria, & Sull, 2000) can be beneficial because incubator tenants often lack necessary management skills and thus heavily depend on business support provided by the incubator (Bruneel et al., 2012). Further, larger incubators are able to provide their tenants with a larger number of network contacts (Aerts et al., 2007). Larger incubators host a greater number of ventures, which enlarges the pool of valuable information and knowledge, as well as potential partners for joint collaboration available within the incubator (Schwartz & Hornych, 2010). Moreover, having more staff members also results in a greater pool of external network contacts on which tenants can potentially rely.

In addition to providing a greater quantity of resources, larger incubators can typically also provide a larger variety of resources to their tenants. For a business incubator, investments in specific infrastructure, such as specialized laboratories and sophisticated equipment (Grimaldi & Grandi, 2005), only pay off when the infrastructure is used by a significant number of tenants. Consequently, incubators hosting a larger number of tenants are more likely to be able to afford such investments. Due to their higher staff member capacity, larger incubators are also likely to be able to offer a greater variety of specific services, such as technological consulting, than their smaller counterparts (Schwartz & Hornych, 2008; Scillitoe & Chakrabarti, 2005). Additionally, the greater the number of network contacts potentially available to tenants in larger

incubators increases the chances that diverse resources will be available through these network contacts (Greve, 1995; Greve & Salaff, 2003).

However, being located in a larger incubator is also associated with particular downsides. While larger incubators may provide a larger quantity and variety of resources, tenant ventures will likely have to invest more time and energy in developing ties to staff members and fellow tenant companies to facilitate timely and easy access to needed resources. The fact that larger incubators comprise a greater number of tenants and staff members results in a more impersonal and anonymous atmosphere (Aerts et al., 2007; Bøllingtoft & Ulhøi, 2005), which is not conducive to establishing stronger interpersonal bonds (Lee & Tsang, 2001; Semrau & Werner, 2014). Stronger interpersonal relationships, however, are essential for obtaining easy and timely access to needed resources, as relationship intensity increases network alters' motivation to grant access to their resources (Krackhardt, 1992; McFadyen & Cannella Jr., 2004; Steier & Greenwood, 2000) and improves the efficacy of resource exchanges by fostering mutual understanding (McFadyen & Cannella Jr., 2004; Uzzi, 1997).

In summary, the quantity and variety of resources potentially available to tenant ventures typically increases with incubator size. At the same time, however, tenant ventures in larger incubators will need to invest more time and energy into establishing strong interpersonal bonds that allow easy and timely resource access. Based on these arguments, and in line with prior research (Aerts et al., 2007; Allen & McCluskey, 1990), we thus anticipate that incubator size will not have a universally positive or negative effect on tenant development. Instead, as we will subsequently outline in detail, we propose that the effect of incubator size on tenant development is contingent upon certain tenant characteristics.

3.2.2 Tenant Characteristics as Contingency Variables

According to contingency theory (Drazin & Van de Ven, 1985), it is the fit among key variables (e.g., environment, structure, and strategy) that determines firm performance and necessitates investigations that go beyond simple main effects. Building on this fundamental premise, we acknowledge the potentially crucial role of "fit" between incubator and tenant companies (Autio & Klofsten, 1998) to suggest that a multilevel fit perspective is needed to explain the link between incubator characteristics and tenant growth. Subsequently, we will detail this notion by developing hypotheses on how two tenant characteristics —a) the size of tenants' venture team and b) whether a tenant operates in a high-tech industry—moderate the link between incubator size and venture growth.

3.2.2.1 The Moderating Impact of Venture Team Size

Academics and practitioners alike have emphasized the importance of venture team size (Klotz, Hmieleski, Bradley, & Busenitz, 2014; Vyakarnam & Handelberg, 2005). The presence of more team members implies that there are more people available for dealing with the challenges of developing a business. Every venture team member also increases the venture's resource pool (Hambrick & D'Aveni, 1992; Wiersema & Bantel, 1992) by contributing physical and financial assets, skills, stocks of knowledge and/or network contacts (Shane & Stuart, 2002). Increasing the number of venture team members also offers additional opportunities for the division of labor (Eisenhardt & Schoonhoven, 1990), which entails the efficiency benefits of specialization (Edwards & Starr, 1987). Even though entrepreneurs tend to team up with others who are similar to themselves (Steffens, Terjesen, & Davidsson, 2012), additional venture team members also typically add to the bandwidth of diversity (Wiersema & Bantel, 1992). Based on these notions, we anticipate that tenants with larger (vs. smaller) venture teams will gain comparably

less from the benefits associated with incubator size. Formally, we thus expect venture team size to negatively moderate the link between incubator size and tenant growth.

As noted above, tenant firms can potentially profit from being located in a larger incubator, as it provides a higher quantity and a larger variety of resources in terms of infrastructure, business support, and network contacts. Compared to tenants with smaller venture teams, those with larger teams typically have greater pools of resources and network contacts readily available (Hambrick & D'Aveni, 1992; Shane & Stuart, 2002). Additionally, specialization benefits may allow larger venture teams to more efficiently use their resources (Cullen, Anderson, & Baker, 1986). Ventures with larger teams are thus less likely to suffer from resource needs constraining their growth. Consequentially, the increased quantity of resources that larger (vs. smaller) incubators can provide will likely be less beneficial for tenants with larger (vs. smaller) venture teams. Similarly, tenants with larger venture teams can rely on comparably greater bandwidth and variety of internal resources (Wiersema & Bantel, 1992). Such resource diversity, however, decreases the probability that additional types of resources available within larger (vs. smaller) incubators will meet unsatisfied needs and thus contribute significantly to tenant growth.

Based on these arguments, we expect that ventures with larger (vs. smaller) venture teams will be less likely to profit from incubator size. Hence, we propose:

Hypothesis 1: The relationship between incubator size and tenant growth will be negatively moderated by tenants' venture team size.

3.2.2.2 High-Tech vs. Low-Tech Ventures

Ventures operate in very different business environments, which shape the quantity and quality of resources needed to prosper and grow (Covin, Slevin, & Covin, 1990). High-

tech ventures operate in a business environment that involves rapid changes in technology, competition, and market demands and is thus associated with time pressures (Anand & Khanna, 2000; Liao & Welsch, 2008) and high levels of environmental uncertainty that induce risk (Dess & Beard, 1984; Francis & Collins-Dodd, 2000; Wu, 2007). In order to adequately respond to such environmental conditions and generate innovative solutions, high-tech businesses are in need of significant amounts of slack resources, which serve as buffers for unforeseen events and temporary setbacks (Miller & Friesen, 1983). Moreover, high-tech companies often need highly specific assets, such as laboratory capacities or equipment (Löfsten & Lindelöf, 2003; Schwartz & Hornych, 2008) as well as network contacts that satisfy specific resource needs, such as venture capitalists who are willing to provide large amounts of financial capital for the pursuit of risky business opportunities (Liao & Welsch, 2008; Shane & Stuart, 2002). Based on these observations, we expect high-tech ventures to benefit more than their low-tech counterparts from being located in larger incubator facilities. In other words, we anticipate that the relationship between incubator size and tenant growth is positively moderated by operating in a high-tech industry.

As noted earlier, tenants can profit from being located in larger incubators, as these incubators provide access to larger amounts of more specific resources. Compared to low-tech ventures, high-tech businesses require larger amounts of resources to prosper (Liao & Welsch, 2008; Roure & Keeley, 1990). Consequently, these businesses should profit more from the greater resource endowments that larger business incubators offer. Similarly, the greater array of resources that larger incubators provide should be more valuable for high-tech than for low-tech tenants. Special laboratory facilities and equipment, for instance, are crucial for developing a high-tech business (Lindelöf & Löfsten, 2004), while these are largely irrelevant for the growth of low-tech firms.

Similarly, high-tech (vs. low-tech) firms will be more likely to profit from specific network contacts, which are more likely to be provided by larger business incubators.

In sum, we thus expect that the growth of high-tech (vs. low-tech) tenants will more likely benefit from incubator size. Consequently, we propose:

Hypothesis 2: The relationship between incubator size and tenant growth will be positively moderated by tenants' high-tech industry affiliation.

3.3 Method

3.3.1 Sample

To test our hypotheses, we collected secondary data from business incubators and their tenants in Germany in two subsequent years (year 1 and year 2). Early in year 1, 113 incubator facilities and their tenants were identified through the website of the German Association of Innovation, Technology and Business Incubation Centers (ADT). Based on information from incubator websites, we then excluded facilities that did not match our conceptualization, as they did not provide their tenants with a "full set" of support components (i.e., infrastructure, business and network support). We further excluded incubators that did not disclose the names of their tenants. This resulted in a shortlist of 81 business incubators. Excluding subsidiaries of larger organizations, we then matched information on the 746 tenants located in those 81 incubators with records from the DAFNE database (Bureau van Dijk, 2016). Updated on a monthly basis, the DAFNE database provides information on variables such as total assets, age, and industry for all German companies that are legally required to disclose financial statements. Due to limited reporting requirements, the data available on small firms are rather sparse. Nevertheless, we were able to identify 276 tenant ventures (37%) located in 67 incubators (82%) for whom the data needed for our study were available. In year 2, we revisited the

DAFNE database to obtain the additional information needed to capture our dependent variable.

On average, the tenant companies in our sample had a venture team comprising 2.85 members. Of the ventures in our sample, 52% operated in a high-tech industry. On average, the incubators in our sample had been in business for 17.22 years. Public institutions sponsored 61% of our incubators. Similar to the percentage of specialized incubators reported by the ADT (Baranowski, Dressel, & Glaser, 2008), 22% of the incubators in our sample specialized in hosting tenants from one or a limited number of industries.

3.3.2 Measures

Dependent Variable. To capture *venture growth*, we followed earlier research (Cooper, Gulen, & Schill, 2008; Weinzimmer, Nystrom, & Freeman, 1998) and used a simple and comprehensive measure of firm asset growth: the year-on-year percentage change in total assets. Specifically, we constructed a measure reflecting firm asset growth from the beginning of year 1 to the beginning of year 2.

Independent Variable. To capture *incubator size*, we followed prior research (Allen & McCluskey, 1990) and created a count variable that reflects the number of tenants located in our business incubators in year 1. Further analyses among those business incubators in our sample, which also made these additional data available (N = 23) reveal that the number of tenants within an incubator is positively related to two other variables associated with incubator size. Specifically, correlation analyses revealed significant positive correlations a) between the number of tenants and incubator staff members (r = .496, p < .05) and b) between the number of tenants and the rental space offered by the incubator (r = .457, p < .05).

Moderators. To capture our first moderator, *venture team size*, we followed earlier research (Burton, Anderson, & Aldrich, 2009; Reynolds, 2007) and created a count variable reflecting the number of venture owners listed in the DAFNE database for year 1. To reflect our second moderator, we followed Schwartz (2012) in constructing a dummy variable that takes a value of 1 for tenants operating in a *high-tech* industry and 0 otherwise. To categorize a venture as either operating or not operating in a high-tech industry, such as "manufacturing of computer, electronic and optical products" or "telecommunication," we relied on a classification established by Niefert, Metzger, Heger, and Licht (2006) and also applied by (Schwartz, 2012).[3]

Controls. In our analyses, we controlled for several incubator and tenant characteristics. We controlled for *incubator age* (measured in years) to account for potential learning effects at the incubator level that may affect tenant development (Allen & McCluskey, 1990). As scholars have suggested that *incubator specialization* can potentially affect tenant development (Aerts et al., 2007; Schwartz & Hornych, 2008, 2010), we also included a dummy variable indicating whether an incubator specialized in hosting tenants from particular industries. We further accounted for the potential effects of differences in incubator sponsorship (Aernoudt, 2004; Allen & McCluskey, 1990; Peters et al., 2004). Specifically, we included two dummy variables—*private* and *public*––in our analyses, leaving *hybrid* as a reference category. While private incubators are set up by independent entities such as individuals (Becker & Gassmann, 2006; Grimaldi & Grandi, 2005), public incubators are sponsored by public institutions, such as the regional or national government (Hackett & Dilts, 2004a). Meanwhile, hybrid incubators are set up by coalitions of the aforementioned sponsors (Phillips, 2002). We further included a dummy variable indicating whether a *university* is associated with the incubator. Finally,

[3] For the entire list of industries considered high-tech, please refer to Niefert, Metzger, Heger, and Licht (2006, p. 68).

we controlled for potential regional differences by including dummy variables in our analyses that reflect whether an incubator was located in the *north*, *south*, or *east* of Germany, leaving *west* as the reference category.

We also controlled for several tenant characteristics. First, we followed earlier research and controlled for industry effects (Schwartz & Hornych, 2010; Short, McKelvie, Ketchen, & Chandler, 2009). Specifically, we built upon the NACE Rev. 2 classification of economic activities (Schneider & Veugelers, 2010) to account for whether tenants operate in *manufacturing*, *construction*, *wholesale and retail trade*, *information and communication*, *scientific and technical activities*, or *other service activities*. *Others* served as a reference category. Since differences in ventures' development may affect the extent to which they rely on incubator services (Bruneel et al., 2012), we further controlled for *venture age*. Considering that firms with limited liability might have a higher willingness to take risks and potentially realize higher growth rates (Almus & Nerlinger, 1999), we also included a dummy variable indicating a legal form associated with *limited liability*. Finally, following earlier research (Barkema & Schijven, 2008; Baum, Calabrese, & Silverman, 2000; Danneels, 2008), we entered our lagged dependent variable in our analyses. Including *lagged venture growth* (ventures' asset growth from year 0 to year 1) mitigates the risk that our results are biased due to a potential selection or self-selection of high-growth firms into particular incubators.

3.3.3 Analytical Approach

As our data comprise two levels of analyses, tenants (level 1) nested in business incubators (level 2), we resorted to a multilevel model (Hofmann, 1997; Klein & Kozlowski, 2000) and used HLM 7 (Bryk & Raudenbush, 1992) to test our hypotheses. A multilevel model allows us to estimate, simultaneously and without biases, effects at different levels of analysis (Arnold, 1992; Gavin & Hofmann, 2002; Klein & Kozlowski,

2000). Consequently, this model is best suited to examine the effects of incubator-level variables on tenant-level outcomes as well as cross-level interactions. Following established procedures, we grand-mean-centered our tenant-level control variables, while we group-mean-centered our moderators to avoid a conflation of between-group and within-group effects and to allow a direct interpretation of cross-level interaction results (Aguinis et al., 2013; Enders & Tofighi, 2007; Hofmann & Gavin, 1998).

3.4 Results

3.4.1 Main Analysis

Table 3.1 displays descriptive statistics and correlations of our study variables.

Table 3.1: Descriptive Statistics and Correlations

N = 276 (L1), 67 (L2)	Mean	SD	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Level 2 (Incubators)													
1. Incubator Size	32.81	16.76											
2. Incubator Age	17.22	5.59	.059										
3. Incubator Specialization	.22	.42	-.196	-.299*									
4. Public	.61	.49	-.140	.259*	.134								
5. Private	.13	.34	.133	-.182	-.107	-.495**							
6. University	.06	.24	.147	.058	.016	.201	-.099						
7. North	.19	.40	.092	.184	-.082	-.074	-.083	.036					
8. South	.16	.37	-.150	-.163	.052	-.060	.180	.058	-.217				
9. East	.48	.50	.052	-.044	-.012	.210	.061	.011	-.469**	-.424**			
Level 1 (Tenants)													
1. Venture Growth	15.53	36.48											
2. Lagged Venture Growth	19.55	75.09	.050										
3. Venture Age	9.78	5.61	-.125*	-.121*									
4. Limited Liability	.91	.29	.132*	-.024	.051								
5. Manufacturing	.28	.45	-.050	-.017	.074	-.018							
6. Construction	.04	.20	-.004	-.059	.011	.002	-.128*						
7. Wholesale & Retail Trade	.17	.38	.096	-.019	-.069	.083	-.288**	-.093					
8. Information & Communication	.14	.35	.017	.096	-.075	-.114	-.258**	-.084	-.189**				
9. Scientific & Technical Activities	.25	.43	-.041	-.016	.051	.069	-.359**	-.116	-.262**	-.235**			
10. Other Service Activities	.03	.18	-.067	-.051	.004	-.011	-.115	-.037	-.084	-.076	-.105		
11. Venture Team Size	2.85	3.11	.036	-.090	.029	-.115	-.022	-.044	-.061	-.030	.146*	.088	
12. High-Tech	.52	.50	.175**	.054	.031	.061	.219**	-.100	-.151*	.273**	-.038	-.150*	.047

Notes:*p < .05, **p <.01 (two tailed).

Correlation results reveal that incubator age and specialization are significantly negatively related (r = -.299, p < .05). This result is in line with the notion that government bodies and other sponsors have only recently begun to establish specialized incubators (Schwartz & Hornych, 2010). Also in line with prior research (Bruneel et al., 2012), we observe a significant negative link between venture age and venture growth (r = -.125, p < .05). Moreover, we find limited liability (r = .132, p < .05) and operating in a high-tech industry (r = .175, p < .01) to be positively associated with venture growth.

Table 3.2 depicts the results of our multilevel regression analyses.

Table 3.2: Results from Multilevel-Analyses

N = 276 (L1), 67 (L2)	**Venture Growth**							
	Model 1:		**Model 2:**		**Model 3:**		**Model 4:**	
Level 2 (Incubator)								
Intercept	14.83	(1.84)**	14.81	(1.84)**	14.80	(1.83)**	14.79	(1.84)**
Incubator Size	-.02	(.08)	-.04	(.08)	-.02	(.08)	-.04	(.08)
Incubator Age	.71	(.35)*	.72	(.35)*	.72	(.34)*	.73	(.35)*
Incubator Specialization	-3.77	(4.54)	-3.66	(4.55)	-3.89	(4.54)	-3.67	(4.57)
Public	-2.80	(4.43)	-2.86	(4.44)	-2.62	(4.41)	-2.94	(4.42)
Private	.77	(4.65)	.70	(4.77)	.95	(4.67)	.57	(4.79)
University	1.67	(4.44)	2.78	(4.69)	1.97	(4.52)	2.92	(4.72)
North	-13.94	(6.50)*	-13.65	(6.50)*	-13.89	(6.48)*	-13.56	(6.47)*
South	-21.87	(7.43)**	-21.59	(7.42)**	-21.91	(7.42)**	-21.66	(7.43)**
East	-6.93	(6.53)	-7.21	(6.49)	-7.04	(6.50)	-7.17	(6.47)
Level 1 (Tenant)								
Lagged Venture Growth	.01	(.05)	.01	(.05)	.01	(.05)	.00	(.05)
Venture Age	-.96	(.42)*	-.98	(.42)*	-.97	(.42)*	-1.00	(.42)*
Limited Liability	14.29	(5.36)*	14.32	(5.42)*	13.84	(5.42)**	13.98	(5.22)**
Manufacturing	-17.14	(9.37)+	-17.62	(9.42)+	-16.85	(9.42)+	-16.96	(9.39)+
Construction	-11.17	(9.79)	-10.77	(9.65)	-10.24	(9.51)	-9.15	(9.15)
Wholesale & Retail Trade	-6.42	(8.53)	-7.00	(8.70)	-7.28	(8.51)	-7.42	(8.63)
Information & Com.	-13.28	(10.73)	-14.16	(10.60)	-12.59	(10.80)	-12.95	(10.63)
Scientific & Technical Act.	-14.53	(9.56)	-14.64	(9.66)	-14.05	(9.69)	-14.13	(9.72)
Other Service Activities	-20.21	(11.28)+	-23.69	(11.09)*	-19.87	(11.15)+	-24.05	(10.90)*
Venture Team Size	.50	(.94)	.91	(.71)	.45	(.94)	.86	(.71)
High-Tech	17.06	(4.88)**	17.50	(4.88)**	13.58	(5.72)*	13.54	(5.67)*
Cross-Level Interactions								
Venture Team Size x Inc. Size			-.12	(.04)**			-.12	(.04)**
High-Tech x Inc. Size					.39	(.16)*	.38	(.15)*
Deviance	2728.31		2723.89		2725.87		2721.16	
Akaike Information Criterion (AIC)	2784.31		2781.89		2783.85		2781.16	

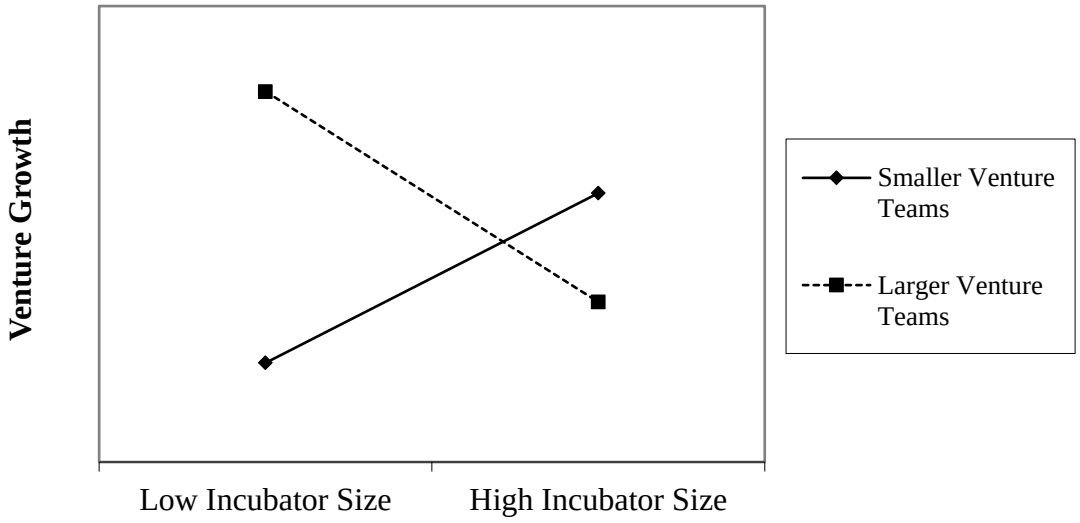
Notes: Full information maximum likelihood estimation; reported are average gamma coefficients with robust standard errors; standard errors in parentheses; + p <.10, *p < .05, **p <.01 (two-tailed).

In line with our theoretical reasoning, Model 1 shows no significant main effect of incubator size on venture growth (γ = -.02, p = n.s.). In contrast, we find significant relationships between venture growth and incubator age (γ = .71, p < .05) as well as whether an incubator is located in the north (γ = -13.94, p < .05) or south (γ = -21.87, p < .01) of Germany. In line with our correlation results, Model 1 further reveals significant relationships between our dependent variable and venture age (γ = -.96, p < .05) and limited liability (γ = 14.29, p < .05).

Hypothesis 1 proposes a negative moderating effect of venture team size on the relationship between incubator size and venture growth. Our data provide supporting evidence for Hypothesis 1. Specifically, Models 2 and 4 reveal significant negative interaction effects of incubator size and venture team size (γ = -.12, p < .01, Model 2; γ = -.12, p < .01, Model 4).

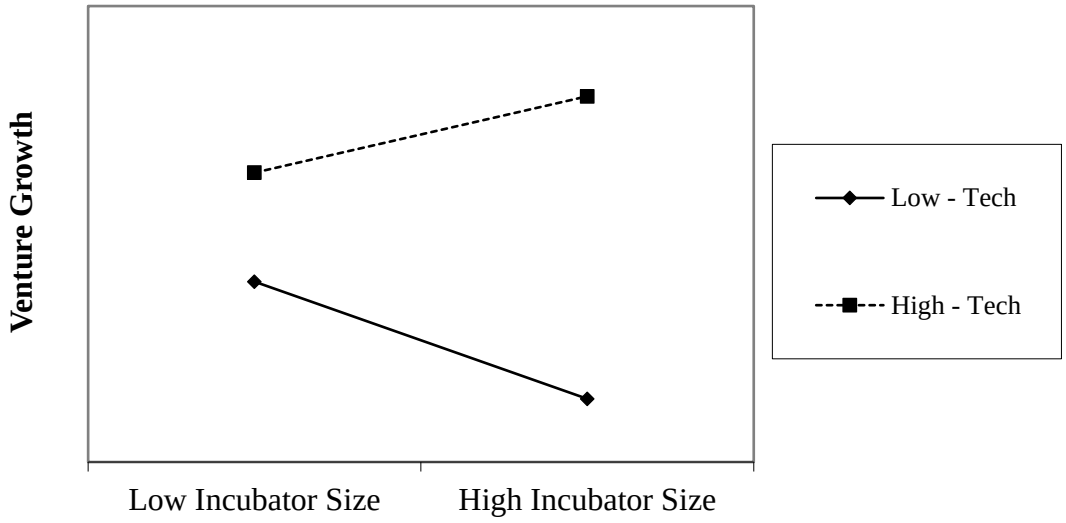
To elaborate upon these results, we conducted simple slope analyses (Aiken & West, 1991; Preacher, Curran, & Bauer, 2006) for the effect of incubator size on venture growth for tenants with a venture team size one standard deviation below the mean (smaller venture teams) and one standard deviation above the mean (larger venture teams). These analyses revealed a significant positive relationship between incubator size and venture growth among tenants with smaller venture teams (b_{low} = .35, p < .01). In contrast, we find a significant negative relationship between incubator size and venture growth among ventures with larger teams (b_{high} = -.42, p < .05). Figure 3.1 illustrates these results.

Figure 3.1: The Moderating Effect of Venture Team Size



Hypothesis 2 proposes that the relationship between incubator size and venture growth is positively moderated by tenants' high-tech industry affiliation. Revealing positive interaction effects between incubator size and high-tech industry affiliation (γ = .39, p < .05, Model 3; γ = .38, p < .05, Model 4), our analyses also support Hypothesis 2. Underlining these results, simple slope analyses revealed a significant negative relationship between incubator size and venture growth for low-tech ventures (b_{low} = -.23, p < .10), whereas the relationship between incubator size and venture growth was found to be positive for high-tech ventures (b_{high} = .15, p < .10). Figure 3.2 illustrates these results.

Figure 3.2: The Moderating Effect of High-Tech vs. Low-Tech



3.4.2 Additional Analysis

While we followed prior incubator research (e.g. Pena, 2004; Peters et al., 2004; Schwartz, 2013; Schwartz & Hornych, 2010) in not limiting our sample of tenant firms to a particular age range, we acknowledge that other incubator studies have focused on new ventures (e.g. Colombo & Delmastro, 2002; Scillitoe & Chakrabarti, 2010). To rule out the possibility that our results are affected by our sampling approach, we reran our analyses based on a subsample. Specifically, we applied a criterion commonly used to distinguish between new and established ventures (Lechner, Dowling, & Welpe, 2006; Sigmund, Semrau, & Wegner, 2015) and excluded from our sample all tenants that had been in business for more than 10 years. Analyses based on this subsample, with 158 tenants located in 59 incubators that had been in business for 5.55 years on average, also supported our theoretical reasoning. Lending support for Hypothesis 1, subsample analyses reveal a significant negative interaction effect of incubator size and venture team size on tenant growth (β = -.18, p < .01). Providing evidence in support of Hypothesis 2, we observe a significant positive interaction effect between incubator size and tenant's high-tech industry affiliation (β = .75, p < .01).

3.5 Discussion and Conclusion

The present study complements and extends earlier research examining which incubators are best suited to facilitate the development of their tenants (Schwartz, 2012; Schwartz & Hornych, 2010). Based on contingency theory (Drazin & Van de Ven, 1985), we argued that, to fully understand the consequences of incubator characteristics for tenant development, business incubation theory and research (Hackett & Dilts, 2004a; Tavoletti, 2013) has to adopt a multilevel "fit" perspective that takes the interplay between incubator and tenant characteristics into account. Providing theoretical arguments suggesting that the implications of incubator size for tenant development are contingent upon two variables driving a venture's need for a greater quantity and variety of external resources––the size of a tenant's venture team as well as whether a tenant is operating in a high-tech industry—we detailed this theoretical reasoning.

Results from multilevel analyses support our arguments. First, we find that venture team size serves as a moderator for the effect of incubator size on tenant growth. In fact, the study results indicate that, while incubator size has a positive effect on the growth of tenants with smaller venture teams, tenants with larger venture teams may actually suffer from being located in a larger incubator. In line with our arguments, this negative effect can be explained when considering that ventures with more team members have a greater quantity and variety of resources and network contacts readily available (Hambrick & D'Aveni, 1992; Wiersema & Bantel, 1992). Having less severe resource constraints, ventures with more team members are less likely to profit from the larger quantity and diversity of resources offered by larger business incubators. However, larger ventures seem to suffer from the more impersonal and anonymous atmosphere present in larger business incubators (Aerts et al., 2007; Bøllingtoft & Ulhøi, 2005), which increases the costs involved in developing personal bonds with staff members and fellow tenant

companies that facilitate timely and easy access to needed resources. Our study also points to a positive moderating effect of whether tenants operate in a high-tech industry. This supports our reasoning that, due to the particular environmental conditions high-tech ventures face (Dess & Beard, 1984; Francis & Collins-Dodd, 2000; Wu, 2007), they need a greater quantity of and more specific resources compared to their low-tech counterparts. Consequently, high-tech firms located in larger business incubators profit considerably from the resource endowments provided, whereas low-tech tenants primarily suffer from the downsides associated with incubator size, as previously described.

With these findings, our study highlights that it is not necessarily incubator characteristics per se but rather the interplay between incubator and tenant characteristics that is crucial for explaining tenant growth. Complementing prior research, the present study thus contributes to establishing a multilevel perspective in business incubation theory and research (Hackett & Dilts, 2004a; Tavoletti, 2013). While implying that a "one-size-fits-all approach" to incubator design may not be appropriate, our study also has clear practical implications. In fact, the study findings suggest that both private investors and policy makers have to take the type of ventures that will be supported into account when aiming to establish a business incubator that is most effective in fostering tenant development. Conversely, our study results also suggest that entrepreneurs should carefully consider their ventures' characteristics to choose a business incubator that is most appropriate to serve their needs.

While the primary interest of the present study was to examine contingencies affecting how incubator size relates to tenant development, our findings also inform the literatures on new venture teams (Klotz et al., 2014; Vyakarnam & Handelberg, 2005) and technology entrepreneurship (Beckman, Eisenhardt, Kotha, Meyer, & Rajagopalan, 2012; Shane & Venkataraman, 2003). We observed a negative interaction between

incubator size and venture team size, which points to a compensatory relationship between the two variables (Grant & Sumanth, 2009; Semrau & Hopp, 2016). Implying that being embedded in an incubator environment that provides a larger quantity and variety of resources can compensate for a larger venture team, our study highlights incubator size as one environmental condition that affects the importance of venture team characteristics (Klotz et al., 2014). Similarly, our study contributes to the literature on technology entrepreneurship (Beckman et al., 2012; Shane & Venkataraman, 2003). Specifically, our study points to significant differences in the factors that stimulate the growth of high- and low-tech firms by suggesting that while high-tech ventures profit from being embedded in a larger incubator, low-tech ventures may actually suffer in such an environment.

Highlighting the importance of "fit" between incubator and tenant characteristics, our study also points to directions for future research. Specifically, future research might fruitfully address potential contingencies for the effects of other incubator characteristics, such as age, specialization strategy, or sponsorship. Similarly, future research might complement the present study by examining the potential moderating effects of other characteristics that drive tenants' resource needs and/or endowments, such as entrepreneurs' prior founding experience or other aspects of their general or task-related human capital (Colombo & Grilli, 2010; Ucbasaran, Westhead, & Wright, 2008). Additional avenues for future research are indicated by the limitations of our study. While we believe it is a strength of our study that we were able to employ objective measures from different data sources to reflect our variables (Podsakoff et al., 2003), data availability did not allow us to test our hypotheses based on alternative measures of venture growth, such as employment or revenue growth (Weinzimmer et al., 1998). In addition, we were not able to assess the long-term effects of incubator size on tenant

development. Finally, since our research is based on data from one national context, future research might further address the generalizability of our results by replicating our study in other countries.

4 Top Management Team Characteristics and Organizational Learning from Failure

4.1 Introduction

Learning is central to organizations' adaptation and survival (Baum & Dahlin, 2007; Chuang & Baum, 2003; Kim & Miner, 2007; Madsen & Desai, 2010) and failure can serve as a valuable learning input (Cannon & Edmondson, 2001, 2005). This is because failure experiences not just reveal a discrepancy between what was expected and what has been achieved (Cannon & Edmondson, 2001, 2005), but typically also yield important insides into cause-and-effect relations (Sitkin, 1992). According to the Behavioral Theory of the Firm (Cyert & March, 1963; Greve, 1998), failure experiences can thus effectively engender learning processes that result in subsequent improvements to organizational performance. However, organizations will not necessarily learn from failure experiences. Instead, failure can also stimulate defensive reactions that are detrimental to learning and may even lead to decreases in subsequent performance (Desai, 2016; Staw, Sandelands, & Dutton, 1981).

Studies examining whether organizations learn from failure experiences echo these two theoretical arguments. While a considerable body of research found evidence in support of the notion that organizations improve their performance after failure (Baum & Dahlin, 2007; Haunschild & Sullivan, 2002; Khanna et al., 2016; Madsen & Desai, 2010), other studies observed organizations to not leverage prior failures to enhance subsequent organizational performance (Baumard & Starbuck, 2005; Desai, 2016; Meschi & Métais, 2015; Staw et al., 1981), or even found organizational performance to decrease following failure (Desai, 2016).

Inspired by these inconclusive findings, the present study builds on upper echelon theory (Hambrick, 2007; Hambrick & Mason, 1984) to shed more light on contingencies

for organizational learning from failure. Upper echelon theory suggests that top management team (TMT) characteristics shape organizational actions and outcomes, as they are reflected in the structures, processes, as well as norms and values that prevail within an organization (Dalton & Kesner, 1985; Finkelstein & Hambrick, 1996). Building on this general notion, I examine how two TMT characteristics—TMT founding experience and TMT exposure to the US culture—help to explain whether organizations seize the learning opportunities inherent in failure.

Following earlier learning research (Deichmann & van den Ende, 2014; Khanna et al., 2016), the present study conceptualizes learning from failure as the link between failure as a learning input and subsequent organizational performance as the observable learning outcome. Based on this conceptualization and a longitudinal data set comprising 550 organization-year observations from 39 research institutes, I find evidence in support of the hypotheses developed. Specifically, I find TMT founding experience and TMT exposure to US culture to moderate the relationship between failure and subsequent performance.

With the insights generated, the present study contributes to the literature on organizational learning from failure (Baum & Dahlin, 2007; Baumard & Starbuck, 2005; Desai, 2015b; Greve, 2003), and TMTs (Bromiley & Rau, 2015; Finkelstein, Hambrick, & Cannella, 2009; Hambrick, 2007; Hambrick & Mason, 1984). First, the study at hand extends our knowledge on organizational learning from failure by pointing to TMT characteristics as a crucial contingency for whether organizations effectively learn from failure (Desai, 2015b). As such, this study complements prior research highlighting the impact of failure characteristics such as the magnitude or importance of the failure (Khanna et al., 2016; Madsen & Desai, 2010) the type of failure (voluntary or involuntary) (Haunschild & Rhee, 2004; Kim & Rhee, 2017) or the heterogeneity in the causes of the

failure (Haunschild & Sullivan, 2002). Other prior research has also shed light on the impact of organization-related factors such as an organization's operating experience (Desai, 2016) or the concentration of failures within an organization (Desai, 2015b). Second, the present study contributes to TMT research (Hambrick, 2007; Hambrick & Mason, 1984) by introducing organizational learning as a relevant outcome affected by the characteristics of the upper echelons, as most research in the field has focused on the impact of TMT characteristics on corporate performance (Nielsen & Nielsen, 2013) or other outcomes such as strategic change (e.g. Kwee, Van Den Bosch, & Volberda, 2011; Wiersema & Bantel, 1992).

4.2 Theory and Hypotheses

Representing a deviation from results that were expected and desired (Cannon & Edmondson, 2001, 2005), failure is regular aspect of organizations' daily operations (Coelho & McClure, 2005). While common sense suggest that failure is something to be avoided (Sitkin, 1992), it may also motivate learning processes within organizations (Cyert & March, 1963; Greve, 1998) that lead to subsequent performance improvements. This is because failure typically challenges the established understanding of cause-and-effect relations (Sitkin, 1992), in that it may help organizations to modify collective knowledge, existing routines and operating practices for subsequent performance improvements (e.g. Fiol & Lyles, 1985; Henderson & Stern, 2004; Levitt & March, 1988; Madsen & Desai, 2010; March, Sproull, & Tamuz, 1991).

However, failure will not necessarily engender learning processes (Baumard & Starbuck, 2005; Desai, 2016; Meschi & Métais, 2015; Staw et al., 1981). When interpreting failure as a threat (Staw et al., 1981), organizations tend to exhibit threat-rigidity reactions, such as restricted information processing and a centralization of authority, and are likely to revert to well-learned responses (Cameron, Whetten, & Kim,

1987; Wiseman & Bromiley, 1996). By constraining an organization's ability to learn and adapt (Ocasio, 1995) and escalating a commitment to failing strategies (Milliken & Lant, 1991), such reactions can even result in a further decline in organizational performance (Desai, 2016; Meschi & Métais, 2015).

In sum, there are arguments suggesting that organizations can, but will not necessarily learn from failure experiences. Subsequently, I will delineate why I expect an organization's TMT to play a crucial role for whether organizations learn from their failures for improved subsequent performance.

4.2.1 Top Management Teams and Organizational Learning from Failure

Questions related to why organizations act and perform the way they do are of key importance to organizational theorists (Hambrick & Mason, 1984). According to upper echelon theory, the most powerful actors within an organization, that is, an organization's top management team, and their characteristics, contribute significantly to answering these questions (Hambrick, 2007; Hambrick & Mason, 1984). Characteristics of top managers affect how they gather, filter and interpret information (Dutton & Jackson, 1987; Hambrick, Geletkanycz, & Fredrickson, 1993). In other words, TMT members evaluate their choices and frame discussions on the basis of their cognitive structures, which are a function of their characteristics (Finkelstein & Hambrick, 1996; Hambrick, 2007; Roberto, 2003). Because of the decisions TMTs are empowered to make, characteristics of TMT members, such as age (e.g. Chen, Hsu, & Huang, 2010; Tihanyi, Ellstrand, Daily, & Dalton, 2000) or educational attainments (e.g. Herrmann & Datta, 2005; Jensen & Zajac, 2004), are reflected in the organization's structures and processes as well as in the norms and values that prevail within their organization (Dalton & Kesner, 1985; Finkelstein & Hambrick, 1996).

To learn from failure experiences, organizations need to encourage employees to systematically share relevant information, discuss the causes of failure experiences and apply the lessons learned (Cannon & Edmondson, 2005; March et al., 1991; Sitkin, 1992). Building on upper echelon and organizational learning theory, the present study suggests that TMT characteristics help to explain whether organizations provide such supportive contexts and thus learn from failure experiences for future performance. Specifically, and building on the conceptualization of organizational learning from failure as the link between failure as a valuable learning input and subsequent organizational performance as an observable learning outcome (Deichmann & van den Ende, 2014; Khanna et al., 2016), I will subsequently derive hypotheses on why TMT founding experience and TMT exposure to the US culture moderate the link between prior failure and subsequent organizational performance.

4.2.1.1 TMT Founding Experience and Organizational Learning from Failure

Founding a new business involves a high level of risk and uncertainty (Bearse, 1982; Schindehutte, Morris, & Allen, 2006; Shepherd, Douglas, & Shanley, 2000) and can be characterized as a process of trial and error learning (Gartner, 1985; Minniti & Bygrave, 2001). Due to the indeterminate nature of new business opportunities, founders have to make decisions based on incomplete information and with few precedents as a guide (Moorman & Miner, 1998; Ravasi & Turati, 2005; Sarasvathy, 2001; Simon, Houghton, & Aquino, 2000). When trying to develop a feasible business concept, founders thus typically encounter several instances of failure, that is, situations in which they experience deviations from expected and desired results, and have to adapt their courses of action accordingly (Klofsten, 2005; Lichtenstein, Dooley, & Lumpkin, 2006; Sarasvathy, 2001; Simon et al., 2000).

Individuals self-select into occupations that match their personality (Caplan, 1987; Holland, 1959; Schneider, 1987). In line with experiential learning theory (Corbett, 2005; Kolb, 1984 ; Schön, 1986), work experiences and personality traits also have been observed to be jointly responsive, as individuals' attitudes, beliefs, and values are shaped in part by the occupational decisions and experiences they make (Jackson, Thoemmes, Jonkmann, Lüdtke, & Trautwein, 2012; Li, Fay, Frese, Harms, & Gao, 2014; Wille & De Fruyt, 2014). In line with these notions, prior research has firmly established that founders are more willing than non-founders to tolerate high levels of uncertainty regarding success or failure (Stewart Jr & Roth, 2001; Zhao & Seibert, 2006), and more likely to regard failure as an opportunity for reflection and learning in a developmental process (Politis & Gabrielsson, 2009).

Based on these notions, I expect organizational learning from failure to be facilitated by TMT founding experience. TMT members with founding experience will be more likely than their counterparts to tolerate failure and perceive it as a learning opportunity (Politis & Gabrielsson, 2009). According to upper echelon theory, this attitude will be reflected in the structures, processes, norms and values that prevail within an organization (Dalton & Kesner, 1985; Finkelstein & Hambrick, 1996) and will provide a context that facilitates learning from failure. Consequently, I propose:

Hypothesis 1a: TMT founding experience positively moderates the relationship between prior failure and subsequent performance.

4.2.1.2 TMT Exposure to US Culture and Organizational Learning from Failure

Due to the social norms and values present, the US culture regards failure as part of an ongoing process of experimentation, which can be utilized to learn for the future (Hofstede, 2001; Landier, 2005). Failing is thus more likely to be tolerated and attached

to less social stigma in the US than in most other societies (Cave, Eccles, & Rundle, 2001; Damaraju, Barney, & Dess, 2010; Hofstede, 2001; Hsu, 1972).

According to cultural self-representation theory (Erez & Earley, 1993), individual attitudes and behaviors are shaped by the societal culture in which they are embedded. Specifically, and reinforced by tendencies to strive for self-enhancement and consistency, individuals develop perceptions, preferences and behavioral tendencies that are in line with the cues provided by their social context (Chen & Aryee, 2007; Erez & Earley, 1993; Farmer, Tierney, & Kung-Mcintyre, 2003). These cues, in turn, are shaped by the cultural norms and values that define what is appropriate and expected in a societal context. In line with these notions, prior research has found that immigrants develop preferences and attitudes that correspond with the cultural norms, values and expectations of their host countries (Berry, 1997; Berry, Phinney, Sam, & Vedder, 2006; Taras, Rowney, & Steel, 2013). Recent research (Farmer et al., 2003) further suggests that individual perceptions and evaluations are even affected by societal contexts to which individuals are just temporally exposed. Specifically, Farmer et al. (2003) found that individuals who spend some time in the US, adopted preferences, attitudes, and behavioral tendencies that aligned with the prevalent societal values or norms.

Based on these notions, I expect TMTs experience with the US culture to predict learning from failure for subsequent performance. Compared to other national contexts, the US culture emphasizes the learning opportunity inherent in failure experiences (Damaraju et al., 2010; Hofstede, 2001; Landier, 2005). TMT members who have been exposed to the US culture are likely to have adapted to such cultural norms. Based on upper echelon theory suggesting that TMT characteristics are reflected in the organization (Dalton & Kesner, 1985; Finkelstein & Hambrick, 1996), I thus propose:

Hypothesis 1b: TMT exposure to the US culture positively moderates the relationship between prior failure and subsequent organizational performance.

4.3 Method

4.3.1 Sample

To test my hypotheses, I collected data on 54 research institutes belonging to the Max Planck Society (MPS), one of the most important and prestigious research associations in Germany (Max Planck Society, 2016). All of those institutes select and carry out their research autonomously and independently within the scope of the research association, administer their own budget, and are free to set their own focus within their research field. Thus, MPS research institutes can rightfully be considered as independent organizations. Depending on their size, institutes are managed by up to 12 directors, who form the research institute's TMT, as they define the strategy of the institute, set research agendas, and decide on internal processes, structures and investments.

To capture failure and subsequent performance, I followed prior research (Khanna et al., 2016) and relied on data from research institutes' patenting activities. Patents represent a relevant performance outcome for publicly funded research institutes, as they are increasingly requested to secure social and economic return by economically exploiting research results where appropriate (Buenstorf, 2009). Also, patents are of interest for research organizations, as they represent a potential source for generating revenue (Göktepe-Hulten & Mahagaonkar, 2010), and thus can help to reduce an institute's dependency on public funding (Buenstorf, 2009). Relying on patent data also seems to be fruitful from a methodological point of view. All patent-related data such as invention disclosures or patent applications can be clearly assigned to a certain point in time. Furthermore, patent applications are prone to failure (European Patent Office, 2016). Patenting data for the years 2000 until 2014 were provided by the central

technology transfer office of the MPS, which handles the administrative and legal aspects of inventions for all institutes. The data included information about the date of both invention disclosure and patent application as well as about the date a patent application was rejected and a patent was granted. These patenting data were supplemented with TMT CV data, which was hand-collected through extensive web-searches.

Of the 54 institutes of the initial sample, 14 institutes were excluded as they never were granted a patent. As the study examines TMT characteristics, an institute that was governed by only a single director was also dropped, leading to a final sample of 39 institutes. The sample contains data about these institutes from the year 2000 to 2014, but since three institutes were founded more recently the sample does not include an equal number of observations for each organization. Therefore, the final sample comprises a total of 550 observations from 39 research organizations.

4.3.2 Measures

To establish temporal precedence (Aguinis & Edwards, 2014), I utilized a lagged data structure that relates failure and the TMT characteristics in the year t to subsequent performance in the year t+1.

Dependent Variable. To reflect my dependent variable, I resorted to research institutes' *invention performance* in terms of the number of granted patents in a given year t+1. Considering the date of invention disclosure as the point an invention was made, the year of disclosure was used to assign a patent to a particular year. For instance, when an invention was disclosed in 2005 and a patent was granted in 2008, the patent is considered a 2005 patent.

Independent Variable. Consistent with the common conceptualization of failure as a deviation from expected and desired results (Cannon & Edmondson, 2001, 2005), I use the overall number of failed patent applications in a given year t to operationalize

invention failure. A patent application is considered as failed if a patent office rejects the application due to a lack of novelty. A failure was assigned to a particular year based on the date the patent application file was closed by the technology transfer office of the MPS.

Moderators. Following prior TMT research (Carpenter & Fredrickson, 2001; Daellenbach, McCarthy, & Schoenecker, 1999; Herrmann & Datta, 2005; Lee & Park, 2008; Sambharya, 1996), I measured the two moderator variables based on the percentage of TMT members with a) founding experience and b) exposure to the US culture. *TMT founding experience* thus indicates the percentage of TMT members who, alone or with others, have founded a venture. Similarly, *TMT exposure to the US culture* indicates the percentage of TMT members who have studied or worked in some professional capacity in the US.

Controls. In my analysis, I also controlled for organizational-level characteristics, additional TMT characteristics, and potential time effects. First, I followed prior research (Desai, 2016) and controlled for *organization age,* reflected by the number of years since the organization has been founded in order to account for accumulated organizational experience. As only a subset of all invention disclosures by an institute in a given year t+1 results in granted patents, I controlled for the *total* number of *invention disclosures* in year t+1 that led to a patent application. In other words, by including the variable *total invention disclosures,* I controlled for the performance potential in each year, as the number of granted patents in year t+1 is contingent on the number of inventions disclosed in year t+1. To ensure that results are not biased by a relationship between past and present performance I also controlled for *prior invention performance* by including the number of granted patents in t.

With regard to the TMT, I followed prior research and controlled for *TMT size* (Carpenter & Fredrickson, 2001; Lee & Park, 2008), indicating the number of team members, and *TMT tenure* (Nadolska & Barkema, 2014; Wiersema & Bantel, 1992) reflecting the average tenure of the TMT members. Further, I included a dummy variable (*TMT change),* indicating if a member of the TMT left and/or a new TMT member entered the team in a particular year. Finally, I followed earlier research (Desai, 2015a) and included a set of year dummies to account for unobserved fixed effects of time.

4.3.3 Analytical Approach

Analyses rest on longitudinal data. Given that the dependent variable is a nonnegative count variable, the assumptions of ordinary least square (OLS) estimation are violated and linear regression would yield inefficient and potentially biased coefficient estimates (Long, 1997). Count models such as negative binominal models or Poisson models offer a better means of analyzing these data. To account for the potential influences of time-invariant characteristics of the research institutes in my sample, such as their areas of expertise, it additionally seemed pertinent to control for panel-fixed effects. A Hausman (1978) specification test substantiated this claim by indicating that a fixed-effects model rather than a random-effect model is appropriate for my analysis. When panel-fixed effects are to be accounted for, however, negative binominal regression models may produce biased estimates (Cameron & Trivedi, 2013; Greene, 2008; Hsiao, 1986; Wooldridge, 2012). Thus, to test my hypotheses, I followed earlier research (Desai, 2015a) and relied on conditional fixed-effect Poisson regressions with robust standard errors, as this approach does not suffer from biased estimates (Wooldridge, 2012).

4.4 Results

Table 4.1 displays descriptive statistics and correlations of our study variables.

Table 4.1: Descriptive Statistics and Correlations

N (Organizations) = 39; N (Observations) = 550		**Mean**	**SD**	**1.**	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**
1.	Invention Performance (t+1)	.54	1.20									
2.	Prior Invention Performance (t)	.61	1.25	.542**								
3.	Invention Failure (t)	1.47	2.31	.237**	.235**							
4.	Total Invention Disclosures (t+1)	2.32	3.37	.643**	.401**	.473**						
5.	Organization Age	52.35	33.84	-.042	-.034	.019	-.046					
6.	TMT Size	4.56	1.96	.373**	.375**	.282**	.366**	.110**				
7.	TMT Tenure	10.52	3.71	.066	.087*	.274**	.178**	.211**	.244**			
8.	TMT Change	.28	.45	.020	.060	.027	.044	-.032	.193**	-.161**		
9.	TMT Founding Experience	.09	.15	.147**	.151**	.143**	.125**	.195**	.142**	.013	-.014	
10.	TMT US Culture Exposure	.68	.25	-.050	-.050	-.021	-.012	.192**	-.030	.114**	.004	.057

Notes:*p < .05, **p <.01, (two tailed).

Correlation analyses reveal a significant positive relationship between prior (t) and subsequent (t+1) invention performance (r = .542, p < .01). As expected, I also observe invention performance (t+1) and total invention disclosures (t+1) to be significantly positively related, as the number of granted patents constitutes a subset of the number of all invention disclosures made by an institute in a given year (r = .634, p < .01). To alleviate potential concerns related to multicollinearity, I computed variance inflation factor (VIF) scores for all variables. Maximum VIFs did not exceed 2.19, which is well below the widely recognized threshold of 10 (Wooldridge, 2012). Thus multicollinearity should not be an issue in the present study.

Results of the regression analysis are presented in Table 4.2.

Table 4.2: Results from Conditional Fixed-Effects Poisson Regression

N (Organizations) = 39; N (Observations) = 550	**Invention Performance**			
	Model 1:	**Model 2:**	**Model 3:**	**Model 4:**
Prior Invention Performance (t)	- .01 (.04)	.00 (.05)	-.00 (.04)	.02 (.05)
Invention Failure (t)	.01 (.03)	-.06 (.05)	-.29 (.15)*	-.44 (.13)**
Total Invention Disclosures (t+1)	.16 (.03)**	.17 (.03)**	.17 (.03)**	.18 (.03)**
Organization Age	-.18 (.31)	-.18 (.31)	-.06 (.27)	-.01 (.28)
TMT Size	.09 (.10)	.10 (.08)	.14 (.09)$^{+}$	.18 (.08)*
TMT Tenure	-.01 (.04)	-.02 (.03)	-.02 (.04)	-.03 (.04)
TMT Change	-.15 (.11)	-.08 (.10)	-.16 (.11)	-.08 (.10)
TMT Founding Experience	2.13 (1.24)$^{+}$	1.08 (1.53)	2.15 (1.25)$^{+}$	.86 (1.51)
TMT US Culture Exposure	.15 (.85)	.09 (.81)	-.75 (.96)	-.97 (.92)
Interactions Terms				
Invention Failure (t) x TMT Founding Experience		.36 (.15)*		.42 (.18)*
Invention Failure (t) x TMT US Culture Exposure			.46 (.23)*	.55 (.17)**
Akaike Information Criterion (AIC)	606.12	602.64	603.55	598.28

Notes: Robust standard errors in parentheses; all models include year dummies; +p ≤ .10; **p ≤ .05; ***p ≤ .01 (two tailed).

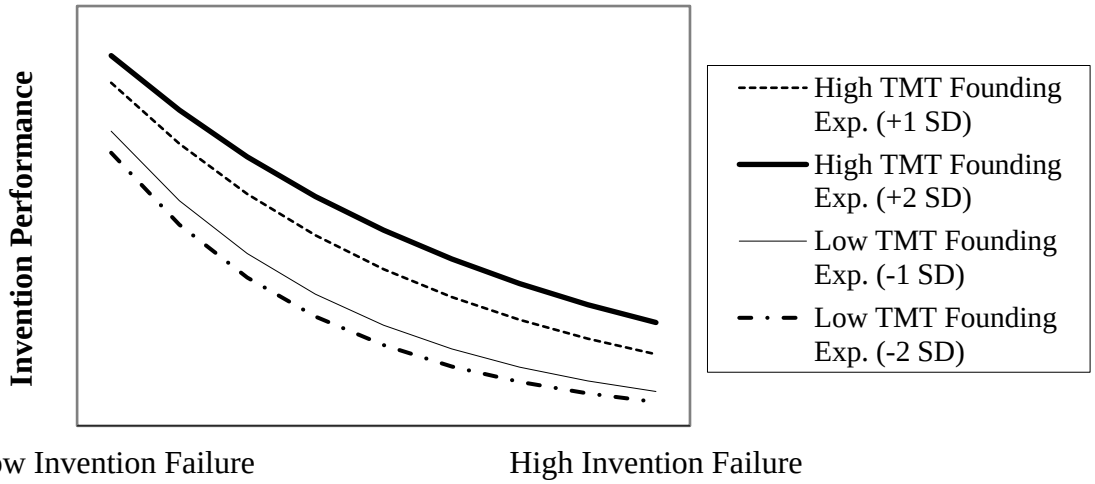
Consistent with correlation results, regression results reveal a positive relationship between total invention disclosures and invention performance (β = .18, p < .01, Model 4). Further, TMT size turns out to be significantly related to invention performance (β = .18, p < .05, Model 4). Additionally, and in line with threat-rigidity theory (Staw et al., 1981) and prior research (Desai, 2016; Meschi & Métais, 2015), I observe a negative effect of failure on subsequent performance. Specifically, Model 3 and Model 4, which account for potential direct effects of TMT founding experience and TMT exposure to the US culture, reveal negative relationships between invention failure and invention performance (β = -.29, p < .05, Model 3 and β = -.44, p < .01; Model 4).

Data also provide supporting evidence for Hypothesis 1, which proposed a positive effect of TMT founding experience on the relationship between failure and subsequent performance. Specifically, Models 2 and 4 reveal significant positive interaction effects of TMT founding experience and invention failure on invention performance (β = .36, p < .05, Model 2; β = .42, p < .01, Model 4).

Hypothesis 2 proposed that the relationship between failure and performance is positively moderated by TMT US culture exposure. Revealing positive interaction effects between TMT exposure to the US culture and invention failure on invention performance (β = .46, p < .05, Model 3; β = .55, p < .01, Model 4), data also support Hypothesis 2.

Given that the study's analyses are conducted using nonlinear models, results may require further examination (Desai, 2015a). Specifically, prior research (Ai & Norton, 2003; Greene, 2010; Karaca-Mandic, Norton, & Dowd, 2012) suggests that statistical tests of interaction terms in nonlinear models may produce ambiguous results and recommends complementing formal hypothesis testing with an examination of partial effects, using interaction plots (Greene, 2010).

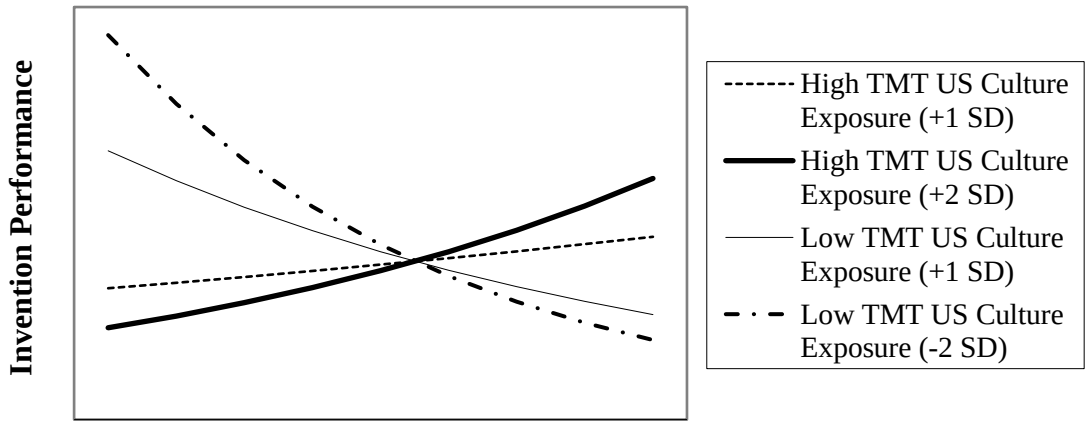
Figure 4.1: The Moderating Effect of TMT Founding Experience



Based on Model 4, Figure 4.1 illustrates the partial effects of invention failure on invention performance for TMT founding experience one standard deviation as well as two standard deviations above and below the mean.

In line with the results described above, Figure 4.1 reveals that the relationship between invention failure and invention performance is more negative at lower levels of TMT founding experience and less negative at higher levels of the moderator.

Figure 4.2: The Moderating Effect of TMT US Culture Exposure



Also based on Model 4, Figure 4.2 illustrates the interaction between invention failure and TMT US culture exposure. In line with the results described above, Figure 4.2 shows that the relationship between invention failure and invention performance is positive when TMT exposure to the US culture is high (one or two standard deviations above the mean) and negative when it is low (one or two standard deviations below the mean).

4.5 Discussion and Conclusion

By connecting theory on organizational learning (Baum & Dahlin, 2007; Baumard & Starbuck, 2005; Desai, 2015b; Greve, 2003) and upper echelon theory (Bromiley & Rau, 2015; Hambrick, 2007; Hambrick & Mason, 1984) the present study aimed at shedding light on contingencies for organizational learning from failure. Specifically, I examined how two characteristics of organization's TMT—TMT founding experience and TMT exposure to the US culture—help to explain whether organizations seize the learning opportunities inherent in failure to improve subsequent performance.

Study results first of all reveal a negative main effect of failure on subsequent performance. This result is in line with predictions based on threat-rigidity theory (Staw et al., 1981) suggesting that organizations are sometimes unable to improve following failure. Specifically, organizations confronted with failure experiences may exhibit threat-rigidity reactions such as restricted information processing, centralization of authority, reverting to well-learned responses and escalating commitment to failing strategies (Cameron et al., 1987; Milliken & Lant, 1991; Wiseman & Bromiley, 1996). By constraining an organization's ability to search for new knowledge, learn from failure and adapt (Ocasio, 1995), such reactions may result in lowered subsequent performance (Desai, 2016; Meschi & Métais, 2015). Pointing to a negative relation between failure related to patenting activity and subsequent patenting performance, the present study also

complements prior research. While a similar result has previously been observed for infrequent, major failures, such as railroad accidents (Desai, 2016), the study at hand suggests that this relationship also holds for instances of failure that are much smaller and more frequent.

However, the present study also provides evidence for the notion that organizations can learn from failure experiences (Cannon & Edmondson, 2001, 2005; Sitkin, 1992). Study results suggest that when certain TMT characteristics are present, organizations are more likely able to draw on information provided by failure about flaws in existing organizational activities to improve subsequent organizational performance. More specifically, study results support the argument that among TMTs with greater founding experience, failure is more likely to be perceived as a learning opportunity. This in turn, increases the chance of organizational learning from failure, as TMTs establish organizational structures, processes and norms and values that facilitate learning. Similarly, the present study reveals that organizational learning from failure profits from a TMT that is characterized by exposure to the US culture. This result supports the theoretical reasoning that when TMT members spend time in the US, they are more likely to hold a learning-attitude towards failure that is reflected in the organizational structures, processes, norms and values they create when running an organization.

Pointing to TMT characteristics as a crucial contingency for organizational learning, the present study contributes to extending our knowledge with regard to the question when do organizations learn from failure (Argote & Miron-Spektor, 2011; Levitt & March, 1988). As such, the study at hand complements prior research that highlights how failure characteristics such as the magnitude or importance of the failure (Khanna et al., 2016; Madsen & Desai, 2010) the type of failure (voluntary or involuntary) (Haunschild & Rhee, 2004; Kim & Rhee, 2017) or the heterogeneity in the causes of the

failure (Haunschild & Sullivan, 2002) affect learning. Additionally, a few earlier studies have indicated that organization-related factors, such as an organizations operating experience (Desai, 2016) or the concentration of failures within an organization (Desai, 2015b), also contribute to explaining the variance in organizational learning from failure across organizations.

With the insights generated, the present study also contributes to TMT research. Up until now, most studies in the field have examined how TMT characteristics affect corporate performance (Finkelstein & Hambrick, 1996; Nielsen, 2010) or organizational outcomes, such as strategic change (e.g. Kwee et al., 2011; Wiersema & Bantel, 1992). Wiersema and Bantel (1992), for example, found that organizations with TMTs characterized by lower average age and higher educational level are more likely to undergo changes in corporate strategy. The present study expands this prior research by highlighting that TMT characteristics also shape organizational learning from failure.

This study also faces a number of limitations, each of which suggests opportunities for future research. First, the present study relied on data of research organizations, which may limit the generalizability of the findings presented. Further research may thus want to replicate the present study in different industry contexts. Second, similar to other studies in the field (Desai, 2015b; Khanna et al., 2016; Madsen & Desai, 2010), the present study did not capture the processes underlying learning from failure. As our knowledge about these learning processes is still limited, future research needs to address in more detail the question of how organizations deal with and learn from failure (Desai, 2015b). Thus, future research should examine, for example, how organizations conduct incident reviews and retrospective analysis as well as how the investigation process affects learning. Furthermore, the present study followed the tradition in TMT research in addressing how particular TMT characteristics relate to

organizational learning from failure, as it builds on the notion that TMT characteristics are reflected within the organization (Carpenter, Geletkanycz, & Sanders, 2004; Hambrick & Mason, 1984). Future research may thus fruitfully build on the study at hand and examine in more detail how TMT characteristics translate into organizational structures, processes, and norms and values that facilitate organizational learning from failure.

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