

Resource Constraints and Innovation Projects

by

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EXTENDED SUMMARY

This dissertation examines the role tangible resources play in innovation projects. Specifically, it is distinguished between two mindsets when it comes to tangible resource constraints in innovation projects. One mindset regarding the relationship between tangible resources and innovation project performance can be described best as “resource driven”, meaning that innovation project performance is strongly linked to the presence of adequate tangible resource input. Counter-intuitively, a vast number of case examples suggest the exact opposite, though. The underlying “less is more” mindset suggests that innovation project performance could also be achieved because (not despite) of constrained tangible resources. Those views reflect the two extremes of the continuous variable “tangible resource orientation” which expresses the perceived dependency on tangible resources in order to achieve a high level of performance in innovation projects.

Since conceptual and empirical evidence on the antecedents and consequences of varying degrees of tangible resource adequacy in extant literature is inconclusive, this dissertation aims at disentangling the ambiguous tangible resources-innovation project performance relationship. The arguments I put forward in this dissertation are based on conceptual evidence as a result of synthesizing literature from neighboring research fields like cognitive psychology, entrepreneurship, and corporate strategy pointing to mechanisms which cause material resource constraints to facilitate creative and innovative performance in innovation projects. These literature streams are then brought together within the framework of the resource based view (RBV) of the firm. The empirical analyses to test the hypothesized relationships are based on a sample consisting of 121 innovation project teams from the electronics industry.

The results presented in this dissertation show that the ambiguity of the relationship between tangible resources and innovation project performance observed in the literature may be a result of moderating variables that determine the direction and strength of tangible resources’ influence on innovation project performance. Specifically, the analyses reveal an interaction effect in that perceptions of material resource adequacy indeed may entail diverging effects on innovation project outcomes in family and non-family businesses, depending on differences in these firms’ organizational culture regarding the orientation toward material resources. In particular, innovation projects in non-family firms do

significantly better when being provided with more adequate material resources, while in family firms innovation projects do not show significant differences in conditions of more or less adequate tangible resources and are shown to perform better (relative to those in non-family firms) under conditions of perceived material resource inadequacy.

Moreover the results of this dissertation point to the influence of socio-cognitive factors on a team's evaluation of material resource adequacy. These socio-cognitive influences are further shown to root both on innovation project team attributes and capabilities, as well as on characteristics of organizational culture. Specifically, regarding team-level factors, it is found that innovation project team members' perception of material resource adequacy is influenced by a team's action repertoire, the belief of a team being able to accomplish a task, and the team task's work volume. Regarding organizational-level factors, this research reveals that innovation project teams in family firms perceived their material resource provisions generally as being more adequate. Further, this relationship is shown to be mediated by an organization's cultural characteristic of material resource orientation, representing an important link that transmits family influence to innovation project teams' perceptions of material resource adequacy.

Finally, the results reveal that depending on which outcome dimension is operationalized as the main project focus, i.e., whether the quality or innovativeness of the developed products is used as outcome measure, converse results may emerge. Specifically, it is found that perceptions of material resource adequacy have a positive effect on new product quality and a negative effect on new product novelty. In a similar vein, relative team size is shown to be negatively related with new product novelty while showing a positive relationship with new product quality. Additionally, relative team size is also found to have a positive relationship with project efficiency.

From these findings, key implications for the management of innovation projects are derived in order to ensure the effectiveness of companies' investments in R&D, showing that adequate tangible resources per se do not have a direct effect (neither positive nor negative) on innovation project performance. Rather, the role of tangible resources in innovation projects is contingent upon how adequate tangible resources are perceived to be, on certain contingency variables, and on the outcome dimension focused on. Thus, sometimes less may indeed turn out to be more and this thesis points to ways how to tap this potential.

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ABBREVIATIONS AND ACRONYMS

b	unstandardized regression coefficient
β	standardized regression coefficient
CEO	chief executive officer
CTO	chief technology officer
e.g.	exempli gratia (for example)
e-mail	electronic mail
etc.	et cetera (and so forth)
HLM	hierarchical linear modeling
i.e.	id est (that is)
ln	natural logarithm
IRA	inter-rater agreement
KSAO	knowledge, skills, abilities, and other characteristics
mio.	millions
N	number of observations in the sample at the respective level of analysis
OLS	ordinary least squares
p	probability of obtaining test statistics at least as extreme as the one observed, assuming that the null hypothesis is true
r	correlation coefficient
r_{WG}	within group interrater agreement coefficient
R^2	coefficient of determination
R&D	research and development
RAS	reticular activating system
RBV	resource based view
SD	standard deviance
TCI	team climate for innovation
VIF	variance inflation factor
VRIN	valuable, rare, inimitable, and non-substitutable

1. RESOURCE CONSTRAINTS AND INNOVATION PROJECTS

1.1. Relevance and scope of the thesis

Most companies are highly committed to innovation. CEOs consider it crucial for their business success (Eisenhardt & Tabrizi, 1995; Schewe, 1994; Wolfe, 1994). Yet, many seriously doubt they are obtaining adequate return on their investments in innovation. Recent results of the Boston Consulting Group's yearly Innovation Survey (Andrew, Manget, Michael, Taylor, & Zablitz, 2010) reflect that situation. According to this survey, the vast majority of companies see innovation as a topic of highest priority in corporate strategy. Furthermore, the majority of companies surveyed are planning to increase their spending on innovation. Nonetheless, nearly half of the executives polled remain unsatisfied with the financial returns on their companies' expenditures in innovation. These numbers underline the need to find possibilities to improve both efficiency and effectiveness of the innovation process. This requirement is only heightened under the growing awareness of tangible resource constraints in the global economy, whether financial (Hamel & Getz, 2004), human (Beechler & Woodward, 2009), or natural resource-based (Alekklett et al., 2010; Walker, 2010; Weber, Georg, & Janke, 2010).

This appears to be partly due to what might be called a "resource-driven" mindset, which represents the predominant mindset in innovation management that, in order to drive innovation, tangible resources like money, equipment, and personnel have to be abundantly available. Consequently, when an innovative endeavor is lagging behind, most managers tend to drive it along by making more such tangible resources available (Gibbert, Hoegl, & Välikangas, 2007). The reason is that innovation performance is thought to be strongly linked to the presence of adequate tangible resources (Amabile, Conti, Coon, Lazenby, & Herron, 1996; Ancona & Caldwell, 1992a; Damanpour, 1991; Ernst, 2010; Hackman, 1987). When the presence of adequate tangible resources is seen as positive, it follows that their absence engenders a fundamentally inhibiting effect on an innovation team's performance (Hoegl, Gibbert, & Mazursky, 2008). Perhaps unsurprisingly, most scholars advocate this position, arguing that constraints in tangible resources are inherently negative and that at least adequate (if not slack) tangible resources are needed to innovate. As such, these funds, people, and materials provided to innovation projects are assumed to enable innovation project teams to

engage in innovation activities like experimenting with new strategies, or idea exploration (Amabile et al., 1996).

Counter-intuitively, a number of case examples suggest the exact opposite, though. The underlying “less is more” school of thought suggests that innovation success could also be achieved because (not despite) of constrained tangible resources (George, 2005; Gibbert & Scranton, 2009; Hoegl, 2010; Hoegl, Weiss, Gibbert, & Välikangas, 2009a, b; King, 1997; Shostack, 1988; Stokes, 2006). For instance, when Michael Dell started assembling and selling the first personal computers in his dorm room at the University of Texas, he was severely constrained in tangible resources, lacking both money to buy inventory as well as storage space to keep it. Rather than buying expensive computer components and stockpiling them, Dell saw no other chance but to purchase hardware components and building custom computers on order. Hence, stimulated by constrained tangible resources, i.e., money and storage capacity, he developed a new business model and thus a core competitive advantage of what later became one of the most successful companies in the computer industry (Gibbert & Välikangas, 2004). As another example, the Dutch flower industry accounts for more than half of world exports of cut flowers, although the most important resources to produce flowers are obviously land and an adequate climate which, as is generally known, are both not abundantly available in the Netherlands. However, exactly this very lack of key resources for flower growing triggered the Dutch flower industry to innovate wherever possible in the value chain, coming up with creative solutions that counter the given natural disadvantages, e.g., a system for year-round greenhouse cultivation (Harvard Business Review, 1995). Hence, precisely because of constraints in necessary resources, the Dutch flower industry developed superior concepts and technologies that finally over-compensated their initial disadvantage, thus ironically benefitting from formerly impedimental conditions. Similarly, in venture-backed bio-technology companies, those firms receiving most funding were not necessarily those to deliver the best returns (Booth, 2007). In addition to such case evidence, there is literature from research fields like cognitive psychology, entrepreneurship, and corporate strategy pointing to mechanisms which may cause tangible resource constraints to facilitate, rather than impede, creativity and innovation (Dahl & Moreau, 2007; Dougherty, 1994; Finke, Ward, & Smith, 1992; George, 2005; Gibbert et al., 2007; Hoegl et al., 2008; Katila & Shane, 2005; Mishina, Pollock, & Porac, 2004; Moreau, Dahl, Iacobucci, & Anderson, 2005; Stokes, 2001, 2007; Ward, 1994, 2004).

It would appear that the intuitive assumption linking the presence (rather than absence) of tangible resources with innovation project performance was widely tested and confirmed, especially with regard to innovation projects, given that innovation project teams are the key unit of analysis when it comes to innovation in companies (Edmondson & Nembhard, 2009; McDonough, 2000; Wuchty, Jones, & Uzzi, 2007). It therefore comes as somewhat of a surprise that virtually no empirical work investigates how tangible resources actually impact the performance of innovation project teams. The apparent research gap in this connection seems to be mainly due to the intuitive logic of the thoughts behind the “resource driven” mindset, i.e., that the adequate provision of tangible resources basically has a positive influence on innovation projects’ success. After all, this mindset has turned into a (sometimes implicit) basic assumption in literature on innovation management (e.g., Chryssochoidis & Wong, 2000; Granot & Zuckerman, 1991; Hauschildt & Kirchmann, 2001; Howell, 2005; Salomo, Talke, & Strecker, 2008; Swink, 2003). In this regard, Moldaschl (2005) notes a deeply rooted a priori positive connotation of tangible resources, even though this basic assumption actually does not hold in reality (Moldaschl, 2005). This view also becomes evident from existing approaches in the field of operations research. Following the question how constrained tangible resources may be optimally allocated within (Correia, Lourenço, & Saldanha-da-Gama, forthcoming; Dillon, Paté-Cornell, & Guikema, 2005; Granot & Zuckerman, 1991), and across (Chao, Kavadias, & Gaimon, 2009; Medaglia, Graves, & Ringuest, 2007; Solak, Clarke, Johnson, & Barnes, 2010) innovation projects, it is usually aimed at providing at least the most important portions of an innovation project with as adequate as possible tangible resources, thus implying the very “resource driven” assumption that adequate provisions of tangible resources facilitate innovation project success. Therefore, in this doctoral thesis I will investigate the role tangible resources play in innovation projects. Drawing on recent theoretical approaches as well as on empirical evidence of a large scale field study showing when and how constrained tangible resources counter-intuitively may have an enabling, rather than inhibiting, effect on innovation projects, or to put it in other words, which capabilities need innovation project teams to succeed in conditions of tangible resource scarcity.

Throughout this doctoral thesis, innovation is defined as the successful implementation of creative ideas into marketable products or services (Amabile et al., 1996), with an idea being defined to be creative when it is both novel and appropriate for the purpose

at hand (Sternberg & Lubart, 1999). An innovation project is defined as a temporary endeavor with a starting date, a budget, and a fixed end date with the goal to achieve innovation (Kratzer, Gemünden, & Lettl, 2008; Lindkvist, Soderlund, & Tell, 1998; Verworn, Herstatt, & Nagahira, 2008). On that score, this doctoral thesis focuses on innovations in terms of physical products, and thus not on services or immaterial products such as software.

Further, tangible resources are defined as financial or equivalent resources that are readily procurable on markets and share the attribute of tangibility (Barney, 1991; Moldaschl, 2005). In this definition, tangible resources comprise of financial resources (budget), equipment, and staff (here explicitly referring to the quantitative aspect of staff, i.e., excluding any aspects of intangible human resources like skill or experience) provided to innovation projects. The number of team members in relation to the tasks an innovation project has to accomplish will be referred to as relative team size. Moreover, financial resources and equipment together make up what is referred to as material resources in this dissertation (Bacharach & Bamberger, 1995). In this vein, tangible resources are explicitly differentiated from intangible resources like organizational processes and routines (Barney, 1991), embeddedness in social and professional networks (De Wever, Martens, & Vandembemt, 2005; Oke, Idiagbonoke, & Walumbwa, 2008), time (Durham, Locke, Poon, & McLeod, 2000; Swink, 2003), or reputation, and technical expertise (Conner, 1991; Kogut & Zander, 1992).

Finally, resources are defined to be adequate if they are sufficient to achieve the given objectives of an innovation project (Hoegl et al., 2008). If resources are not judged to be sufficient to achieve the objectives pursued, they will be termed synonymously as constrained or inadequate resources (Mone, McKinley, & Barker, 1998). In the reverse case, i.e., tangible resources in excess of those required to achieve the project's objectives, it is referred to slack resources (Bourgeois, 1981). Of course, (in-)adequacy of resources can be seen as a matter of degree on a continuum, rather than seeing resources being merely adequate or constrained (Hoegl et al., 2008).

1.2. Literature on tangible resource constraints and innovation

As mentioned above, in the innovation literature there are two main notions concerning the effect of constraints in material resources and relative team size on innovation.

Predominantly, authors argue in favor of a “resource driven” mindset that at least adequate material resources and relative team sizes foster creative problem solving and thereby new product development (Ancona & Caldwell, 1992b; Bromiley, 1991; Camison-Zornoza, Lapedra-Alcami, Segarra-Cipres, & Boronat-Navarro, 2004; Cooper & Kleinschmidt, 1995; Damanpour, 1991; Herold, Jayaraman, & Narayanaswamy, 2006; Nohria & Gulati, 1996). The main argument is relative team size and material resources need to be adequate to create the ability to innovate (Miller & Friesen, 1982), i.e., the conditions that permit to engage in innovation supporting activities like experimenting with new strategies (Cyert & March, 1963) or idea exploration (Damanpour, 1991), and that supply necessary funds and materials to projects (Amabile et al., 1996). Additionally, it is argued that slack tangible resources, cause relaxation of controls (Nohria & Gulati, 1996, 1997), thereby allowing more autonomy and thus creativity to the project teams (George, 2007; Shalley, Zhou, & Oldham, 2004). Thus, adequate tangible resources, or even slack tangible resources, are assumed to lead to better outcomes, whereas inadequate tangible resources are expected to starve out innovation projects.

While the above arguments suggesting that constrained tangible resources inhibit innovation project performance seem intuitively plausible, there is literature indicating the exact opposite. The common denominator among these literatures supporting the “less is more” mindset is that tangible resource constraints are instrumental in overcoming what cognitive psychologists call the “design stance” (Barrett, Laurence, & Margolis, 2008; Goldenberg, Mazursky, & Solomon, 1999a; Jaswal, 2006; Matan & Carey, 2001) or “functional fixedness” (Arnon & Kreitler, 1984; Birch & Rabinowitz, 1951; Duncker, 1945; German & Barrett, 2005; Glucksberg & Weisberg, 1966; Wiley, 1998). That means, in contrast to young children, adult people are so persuaded by the purpose something was designed for that they find it hard to see which other purposes an artifact could also be used for, even if it was not designed for that purpose (German & Defeyter, 2000; Matan & Carey, 2001; Snyder, 1998). One theoretical approach applying this school of thought is based on the existence of the so called “path of least resistance” (Ward, 1994). The underlying theory suggests that when facing a problem, the default approach of people is to implement the first solution that comes to mind, as long as this solution is feasible and affordable (Finke et al., 1992; Moreau et al., 2005; Ward, 1994). Straying from this path of least resistance, however, demands more cognitive effort and creates a higher level of uncertainty in the outcome

(Moreau et al., 2005). Thus, people will stay on the path of least resistance, unless the first solution that came to mind is not available, for example, when constrained material resources or insufficient relative team sizes push people not being able to afford this solution off this proverbial path. This theory was validated in numerous studies on the individual level, showing that tangible resource limitations make people feel more creative and lead to more creative outcomes (Dahl & Moreau, 2007; Moreau et al., 2005; Smith, Ward, & Schumacher, 1993; Stokes, 2001, 2006; Ward, Dodds, Saunders, & Sifonis, 2000).

Another literature stream that can be ranked among this “less is more” school is research on *Bricolage* (Duymedjian & Rüling, 2010). Roughly defined, the French word *Bricolage* means making do with whatever resources are at hand (Baker & Nelson, 2005; Berry & Irvine, 1986; Miner, Bassoff, & Moorman, 2001; Weick, 1993). The idea behind this concept is that people engaging in *Bricolage* see value in tangible resources otherwise being deemed worthless (Baker & Nelson, 2005; Garud & Karnoe, 2003). This concept, originally developed by French anthropologist Claude Lévi-Strauss (1967) to contrast the attitude of an engineer, resonated with the *Bricolage*-prone context of entrepreneurship, suggesting that product developers engaging in *Bricolage* may find ways to apply certain tangible resources that would have been neglected by others (Baker & Nelson, 2005). A nice illustration of how novel solutions may be obtained by engaging in *Bricolage* is shown by the Apollo 13 case, when ground control in Houston had to think about how to upgrade the under-dimensioned carbon dioxide reduction device with only the materials on board the space modules at hand (King, 1997).

The traditional Indian concept of *Jugaad*, which means something coming close to “finding creative short-term workarounds” (Gupta, 2008: 61), is highly related to *Bricolage*. Having its origins in the traditionally resource scarce regions of India, where people simply are barred from purchasing the products they actually need and thus forced to use their wits and originality to make do with the materials at hand. In contrast to *Bricolage*, the concept of *Jugaad* incorporates a clear inferiority of the products being developed in such a way, thus possessing a basically negative connotation. To describe a concept basing on *Jugaad* that keeps the aspect of clever improvisation and of making do with what is at hand, while wiping off the aspect of compromising on quality, Prahalad and Mashelkar (2010) introduced the term *Ghandian innovation*. *Ghandian innovation*, in their view, represents a parsimonious

way of innovating that puts the main focus on affordability and sustainability, thereby explicitly opposing the common “resource driven” attitude of Western cultures and promoting a “potent combination of constraints and ambitions” (Prahalad & Mashelkar, 2010: 134). The automobile industry, for instance, has shown large Western car makers frequently struggling to come up with highly efficient or cheap cars, in contrast to Indian firms such as Tata (Hoegl et al., 2009a; Waeyenberg & Hens, 2008).

Similarly, literature on understaffing theory (sometimes also referred to as undermanning theory) comes up with counter-intuitive insights, proposing that members of inadequately staffed teams (in terms of relative team size) are expected to be increasingly motivated and expend greater effort (Oxley & Barrera, 1984; Wicker, Kirmeyer, Hanson, & Alexander, 1976). Moreover, results of this research stream suggest that members of inadequately staffed teams show higher feelings of job satisfaction and empowerment (Greenberg, 1979; Vecchio & Sussmann, 1981), aspects commonly associated with positive effects on performance and innovation. Overall, various literatures provide indication that tangible resource constraints can also have an enabling effect on innovation projects.

Nonetheless, the potentially enabling effects of constraints in material resources and relative team size are not well-integrated in the management literature. Prior empirical research investigating the effects of constrained material resources and relative team size on innovation, however, has been predominantly conducted on the individual level, e.g., work in cognitive psychology and creativity research (e.g., Goldenberg, Lehmann, & Mazursky, 2001; Moreau et al., 2005), or on the organizational level (e.g., Dougherty, 1994; George, 2005; Greve, 2003; Katila & Shane, 2005; Mishina et al., 2004; Mone et al., 1998; Nohria & Gulati, 1996) so far. On the organizational level, an inverse U-shaped relationship between tangible resources and a company’s success in innovation is quite established in the literature, with a certain amount of slack being assumed to be optimal (Geiger & Cashen, 2002; Nohria & Gulati, 1996, 1997). In contrast, on the individual level, laboratory research has repeatedly demonstrated that “less is more” and tangible resource constraints act as a driver for creativity and innovation (Finke et al., 1992; Goldenberg et al., 2001; Moreau et al., 2005). Most innovative endeavors in organizations, however, take place in team projects (Edmondson & Nembhard, 2009; McDonough, 2000; Wuchty et al., 2007), and there are several sound reasons why the nature of tangible resource constraints’ effects at the project level is likely to

differ from the relationships observed at the individual, as well as at the organizational level. In contrast to the individual level, at the project level there is plenty of interaction between team members, as well as with people from outside the project team (Ancona & Caldwell, 1992b; Hoegl & Gemuenden, 2001). This interaction influences the behavior of the team members, thereby altering the response patterns to tangible resource constraints of each individual in the group, compared to an isolated laboratory setting (Moreau et al., 2005). Similarly, there are many relevant factors on the organizational level that do not affect work within a project team, e.g., corporate innovation portfolio issues (e.g., Lichtenthaler, 2009; Loch & Kavadias, 2002).

The present body of empirical research on the influence of material resource constraints and relative team size focusing on the project level, however, is almost non-existent. Further, the discussion of potential effects of tangible resources in innovation projects usually takes place based solely on theoretical arguments (e.g., Amabile et al., 1996; Gibbert et al., 2007; Gibbert & Välikangas, 2004; Hoegl et al., 2008). This is surprising, given the immense attention that research on innovation in teams or projects has received so far (for an overview see Hülshager, Anderson, & Salgado, 2009; or Paulus, 2000). With the exception of Weiss, Hoegl, and Gibbert's study (forthcoming), to which I return in more detail at a later point in this doctoral thesis, published studies empirically examining innovation project performance have never made material resource adequacy or relative team size a central aspect of investigation. Instead, adequacy of tangible resources in innovation projects has been examined mostly as a control variable. Three of the published studies empirically examining the influence of tangible resources on innovation projects yielded significant, yet contradicting results. Song and Noh (2006) found tangible resource availability to significantly differentiate between successful and unsuccessful innovation projects, with more tangible resources leading to better outcomes. In contrast, Sethi and Iqbal (2008) discovered relatively higher financial resource provisions to innovation projects, compared to similar prior projects, to be significantly negatively related to the success of newly developed products. Finally, Sicotte and Bourgault (2008) found staffing adequacy of innovation project teams being significantly positively related with these teams' performance. However, none of those studies checked for any moderating effects on the relationship between tangible resources and innovation project success. Neither did other studies that scrutinized effects of tangible resource adequacy on innovation project performance and revealed no significant

relationships (De Dreu, 2006; Hoegl & Parboteeah, 2006a; Joshi & Sharma, 2004; Leenders & Voermans, 2007; Markham, 2000; Sethi, Smith, & Park, 2001). Table 1-1 provides a summary of extant studies that empirically examined the relationship between tangible resources and innovation project outcomes.

Source	Type of tangible resource	Results
(Song & Noh, 2006)	Tangible resources in general	Resource availability significantly differentiated between successful and unsuccessful innovation projects, with more resources leading to better outcomes.
(Sethi & Iqbal, 2008)	Financial resources	Relatively higher financial resource provisions to innovation projects were significantly negatively related to the success of newly developed products.
(De Dreu, 2006)	Tangible resources in general	No significant relationship between resource constraints and innovation.
(Hoegl & Parboteeah, 2006a)	Material resources	No significant relationship between resource adequacy and innovation project performance.
(Leenders & Voermans, 2007)	Tangible resources in general	No significant relationship between resource availability and innovation project performance.
(Sethi et al., 2001)	Tangible resources in general	No significant relationship between resource availability and the innovativeness of developed products.
(Sicotte & Bourgault, 2008)	Staffing adequacy	Significantly positive relationship between staffing adequacy and innovation project performance.
(Weiss et al., forthcoming)	Financial resources	No significant direct relationship between resource adequacy and innovation project performance. Team climate for innovation significantly moderated the relationship between resource adequacy and innovation project performance.

Table 1-1: Empirical studies examining the relationship between tangible resources and innovation project outcomes.

The disquieting finding from these studies is that tangible resource adequacy and innovation project performance turn out not to be systematically related to each other at all

(whether positively, negatively, or in a curvilinear way). Hence, in the sparse empirical research on the role tangible resources play in innovation projects, there is a clear lack of investigations focusing on mechanisms that could explain the mixed results or the non-findings observed regarding more or less successful outcomes of innovation projects being constrained in tangible resources in order to reconcile the contradicting notions in literature. Notably, the probability of accidental coincidence or measurement errors is low, as the mentioned studies were conducted in quite diverse environments, providing further confidence in the findings (samples consisting, e.g., of software development teams, automotive development teams, product development teams from electronics industry, or teams from mixed-industries).

1.3. Research gap and contributions

As the literature mentioned above suggests, there does not appear to exist a direct relationship between the adequacy of tangible resources, both in terms of material resources as well as relative team size, and innovation project performance. Although it becomes clear that tangible resource constraints may stimulate and facilitate innovation, they not necessarily do so. To shed light on the mechanisms behind this observation, this doctoral thesis aims at providing a systematic analysis of the role tangible resources play in innovation projects. Prior research systematically investigating the effects of tangible resource constraints on innovation was either conducted on the individual level, or on the organizational level. However, most innovative endeavors in organizations actually take place in team projects (Edmondson & Nembhard, 2009; McDonough, 2000; Wuchty et al., 2007), which this doctoral thesis explicitly focuses on. This dissertation's conceptual considerations as well as empirical analyzes of 121 real world innovation projects will shed light on how tangible resource constraints operate in innovation projects and will clarify which, if any, of the differing natures of the influence of tangible resource scarcity observed on the individual and the organizational level holds true for the project level of enquiry.

1.3.1. Tangible resource constraints and the resource-based view of the firm

For this purpose, the resource-based view (RBV) of the firm (Barney, 1991; Wernerfelt, 1984) will be applied as a guiding theoretical framework in this dissertation. The

core tenet of the RBV is that firms possessing valuable, rare, inimitable, and non-substitutable organizational resources, the so called VRIN-criteria (Barney, 1991), are supposed to yield sustained competitive advantage (Barney, 1991; Meyer, 1991; Wernerfelt, 1984). These firm-specific resources can be both tangible and intangible (Barney, 1991; Grant, 1991; Helfat & Peteraf, 2003). Essentially, the RBV sees firms as bundles of resources to which their returns are largely attributable (Hitt & Ireland, 1985; Wernerfelt, 1984), thereby providing a firm-internal or input oriented focus to explain firms' varying success (Crook, Ketchen, Combs, & Todd, 2008; Sirmon, Hitt, & Ireland, 2007). Originating from research on strategic management, the highly influential concept of the RBV in the meantime has been applied in as diverse fields of management research as entrepreneurship (Alvarez & Busenitz, 2001), new product development (Verona, 1999), or human resource management (Wright, Dunford, & Snell, 2001). However, upcoming criticism of the RBV notes that the mere possession of resources can hardly explain the development of competitive advantages or the creation of value (Armstrong & Shimizu, 2007; Kraaijenbrink, Spender, & Groen, 2010; Newbert, 2007; Priem & Butler, 2001). Moreover, a number of critics cast doubts on the necessity of the aforementioned VRIN criteria that constitute what should be termed as a resource and find fault with the RBV's insufficient consideration of the role people play in value assessment and creation (Foss, Foss, Klein, & Klein, 2007; Kraaijenbrink et al., 2010). From this criticism on classic concepts in the framework of the RBV follows that to indeed realize competitive advantages, it is by far not enough for firms only to possess certain resources. Addressing the shortcomings of the RBV, Sirmon and Hitt (2003) therefore reason that, more importantly, resources also have to be evaluated, managed, and deployed in a proper way by people, thereby expanding the classic concept of the RBV. In so doing, Sirmon, Hitt, and colleagues point to the central role of managers and employees when it comes to explaining how resources are transformed to create value (Sirmon, Gove, & Hitt, 2008; Sirmon & Hitt, 2003; Sirmon et al., 2007) and thus enable the incorporation of behavioral influences on whether a given set of resources is actually resulting in a competitive advantage or not.

This expanded view of the RBV, with the central role of people evaluating, managing, and deploying resources, offers the starting-point for a systematical analysis of the role tangible resources play in innovation projects. In this regard, the insights from a number of literatures hint at causal mechanisms which can be accounted for as plausible explanations for differences among innovation project teams regarding how material resources and relative

team sizes of varying adequacy are evaluated and managed. These mechanisms, which are expected to be also responsible for the observed non-effect of tangible resource constraints on innovation project performance in the literature, will be briefly outlined in the following paragraphs and presented in more detail in Chapters 3-5. In particular, three major explanatory approaches can be summarized.

1.3.2. Resource evaluation

First, there may be considerable differences how people involved in innovation projects actually evaluate the tangible resources they are provided with to carry out these innovation projects, i.e., how adequate they perceive these tangible resources to be, given the project tasks at hand (Sirmon & Hitt, 2003). There is a vast amount of literature in organizational research pointing to the notion that the value of resources resides in the eye of the beholder (Baker & Nelson, 2005; Brush & Artz, 1999; Garud & Karnoe, 2003; Kor, Mahoney, & Michael, 2007; Penrose, 1959). However, scholarly work dealing with effects of tangible resource adequacy on innovation projects, both conceptual as well as empirical work, has more or less explicitly bracketed off how team members actually perceive tangible resources and whether there may be systematic influences on these perceptions (e.g., Hoegl et al., 2008; Sethi & Iqbal, 2008). Could it be that some innovation project teams are less bothered or even encouraged by tangible resource constraints compared to other teams, and if so why?

This question can be addressed using insights from research in cognitive psychology showing that perceptions are very prone to socio-cognitive influences not actually connected to the aspects under evaluation (Ackerman, Nocera, & Bargh, 2010; Blickle et al., 2011; Selfhout, Denissen, Branje, & Meeus, 2009; Stefanucci & Storbeck, 2009; Ungemach, Stewart, & Reimers, 2011; Williams & Bargh, 2008; Zhong & Liljenquist, 2006). For instance, Jostmann, Lakens, and Schubert (2009) showed that individuals' experience of a heavy weight (e.g., holding a heavy clipboard) increased evaluations of monetary value. Further results from this field of cognitive psychology underline that perceptions play a key role in explaining task behavior and resulting success. Clarkson, Hirt, Jia, and Alexander (2010), for example, found that a person's perceived depletion may influence subsequent task performance, regardless of the actual state of depletion. Translated to the context of this

dissertation, an innovation project team's perception of how adequate the innovation project's tangible resources are is likely to be influenced by socio-cognitive factors as well. Consequently, when perceptions of tangible resource adequacy may differ, what constitutes adequate to some teams may well appear inadequate to others. It is important, therefore, to understand which socio-cognitive influences shape perceptions of tangible resource adequacy among the members of innovation project teams, because it is these perceptions of tangible resource adequacy that actually drive individual and team behaviors.

Addressing this research gap, this doctoral thesis contributes by explicitly including socio-cognitive influences on perception of material resource adequacy in the examination of the role tangible resources play in innovation at the project level. In this connection, innovation project endogenous, i.e., attributes of the innovation project and its team, as well as innovation project exogenous socio-cognitive influences, i.e., influences originating from outside the innovation project such as a company's organizational culture, will be addressed in this dissertation. This inclusion of perceptual aspects in theoretical considerations and the empirical investigation of the tangible resource-innovation project performance relationship might open up new directions for research and help reconciling opposing conceptual views and contradictory empirical results. Moreover, this doctoral thesis contributes by identifying specific drivers of how tangible resources are perceived. Learning more about such drivers of team perception by drawing on parallels from cognitive psychology appears particularly worthwhile, since they may be shaped by managers or by team members of the innovation project teams themselves.

1.3.3. Resource management and deployment

Second, the way tangible resource provisions are managed and deployed by innovation project teams is expected to considerably influence the relationship between tangible resources and innovation project outcomes. In this regard, Hoegl et al. (2008) proposed that the relationship of tangible resource adequacy and innovation project performance is likely to be contingent on third variables actually determining the direction and the slope of this relationship. In their view, these contingency variables reflect the notion in innovation management research that innovators must overcome barriers to be successful (Gemuenden, 1988; Mirow, 2010). Two barriers, in particular, stand out: barriers of capability and barriers

of will (Gemuenden, 1988; Hoegl et al., 2008). Barriers of capability refer to “the inability to perform work strategies that proved successful in the past due to the reduced tangible resource provisions” (Hoegl et al., 2008: 1384). For instance, a smaller tangible resource base than in prior projects limits the team’s options regarding the purchase of innovative components and the costly experimentation with new ideas. Barriers of will refer to “the motivational challenge of engaging with full resolve in a project that is afforded fewer tangible resources than prior successful projects absorbed” (Hoegl et al., 2008: 1384). As a result of these additional barriers, an innovation project team may perceive the project as largely ill-fated due to its inadequate tangible resource provisions.

Empirical research thus far has pointed to the team climate for innovation (TCI) (Anderson & West, 1998; West, 1990) as a key contingency variable positively influencing the relationship between financial resource constraints and innovation project performance by overcoming the two barriers mentioned above (Weiss et al., forthcoming). Regarding barriers of capability, TCI is suggested to support team members of innovation projects in their search for novel strategies in the innovation process by facilitating access to necessary information, and by encouraging team members to think creatively and to develop new approaches to known problems (Anderson & West, 1998; Caldwell & O’Reilly, 2003). Furthermore, TCI incorporates the provision of sufficient space and opportunity for team members to experiment with new ideas, thus allowing for phases of individual thought and work which are necessary to better leverage individual creative ability (Anderson & West, 1998; West, 1990). Hence, TCI is expected to tackle barriers of capability, effectively forcing the team to look for alternative solutions elsewhere. As regards overcoming barriers of will, TCI is assumed to exert a positive influence by creating a feeling of safety among team members when experimenting with novel ideas and approaches, allowing them to make mistakes without fearing negative consequences (Baer & Frese, 2003; Edmondson, 1999). In this way, team members are more likely to take risks and subsequently to be motivated to push a project with lower outcome certainty.

In a similar way, further variables may exert a moderating influence on the relationship between tangible resource adequacy and innovation project performance, e.g., those mentioned in the contingency model developed by Hoegl et al. (2008), which is shown in Figure 1-1. In this doctoral thesis, particular attention is oriented toward influences

originating on the organizational level of enquiry which have not found their way into conceptual or empirical research on the role of tangible resources in innovation projects so far. Such cross level relationships are expected to exert notable influence on how tangible resources are managed and deployed in innovation projects, in particular those that represent aspects of corporate mindset (Talke, 2007), and organizational culture (Denison & Mishra, 1995; Detert, Schroeder, & Mauriel, 2000; Schein, 1990). By operationalizing such differences in corporate mindsets and cultures through differences in firm-ownership, specifically, whether a company can be considered as a family firm or not, this dissertation offers a conceptual expansion of Hoegl et al.'s (2008) model to a cross-level model and an empirical test of the question under which conditions constrained tangible resources have a facilitating, rather than an inhibiting effect on innovation project performance.

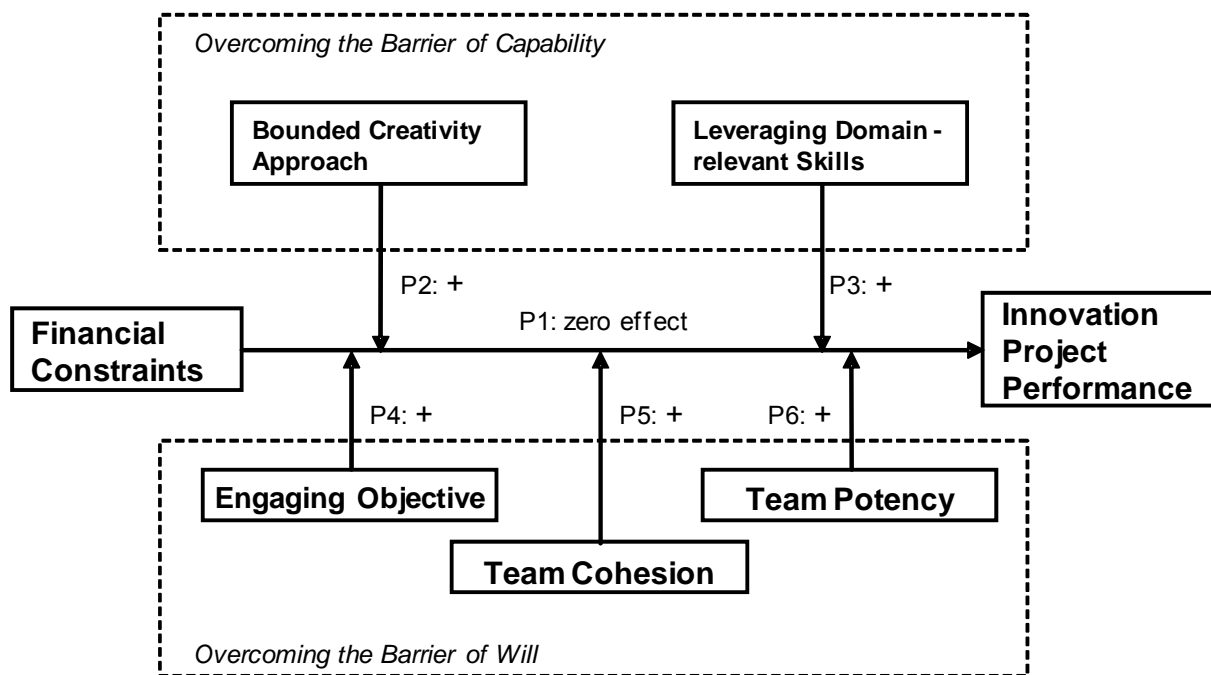


Figure 1-1: The theoretical model proposed by Hoegl et al. (2008: 1385).

1.3.4. Measurement of innovation project outcomes

Finally, the inconclusive results of studies examining the effect of material resource adequacy and relative team size on innovation project performance might also originate from

a lack of detail in the measurement of innovation project outcomes. When specifying the effect of tangible resource adequacy perceptions on innovation performance, it is also necessary to reconsider the conceptualization of the performance variable itself (Chiesa, Frattini, Lazzarotti, & Manzini, 2009; Griffin & Page, 1996; Shenhar, Dvir, Levy, & Maltz, 2001). In particular, whether the quality or innovativeness of the developed products is used as outcome measure may notably influence results, since these performance dimensions have been shown to deviate largely from each other, sometimes even being reported as antagonizing each other (Molina-Castillo & Munuera-Aleman, 2009; Sethi, 2000; Sethi & Sethi, 2009). The application of such more fine-grained outcome measures may then enable to identify potential differences between the most frequently used, but divergent, indicators of innovation project performance. In less detailed analyses using compound measures of innovation project outcomes (e.g., Hoegl & Parboteeah, 2006a; Joshi & Sharma, 2004; Leenders & Voermans, 2007; Sethi et al., 2001), these are likely to cancel each other out. Therefore, this lack of detail in the outcome variable might have contributed to the frequently observed non-significant results between tangible resource constraints and innovation project performance. Hence, this dissertation contributes by offering a more fine-grained analysis of the relationship between tangible resources and differing outcome dimensions of innovation project performance. In so doing, this thesis also offers answers to the still unresolved question whether the relationship of tangible resources with innovation project outcomes hinges on the type of tangible resource focused on, i.e., whether material resources or relative team size is analyzed.

Moreover, for the first time, the relationship between relative team size and innovation project performance is theoretically and empirically examined as the scarce prior research on this topic dealt solely with teams pursuing routine tasks. Expanding this analysis to teams pursuing innovative tasks appears important, given the peculiarities of such teams like an elevated level of uncertainty and ambiguity (Caldwell & O'Reilly, 2003; Veryzer, 1998). This investigation also nicely complements research on team staffing in general, which almost exclusively focused on the investigation of team members' qualities that are beneficial for innovative endeavors (e.g., McComb, Green, & Dale Compton, 2007), and on the effects of absolute team headcount on teams' innovation performance (Hoegl, 2005; Hülshager et al., 2009; Stewart, 2006) so far.

Building on the theoretical contributions outlined above, this doctoral thesis ultimately aims to identify success factors of project work under constrained tangible resources and the development of actionable managerial recommendations in order to make better use of companies' investments in innovation instead of tenaciously sticking to a "resource driven" mindset in innovation management.

1.4. Research questions

In sum, this dissertation aims at providing the contributions outlined above by addressing the following central research questions:

- a) What role do socio-cognitive influences on perception play in innovation project teams' evaluation of tangible resources, and are there specific drivers of how adequate tangible resources are perceived in innovation projects? – If so, which effects entail differences in these perceptions of tangible resource adequacy for the novelty and quality of developed products?
- b) Do aspects of organizational culture such as the orientation toward material resources influence innovation project teams' perceptions of material resource adequacy, and are there cross-level effects of such organizational level variables that influence how successful innovation project teams manage tangible resources of varying adequacy?
- c) What is the relationship between relative team size and innovation project performance in terms of differing innovation project outcomes, and are there differences between relative team size's relationship with innovation project outcomes and the relationship found between material resource adequacy and innovation project outcomes?

1.5. Outline of the thesis

In this doctoral thesis, the three core explanatory approaches mentioned above will be further theoretically developed, converted to testable hypotheses, and empirically examined.

The thesis itself is organized as follows. In Chapter 2, the design of the empirical study on which the statistical analyzes of this doctoral thesis are based is outlined in detail. Thereafter, three Chapters (3-5) follow, in which the main conceptual approaches to explain the tangible resources-innovation project performance relationship are developed and empirically tested.

Specifically, Chapter 3 provides a project-level theory of mechanisms potentially explaining why material resources that are perceived to be adequate by one team are judged being inadequate by others. Subsequently, the derived hypotheses that are grounded in insights of cognitive psychology are empirically tested. Furthermore, this chapter provides a fine grained investigation of the effects of different levels of perceived material resource adequacy on innovation project outcomes, i.e., new product novelty, and new product quality. This higher detail in the measurement of innovation project outcomes may help explaining why most empirical studies in the past yielded non-significant results for the material resource constraints-innovation project performance relationship.

Chapter 4 applies a cross-level approach to scrutinize influences of organizational mindsets on how material resources are evaluated and managed by team members of innovation projects. Operationalizing differences in firm ownership, i.e., whether a company is a family firm or a non-family firm, as a proxy for cultural differences among companies allows probing the assumption that the evaluation as well as the management and deployment of material resources may be influenced by socio cognitive variables such as the orientation toward material resources. This investigation involves multi-level mediation and moderation analyses.

Chapter 5 builds on the results from Chapter 3 regarding differences between outcome dimensions as a consequence of material resource provisions, and examines which effects an insufficient relative team size has on innovation project performance, and whether and how these effects differ from those of constraints in material resources on innovation project performance. Controlling for qualitative features of team staffing, such as technical expertise, experience, and originality of team members, as well as for structural aspects of innovation projects like project length and absolute team size, effects of relative team size are isolated and scrutinized.

Chapter 6 then summarizes the findings reported in Chapters 3-5 and discusses their major theoretical and practical implications. Chapter 7 finally builds on the findings of this doctoral thesis and provides an outlook and an agenda for future research on the role of resource constraints in innovation. Figure 1-2 depicts the structure of the doctoral thesis outlined here. The Chapters 3, 4, and 5 are each structured as an empirical research paper with its own abstract, introduction, theory, hypotheses development, methods, results, and discussion section. Although effort was taken to avoid such occurrences, some redundancies and overlaps of theoretical and, in particular, methodological issues have been inevitable.

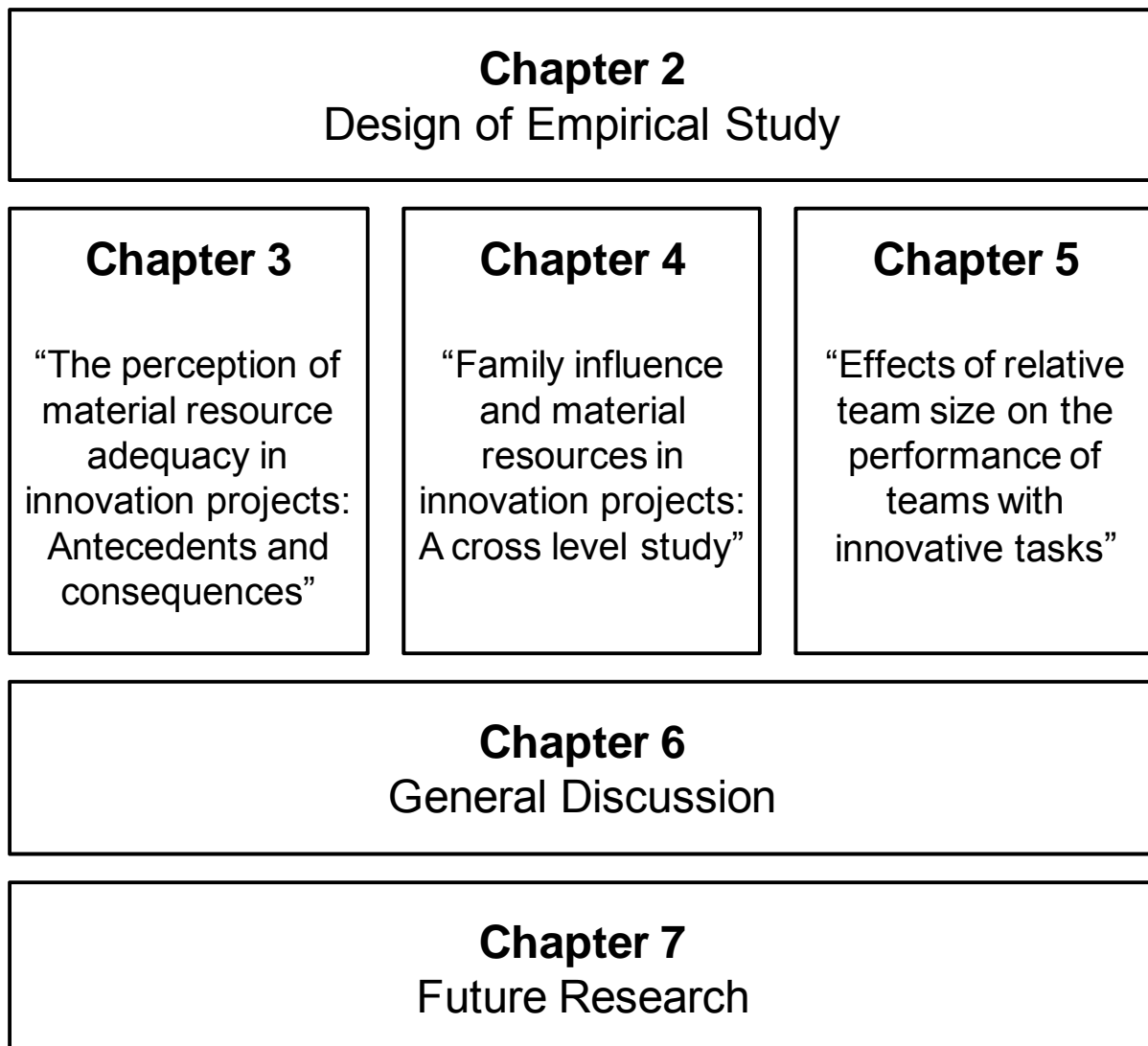


Figure 1-2: Structure of the thesis

2. DESIGN OF EMPIRICAL STUDY

2.1. Data collection

In order to test the hypotheses of this dissertation, a large scale field study was conducted. This quantitative survey study aimed at analyzing teams of innovation projects executed by companies in the electronics industry. The electronics industry was chosen for its high innovation pressure, which is reflected by the outstandingly high amount of investments in R&D activities in this industry, and the fact that the electronics industry alone accounts for nearly one third of total yearly patents in Germany (ZVEI, 2010). Furthermore, the presence of large as well as small and medium sized companies in the targeted countries (Austria, Germany, and Switzerland) spoke in favor of choosing the electronics industry as the setting for this empirical study. This high variance in enterprise sizes in this industry allows comparing firms that are able to dispose of more tangible resources with companies that have to operate under a rather scarce tangible resource base. A single industry was selected because companies in the same industry share strategic factor markets (Barney, 1986), and industry attributes that influence strategy decisions (Mascarenhas & Aaker, 1989), which thus can be controlled for.

To obtain the sample for this thesis, the acquisition strategy was as follows: In order to clarify the general willingness to participate in the study, executives responsible for R&D activities (mostly CEOs and CTOs) in companies that were considered suitable for the study were contacted. Companies were considered suitable when visibly pursuing innovation activities in the electronics industry. As an incentive to take part in this survey study, participating companies were offered a final benchmark report, and an individual post study workshop in which key practical implications of the survey results were presented. In case of an agreement to participation, the innovation project teams to participate in the study were determined in close collaboration with the responsible managers. In order to guarantee respondents' accurate retrospection, the innovation projects had to be completed within a maximum of 12 months prior to the date of survey. Next, the executives named the project leaders that were responsible for the innovation projects to be analyzed who were then contacted. In the following step, these project leaders provided detailed information about the projects and named the team external managers as well as those team members of the core team to be surveyed in the study.

In order to avoid common source biases (Podsakoff, MacKenzie, Jeong-Yeon, & Podsakoff, 2003), multiple respondents from each innovation project were surveyed, i.e., team external managers, project leaders, and at least two team-members of each project. Team external managers were the line managers responsible for the innovation projects, i.e., to whom the innovation project leaders reported. Throughout this doctoral thesis, all innovation project outcomes were measured using data from team-external managers. In line with previous research taking the same approach (e.g., Faraj & Sproull, 2000; Hoegl & Gemuenden, 2001; Hoegl, Weinkauff, & Gemuenden, 2004; Zhang, Hempel, Han, & Tjosvold, 2007), the line managers were in an ideal position to rate the innovation project outcomes without being biased by team-internal processes.

Data were collected via web-based online-questionnaires administered in German language. Links to these online-questionnaires were sent via e-mail to all team leaders, team-external managers, as well as to the randomly-chosen team members after the participating employees were informed that a study about team management was to be conducted. Respondents' participation in this study was strictly voluntary. The respondents were assured that the researchers would maintain their anonymity and guarantee the confidentiality of the completed questionnaires. Acquisition of participants and data collection for this empirical study started in August 2008 and was completed by the end of May 2009.

The data gathered with the online questionnaires were then directly and automatically transferred to an online database which secured high confidentiality of data and avoided any loss or mismatching of data, that could occur in the manual transfer of questionnaire data. After the completion of data collection, the content of this database was directly exported into the applied statistics software package SPSS 17.0 (SPSS Inc., 2008).

2.2. Measurement instrument

The items of the administered online questionnaires – there were different versions of questionnaires for project leaders, project team members, and team external managers, respectively – mainly consisted of statements rated on 5-point Likert-type scales. These scales were anchored using equi-distant labels for each scale point (Dobson & Mothersill, 1979; Rohrman, 1978; Spector, 1976). Existing scales and items from published research were applied where possible. These have been selected depending on their fit to the purpose of this

study, their content and construct validity (Rossiter, 2008), as well as on the evaluation of reported quality criteria such as internal consistency, test-retest stability, inter-rater reliability, and criterion validity (Churchill, 1979; Hinkin, 1995, 1998).

Several qualitative in-depth case studies of innovation projects in big multinational companies (e.g., Robert Bosch GmbH, Audi AG), as well as in small and medium sized enterprises (e.g., Loremo AG) served as preliminary studies to assess whether the measurement scales included in the questionnaire are of relevance in the given context of innovation projects, and whether the items are worded in an unambiguous and understandable way. These preliminary surveys were conducted by interviewing key informants, i.e., team leaders of completed or terminated innovation projects. In addition to probing a pilot version of the questionnaire, I conducted semi standardized interviews with these key informants during which respondents were asked to name critical incidents (Flanagan, 1954) that led to success or failure of those innovation projects. Further, they had to estimate the influence of the variables applied in the questionnaire with regard to the mentioned critical incidents during the innovation projects. In total, 24 project managers of five companies have been interviewed in the course of this preliminary study. Based on the results of this analysis, I revised the initial questionnaires.

2.3. Sample

The final sample consisted of 121 innovation projects in 35 companies from the electronics industry in Germany, Austria, and the German speaking region of Switzerland. Given the premise of surveying a minimum of two team members from each project team (in addition to the team leader and a team external manager), I sent out a total of 614 invitations to participate in the survey. A total of 497 individual responses (461 men and 36 women) have been collected, resulting in a response rate of 81 %. A detailed summary of the firms included in the sample is given in Figure 2-1 and Table 2-1.

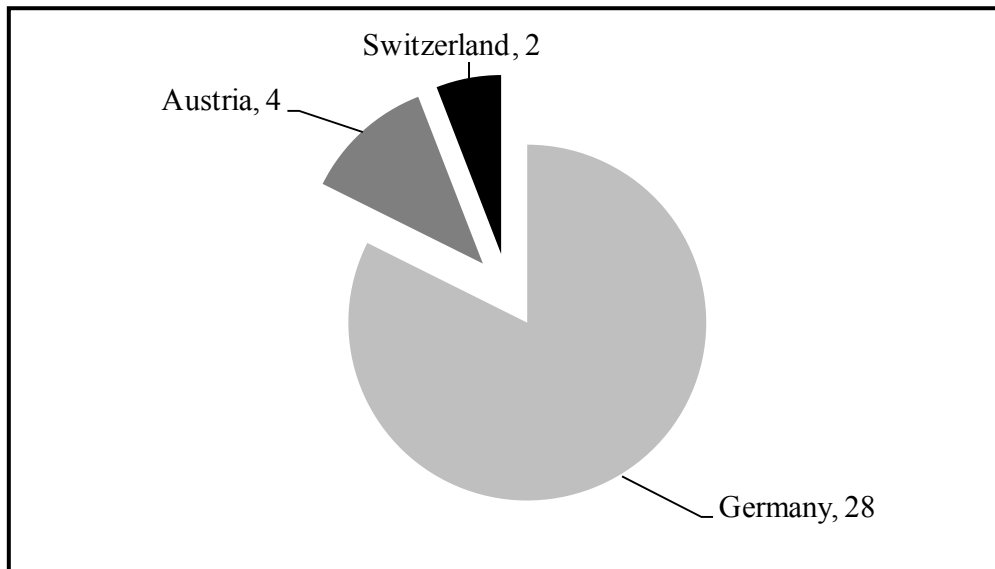


Figure 2-1: Countries of participating companies.

Number of companies	
Number of employees	
< 500	13
500 - 1,000	6
1,001 - 10,000	9
> 10,000	6
Sales volume (in mio. Euro)	
< 25	2
25 - 100	9
101 - 1,000	15
1,001 - 10,000	7
> 10,000	2
Number of teams in sample	
1	9
2	9
3	4
4	4
> 4	9

Table 2-1: Details of companies participating in the study ($N = 35$).

The pronounced proportion of men within the sample reflects the relatively low number of women regularly working in the development of new technological products in the countries the innovation projects took place and is thus assumed to be representative for this domain. In this regard, a number of studies examining new product development projects in a technological context reported a similar dominance of men (e.g., Keller, 1994; Scott & Bruce, 1994).

The average headcount of innovation project teams in the sample of this study (including the team leader) was 8.7 team members (median = 7, standard deviation = 6.8). The distribution of team sizes within this sample is shown in Figure 2-2.

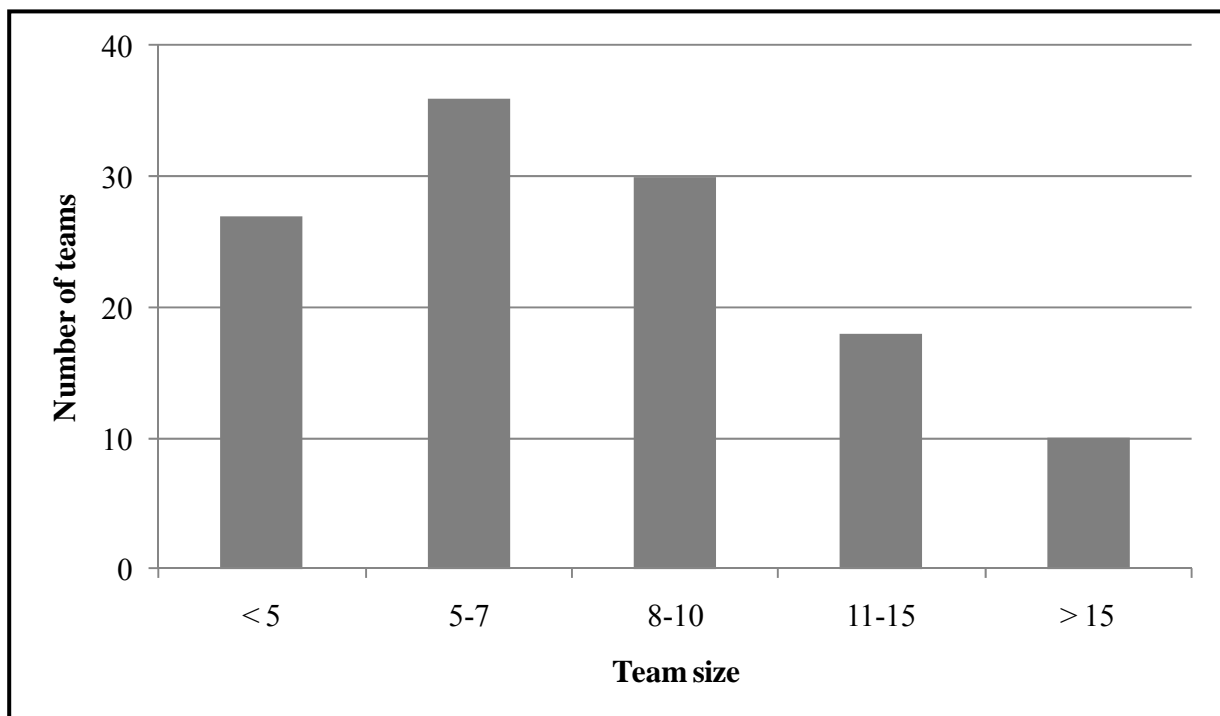


Figure 2-2: Distribution of team sizes of innovation projects ($N = 121$).

2.4. Data aggregation

Prior to aggregating team members' evaluations of team level variables (Van Mierlo, Vermunt, & Rutte, 2009), interrater agreement (Klein et al., 2000; LeBreton & Senter, 2008; Lindell & Brandt, 1999) was assessed using the multiple-item estimator $r_{WG(j)}$ for within-

group interrater agreement as proposed by James, Demaree, and Wolf (1984). This test yielded satisfactory $r_{WG(j)}$ for all examined variables, thus indicating generally strong agreement of ratings referring to the same team (specific values for each variable examined are given in the methods sections of the respective chapters). Given this homogeneity of within-team ratings, aggregation of the data to the team level appeared justified in all cases (George & James, 1993) and was conducted by calculating the arithmetic mean.

3. THE PERCEPTION OF MATERIAL RESOURCE ADEQUACY: ANTECEDENTS AND CONSEQUENCES¹

ABSTRACT

Studies on the role of material resources for innovation project performance have provided inconclusive results. Addressing this gap in the literature, this dissertation builds on analyses of data stemming from 121 innovation projects from the electronics industry and identifies team potency, team action repertoire, and workload as socio-cognitive drivers of innovation project teams' perception of material resource adequacy. Moreover, the perception of material resource adequacy is found to relate positively to new product quality, while it relates negatively to new product novelty. This research points to new directions for further theorizing on the link between material resources and innovation project performance.

¹ This paper was written by Matthias Weiss based on conjoint work with Prof. Dr. Martin Högl and Prof. Dr. Michael Gibbert.

3.1. Introduction

Evidence in a number of socio-cognitive research fields shows that perception can be substantially influenced by socio-cognitive factors (e.g., Beunza, Hardie, & MacKenzie, 2006; Clarkson et al., 2010; Gibson, Cooper, & Conger, 2009; Selfhout et al., 2009; Williams & Bargh, 2008). For instance, Jostmann et al. (2009) found that individuals' experience of a heavy weight (e.g., by holding a heavy clipboard) increased evaluations of monetary value. While it perhaps comes as no surprise that subjective and difficult-to-evaluate constructs like the similarity to another person were shown to underlie biased perception; even the perception of hard facts, such as geographical distance (Balcetis & Dunning, 2010; Proffitt, Stefanucci, Banton, & Epstein, 2003), as well as prices and money (Ackerman et al., 2010; Beunza et al., 2006; Jonung & Laidler, 1988; Jostmann et al., 2009), seems to be significantly influenced by socio-cognitive factors.

This evidence from socio-cognitive research suggests that the observation in management that the adequacy of material resources, i.e., the sufficiency of a project's material resources compared to a project's objectives, seems to be in the eye of the beholder (Baker & Nelson, 2005; Kor et al., 2007; Kraaijenbrink et al., 2010; Penrose, 1959) may also be a consequence of socio-cognitive influences on perception, in this case on the perception of material resource adequacy. In the field of innovation management, scholars have long argued over the effects of material resource adequacy on innovation on the project level (e.g., Amabile et al., 1996; Ancona & Caldwell, 1992a; Damanpour, 1991; Dillon et al., 2005; Hackman, 1987; Hoegl et al., 2008) where the vast majority of innovative endeavors is carried out (Edmondson & Nembhard, 2009; McDonough, 2000). Material resources are typically defined as the liquid funding available to an innovation project team, as well as monetary-equivalent resources such as technical equipment, but not human resources (i.e., the team members themselves) assigned to the innovation project (Hoegl et al., 2008). It follows that the material resource base of an innovation project must necessarily be seen in the light of the project team's assignment and the project's attributes like size, scope, or type of technology, and is therefore likely to be prone to socio-cognitive influences (Alvarez & Busenitz, 2001; Foss & Ishikawa, 2007; Kor et al., 2007; Kraaijenbrink et al., 2010).

This leads to the two key questions, which form the objectives of this article: First, what socio-cognitive factors influence the perception of material resource adequacy? To answer this question, we build on results from cognitive psychology (Witt & Proffitt, 2008), and identify team-level drivers of the perception of material resource adequacy, including team potency, team action repertoire, and workload. Second, how do such differences in the perception of material resource adequacy matter? In other words, which consequences (if any) on the performance of innovation projects, i.e., the degree of novelty and quality realized in the developed new products (Madhavan & Grover, 1998), may result from variations in the perception of material resource adequacy?

Answers to these questions would constitute a major step forward, since the question whether material resource adequacy influences innovation projects positively or negatively is far from clear, in the first place. The traditional mindset in innovation management is best described as “resource driven”, in that adequate material resources, or even material resource slack, are seen as drivers of creativity and innovation in projects aiming at developing new products (Amabile et al., 1996; Ancona & Caldwell, 1992a; Camison-Zornoza et al., 2004; Cooper & Kleinschmidt, 1995; Damanpour, 1991; Gladstein, 1984; Greve, 2003; Mellahi & Wilkinson, 2010; Mishina et al., 2004). Recently, however, a “less is more” stream of literature emerged which points to situations where, counter-intuitively, constrained material resources enable, rather than inhibit, innovation performance (Baker & Nelson, 2005; Garud & Karnoe, 2003; George, 2005; Gibbert & Scranton, 2009; Goldenberg et al., 2001; Katila & Shane, 2005; Moreau et al., 2005). It is likely that much of this ambiguity may be a function of *which* outcomes were examined in order to operationalize innovation project performance. In particular, whether the quality (e.g., Sethi, 2000) or novelty (also referred to as innovativeness) (e.g., Salomo et al., 2008) of the new products are used as outcome measures may influence results. Recent research in the area of individual performance in organizational behavior increasingly takes into consideration differential relationships and the multidimensional nature of performance (e.g., LePine & Van Dyne, 2001; Murphy & Shiarella, 1997; Van Dyne, Jehn, & Cummings, 2002). Thus, increasing conceptual rigor also in team level research seems desirable and timely.

Given these gaps in the literature, the investigations in this dissertation aim at making two main contributions. First, this paper contributes by identifying drivers of the perception of

material resource adequacy. Despite the impact of socio-cognitive research on perception on various other fields, not much is currently known about this in the context of innovation projects. This article breaks new ground, then, by explicitly including the influence of socio-cognitive factors on the perception of material resource adequacy in innovation projects. Given the complexity and uncertainty in innovative tasks (Souder & Moenaert, 1992), it is expected that through intensive team interaction, an inter-subjective team-level perception of material resource adequacy will emerge (Drazin, Glynn, & Kazanjian, 1999). Previous research examining the role of material resource adequacy in innovation projects did not take into consideration project endogenous factors that could influence this perception of material resource adequacy (e.g., De Dreu, 2006; Hoegl & Parboteeah, 2006a; Leenders & Voermans, 2007; Sethi et al., 2001). Learning more about such socio-cognitive drivers of teams' perception of material resource adequacy by drawing on parallels from cognitive psychology appears particularly worthwhile, since such drivers may be positively influenced and shaped by project management or characteristics of the innovation project team itself.

Second, the present study offers a more fine-grained analysis of the relationship between material resource adequacy and innovation project performance. Past theoretical approaches and empirical studies on this topic did not separate between different outcome measures, but instead aimed at explaining innovation project performance more generally (e.g., De Dreu, 2006; Hoegl et al., 2008; Leenders & Voermans, 2007). This research, however, distinguishes between two different outcomes of innovation projects, i.e., a new product's quality and novelty. It thus provides an important step towards disentangling the ambiguity surrounding the material resource adequacy-innovation project performance relationship. This is highly desirable since a unifying theory of the role material resources play in innovation projects is much needed both in the academic debate and in management practice (Hoegl et al., 2008). The study aims to help reconcile the different conceptual views and contradictory empirical results on the material resource adequacy-innovation project performance link.

The following section starts out by proposing three drivers of material resource adequacy perception, building on insights from cognitive psychology. Thereafter, it is argued for positive and negative relationships between the perception of material resource adequacy and innovation project performance, depending on the particular outcome measure, and

develop hypotheses which are tested on a sample of 121 innovation projects from the electronics industry. The article closes with a discussion of this study's main theoretical and practical implications, along with limitations and outlook.

3.2. Theory

3.2.1. Antecedents of the perception of material resource adequacy

If perception of material resource adequacy is influenced by socio-cognitive factors, which, specifically, are the factors determining a team's perception of adequate material resources? In order to develop a theoretical framework for socio-cognitive influences on the perception of material resource adequacy in innovation projects, it is referred to findings of grounded cognition (Barsalou, 2008) focusing on the role of simulation in human cognition (e.g., Decety & Grèzes, 2006; Kent & Lamberts, 2008). These approaches point to the mechanism in cognitive processing that when evaluating or judging tasks, actions, or objects, individuals execute mental simulations of these tasks, actions, or the actions connected with these objects in order to predict their outcomes or their favorability (Barsalou, 2008; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005). For example, when reasoning about in which direction a particular gear will turn given an inactive configuration of several gears, individuals perform a mental simulation to figure out how the focal gear will respond to setting the configuration in motion (Hegarty, 2004). Such mental simulations may, on the one hand, be deliberately performed in a conscious way of mental imagery (Cross, Hamilton, & Grafton, 2006; Kunz, Creem-Regehr, & Thompson, 2009), on the other hand, they may also be initiated automatically and executed unconsciously (Barsalou, 2008; Grèzes & Decety, 2002; Willems, Hagoort, & Casasanto, 2010). Moreover, these mental simulations are not bounded to predict the outcomes of individuals' own actions. Rather, such simulations are also performed when predicting the outcomes of actions performed by other persons (Knoblich & Sebanz, 2006; Niedenthal, 2007; Wilson & Knoblich, 2005). These simulations are future oriented and include the objectives of an action, the way how to execute the action, and its consequences (Jeannerod, 2001). The results of these simulations then determine individual judgments and predictions (for a review see Barsalou (2008). It would appear, then, that team members of innovation projects, when evaluating the adequacy of material resources at hand, perform similar mental simulations, taking into consideration relevant

attributes of the team and the project (Knoblich & Sebanz, 2006; Sebanz, Bekkering, & Knoblich, 2006).

Specifically, we draw on factors found to influence the optical perception of object favorability, constituting a convenient individual-level parallel to the team perception of material resource favorability. In their article, Witt and Proffitt (2008) summarize the state of the art of research in cognitive psychology on the perception of object favorability by pointing out that the perception of slant, distance, height, and size of objects is influenced by three factors: an individual's performance capabilities and action repertoire, as well as the physiological effort anticipated from the observed attributes of objects. These findings have been conceptually replicated in numerous studies (e.g., Bhalla & Proffitt, 1999; Proffitt et al., 2003; Wesp, Cichello, Gracia, & Davis, 2004; Witt & Proffitt, 2005). As a review of the literature suggests, these three individual-level variables may be appropriately transferred onto the team-level as team potency, team action repertoire (consisting of the three subdimensions heterogeneity of expertise, transactive memory, and the assignment to tasks commensurate with the respective expertise), and workload. These are elaborated below.

3.2.1.1. Team potency.

Team Potency is defined as the "collective belief of a group that it can be effective" (Shea & Guzzo, 1987: 335). It may be distinguished from collective efficacy (Bandura, 1982; Bandura, 1997) in that team potency is a general belief about a team's abilities and potential regarding any possible task a team might face (Stajkovic, Lee, & Nyberg, 2009; Zaccaro, Blair, Peterson, & Zazanis, 1995). Collective efficacy, by contrast, refers to specific tasks (Bandura, 1997; Stajkovic et al., 2009). Team potency further reflects a shared view of all team members, while collective efficacy depends on individual effectiveness judgments that need not necessarily be shared between team members (Guzzo, Yost, & Campbell, 1993; Jung & Sosik, 2003).

In this framework, team potency corresponds to personal performance capabilities, i.e., an individual's assessment of the possibility to perform a certain action satisfactorily (Witt & Proffitt, 2008). A number of studies found evidence that personal performance capabilities influenced the perception of size (Wesp et al., 2004; Witt & Proffitt, 2005), distance (Linkenauger, Witt, Stefanucci, Bakdash, & Proffitt, 2009; Witt, Proffitt, & Epstein,

2005), and slope (Proffitt, Bhalla, Gossweiler, & Midgett, 1995; Proffitt, Creem, & Zosh, 2001). The mechanism behind this observation seems to be that individuals mentally simulate how well they are able to perform a certain action (Witt & Proffitt, 2008). Thus, the better individuals judge their capability for performing the action based on that simulation, the more favorable the relevant object is perceived (Witt & Proffitt, 2005, 2008; Witt et al., 2005). As illustrative examples, consider that proficient golf players were shown to perceive the holes as being bigger (Witt, Linkenauger, Bakdash, & Proffitt, 2008) and skilled softball players to perceive the ball as being bigger (Witt & Proffitt, 2005) than novices do.

In innovation teams, team members likely perform similar simulations, eventually leading to a judgment of the team's capability to accomplish a certain task. Team members' judgment is either expressed verbally in the team or through a more implicitly shared opinion developed through non-verbal interaction (Anderson & West, 1998; Ashmore, Deaux, & McLaughlin-Volpe, 2004; Campion, Medsker, & Higgs, 1993). Such a shared belief among team members usually develops quite quickly in innovation project teams after the completion of preliminary project tasks (Lester, Meglino, & Korsgaard, 2002). The usually intense social interaction within innovation project teams is likely to further strengthen this shared belief within the team (González-Romá, Peiró, & Tordera, 2002). Hence, a team's perception of material resource adequacy should be affected by the team's belief in its own performance capabilities. As a result, teams judging themselves as having greater team potency should perceive the material resources being available to them as more adequate.

Hypothesis 1: Team potency is positively related with the perception of material resource adequacy.

3.2.1.2. Team action repertoire.

With team action repertoire, it is referred to a team's ability to leverage a diverse set of skills among team members. In the introduced framework, team action repertoire (as a team-level variable) corresponds to the action repertoire of an individual in the sense of Witt and Proffitt (2008), which is defined as the range of actions an individual is able to perform. Individuals' broader action repertoires influence their perception of objects in a way that

relates these objects and their affordances to their range of abilities and skills (Knoblich & Sebanz, 2006; Witt et al., 2005). If the affordances of an object overlap with the skills of an individual, the object will be perceived more favorable in the relevant dimensions (Witt et al., 2008). As a consequence, the broader one's action repertoire, the higher the probability is that it matches the affordances of a certain object. These mechanisms are assumed to apply to the team-level as follows. First, a team's action repertoire depends on the diversity of skills and expertise of the team members (Van der Vegt & Janssen, 2003), i.e., their expertise heterogeneity (Campion et al., 1993; Tiwana & McLean, 2005). Second, in order to be able to leverage this diversity and to provide a broad action repertoire, the team members have to know just where these skills and expertise are located in the team, i.e., the team has to possess a high level of transactive memory (Brodbeck, Kerschreiter, Mojzisch, & Schulz-Hardt, 2007; Faraj & Sproull, 2000; Madhavan & Grover, 1998), as shown both in laboratory experiments (Hinsz, Tindale, & Vollrath, 1997; Stasser, Stewart, & Wittenbaum, 1995) as well as in organizational settings (Faraj & Sproull, 2000). Transactive memory here refers to the „knowledge held within the group about its members' differential knowledge, skills, and roles" (Brodbeck et al., 2007: 469). Transactive memory thus allows the team to locate and subsequently better share the domain-relevant skills necessary for the team tasks (Faraj & Sproull, 2000; Madhavan & Grover, 1998), which should increase the action repertoire of the innovation project team. Third, for leveraging the diverse expertise within a team of which the team members know where it is located, a team has to possess the ability to assign the team members to tasks which are commensurate to their particular skills and knowledge (Faraj & Sproull, 2000).

Accordingly, the broader the action repertoire of a team in terms of the three necessary prerequisites outlined above, the higher the probability that the team's skills match the innovation project tasks at hand. As with an individual's perception of objects that turn more favorable when an action to be performed matches his or her skills, teams then are more likely to perceive the material resources they can dispose of as more adequate.

Hypothesis 2: Breadth of team action repertoire is positively related with the perception of material resource adequacy.

3.2.1.3. Workload

Workload refers to the perception of the volume of work to be completed and the pace with which this has to be accomplished (Spector & Jex, 1998). Regarding its influence on team perception of material resource adequacy, it corresponds to Witt and Proffitt's (2008) third factor, i.e., physiological effort. The logic behind this factor is that a higher effort required to act upon an object will change an individual's perception of this object (Proffitt et al., 2003; Witt, Proffitt, & Epstein, 2004). As alluded to in the introduction, perception of slant and distance were shown to depend on the expected energetic effort to walk over the relevant area in such a way that hills appeared steeper to persons carrying a weighty backpack, being fatigued, or of low physical fitness (Bhalla & Proffitt, 1999; Proffitt et al., 2003). In the same manner, it is expected that a team's workload affects its perception of material resource adequacy. If innovation projects pose a high work volume for the team, e.g., myriad meetings and details to attend to within and outside of the team, the heightened effort necessary for coping with all of this is likely to influence perception of material resource adequacy (similar to a heavy backpack making the mountain appear steeper) (Bhalla & Proffitt, 1999; Proffitt et al., 2003). Notably, time pressure (or the pace with which the work has to be done) has been indicated to influence perception of material resource adequacy (Amabile, Hadley, & Kramer, 2002). Teams having to put in longer hours to accomplish their innovation project goals will perceive the material resources at hand as less adequate, as team members fatigue (or anticipate to fatigue) both physically and mentally.

Hypothesis 3: Workload is negatively related with the perception of material resource adequacy.

3.2.2. Perception of material resource adequacy and innovation project outcomes

As mentioned above, in the recent innovation literature two main notions concerning the effect of material resource adequacy on innovation projects prevail. Predominantly, authors argue that adequate material resources foster creative problem solving and thereby innovation project performance (Amabile et al., 1996; Bizan, 2003; Cooper & Kleinschmidt, 1995; Damanpour, 1991; Dillon et al., 2005; Gladstein, 1984). Consequently, adequate

innovation project budgets and equipment, or even material resource slack, are supposed to lead to better outcomes. Insufficient material resources, by contrast, are expected to starve out innovation projects as they constrain the teams in their ability to undertake material resource-demanding activities such as prototype-testing. On the other hand, in recent years an alternative view on material resource adequacy's role in innovation projects has emerged. This "less is more" view provides evidence that scarce material resources, under certain conditions, facilitate rather than impede innovative project work (Baker & Nelson, 2005; Garud & Karnoe, 2003; Gibbert & Scranton, 2009; Hoegl et al., 2008).

It is interesting to note that only two of the studies empirically examining the influence of material resource adequacy on innovation projects actually yielded significant results. These results contradict each other, though. Song and Noh (2006) found material resource availability to significantly differentiate between successful and unsuccessful innovation projects, with more material resources leading to better outcomes. In contrast, Sethi and Iqbal (2008) discovered relatively higher material resource provisions to innovation projects to be significantly negatively related to the success of newly developed products. Other studies analyzing the effects of material resource adequacy on innovation project performance (albeit not as the respective studies' main focus) revealed no significant relationships (De Dreu, 2006; Hoegl & Parboteeah, 2006a; Joshi & Sharma, 2004; Leenders & Voermans, 2007; Markham, 2000; Sethi et al., 2001).

We take the stance that in order to build an appropriately fine-grained theoretical foundation for analyzing a question as important as the role of material resource adequacy in innovation, it is important to distinguish between more specific outcome variables. To this end, we subsequently review the arguments put forth by scholars of both, the "resource driven", as well as the "less is more" view and put them into the context of the two commonly-used indicators of innovation project performance, new product novelty and new product quality.

3.2.2.1. New product novelty

Arguments regarding the influence of perception of material resource adequacy on new product novelty are based on the assumed existence of the so-called "path of least resistance". The underlying theory suggests that when facing a problem, the default approach

is to implement the first solution that comes to mind and seems to fit (Ward, 1994; Ward et al., 2000). Getting off this path of least resistance demands more cognitive effort and creates a higher level of uncertainty in the outcome (Ward, 1994). Only when established approaches are not available, e.g., because of constrained material resources, are people more likely to seek novel solutions off the path of least resistance (Moreau et al., 2005). In this vein, firms have been reported to be more innovative and to use their resources more creatively in resource scarce environments (Baker, Miner, & Eesley, 2003; Katila & Shane, 2005; Schoonhoven, Eisenhardt, & Lyman, 1990). Moreover, psychological experiments on the individual-level provide evidence for the novelty-enhancing effect of material resource limitations in that persons having fewer materials at hand were able to design more creative products (Dahl & Moreau, 2007; Moreau et al., 2005).

Furthermore, a situation characterized by inadequate material resources requires a higher risk-taking propensity from the innovation project team in order to successfully accomplish the project goals under increased uncertainty and ambiguity (Bromiley, 1991; March & Shapira, 1987). Risk taking will encourage team members to query and challenge existing approaches and principles, thereby enhancing the probability of generating novel ideas and solutions (Amabile, 1988; Kijkuit & van den Ende, 2007; Sethi & Sethi, 2009). As such, the products developed will likely differ more from previously existing products, as suggested by numerous examples in a vast array of different literatures. In the arts, for example, self-imposed constraints such as precluding the application of certain colors or forms facilitated the emergence of novel painting styles (Stokes, 2001). In space travel, the highly-cited case of the Apollo 13 mission showed that the constrained range of materials and equipment on board the spacecraft facilitated the development of a highly original alternative for upgrading an under-dimensioned carbon dioxide reduction device (King, 1997).

Hypothesis 4: Perceived adequacy of material resources is negatively related to new product novelty.

3.2.2.2. New product quality

With regard to new product quality, Millson and Wilemon (2008) found that developing prototypes, in-house product testing, and trial production significantly increased new product quality. Moreover, adequate (rather than constrained) material resources are clearly needed for activities such as extensive market research, prototype building, and product testing. As a result, innovation project teams perceiving their material resources as adequate are quite simply more likely to undertake these activities. Furthermore, material resource provisions are often seen as an indicator of innovation project importance by development engineers (Amabile et al., 1996; Delbecq & Mills, 1985). Hence, the more adequate the team perceives its material resources to be, the more important the team judges the innovation project to be for the organization. In line with this, Denison et al. (1996) found a positive relationship between product development team members' perception of the importance of their work and the teams' effectiveness. Additionally, perception of more adequate, if not slack, material resources available to the innovation projects are regularly accompanied by a relaxation of managerial controls, which results in a higher degree of autonomy of the innovation project team (Nohria & Gulati, 1996). This autonomy of an innovation project team to decide about objectives and tasks within the team and about the way how those are pursued and how problems are sorted out, in turn, has been shown to heighten new product quality (Stewart, 2006), apparently because the teams will feel more control over their work, heightening their sense of responsibility for the new product (Atuahene-Gima, 2003). Less-than-adequate material resources, on the other hand, are likely to involve a great number of changes in the technical concept of the product to be developed or in prearranged project procedures such as prototyping and testing (Verworn, 2009), precisely because the teams have to venture into more uncharted territory, as argued above. These changes are likely to compromise the team's attention to detail and subsequently the new product's coherence and overall quality, as they clearly counteract the core principle of quality orientation (Sethi & Sethi, 2009), which is to minimize variations in organizational processes (Sethi, 2000). As a result, new product quality will be impaired. Hence, we posit:

Hypothesis 5: Perceived adequacy of material resources is positively related to new product quality.

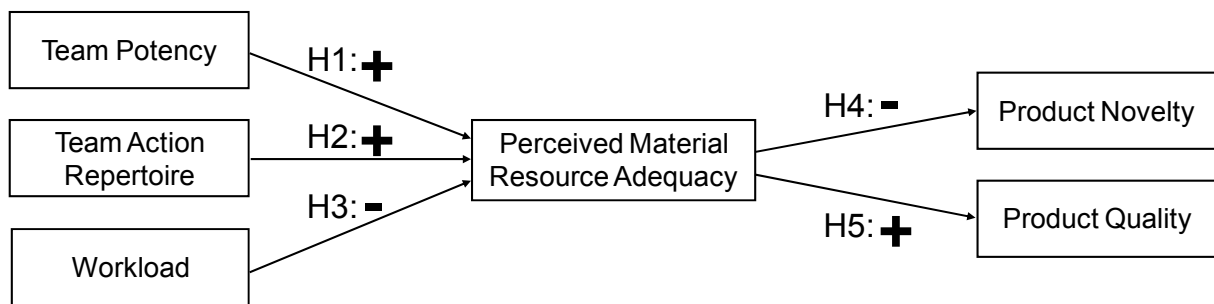


Figure 3-1: Hypothesized relationships.

3.3. Methods

3.3.1. Sample and data collection

The empirical analyses of the hypothesized model depicted in Figure 3-1 are based on data pertaining to 121 innovation project teams from 35 companies from the electronics industry in Germany, Austria, and Switzerland. The electronics industry was chosen for its high innovation pressure. We selected a single industry because companies in the same industry share strategic factor markets (Barney, 1986) and industry attributes influence strategy decisions (Mascarenhas & Aaker, 1989) and organizational factors such as culture (Chatman & Jehn, 1994; Gordon, 1991).

Upon request, the companies provided the researchers with lists of innovation projects including names, contact information of project members, etc. and the employees were informed that a study about team management was to be conducted. All innovation projects were completed within one year prior to the time of data collection. E-mail links to the online-questionnaire were sent to all team leaders and team-external managers as well as randomly-chosen team members. Respondents' participation in this study was strictly voluntary. The respondents were assured that the researchers would maintain their anonymity and the confidentiality of the completed questionnaires. Given the premise of surveying a minimum of two team members from each project team (in addition to the team leader and a team external manager), a total of 614 invitations to participate in the survey was sent out. The final sample consisted of 121 innovation projects, with a total of 497 individual responses, resulting in a response rate of 81 %. Although some companies delivered more than one

innovation project in the sample we do not expect organizational affiliation of the innovation projects exerting a systematic influence on the analyzes since the average number of innovation projects per firm was quite small (3.46), thereby suggesting ample variance within the sample. Likewise, there should be no systematic international differences due to the high level of similarity between the countries in which this study was conducted (Brodbeck et al., 2000; Szabo et al., 2002). Nonetheless, following recommendations by Cohen et al. (2003), we checked for potential systematic effects of organization and country on the results. Any effects that organization and country had on any of the variables in the calculated models have been partialled out and subsequently the models have been re-run, a similar approach as taken in a number of previous studies (e.g., Hoegl et al., 2004; Lynn & Akgün, 2001). As expected, in these analyses no significant influences were detected, thus not indicating systematic differences between the organizations or the countries in which the study was conducted.

3.3.2. Multiple informants

To ensure content validity and to avoid common source bias, data from different groups of respondents were used to measure the different variables. The innovation project performance variables, i.e., new product quality and new product novelty, were measured using data from team-external managers. Team external managers were the line managers responsible for the innovation projects, i.e., to whom the innovation project leaders reported. In line with previous research taking the same approach (Faraj & Sproull, 2000; Hoegl et al., 2004; Zhang et al., 2007), we believe that the line managers were in an ideal position to rate the innovation project outcomes without being biased by team-internal processes. A small number of the team-external managers rated more than one innovation project's outcomes. However, as the average number of innovation projects rated by one team-external manager was 2.28 we do not expect any systematic differences to introduce a bias. Using the same procedure as described above (Cohen et al., 2003), we also have partialled out effects that the team-external managers had on any of the variables in the statistical models and re-ran the models and neither found any significant influences. The perception of material resource adequacy and its hypothesized antecedents, i.e., team action repertoire, team potency, and workload, were measured using responses from team members. The applied control variables, i.e., team size, project duration, task complexity, and general evaluation, are based on data collected from team leaders.

3.3.3. Measures

All constructs considered in this investigation refer to the team as the unit of analysis. Accordingly, all measures were specified at the team-level. The questionnaire was administered in German language. The measurement scales were based on measures of related constructs in the literature, as detailed below.

3.3.3.1. Perception of material resource adequacy.

The perception of material resource adequacy was assessed using a two item index. We obtained these data using innovation project team members' evaluations of two items adapted from Hoegl and Parboteeah (2006a), referring to financial resource and equipment adequacy. These two items cover in equal representation the relevant aspects constituting material resources (e.g., Barney, 1991). Answers on these items were given on 5-point Likert scales (1 = *strongly disagree*, to 5 = *strongly agree*). Using such two-item indices is an established practice in the management literature (e.g., Griffeth, Steel, Allen, & Bryan, 2005; Ledgerwood & Chaiken, 2007; Li & Hambrick, 2005), while agreement among multiple informants per team is an indicator of reliability across raters on individual items (Wanous & Hudy, 2001).

3.3.3.2. Innovation project performance.

For the present study, innovation project performance was measured as described by the variables new product novelty and new product quality (Hoegl & Gemuenden, 2001; Madhavan & Grover, 1998). To measure new product novelty, six items (Cronbach's alpha = .87) from the scale of Salomo, Weise, and Gemuenden (2007) were adopted, a measure of innovativeness that covers aspects of product and process technology, market characteristics, and fit with internal and external capabilities (Salomo et al., 2007).

New product quality refers to the degree to which expectations regarding the quality of the outcome were met by the team and was measured using three items (Cronbach's alpha = .86) from Hoegl and Gemuenden (2001). Participants were asked to rate these items on 5-point Likert scales (1 = *strongly disagree*, to 5 = *strongly agree*).

3.3.3.3. Team action repertoire.

Team action repertoire covers three aspects, namely the heterogeneity of expertise among team members, the knowledge among team members about where this expertise is located, i.e., their transactive memory, and the assignment of team members to tasks commensurate with their expertise. This construct was measured using a three item index which represents in equal parts these three constituting aspects of team action repertoire. It consists of one item taken from Campion et al. (1993) to measure expertise heterogeneity which was applied frequently in empirical studies (e.g., Tiwana & McLean, 2005), and two items adapted from Faraj and Sproull (2000), one measuring team members' knowledge about expertise location, and one item measuring adequate assignment of tasks to team members. Faraj and Sproull (2000) developed this scale in order to measure the construct of expertise coordination and validated this scale in the same study, confirming the three factor structure of this construct, consisting of the factors "expertise location", "expertise needed", and "bring expertise to bear" (Faraj & Sproull, 2000: 1559). Items from this scale were also used in a number of previous empirical studies (e.g., Gemino, Reich, & Sauer, 2007; He, Butler, & King, 2007).

3.3.3.4. Team potency.

Team Potency was measured with seven items (Cronbach's alpha = .87) from Guzzo et al. (1993). This scale has been widely used to measure team potency in organizational research (e.g., De Jong, De Ruyter, & Wetzels, 2005; Jung & Sosik, 2003; Lester et al., 2002). Questions were answered on 5-point Likert scales (1 = *strongly disagree*, to 5 = *strongly agree*).

3.3.3.5. Workload.

Workload was measured using four items (Cronbach's alpha = .82) adapted from the "pressure to produce" scale developed and validated by Patterson et al. (2005: 407). The scale is about the volume of work to complete in a project and the pace with which it has to be done. Questions were answered on 5-point Likert scales (1 = *strongly disagree*, to 5 = *strongly agree*).

3.3.3.6. Control variables.

Team size was controlled for, as the number of members of an innovation project team constitutes an important structural variable with potential influences on its social and task processes (Campion et al., 1993; Gladstein, 1984; Hackman, 1987). For example, a large team size makes it more difficult for team members to interact with all other team members given the increase of possible individual links between team members as team size grows (Steiner, 1966). Furthermore, we controlled for the duration of the innovation projects, as longer innovation projects are most probably managed and monitored in a different way than innovation projects of short duration and are likely to include a wider scope of project goals. Additionally, we controlled for the complexity of the project tasks, using assessments of a single item measure, applying a 5-point Likert scale (1 = *strongly disagree*, to 5 = *strongly agree*). We also controlled for the overall success of the innovation projects, as the perception of a generally (un)successful project could override the perception of material resource adequacy and the hypothesized antecedents. In order to control for such a hindsight bias, i.e., the tendency of individuals to judge past situations in line with the outcome of these situations (Carli, 1999; Louie, 2005; Mussweiler, 2003), a three item scale based on a measure of Hoegl, et al. (2004) applying a 5-point Likert scale (1 = *strongly disagree*, to 5 = *strongly agree*; Cronbach's alpha = .87) was included for a general evaluation of the projects. Table 3-1 shows all individual items used for the variables used in this study and Table 3-2 provides descriptive statistics and correlations for all variables.

3.3.4. Data aggregation and analytical techniques

Prior to aggregating team members' evaluations, interrater agreement (Lindell & Brandt, 1999) was assessed using the multiple-item estimator $r_{WG(j)}$ for within-group interrater agreement as proposed by James, Demaree, and Wolf (1984). This test yielded $r_{WG(j)}$ values of .77 (perception of material resource adequacy), .87 (team action repertoire), .93 (team potency), and .84 (workload), thus indicating generally strong agreement of ratings referring to the same team. Given this homogeneity of within-team ratings, aggregation of the data to the team-level appeared justified (George & James, 1993) and was conducted by calculating the arithmetic mean.

We used multiple regression analysis to test the hypotheses (Cohen et al., 2003). Since a number of significant correlations among the independent variables were found, we also checked for collinearity. Variance inflation factors ($VIF < 1.2$) indicate no distortion of results due to collinearity.

Variable	Items
Perception of material resource adequacy	In this project, the team had sufficient financial resources. In this project, the team had sufficient equipment.
New product novelty	The new product followed a completely new technological principle. Existing technologies will be crowded out by this innovation. This innovation created entirely new customer benefits. This innovation offers unique benefits to the customers in comparison to competitive products. We had barely any experience regarding the technical components applied to this innovation. The design of this innovation differed substantially from our previous products.
New product quality	The project result was of high quality. The customer was satisfied with the quality of the project result. The product required little rework.
Team action repertoire	Members of this team varied widely in their area of expertise. Team members knew what task-related skills and knowledge they each possessed. Team members were assigned to tasks commensurate with their task-relevant knowledge and skills.
Team potency	This team had confidence in itself. This team believed it can produce high quality work. This team expected to have a lot influence around here. This team felt it can solve any problem it encountered. This team believed it can be very productive. This team expected to be known as a high-performing team. This team was of the opinion, that no task was too tough for it. This team could get a lot done when it worked hard.
Workload	In this project, team members were expected to do too much in a day. In this project, people were required to work extremely hard. In this project, people were under pressure to meet targets. In this project, the pace of the work was pretty relaxed. (reverse coded item)
General evaluation	Going by the results, this project can be regarded as successful. From the company's perspective, all project goals were achieved. From the company's perspective one could be satisfied with how the project progressed.

Table 3-1: Items used for the variables.

3.4. Results

Table 3-3 shows the relationship between the perception of material resource adequacy and its proposed antecedents, as well as the relationship between perception of material resource adequacy and the two indicators of innovation project performance. The examination of antecedents of the perception of material resource adequacy yielded significant relationships between team potency and perception of material resource adequacy as well as between team action repertoire and the perception of material resource adequacy. Thus, hypotheses 1 and 2 were supported. For team potency, the regression analyses also revealed a significant curvilinear (inverse-U-shaped) relationship with the perception of material resource adequacy. Nonetheless, when including this quadratic term in the regression equation, the observed linear relationship between those variables remained significant. In support of hypothesis 3, the results show a significant negative relationship between workload and the perception of material resource adequacy. The regression analyses further yield a significant negative relationship between perception of material resource adequacy and new product novelty, supporting hypothesis 4. For new product quality, the results show a positive relationship with perception of material resource adequacy, thus supporting hypothesis 5. Since some studies on the organizational-level found evidence for curvilinear relationships between material resources and innovation performance (Geiger & Cashen, 2002; Nohria & Gulati, 1996, 1997), we checked for such a quadratic relationship between the perception of material resource adequacy and the two outcome variables. However, neither a significant quadratic relationship among these variables was found, nor did the inclusion of the respective quadratic terms yield noteworthy increases in R-squared.

Variable	Source	Mean	SD	1	2	3	4	5	6	7	8	9	10
1. Team size	PLD	8.64	6.78	-									
2. Project duration (months)	PLD	21.83	15.04	.31**	-								
3. Task complexity	PLD	3.94	0.86	.20*	.18*	-							
4. General evaluation	PLD	4.01	0.78	.00	-.07	.05	-						
5. Material resource adequacy perception	PTM	3.69	0.67	-.04	-.03	-.06	.14	-					
6. Team action repertoire	PTM	3.98	0.53	.12	-.05	-.09	.08	.26**	-				
7. Team potency	PTM	3.87	0.50	-.07	-.04	-.09	.18	.24**	.33**	-			
8. Workload	PTM	3.54	0.67	.17	.11	.16	-.12	-.01	-.13	-.13	-		
9. New product quality	TEM	3.69	0.83	.02	-.10	-.24**	.38**	.18	.21*	.36**	-.31**	-	
10. New product novelty	TEM	2.94	0.81	.06	.11	.38**	.08	.04	-.09	-.13	.12	-.09	-

N = 121; *p < .05; **p < .01 (two-tailed); PTM = project team members; PLD = project leader; TEM = team external manager.

Table 3-2: Descriptive statistics and correlations between variables.

	Material Resource Adequacy Perception			New Product Novelty		New Product Quality	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	
Control variables							
Team size	-.03 (.01)	-.02 (.01)	-.03 (.01)	-.04 (.01)	.09 (.01)	.10 (.01)	
Project duration	.00 (.01)	.02 (.01)	.06 (.01)	.06 (.01)	-.06 (.01)	-.06 (.01)	
Task complexity	-.06 (.07)	.01 (.07)	.38** (.08)	.36** (.08)	-.27** (.08)	-.26** (.08)	
General evaluation	.15 (.08)	.06 (.08)	.06 (.09)	.10 (.09)	.39** (.09)	.36** (.09)	
Main effects							
Material resource adequacy perception				-.22** (.10)		.20* (.10)	
Team action repertoire		.20* (.11)					
Team potency		.24** (.12)					
Workload		-.22* (.09)					
ΔR^2		.16**		.05*		.04*	
R ²	.03	.19	.15	.20	.22	.26	
F-Value	.79	3.80**	5.22**	5.77**	8.18**	8.08**	

N = 121; *p < .05; **p < .01 (two-tailed); standardized regression coefficients with standard errors in parentheses

Table 3-3: Results of regression analyses.

3.5. Discussion

The results from this study show that innovation project team members' perception of material resource adequacy is influenced by three socio-cognitive factors, the team's action repertoire, the belief of the team being able to accomplish a task (team potency), and the task's work volume (workload). Notably, a positive relationship between the perception of material resource adequacy and new product quality was found, as well as a negative relationship between the perception of material resource adequacy and new product novelty. Thus, in contrast to the prevailing belief in innovation management literature (e.g., Amabile et al., 1996; Bizan, 2003; Damanpour, 1991), new product novelty (but not quality) benefits from less perceived adequacy of material resources. This is in line with the notion that acquiring existing solutions, rather than going through the more consuming process of searching for novel solutions to the problem at hand, appears more likely if one perceives having access to adequate material resources to afford such standard solutions (Finke et al., 1992; Ward, 2004). As we will discuss below, these empirical insights entail conceptual and practical implications for managing innovation projects.

3.5.1. Theoretical implications

The results reveal that a key finding of cognitive psychology (Clarkson et al., 2010; Witt & Proffitt, 2008) seems to hold also on the team-level of inquiry, namely the significant influence of socio-cognitive factors on perception. Specifically, teams with high team potency, broad action repertoires, and manageable workloads are likely to perceive material resources as more adequate. Since perception is highly relevant for human behavior (e.g., Ackerman et al., 2010; Barden & Petty, 2008; Jostmann et al., 2009), but has only played a minor role in innovation research on the project level so far (Anderson, de Dreu, & Nijstad, 2004), this finding constitutes an important contribution. It also paves the way for putting more attention in research on innovation and project management on perceptual aspects, in particular considering mechanisms behind the formation of team perception (Roberson & Colquitt, 2005). The contribution to the team literature is a timely one, since work on individual level (e.g., Cruz, Gómez-Mejía, & Becerra, 2010; Simsek, Veiga, & Lubatkin, 2007), and on organizational level (e.g., Diefendorff & Greguras, 2009; Plambeck & Weber,

2010) has recently begun explaining perceptual differences in variables such as conflict and fairness (Hollensbe, Khazanchi, & Masterson, 2008; Hoobler, Wayne, & Lemmon, 2009).

Moreover, the results provide evidence for differential effects of the perception of material resource adequacy on innovation project performance depending on the indicators used for measuring the outcomes of an innovation project. This contributes necessary detail to studies that have outlined conditions under which constraint material resources enable, rather than inhibit, innovation project performance (Gibbert et al., 2007; Hoegl et al., 2008) and thus facilitate innovation in situations that otherwise do not appear conducive to innovation. The present research adds to this by focusing attention squarely on the conceptualization and measurement of output variables (new product quality and new product novelty), thus further adding missing pieces to the puzzle surrounding their relationship with the adequacy of material resources. So far, views on the influence of material resource adequacy on innovation project performance contradicted each other, which has all but stopped progress in the field (e.g., Amabile et al., 1996; Baker & Nelson, 2005; Camison-Zornoza et al., 2004; De Dreu, 2006; Hoegl et al., 2008; Hoegl & Parboteeah, 2006a; Joshi & Sharma, 2004; Leenders & Voermans, 2007; Markham, 2000; Sethi & Iqbal, 2008; Sethi et al., 2001; Song & Noh, 2006). The present study suggests that these contradictions might result to a large degree from different operationalizations of innovation project performance. By applying an appropriately fine-grained outcome measure, substantial differences between the different indicators of innovation project performance have been identified. In less detailed analyses, such as the ones in prior literature (e.g., Hoegl & Parboteeah, 2006a; Leenders & Voermans, 2007; Sethi et al., 2001), these are likely to cancel each other out. Consequently, a break-down of the overall outcome measure seems essential for the field to progress and the current results will hopefully encourage others to undertake similarly detailed analytical approaches.

The results of the present study may also be seen in context of the different stages of the innovation process (Cooper & Kleinschmidt, 1986), suggesting that the perception of less adequate material resources may be instrumental in generating more innovative concepts during the initial stages of the innovation process, while in the later stages of the innovation process new product quality may be enhanced by facilitating the perception of adequate material resources. Note that this challenges an established notion in innovation management. The traditional view advocates that particularly in the fuzzy front end of the innovation process the availability of slack material resources has beneficial effects on activities like

experimentation (Ahuja & Lampert, 2001; Damanpour, 1991) and thus on the generation of novel ideas and concepts (Geiger & Makri, 2006). Here, the data suggest that some level of challenge or pressure may well be beneficial, in this case induced by perceiving material resource provisions as being inadequate, for the development of innovative solutions, which is in line with literature suggesting the innovation supporting influence of challenge (Amabile et al., 2002; Hoegl et al., 2008; McDermott & O'Connor, 2002). Hence, one could speculate that at the early stages of the innovation process “less is more” to create an innovative idea, but the final development of that idea and the process of turning the idea into a high quality product, however, require perceiving material resources as being adequate.

Lastly, the results of this research fundamentally contest a core tenet of the operations research literature, which focuses on how to “optimally” allocate material resources across (Lichtenthaler, 2009; Loch & Kavadias, 2002), and within innovation projects (Granot & Zuckerman, 1991; Vairaktarakis, 2003). In view of the differential effects of perception of material resource adequacy on innovation project outcomes, “optimal” material resource levels for a given team task represent a gross oversimplification as they are likely to vary across teams. The present study provides an alternative way of defining “optimally” in ways that heed critical socio-cognitive factors. More sophisticated approaches should take into consideration what shapes this perception of material resource adequacy and whether the aim is to optimize new product quality or new product novelty (e.g., in different stages of the innovation process).

3.5.2. Practical implications

On a practical level, results of this study encourage managers to reconsider their investments in R&D in the light of the primary purpose of a given innovation project. While perceiving material resources being adequate for the tasks at hand fostered new product quality, perceiving material resources being less-than-adequate was shown to be a driver of new product novelty. The observation that new product novelty and new product quality do not always go along and may even antagonize each other is not a new insight (e.g., Calantone, Chan, & Cui, 2006; Molina-Castillo & Munuera-Aleman, 2009; Sethi, 2000; Sethi & Sethi, 2009). However, the different effects of the perception of material resource adequacy on these outcomes enable managers to adjust their material resource provisions to innovation projects

depending on whether they aim at radical innovations (McDermott & O'Connor, 2002; Veryzer, 1998) with focus on new product novelty or rather at incremental functional improvements with new product quality being the central objective (Garcia & Calantone, 2002; Vermeulen, Van Den Bosch, & Volberda, 2007).

Thus, the perception of material resource adequacy is no catch-all variable influencing innovation project outcomes in a uniform way. It appears to be a useful lever for influencing team outcomes in a goal-oriented way and may even be manipulated by shaping team variables. For example, Brodbeck et al. (2007: 473) mention some “low-cost interventions” of team decision making processes that are likely to facilitate transactive memory (and thus a broad team action repertoire) by improving information processing within the teams. Team potency, especially regarding problems requiring creative thought (Tierney & Farmer, 2002), may be cultivated by structuring the project task to allow for “quick wins” to be celebrated as early team success has shown to result in elevated team potency (Jordan, Feild, & Armenakis, 2002; Sosik, Avolio, & Kahai, 1997). In this regard, also a curvilinear effect of team potency on the perception of material resource adequacy was noticed. This observation goes along with evidence suggesting that above a certain level, elevated team potency is likely to turn into overconfidence in the team’s capabilities and importance (e.g., Camerer & Lovallo, 1999; Moore & Cain, 2007). This may lead to teams being more critical and demanding in terms of the material resources made available to them. Hence, teams possessing a very high level of potency might perceive a given provision of material resources as inadequate because of their self-rated importance, which makes them believe to “deserve” more or better material resources for executing their project work. The fact that the linear relationship between team potency and perception of material resource adequacy remained significant when including the quadratic term in the equation suggests, however, that in practice very high levels of team potency must be reached before negative effects of team potency on perception of material resource adequacy materialize. Finally, a reduction of workload and its negative consequences can be achieved by providing more control to the members of the innovation project teams (Hockey & Earle, 2006).

3.5.3. Limitations and outlook

Some limitations of this study should be noted, along with directions for future work. First, the data for this research are cross-sectional rather than longitudinal. While this study demonstrates associations between variables, it cannot establish causality. A longitudinal research design would further our knowledge about the perception of material resource adequacy over the entire duration of an innovation project and toward causality of relationships and the effects of material resource adequacy on the different indicators of innovation project performance over time. Second, the application of cross-level analyses appears worthwhile to draw conclusions, e.g., about how team members' individual perception shapes the team level perception of material resource adequacy, or how organizational level variables like culture might influence team level perception. Similarly, examining potential moderator effects, as proposed by Hoegl et al. (2008), could complement the results of this study regarding differential effects of the perception of material resource adequacy on different indicators of innovation product performance. Third, this study was conducted in companies located in Austria, Germany, and Switzerland, raising the question of generalizability to other cultures (Henrich, Heine, & Norenzayan, 2010). While this study is not internationally comparative in nature and cannot offer any answers to this question, the theoretical considerations presented in this article are not country-specific, but rather based on international scholarly work and empirical findings. Further research in other countries is encouraged to increase our understanding of the possible influences of cultural contexts on the investigated relationships (Hofstede, 1998; House, Javidan, Hanges, & Dorfman, 2002).

Despite or because of these limitations, the present research may stimulate further appropriately fine-grained investigations into the role of material resource adequacy in innovation on project level. Cross-level analyses scrutinizing the role of material resource adequacy in innovation that integrate variables from individual, project, and organizational level as well as giving more attention to aspects of team perception would be desirable next steps towards a much-needed comprehensive theory of the role of material resources in innovation projects.

4. FAMILY INFLUENCE AND MATERIAL RESOURCES IN INNOVATION PROJECTS: A CROSS LEVEL STUDY¹

ABSTRACT

Research on family firms has identified certain attributes of family firms distinguishing them from non-family firms. Whether and how such differences influence innovative endeavors, however, remains largely unclear. We argue that family firms differ from non-family firms in the way material resources are evaluated and managed in innovation projects, and that these differences arise to a large portion from the degree to which a firm's organizational culture is oriented toward material resources. In a comparative empirical study, the hypotheses are tested on a sample of 116 innovation projects in the electronics industry. Results of multilevel analyses using hierarchical linear modeling (HLM) show that material resource orientation of an organizational culture mediates the positive relationship between family influence and innovation project teams' perception of material resource adequacy. Further, the relationship between material resource adequacy and innovation project performance is contingent upon family influence in that for non-family firms a significant positive relationship between material resource adequacy and innovation project performance was detected while no significant relationship between those variables was found for family firms. Implications for research and practice are discussed.

¹ This paper was written by Matthias Weiss based on conjoint work with Prof. Dr. Martin Högl.

4.1. Introduction

Family firms are of great importance for economic growth and development (Burkart, Panunzi, & Shleifer, 2003; La Porta, Lopez-de-Silanes, & Shleifer, 1999). This is not only because family firms make up a considerable part of the entire business landscape (Chua, Chrisman, & Chang, 2004), they are also argued to represent an important source of innovative activity, which is a key enabler of economic growth and welfare (Zahra, 2005; Zahra, Hayton, & Salvato, 2004). As a theoretical underpinning of this observation, it is argued that the long-term nature of family firms' ownership facilitates innovation and risk taking (Zahra et al., 2004). Furthermore, family ties (Alvarez & Barney, 2005; Hsieh, Yeh, & Chen, 2010), reciprocal altruism (Corbetta & Salvato, 2004; Eddleston & Kellermanns, 2007), care for succeeding generations (LeBreton-Miller & Miller, 2006), and the social capital available in family firms (Arregle, Hitt, Sirmon, & Very, 2007; Tsai & Ghoshal, 1998) have been proposed as unique family-based attributes that may put family firms in an advantageous position for innovation. On the other hand, the literature also mentions attributes that may impede innovative activities by family firms, the most important of which is risk aversion, i.e., the reluctance to invest own capital in innovation (e.g., Cabrera-Suárez, 2005; Sharma, Chrisman, & Chua, 1997), given the inherently high degree of uncertainty and ambiguity (Kijkuit & van den Ende, 2010; McDermott & O'Connor, 2002). Hence, prior research is inconclusive whether the unique features of family firms are indeed beneficial or, instead, rather detrimental to innovation (Kellermanns, Eddleston, Sarathy, & Murphy, 2010).

This paper aims at identifying how the role of material resources in innovation projects systematically differs between family firms and non-family firms, and how this may help reconciling the opposing views on innovation in family firms. The focus of this paper lies on an innovation project's material resources, i.e., the amount of liquid funding available to an innovation project team, as well as monetary-equivalent resources such as technical equipment, but not human resources (i.e., the team members themselves) assigned to the innovation project (Hoegl et al., 2008). For the purpose of our analyses, we keep with a widely established practice in research on family businesses and apply the resource-based view of the firm (RBV) (Barney, 1991; Wernerfelt, 1984) as a theoretical framework for the performed analyses (Chrisman, Chua, & Sharma, 2005; Eddleston, Kellermanns, & Sarathy, 2008a; Habbershon & Williams, 1999). In particular, we build on the expansion of the RBV provided by Sirmon, Hitt, and colleagues (Sirmon et al., 2008; Sirmon & Hitt, 2003; Sirmon

et al., 2007). They explicitly include the processes of resource evaluation, as well as resource management and deployment in their conceptualization of the RBV, stating that the mere presence of certain resources is not sufficient to explain differences in performance between firms. This is in accordance with Grant (1996), who argues that it is not resources themselves that result in a competitive advantage for a firm but the degree to which managers are capable of integrating these resources. In so doing, we also address some well-founded critique of the RBV (Kraaijenbrink et al., 2010).

Keeping with the distinction between resource evaluation and resource management, two related research questions are addressed: (1) Do family businesses have an organizational culture that is less focused on material resources, and is this evident in innovation project teams' resource perceptions? (2) Does a family business context affect how successfully innovation project teams operate under perceived material resource inadequacy?

The first research question implies that the evaluation of available material resources is of crucial importance. Since a resource's value does not represent a fixed and objectively evaluable amount (Barney, 1991; Penrose, 1959), the perceived value depends on the particular context of the involved actors (Brush & Artz, 1999; Katila & Shane, 2005; Kor et al., 2007; Priem & Butler, 2001). For example, Baker and Nelson (2005) showed how entrepreneurs created value of resources which the vast majority of people would have deemed useless or even detrimental. Similarly, there is abundant evidence in cognitive psychology showing that perceptions of the same subject may well differ significantly between individuals, and are to a considerable degree depending on contextual factors (Ackerman et al., 2010; Witt & Proffitt, 2008). In this regard, even perceptions of hard facts, such as geographical distance (Witt et al., 2004; Woods, Philbeck, & Danoff, 2009), or perceptions of prices and money (Jostmann et al., 2009) may vary significantly.

The second research question addresses the way the material resources at hand are managed and deployed in innovation projects. In this regard, there is notable evidence that being able to dispose of more adequate material resources not necessarily leads to more success in the innovation process (George, 2005; Gibbert et al., 2007; Hoegl et al., 2008). Extant literature on this topic offers inconsistent conceptual arguments and empirical findings. While many scholars point to the benefits of adequate material resources in order to achieve innovation success (e.g., Amabile et al., 1996; Cooper & Kleinschmidt, 1995; Damanpour,

1991), there are also proponents of the opposite view, i.e., that less than adequate resources may sometimes foster innovation (e.g., Garud & Karnoe, 2003; Katila & Shane, 2005; Mishina et al., 2004). To resolve these contradicting views, Hoegl et al. (2008) have proposed that the ambiguous relationship between material resource adequacy and innovation performance may be contingent upon moderating variables that actually determine the slope of this relationship. To put it in other words, they propose that depending on how material resources are managed, both adequate and less than adequate material resource provisions may prove beneficial in innovation endeavors. However, the considerations and contingency variables proposed by Hoegl et al. (2008) have been limited to the team level so far and empirical evidence supporting their propositions still is largely missing.

As such, the present article aims at making three contributions. First, this study contributes to family business research by linking the RBV with innovation activities in family firms. In so doing, we build on Sirmon and Hitt's (2003) expansion of the RBV. Explicitly integrating the evaluation and management of resources in the analyses enables a new and broadened resource-based perspective on innovation in family firms. This is important since the RBV represents one of the two key theoretical pathways that are currently pursued in building a unified theory of the family firm (Chrisman et al., 2005). In introducing the aspect of resource orientation in organizational culture as a variable determining the role of resource evaluation and management in the innovation process, a better understanding of how family firms differ from firms without family influence is provided.

Second, this is to our knowledge the first study that includes the project level of enquiry in research on family business. So far, empirical as well as conceptual papers in family business research have mostly concentrated either on the individual level (e.g., Mitchell, Morse, & Sharma, 2003; Ram, 2001), or on the organizational level (e.g., Anderson & Reeb, 2003; Gomez-Mejia, Nuñez-Nickel, & Gutierrez, 2001). By examining 116 real world innovation projects, this manuscript contributes to family business research by conceptually and empirically integrating organizational level variables (e.g., organizational culture) with the level at which innovation tasks are usually carried out, i.e., the project level (Edmondson & Nembhard, 2009; Wuchty et al., 2007). In so doing, this paper makes a first step to close a significant gap in theory and empirical research on family firms, identifying aspects that might help further explain observed differences in innovative achievement depending on ownership structure. While existing research concentrated either on the

identification of aspects facilitating and inhibiting innovation, respectively (e.g., Balachandra & Friar, 1997; Cooper & Kleinschmidt, 1995), or viewed family influence itself as such a facilitator or inhibitor (e.g., Gómez-Mejía, Haynes, Núñez-Nickel, Jacobson, & Moyano-Fuentes, 2007; Zahra et al., 2004), this paper sets out to examine factors whose relationship with innovation project performance is contingent upon different cultural attributes within family and non-family firms.

Third, this research adds to literature on innovation management by providing further empirical and conceptual input to a multi-level theory of innovative achievement, which marks an important advancement of literature in this area, that mainly focused on single level research in the past (Anderson et al., 2004). Such multi-level research efforts are long needed since contextual influences on innovative endeavors usually span multiple levels of analysis (Baer & Frese, 2003). Furthermore, we are confident that this investigation on the role of material resources in innovation projects contributes to disentangling the contradicting findings on this topic (Hoegl et al., 2008) by detecting further mediating and moderating variables of the material resource adequacy-innovation project performance relationship.

The following section starts out by developing theory for a mediated model regarding the evaluation of material resource adequacy in innovation projects, and by developing hypotheses which are tested on a sample of 116 real world innovation projects. The article closes with a discussion of this study's main implications, along with limitations and outlook.

4.2. Theory

There are different conceptual notions regarding the influence of ownership structure on a firm's innovative activities and success (Kellermanns et al., 2010). The rather limited empirical evidence available tends to support the view that the unique attributes of family firms are conducive to innovation (Chin, Chen, Kleinman, & Picheng, 2009; Craig & Dibrell, 2006; Craig & Moores, 2006; Hsieh et al., 2010). However, the mechanisms that underlie this observation still remain unclear. In this regard, Chin et al. (2009) found that agency problems between controlling owners and minority owners were negatively related to firm innovation, while Hsieh et al. (2010) reported family ties having positive effects on innovation. However, we are still far from possessing a complete picture about the mechanisms operating behind the

family influence-innovation relationship. One such mechanism we expect to originate from resource-related differences between family and non-family firms.

In research on family businesses, the RBV was frequently taken to identify resources and capabilities that allow family firms to develop family-based competitive advantages (Habbershon, Williams, & MacMillan, 2003). However, scholars increasingly question the predictive power of the RBV without managerial involvement (Carney, 2005; Kellermanns, 2005; Kraaijenbrink et al., 2010; Priem & Butler, 2001; Sirmon et al., 2007). To resolve this shortcoming of the RBV, Sirmon, Hitt, and colleagues (Sirmon et al., 2008; Sirmon & Hitt, 2003; Sirmon et al., 2007) expanded the RBV, acknowledging the importance of evaluating, managing, and deploying available resources. Therefore, although the resource stock of a firm surely has an important influence on performance, without proper evaluation and management competitive advantage is not expected to arise from the sole possession of certain resources (Makadok, 2003; Sirmon et al., 2008; Sirmon & Hitt, 2003). Further, evaluation and deployment decisions are likely to depend on organization-based contingencies (Sirmon et al., 2008), a very prominent of which being organizational culture (Denison & Mishra, 1995; Zahra et al., 2004).

4.2.1. Material resource orientation and resource evaluation in family firms

Organizational culture is defined as the “enduring values that shape the firms’ characters and how they adapt to the external environment” (Zahra et al., 2004: 364). These beliefs and values form the basis for socializing new employees in the way things are done in an organization (Glisson & James, 2002), and result in “automatic patterns of perceiving, thinking, feeling, and behaving” in organizations (Schein, 1990: 111). Previous research on family businesses found differences between the culture of family firms and publicly held firms in numerous aspects of culture (e.g., Astrachan, Klein, & Smyrnios, 2002; Kellermanns, 2005; Koiranen, 2003; Zahra, Hayton, Neubaum, Dibrell, & Craig, 2008). In fact, many scholars view the proposedly distinct culture in family businesses even as a constituting attribute of “familiness” (e.g., Chua, Chrisman, & Sharma, 1999; Klein, Astrachan, & Smyrnios, 2005; Litz, 1995). This research focuses on material resource orientation as one aspect of organizational culture, i.e., the degree of importance ascribed to material resources in work processes and the perceived dependence on adequate material resource provisions for being successful in innovative activities.

We argue that innovation project teams in family firms are less likely to perceive their material resource provisions as inadequate because their organizational cultures generally attribute a less important role to the presence of material resources. Evidence from cognitive psychology supports this notion, showing that perceptions are generally prone to influences of socio-cognitive factors (Ackerman et al., 2010; Balcetis & Dunning, 2006; Jostmann et al., 2009; Witt & Proffitt, 2008). For instance, perceptions of money depend not only on the actual amount, but also on emotional aspects and on shared expectations regarding the value (or significance) of money (Ferrari & Lozza, 2005; Tyszka & Przybyszewski, 2006). Therefore, we believe that a team's perception of how sufficient the innovation project's material resources are (given the innovation project's objectives), is likely to be influenced by an organization's material resource orientation. As such, innovation project teams' judgments of material resource adequacy are likely affected by team members' attitudes towards material resources, which in turn are formed through socialization in a particular organizational culture (Schein, 1990). Although the aspect of material resource orientation within organizational culture has never been subject to studies on family businesses, there are some strong indications that point to peculiar attributes of family firms suggesting that their organizational cultures generally assign a lesser role to the presence of material resources.

Family businesses are usually not as subjected to short term planning and goal setting (Bertrand & Schoar, 2006) as non-family firms are, due to the pressures imposed on non-family firms by capital markets and reporting regulations (Gomez-Mejia et al., 2001; Zahra, 2005). Family firms may dispose of more patient capital (Berrone, Cruz, Gomez-Mejia, & Larraza-Kintana, 2010), i.e., long-term financial capital being invested without threat of liquidation (Zellweger, 2007). Thus, having more time to adapt non-adequate material resource provisions for the required purposes, family businesses are less likely to desperately seek for optimal material resource provisions in order to quickly monetarize new ideas and innovations. In contrast, short time horizons in non-family firms leave little time for thinking about how to make do without adequate material resources at hand (Sirmon & Hitt, 2003), thereby likely reinforcing a culture of demanding and anticipating adequate material resource provisions. A frequently observed consequence of such a material resource-oriented culture is to drive along stalled innovation projects by making available additional material resources (Gibbert et al., 2007).

In sum, it is proposed that organizational culture in family firms is less oriented toward material resources, which is expected to be reflected in innovation project teams' more favorable perceptions of the adequacy of their material resources. Therefore, we posit:

Hypothesis 1a: Innovation project teams in family businesses perceive higher material resource adequacy than innovation project teams in non-family businesses.

Hypothesis 1b: Material resource orientation of an organization's culture mediates the positive relationship between family influence and innovation project teams' perception of material resource adequacy.

4.2.2. Family influence and the management of material resources

As we argue family firms to possess a less material resource oriented culture (as outlined in the previous section), we also posit that innovation projects being carried out in family firms are likely to perform better than projects in non-family firms when the teams perceive their material resources as being less than adequate. Prior studies indicate that employees of family firms demonstrate a better knowledge of the resources they actually can dispose of (Sirmon & Hitt, 2003), resulting from assumed higher levels of internal social capital (Nahapiet & Ghoshal, 1998), and firm-specific tacit knowledge (Sirmon & Hitt, 2003). Therefore, innovation project teams in family businesses may rely on their deeper knowledge of the material resources at hand and their organizations' capabilities and depend therefore to a lower degree on material resource adequacy. Moreover, such a better knowledge is expected to enable a more complete picture of potential applications of the material resources at hand and possible combinations, and cross-synergies among them. In this vein, Hoegl, Weiss, Gibbert, and Välikangas (2009a) showed the case of a small start-up company, which was able to construct a highly efficient automobile in considerable material resource scarcity due to creatively applying the scarce material resources at hand and modifying the product in a way that allowed reaching the set development goals. Consistently, Chrisman et al. (2009) found family businesses being less sensitive in changes of resource stocks, and Carney (2005) mentions family firms' parsimony being especially beneficial in settings characterized by scarcity. Finally, results of a study by McConaughy, Matthews, and Fialko (2001) suggest

that family firms have more efficient operations, thus being likely to cope more successfully with inadequate resources.

Moreover, literature advocates a strong prevalence of community within family firms (Lee & Miller, 1999; Miller, Lee, Chang, & Breton-Miller, 2009), which we argue is likely to benefit teams with perceived material resource inadequacy. As such, Miller et al. (2009) describe family firms' activities to create close bonds with employees, including "loyalty to and caring for workers beyond immediate legal or bureaucratic requirements, and providing secure, satisfying jobs" (Miller et al., 2009: 804). The assumption that family firms are more likely to invest in the development of such community corresponds with the observation frequently reported in recent literature that family firms tend to adopt a stewardship position how they organize their business and how they treat their employees (Corbetta & Salvato, 2004; Eddleston & Kellermanns, 2007; Pearson & Marler, 2010; Zahra et al., 2008), in contrast to non-family firms which usually take a more "professional" (or less committed) posture towards their employees (Beehr, Drexler, & Faulkner, 1997; James, 1999). Such community efforts of family firms are likely to stimulate employees' loyalty, responsibility, as well as their consciousness in carrying out their job tasks and a sense of involvement with their company, and thus the willingness to take more effort and give more thought at work (Eisenberger, Fasolo, & Davis-LaMastro, 1990; Miller & Lee, 2001; O'Reilly & Chatman, 1986). This, in turn, is expected to increase the likelihood that employees take the effort of more deeply pondering the available material resource stock in order to achieve higher efficiency in the use of material resources for their company's sake. In so doing, they increase the probability of identifying more options of how to successfully employ a certain set of material resources in an innovation project. As a nice illustration for these arguments, Baker and Nelson (2005) report a number of intriguing examples how small family-owned firms came up with ideas for successfully applying material resources like abandoned coal mines that are usually judged being a burden rather than a resource.

Given these arguments, it is likely that the relationship between material resource adequacy and innovation project performance is contingent upon whether the project is conducted in a family firm or a non-family firm. More specifically, we posit that innovation project performance in family firms is less affected by the teams' perceptions of material resource adequacy. In non-family firms, however, we expect a stronger positive relationship between innovation project performance and material resource adequacy. This is in

accordance with the view of Hoegl et al. (2008) and their attempt to reconcile the contradicting notions concerning the relationship between material resource constraints and innovation project performance. These contradicting notions either advocate that adequate material resources generally foster creative problem solving and thereby new product development (Amabile et al., 1996; Ancona & Caldwell, 1992a; Damanpour, 1991; Hackman, 1987) or suggest that material resource constraints tend to be rather beneficial for innovation performance (George, 2005; Moreau et al., 2005; Ward, 2004). Hoegl and colleagues (2008) conceptualize the nature of this relationship being contingent upon certain team-level moderator variables determining its slope and direction. We subscribe to this view, expanding it to a multilevel approach, and posit correspondingly:

Hypothesis 2: The relationship between material resource adequacy and innovation project performance is moderated by family influence in that this relationship is stronger for non-family firms.

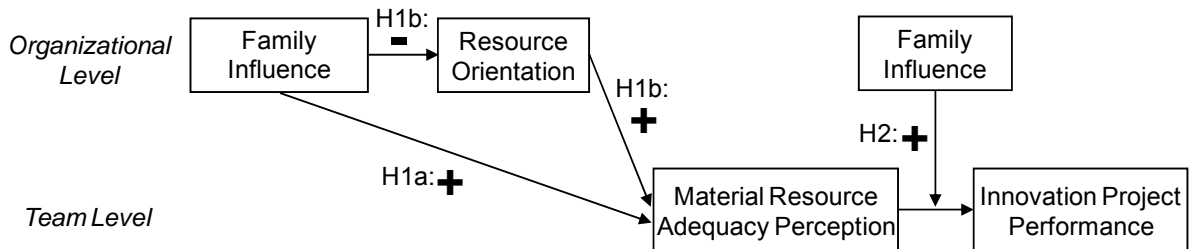


Figure 4-1: Hypothesized relationships.

4.3. Methods

4.3.1. Sample

The empirical analyses of the hypothesized relationships (see Figure 4-1) are based on data pertaining to 116 innovation project teams in 34 companies from the electronics industry in Germany, Austria, and the German speaking region of Switzerland. The electronics industry was chosen for its high innovation pressure. We selected a single industry because

companies in the same industry share strategic factor markets (Barney, 1986), and industry attributes (Mascarenhas & Aaker, 1989).

For data collection, the companies provided lists of innovation projects including names and contact information of project members, while the employees were informed that a study about team management was to be conducted. All innovation projects were completed within one year prior to the time of data collection. E-mail links to the online-questionnaire were submitted to all team leaders and team-external managers as well as randomly chosen team members. Respondents' participation in this study was strictly voluntary.

To ensure content validity and to avoid common source bias, data from different groups of respondents were used to measure the different variables, i.e., team external managers, innovation project leaders, and randomly chosen team members of innovation projects. Team external managers were the line managers responsible for the innovation projects, i.e., to whom the innovation project leaders reported. Given the premise of surveying a minimum of two team members from each project team (in addition to the team leader and a team external manager), a total of 614 invitations to participate in the survey was sent out. The final sample consisted of 121 innovation projects, with a total of 497 individual responses, resulting in a response rate of 81 %. As managers from one company failed to complete the items on organizational culture, this company and the corresponding five projects have been removed from the sample, reducing it to 116 innovation projects.

The high level of similarity prevailing between the countries in which the study was conducted (Brodbeck et al., 2000; Gupta, Hanges, & Dorfman, 2002; Szabo et al., 2002) did not suggest systematic differences between the countries in which the companies were located in. Nonetheless, following recommendations of Cohen et al. (2003), we checked for potential systematic effects of organization and country on the results. We partialled out any effects that organization and country had on any of the variables in the computed models and re-ran the models, a similar approach as taken in a number of prior studies (e.g., Hoegl et al., 2004; Lynn & Akgün, 2001). As expected, these analyses did not reveal any significant influences.

There is an ongoing debate on how to define family businesses (e.g., Chua et al., 1999; Klein et al., 2005; Litz, 1995). To distinguish between the two types of firms, i.e., family and non-family businesses, we refer to Zahra et al. (2004: 369), defining family firms as "those businesses that report some identifiable share of ownership by at least one family member and

having multiple generations in leadership positions within that firm". Zahra et al. (2004) developed this definition following Astrachan and Kolenko (1994), who proposed the ownership of over 50 percent of the business in a private company or more than 10 percent of a public company constituting characteristics of a family business. Applying the criteria mentioned above led to the categorization of the 34 firms in the sample into 14 family firms and 20 non-family firms. Of the 116 innovation projects analyzed, 49 pertained to family firms, 67 to non-family firms.

4.3.2. Measures

The questionnaire was administered in German language. The measurement scales were based on measures of related constructs in the literature when possible. To ensure content validity and to avoid common source bias, data from different groups of respondents were used to measure the different variables. If not specified otherwise, all items were rated on 5-point Likert scales (1 = *strongly disagree*, to 5 = *strongly agree*).

4.3.2.1. Family influence

In this study, family influence was measured using a single categorical variable that indicates whether a company is a family firm or not. This is consistent with the vast majority of comparative studies in family business research (e.g., Eddleston & Kellermanns, 2007; Eddleston et al., 2008a; Hsieh et al., 2010; Miller et al., 2009; Zahra et al., 2004).

4.3.2.2. Material resource orientation

An organizational culture placing high importance and dependence on material resources, i.e., material resource orientation, was measured applying a five-item scale (Cronbach's alpha = .72) which was developed for this study, lacking any prior such measure in the literature. In developing this scale for material resource orientation, we built on approaches dealing with attitudes and cultural norms relating to the meaning and importance of money (Falicov, 2001; Ger & Belk, 1996; Mitchell & Mickel, 1999; Tang, 1992; Wernimont & Fitzpatrick, 1972). For example, the items were inspired by the mindset promoted by Total Quality Management which involves the belief of being able to improve quality without necessarily employing additional material resources (Detert et al., 2000), the aforementioned concept of *Bricolage* (Baker & Nelson, 2005; Garud & Karnoe, 2003), and

research on extrinsic value orientation and the meaning of money (Sheldon & McGregor, 2000; Tang, 1992; Tang, Tang, & Luna-Arocas, 2005).

Following suggestions of Davis, Schoorman, and Donaldson (1997), we chose to use manager's evaluations of organizational culture because executives are likely to implement their own thoughts and values in the reward and control systems which they are responsible for (Zahra et al., 2008). For example, executives with a strong material resource orientation are very likely to organize R&D processes reflective of a material resource-oriented culture. In so doing, we also keep with recommendations and common practice in the examination of cultural aspects in family firms (Klein et al., 2005).

4.3.2.3. Perception of material resource adequacy

The perception of material resource adequacy was assessed using a two item index. These data were obtained using innovation project team members' evaluations of two items adapted from Hoegl and Parboteeah (2006a), referring to financial resource and equipment adequacy. We assume that the usually intense social interaction within innovation project teams will generate a shared belief about material resource adequacy within the team (González-Romá et al., 2002). Such a shared belief among team members usually develops quite quickly in innovation project teams after the completion of preliminary project tasks (Lester et al., 2002). The two items used here ($r = .35$, $p < .05$) cover in equal representation the relevant aspects constituting material resources (Barney, 1991). We see this variable representing a formative construct, where the items are not expected to be highly correlated, mainly due to the sensitivity of financial resource provisions to short term changes in the business environment, in contrast to the more robust nature of available equipment like technical facilities, which is expected to be considerably less vulnerable to abrupt changes in business activities. Therefore, we abstained from including measures of the scale's internal consistency in the paper (Diamantopoulos & Winklhofer, 2001).

Prior to aggregating team members' evaluations of material resource adequacy perceptions to the team level, interrater agreement was assessed using the multiple-item estimator $r_{WG(j)}$ for within-group interrater agreement as proposed by James, Demaree, and Wolf (1984; James, Demaree, & Wolf, 1993). This test yielded a $r_{WG(j)}$ value of .77. Given this homogeneity of within-team ratings, aggregation of the data to the team level appeared justified (George & James, 1993) and was conducted by calculating the arithmetic mean.

4.3.2.4. Innovation project performance

Innovation project performance refers to the degree to which expectations regarding the quality of the outcome were met by the team and was measured for the present study adapting three items (Cronbach's alpha = .86) from Hoegl and Gemuenden (2001) using data from team-external managers. In line with previous research taking the same approach (e.g., Hoegl et al., 2004; Zhang et al., 2007), we believe that the line managers were in an ideal position to rate the innovation project outcomes without being biased by team-internal processes. A small number of the team-external managers rated more than one innovation project's performance. However, as the number of innovation projects rated by one team-external manager was about two in average, we do not expect any systematical differences to the investigated variables or relationships. Nonetheless, following the same approach as described above, we have partialled out any effects that team-external managers had on any of the variables in the models and re-ran the models. No significant influences were detected in these analyses. The individual items used to measure the variable described above are shown in Table 4-1.

Variable	Items
Perception of material resource adequacy	In this project, the team had sufficient financial resources. In this project, the team had sufficient equipment.
Innovation project performance	The project result was of high quality. The customer was satisfied with the quality of the project result. The product required little rework.
Team potency	In this company, usually project members ask for more budget if things don't work out. In this company, the predominant view is that more budget leads to more successful results in projects. In this company, the adequacy of resources granted to a project is seen as an indicator for the project's importance. In this company, a lack of resources is a main reason for the failure of projects. In this company, the lack of resources is oftentimes brought forward as excuse for the failure of projects.

Table 4-1: Items used for the variables

4.3.2.5. Control variables

Team size was controlled for, since the number of members of an innovation project team constitutes an important structural variable with potential influences on its social and task processes (Campion et al., 1993; Hackman, 1987). For instance, large team sizes make it more difficult for team members to interact with all other team members given the increase of possible individual links between team members as team size grows (Steiner, 1966). Furthermore, we controlled for the duration of the innovation projects, as longer innovation projects are likely to include a wider scope of project goals and may be managed and monitored in a different way than innovation projects of shorter duration. The number of team members, as well as the start and end dates of the innovation projects were provided by team leaders. Being argued that differences in company size may affect the relationships under study (Cockburn, Henderson, & Stern, 2000; Schulze, Lubatkin, & Dino, 2003), we controlled for organizational size by including the number of employees in the respective models. We used the logarithm (ln) of number of employees to minimize skewness. For project- and organizational level descriptive statistics and correlations see Table 4-2.

4.3.2.6. Analytical techniques

Multiple regression analysis (Cohen et al., 2003) and hierarchical linear models (HLM) (Raudenbush & Bryk, 2001) were applied to test the hypotheses. Since this study involved assessing the impact of organization-level factors on projects, the HLM models consisted of two levels (Raudenbush & Bryk, 2001). As the hypothesis tested in the first part of the model on material resource evaluation was for main effects of level 2 variables on the project mean level 1 outcome (team members' perceptions of material resource adequacy) adjusted for within-project level 1 predictors, we used intercept-as-outcomes models (as opposed to a slopes-as-outcomes model). Furthermore, given that on this level we are interested in the effects of firm-level factors after controlling for all individual-level factors, we used the grand-mean centering option for all project-level variables (Hofmann & Gavin, 1998). Dealing in the mediational analyses with a level-2 antecedent that influences a Level-2 mediator, which, in turn, affects a level-1 outcome, grand mean centering is not expected to confound mediation effect estimates and thus represents the commonly recommended practice (Zhang, Zyphur, & Preacher, 2009). In contrast, as the second model aims at testing a cross-level interaction of a single main effect predictor at level 1 and a single main effect predictor

at level 2, a slopes-as-outcomes model was applied. In this model, for computing the moderation analyses, we used the group mean centering option for level-1 variables (Davison, Kwak, Seo, & Choi, 2002; Hofmann & Gavin, 1998).

Variable	Source	Mean	SD	1	2	3	4	5	6	7
Project level										
1. Team size	PLD	8.70	6.90	-						
2. Project duration (months)	PLD	22.30	15.16	.32**	-					
3. Perceived material resource adequacy	PTM	3.70	0.65	-.04	-.04	-				
4. Innovation project performance	TEM	3.67	0.83	.03	-.08	.25**	-			
Organizational level										
6. Organizational size ^a	CR	7.12	1.83	.35**	.28**	-.02	.12	-		
7. Family influence	CR	0.41	0.50	.02	-.03	.25**	.35**	-.14	-	
8. Material resource orientation	TEM	3.01	0.57	.10	-.07	-.30**	-.27**	-.04	-.28 ⁺	-

N = 116 teams in 34 companies; ^alogarithmized (ln); ⁺p < .10; *p < .05; **p < .01 (two-tailed). CR = company records; PTM = project team members; PLD = project leader; TEM = team external manager.

Table 4-2: Descriptive statistics and correlations between variables.

4.4. Results

Hypotheses 1a and 1b predicted that material resource orientation would mediate the relationship between family influence and innovation team members' adequacy perceptions of material resources. The results applying ordinary least squares (OLS) regression and HLM analyses are depicted in Table 4-3. We followed the four-step procedures for mediation described by Baron and Kenny (1986), as described for the use in multilevel models by Zhen et al. (2009) and including all control variables in the respective models. In step 1, family influence needs to be related to innovation project teams' perceptions of material resource adequacy. Results revealed that family influence was significantly related to innovation project teams' perceptions of material resource adequacy (model 2). Thus, the first requirement was met. Step 2 requires that family influence be related to material resource orientation. In this regard, OLS regression results of the organizational level variables (Krull & MacKinnon, 2001) revealed that family influence significantly predicted an organizational culture less oriented towards material resources (model 1). Although significant at the .10 level, the relatively high regression coefficient ($\beta = -.34$) and the small sample size of 34 companies point to a substantive relationship here. Step 3 requires the mediator, i.e., material resource orientation, to affect the outcome variable, i.e., innovation project teams' perceptions of material resource adequacy. Baron and Kenny (1986) argue that for probing this relationship just correlating the mediator with the outcome variable would not be sufficient and that the initial variable has to be controlled for in establishing the effect of the mediator on the outcome. Step 4 finally requires that the significant relationship between family influence and perceptions of material resource adequacy of innovation project teams shown in step 1 is reduced or eliminated when material resource orientation is entered in the same model. Results revealed (model 3) that, with the inclusion of family influence in the model, the relationship between material resource orientation and perceptions of material resource adequacy was significant. Moreover, the effect of family influence was reduced when entering material resource orientation in the equation in model 3. Altogether, these results suggest that material resource orientation mediates the relationship between family influence and material resource perceptions in innovation projects. Therefore, Hypotheses 1a and 1b are supported.

	Mat. resource orientation	Perceived material resource adequacy	
	Model 1	Model 2	Model 3
Level 1			
Team size		-.01 (.01)	.00 (.01)
Project duration		.00 (.01)	.00 (.01)
Level 2			
Organizational size (ln)	-.03 (.05)	.03 (.02)	.01 (.03)
Family influence	-.34 ⁺ (.20)	.38** (.12)	.23 ⁺ (.12)
Material resource orientation			-.25* (.11)

N = 116 (level 1); 34 (level 2). ⁺p < .10; *p < .05; **p < .01 (two-tailed). Unstandardized regression coefficients with standard errors in parentheses. Level 1 variables are grand-mean centered. Entries corresponding to the predicting variables are estimations of the fixed effects, γ s, with robust standard errors.

Table 4-3: Results of mediation analyses.

Hypothesis 2 predicted an interaction effect of the relationship between material resource adequacy and innovation project performance in that this relationship is stronger for non-family firms. Results documented in Table 4-4 provide support for this hypothesis, showing a significant interaction term of material resource adequacy and family influence.

	Innovation project performance		
	Model 1	Model 2	Model 3
Step 1 (control variables)			
Team size	.00 (.01)	.00 (.01)	-.01 (.01)
Project duration	-.02 (.01)	-.02 (.01)	-.01 (.01)
Organizational size (ln)	.02 (.04)	.06 (.03)	.05 (.03)
Step 2 (linear effects)			
Perceived material resource adequacy		.18* (.09)	.18** (.07)
Family influence		.59** (.15)	.57** (.15)
Step 3 (interaction term)			
Perceived material resource adequacy* family influence			-.36* (.14)

N = 116 (level 1); 34 (level 2). ⁺p < .10; *p < .05; **p < .01 (two-tailed). Unstandardized regression coefficients with standard errors in parentheses. Level 1 variables are group-mean centered. Entries corresponding to the predicting variables are estimations of the fixed effects, γ s, with robust standard errors.

Table 4-4: Results of moderation analyses.

In addition, we also plotted a graph to depict this interaction in a more detailed way (see Figure 4-2). This graph and probing the simple slopes of the interaction effect (Aiken & West, 1991) show that for innovation projects in family firms there is no significant relationship between material resource adequacy and performance ($b = 0.06$, n.s.) while there is a significant positive relationship between these two variables for non-family firms ($b = 0.38$, $p < .05$).

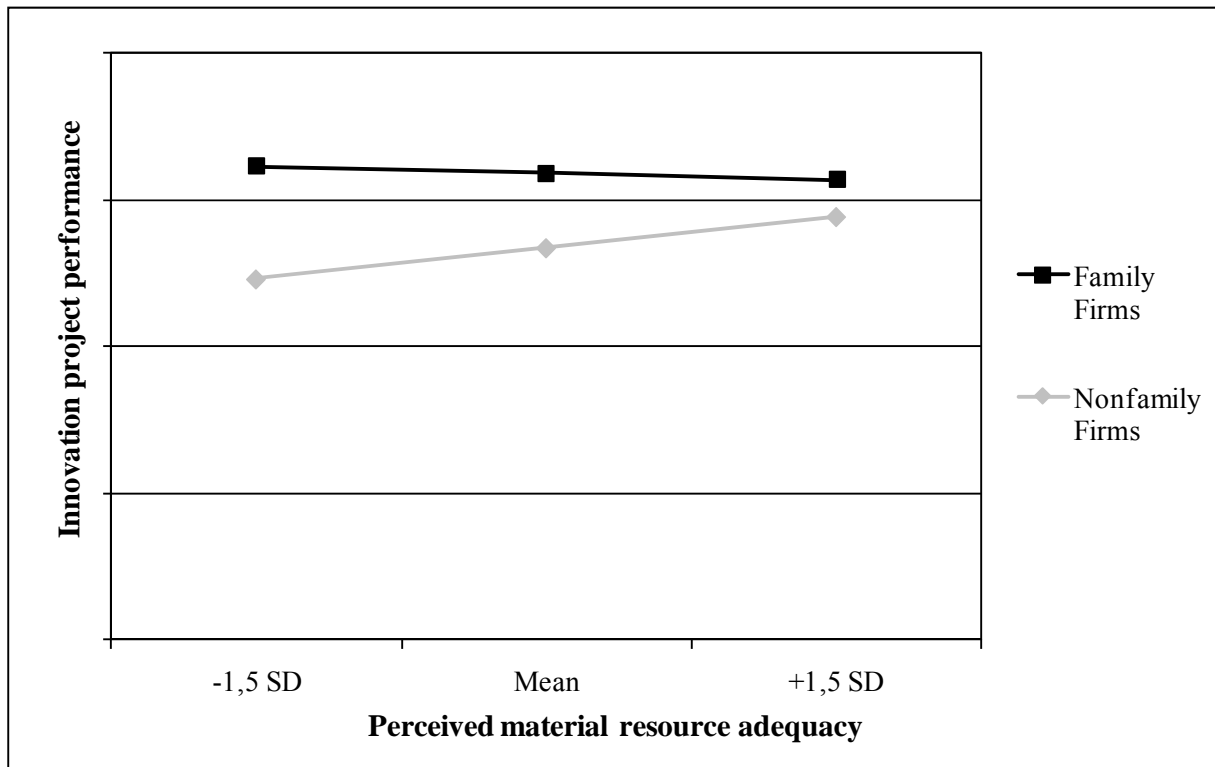


Figure 4-2: Interaction of perceived material resource adequacy and firm type on innovation project performance.

4.5. Discussion

This research found that innovation project teams in family firms saw their material resource provisions generally as more adequate. Moreover, we identified the organizational cultural characteristic of material resource orientation to be a mediating variable, representing an important link that transmits family influence to perceptions of material resource

adequacy. The analyzes further show an interaction effect in that perceptions of material resource adequacy indeed appear to have differential effects on innovation project outcomes in family and non-family businesses. In particular, innovation projects in non-family firms did significantly better when being provided with more adequate material resources than when being provided with inadequate material resources. In contrast, innovation projects conducted in family firms performed better (relative to those in non-family firms) under conditions of perceived material resource inadequacy, and their performance was not affected by differences in perceptions of material resource adequacy. Taken together, the conceptual arguments provided above and the empirical findings suggest that innovation project teams in family firms are less likely to construe their material resource provisions as inadequate, and even if they do, they seem highly resilient with regard to such circumstances. These findings have important implications.

4.5.1. Theoretical and practical implications

The revealed results shed necessary new light on the role organizational culture plays in family firms and on differences in this regard between family and non-family firms. Specifically, existing literature on cultural influences in family firms (Denison, Lief, & Ward, 2004; Zahra et al., 2004) is expanded by investigating cultural aspects concerning material resources. Finding that family firms tend to possess a culture less oriented towards material resources highlights an important difference to non-family firms and adds missing pieces to a theory of family firms seen in the light of the RBV (Carney, 2005; Chrisman et al., 2009; Eddleston et al., 2008a; Sirmon & Hitt, 2003). Organizational culture seems thus to be an important strategic firm resource (Zahra et al., 2004) that is particularly beneficial for the evaluation and management of material resources in innovation projects.

The significant influence of material resource evaluation and management on innovation performance supports the basic assumptions by Sirmon, Hitt, and colleagues (Sirmon et al., 2008; Sirmon & Hitt, 2003; Sirmon et al., 2007) in their enhanced conception of the RBV, stating that competitive advantage does not solely arise from the presence of certain resources, but even more so from these resources' evaluation and management. In addition to providing first comparative empirical evidence on this conception from family and non-family firms, this study extends the RBV (Barney, 1991; Wernerfelt, 1984), and literature on family businesses (Chrisman et al., 2005), respectively, by explicitly including the project

level in the analysis, and by considering cross-level contingencies that may help explain when and how certain resources contribute to a firm's competitive advantage. So far, research on the RBV has generally focused on the organizational level, thereby neglecting micro foundations of resources' impact on firm success, which originate in subordinate organizational entities. In contrast to the literature on the RBV, research on family businesses did include multi-level considerations in concepts and frameworks (e.g., Eddleston, Otondo, & Kellermanns, 2008b; Shepherd, 2009). Nonetheless, concentrating on the individual and organizational level so far, the project level marked largely uncharted but important territory on the map of family business research as well.

Showing that the degree to which people attribute significance to material resources when working on innovative tasks influences their evaluation of how adequate the material resources at hand are reveals that a key finding of cognitive psychology (Clarkson et al., 2010; Knoblich & Sebanz, 2006) appears to hold also on team level, namely the significant influence of socio-cognitive factors on perception. Here, the results showed that family influence and organizational culture shape the mindset of innovation project teams in such a way that they tend to evaluate material resources as being more adequate than innovation project teams in non-family firms did.

Moreover, the results indicate that a culture less oriented towards material resources, which is more likely to be present in family firms, appears to be beneficial especially when material resources are scarce. In contrast, in projects provided with adequate material resources, family firms tend to perform worse than non-family businesses. This suggests industry-specific advantages of family firms and is in line with the observation that Asian family firms, while having had an advantage in times characterized by material resource scarcity, had problems to adequately allocate additional material resources when outside capital became available more easily (Carney & Gedajlovic, 2002; Johnson, Boone, Breach, & Friedman, 2000). Hence, in markets characterized by low revenues or low availability of capital and thus a higher pressure to keep down development cost, the results suggest advantages for family firms. In the reverse case of resource abundance, however, certain weak-spots of family firms, e.g., when it comes to divest unnecessary resources (Sharma & Manikuttu, 2005), seem to be hindering particularly in resource rich environments.

Finally, we empirically showed the importance of material resource availability in the context of innovation. Putting this into the terms of Hoegl et al. (2008), the results suggest that innovation projects in non-family firms seem to be material resource-elastic, i.e., the more adequate available material resources are, the higher the resulting performance tends to be. In contrast, innovation projects carried out in family businesses appear rather material resource-inelastic, such that varying adequacy levels of material resource provisions in these projects have little or no impact on their subsequent performance. Furthermore, we empirically confirm Hoegl, Gibbert, and colleagues' view on the material resource-innovation project performance relationship (Gibbert et al., 2007; Hoegl et al., 2008; Hoegl et al., 2009a), proposing that it is contingent upon certain moderating variables and expand it to a multilevel-concept by introducing family influence as a further moderating variable in this framework.

On a practical level, this study puts the spotlight on an organization's cultural values with regard to material resources. Family firms tend to have cultures that attribute less importance to material resources as a prerequisite for success. However, such an organizational culture is not reserved to family businesses and may be cultivated in non-family firms as well in order to make innovation projects less material resource elastic. To do so, managers might strengthen the feeling of community among employees in order to enhance their level of involvement, emotional attachment and motivation (Miller & Le Breton-Miller, 2007; Miller et al., 2009), e.g., by paying attention to employees beyond immediate legal or bureaucratic requirements (Miller et al., 2009). At this point, it is worth noting, however, that even in family firms there surely exists a point where material resource provisions get to be so scarce that a detrimental effect on performance has to be logically expected (Gibbert et al., 2007; Hoegl et al., 2008).

4.5.2. Limitations and outlook

Some limitations of this study should be noted, along with directions for future work. First, the data for this research are cross-sectional rather than longitudinal. While this study demonstrates associations between variables, it cannot establish causality. A longitudinal research design would further our knowledge about the causality of relationships and the effects of family influence on evaluation and management of material resources subsequent innovation project performance over time. Second, a dichotomous variable was used in order

to distinguish between family and non-family firms, basing on the ownership structure and leadership positions taken in by family members. Although we are aware of firms not being either a family or a non-family firm and the “familiness” of a firm spanning multiple aspects (Klein et al., 2005), adopting a dichotomous approach in categorizing firms appeared to represent the most appropriate approach for the present purpose here. Despite many prior studies on family firms having used such dichotomous measures (e.g., Chua et al., 2004; Eddleston et al., 2008a; Schulze et al., 2003), future research may want to find out if different degrees of family influence impact the relationships established in this study. Third, this study was conducted in companies located in Germany, Austria, and Switzerland, raising the question of generalizability to other countries (Henrich et al., 2010). While this study is not internationally comparative in nature and cannot offer any answers to this question, the theoretical considerations presented in this article are not country-specific, but rather based on international scholarly work and empirical findings. Further research in other countries is encouraged to increase our understanding of the possible influences of country specific contexts on the investigated relationships (Miller et al., 2009). Finally, the sample size at the organizational level (34) might raise concerns about statistical power because of increasing the possibilities of a Type II error, i.e., incorrectly sustaining the null hypothesis (Aguinis, 1995). Finding support for both the mediation and moderation hypotheses, however, suggests robust effect sizes being present (Aguinis, 1995) and sample size not being a major problem, given that the analyzes in this paper did not seek to substantiate a null hypothesis (Eddleston et al., 2008a).

We hope that the present research stimulates further cross-level analyses scrutinizing the role of family influence in innovation, integrating variables from individual, project, and organizational level. Given the apparent differences in culture and mindset between family firms and firms possessing other ownership structures (Kets de Vries, 1993; Schulze, Lubatkin, Dino, & Buchholtz, 2001), common knowledge about drivers or impediments of innovation (Balachandra & Friar, 1997; Cooper & Kleinschmidt, 1995; Henard & Szymanski, 2001) may not necessarily hold one-to-one for innovative endeavors in family businesses. Moreover, the results suggest that scarce material resources do not necessarily impede innovation performance and that family firms may have specific advantages under such conditions. Therefore, it appears worthwhile to shed light on further potentially existing contingency effects of ownership structure in the context of innovation. Here, we advocate

focusing on the project level of analysis, because projects are, after all, the organizational entities in which the lion's share of innovation actually takes place (Edmondson & Nembhard, 2009; McDonough, 2000; Wuchty et al., 2007).

5. EFFECTS OF RELATIVE TEAM SIZE ON THE PERFORMANCE OF TEAMS WITH INNOVATIVE TASKS¹

ABSTRACT

Prior research intuitively suggests that a more adequate relative team size leads to superior performance. However, several literatures, in particular that on understaffing theory, suggest that the relationship between relative team size and innovation project performance is not that simple (i.e., uniformly positive). We posit that the relationship of relative team size and innovation project performance depends on which outcomes are used as dependent variables (i.e., new product novelty, project efficiency, new product quality). Analyzing data pertaining to 121 innovation projects reveals a positive relationship of relative team size with new product quality, and with project efficiency. In contrast, the relationship between relative team size and new product novelty is a negative one. Implications for theory and practice are discussed.

¹ This paper was written by Matthias Weiss based on conjoint work with Prof. Dr. Martin Högl.

5.1. Introduction

There is agreement among scholars that today the lion's share of innovative work in organizations is executed by innovation project teams (e.g., Edmondson & Nembhard, 2009; McDonough, 2000; Wuchty et al., 2007). When it comes to staffing such an innovation project, assigning the right number of team members surely is a key objective of those having to recruit and set up the innovation project's team. However, what actually constitutes the "right" number of team members in innovation projects? Existing research on this topic is scarce, while, in contrast, there is abundant research seeking out to identify which qualities of individual team members are beneficial for innovative endeavors (e.g., Leonard-Barton, 1992; McComb et al., 2007), like their capabilities and expertise (Hargadon & Bechky, 2006; Leonard-Barton, 1992). Generally, there is a lack of empirical studies actually examining the topic of staffing on the team level, which is underlined by Ployhart's (2004: 138) notion that "while there is a large amount of research on teams, very little of this research is focused specifically on *team staffing*". This situation is reflected by the observation that searching the databases EBSCO and SCOPUS for the terms "staffing" AND "team" in document titles and keywords yields little more than ten results. Most of them are dealing with the topic of team composition, which is usually measured as within-team averages of individual knowledge, skills, abilities, and other characteristics, i.e., KSAOs (Ployhart, 2004). However, above and beyond the problem that such measurement actually captures KSAOs specified on the individual level rather than on the team level (Ployhart, 2004), staffing for innovation project teams for obvious reasons does not only depend on team members' qualities but also on the quantity of team members.

Although there is considerable research on the effects of absolute team headcount on teams' innovation performance (Bouchard & Hare, 1970; Gallupe et al., 1992; Hülshager et al., 2009; Stewart, 2006), and on approaches to optimize staffing decisions using mathematical models (Gagnon & Krasner, 1990; Gutjahr, 2011; Heimerl & Kolisch, 2010; Taylor, Moore, & Clayton, 1982), there is barely any research considering the number of team members in relation to the project tasks at hand, i.e., relative team size. However, the same number of team members adequate for one innovation project team may well be inadequate for another one (Kor et al., 2007; Vecchio & Sussmann, 1981). Hence, the question which relative team size facilitates or hampers performance in innovation projects still remains unsolved.

Prior concepts suggest a very plausible answer, i.e., that a more adequate relative team size leads to better performance (Ancona & Caldwell, 1992b; Hackman, 1987; Sicotte & Bourgault, 2008). However, there is evidence that this intuitive logic does not generally hold, suggesting that the relationship between relative team size and innovation project performance is not that simple (i.e., not uniformly positive). As such, literature on understaffing theory (Ganster & Dwyer, 1995), which is sometimes also referred to as undermanning theory, comes up with less intuitive insights. Specifically it suggests that members of teams with an insufficient relative team size are increasingly motivated and expend greater effort (Greenberg, Wang, & Dossett, 1982; Oxley & Barrera, 1984; Vecchio & Sussmann, 1981), and are therefore not necessarily lower in performance relative to teams with a more adequate relative team size (Perkins, 1982; Wicker et al., 1976). These prior studies on the consequences of insufficient relative team size, however, were conducted mainly in laboratory experiments (Arnold & Greenberg, 1980; Greenberg et al., 1982; Perkins, 1982; Wicker et al., 1976) and the field work in this domain was either conducted using samples of students, blue collar workers, or white collar workers pursuing routine tasks (Cini, Moreland, & Levine, 1993; Ganster & Dwyer, 1995; Oxley & Barrera, 1984; Vecchio & Sussmann, 1981). Yet, it is very likely that an innovation setting which includes a high level of complexity, ambiguity, and uncertainty differs substantially from other organizational settings (Mumford, Hunter, Eubanks, Bedell, & Murphy, 2007), leaving in question to what degree those insights can be transferred to the context of teams with innovative tasks. This is in line with Perkins (1982), who supposed that the consequences of an insufficient team size are contingent upon the task type a team has to perform. Indeed, it appears highly probable that the team type and the kind of task a team has to execute influence the effect relative team size exerts on team performance. A team dealing with routine tasks, e.g., production teams (Pagell & LePine, 2002), may react quite differently on an insufficient relative team size than a team in an uncertain environment dealing with ill-defined and complex tasks like new product development project teams (Caldwell & O'Reilly, 2003). In this vein, Ganster and Dwyer (1995) differentiated in their study between blue collar and white collar teams pursuing routine tasks and, as expected, obtained significant differences between the results they detected for those team types.

However, while such related prior work suggests implications for the staffing of innovation project teams, no systematic analysis of the effect of relative team size on different

innovation project outcomes has been conducted yet in the literature. We believe, however, that a more fine grained analysis on relative team size's performance effects is necessary since performance in the setting of innovation projects may not be captured by a unidimensional measure. Rather, innovation project performance represents a multi-dimensional construct (Shenhar et al., 2001), consisting of aspects that are not necessarily related to each other (i.e., product quality, product novelty, and project efficiency) (Molina-Castillo & Munuera-Aleman, 2009; Sethi & Sethi, 2009). This article therefore sets out to identify the consequences resulting from an insufficient relative team size on different aspects of innovation project performance, and as such aims at making two main contributions.

First, to our knowledge, there has been no systematic investigation of relative team size in project teams dealing with innovative tasks. This is surprising, bearing in mind the obviously central importance of an adequate number of team members in project work. Given the fact that most innovative endeavors are carried out in team projects (Edmondson & Nembhard, 2009; McDonough, 2000; Wuchty et al., 2007), the question which effects relative team size exerts on the performance of teams with innovative tasks possesses great relevance for organizations' success in innovation. This is particularly the case since an insufficient relative team size may represent the rule rather than the exception in times of tight budgets and increasing efforts towards R&D efficiency (Hamel & Getz, 2004), where project team staffing is often seen as a hot spot for cost reduction (Kessler, 2000). Therefore, this paper will shed light on the relationship between relative team size and innovation project performance by empirically investigating 121 teams of real world innovation projects. In so doing, we also put findings of understaffing theory (Ganster & Dwyer, 1995; Wicker et al., 1976) to the test in an innovation context since in this literature solely teams pursuing routine (i.e., non-innovative) tasks have been examined so far. Given the peculiarities like an elevated level of uncertainty and ambiguity inherent in innovative tasks (Pich, Loch, & De Meyer, 2002; Veryzer, 1998), which result from working on ill-defined tasks and substantial interaction with persons from outside the team (Caldwell & O'Reilly, 2003; Sundstrom, de Meuse, & Futrell, 1990), we expect that in the context of innovation project teams (Edmondson & Nembhard, 2009; McDonough, 2000) findings of prior studies on understaffing theory do not hold one to one for the domain of teams pursuing innovative tasks.

Second, this paper contributes by offering a detailed analysis of the relationship between relative team size and innovation project teams' performance. Past theoretical approaches, empirical studies, as well as meta-analyses and reviews on this topic mainly did not separate between different outcome measures, but aimed at explaining team performance and team innovation, respectively, in a more general way (see, e.g., Hülshager et al., 2009). Building on theories of trait activation (Haaland & Christiansen, 2002; Kenrick, McCreath, Govern, King, & Bordin, 1990; Tett & Guterman, 2000) suggesting that a varying relative team size activates different traits and capabilities of team members (Kell, Rittmayer, Crook, & Motowidlo, 2010; Robert & Cheung, 2010; Tett & Burnett, 2003; Tett & Guterman, 2000) which, in turn, are likely to facilitate or hamper certain project outcomes, this research distinguishes between three distinct outcomes of innovation projects: the novelty of the developed products, the quality of the developed products, and the efficiency of project work. Moreover, we apply a measure of relative team size which explicitly takes into account the tasks an innovation project team has to accomplish. Empirically, this analysis therefore contributes by investigating whether and how innovation project outcomes are differently affected by varying levels of relative team size. Conceptually, this higher detail in analysis provides an important step for appropriately staffing teams for innovation projects in order to facilitate the achievement of those innovation project outcomes actually focused on. By controlling for qualitative aspects of staffing, such as technical expertise, experience, and originality of the team members, the analyses here set out to perform a relatively pure measurement of relative team size.

The article is organized as follows. The next section provides theoretical foundations and a summary of the arguments regarding the role relative team size plays in innovation project teams. Thereafter, hypotheses on the consequences of varying levels of relative team size are developed, which are tested on a sample of 121 innovation project teams. The article closes with a discussion of this study's main theoretical and practical implications, along with limitations and outlook.

5.2. Theory

Throughout this paper, the focal independent variable relative team size is specified as how sufficient the innovation project's number of team members is perceived to be by members of the innovation project team, given the innovation project's objectives (Ganster &

Dwyer, 1995). In this regard, it is referred to Wicker (1973), who conceptualized the degree of adequacy of relative team size as a continuum (see Figure 5-1). This continuum ranges from “undermanned” (or understaffed) teams, i.e., a team size below the minimum of team-members needed to maintain the behavior setting itself, to “overmanned” (or overstaffed) teams, i.e., the condition when team size exceeds the capacity maximum of a behavior setting (Wicker, 1973: 191). The relative team size we refer to as insufficient in this paper corresponds the “poorly manned” condition in Wicker’s concept (Wicker, 1973:191), i.e., a relative team size being equal or slightly above the maintenance minimum but well below what Wicker calls a “richly manned” condition. This operationalization of relative team sizes corresponds the concept of inhabiting levels (Heston, 1995; Wicker, 1979) in ecological psychology which can be defined as “the number of people in a setting for each of its ‘people positions’” (Scott, 2005: 299), and which was shown to exert considerable influence on how the setting of a group task influences the execution of this task (Scott, 2005).

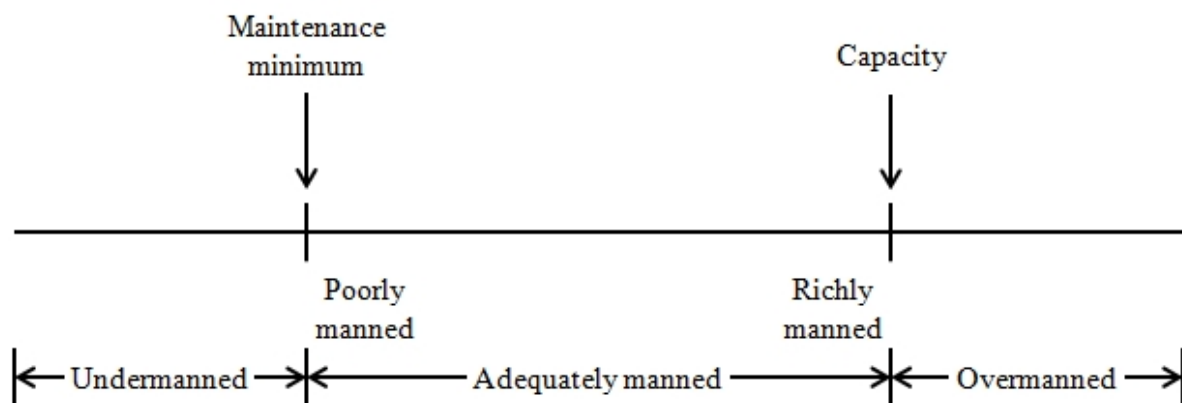


Figure 5-1: Continuum of manning levels by Wicker (1973: 191).

We believe that it is important to focus on subjective perceptions of relative team size, since research in cognitive psychology suggests that exactly such subjective perceptions are actually determining patterns of individual and group behavior (Barden & Petty, 2008; Clarkson et al., 2010; Riggs & Knight, 1994). Further, it is important to distinguish between the absolute number of team members and relative team size, because the latter takes into account the tasks to be accomplished by a team. We admit that absolute team headcount

numbers certainly represent a meaningful explanatory variable of team processes in innovation (Stewart, 2006), e.g., by impeding innovation through increasing problems in team internal communication (Hoegl, 2005; Price, Smith, & Lench, 2006), or by facilitating innovation through providing an increasingly diverse reservoir of knowledge (Guimera, Uzzi, Spiro, & Amaral, 2005; Huckman, Staats, & Upton, 2009) with growing absolute team sizes. Nonetheless, the headcount of a team does, by itself, say nothing about how adequate the number of team members actually is since it does not take into account the number and type of tasks the team is assigned with (Heston, 1996).

5.2.1. Understaffing theory

Building on foundations of ecological psychology (Barker, 1968; Schoggen, 1989; Stokols, 1995), the central assumption of understaffing theory is that relative team size influences team member behavior (Ganster & Dwyer, 1995). For example, if a team has an insufficient relative team size, it is expected that the members of this team will be increasingly motivated and will show greater effort in performing the team task in order to accomplish team goals despite the disadvantageous staffing conditions (Perkins, 1982; Wicker, 1973). This assumption reflects a frequently observed phenomenon in team sports that players of a short-handed team tend to increase their efforts, sometimes even outdoing their selves (Mechtel, Bäker, Brändle, & Vetter, in press). Indeed, a study on the consequences of player dismissal in professional soccer found that the individual work-rate of players in the short-handed team increased significantly after the dismissal (Carling & Bloomfield, 2010). This, in turn, suggests that the players do not always utilize their full physical potential and that the occurrence of possessing an insufficient relative team size indeed results in an increased motivation among the remaining team members. On first sight plausible, it is nonetheless surprising that professional soccer players on the highest national levels do not always utilize their full physical potential, thereby suggesting a parallel to teams in organizational contexts.

However, although such motivational effects have been confirmed in experimental studies (e.g., Greenberg et al., 1982), as well as in empirical studies conducted in organizational settings (e.g., Ganster & Dwyer, 1995; Vecchio & Sussmann, 1981), either no direct effect of relative team size on team performance was found (Wicker et al., 1976) or even a negative relationship between those variables was detected (Ganster & Dwyer, 1995;

Perkins, 1982). Similarly, in the professional soccer analogy, the dismissal of a player was also found to be negatively related with scoring (Bar-Eli, Tenenbaum, & Geister, 2006). So, what are we to make of this evidence when theorizing about varying relative team sizes' effect on the performance of innovation project teams?

Innovation project performance as such represents a multi-dimensional construct (Shenhar et al., 2001), consisting of aspects that are not necessarily related to each other (e.g., product quality, product novelty, and project efficiency) (Molina-Castillo & Munuera-Aleman, 2009; Sethi & Sethi, 2009). In order to derive hypotheses about the respective effect of relative team size on the different innovation project outcomes covered in this paper, trait activation theory (Tett & Burnett, 2003; Tett & Guterman, 2000) is used as a guiding framework. This research stream originated from the scholarly discourse on traits and situations as a cause of behavioral variance (Epstein & O'Brien, 1985), integrating trait and situationist perspectives (Kenrick et al., 1990; Tett & Guterman, 2000). Its core tenet is that „personality traits require trait-relevant situations for their expression” (Kenrick & Funder, 1988; Tett & Guterman, 2000: 398), i.e., “the behavioral expression of a trait requires arousal of that trait by trait-relevant situational cues” (Tett & Guterman, 2000: 398). As an example from the context of innovation projects, people being high on attributes facilitating creativity like divergent thinking skills (McCrae, 1987; Runco, 2004) or openness to experience (Feist, 1998; Schilpzand, Herold, & Shalley, 2011) are rather unlikely to bring those attributes fully to bear unless they are intrinsically motivated (Amabile, 1983, 1985) or the situation forces them to do so (Gibbert & Scranton, 2009; Kim, Hon, & Lee, 2010). Therefore, we propose that the influence of relative team size differs regarding the conceptualization and measurement of innovation project outcomes (i.e., whether product novelty, product quality, or project efficiency is used as dependent variable) since the attributes activated by varying levels of relative team size are supposed to differentially support and impede, respectively, the achievement of innovation project outcomes.

Therefore, empirical and conceptual evidence from a variety of literatures is reviewed in the following section in order to argue which traits, capabilities, or processes are expected to be unleashed as a consequence of varying relative team sizes and thus, which effect relative team size is assumed to have on new product novelty, new product quality, and project efficiency.

5.2.2. Relative team size and new product novelty

There are a number of findings from neighboring research fields which can be drawn on when reasoning about traits that are activated by varying levels of relative team size and that are potentially influencing product novelty. First, insights from prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1981) suggest that along with facing an insufficient relative team size comes a higher risk propensity of people (Fiegenbaum & Thomas, 1988; Latham & Braun, 2009). In this regard, members of innovation project teams may perceive taking an increased risk as the only possibility to accomplish the tasks at hand despite an insufficient relative team size. Such higher risk propensity is then assumed to spur novelty and innovativeness of new products since novelty is commonly linked with higher uncertainty and complexity, and thus, higher risks (Molina-Castillo & Munuera-Aleman, 2009; Sethi & Sethi, 2009) from which innovation project teams usually tend to shy away (Woodman, Sawyer, & Griffin, 1993).

Furthermore, findings from experimental studies (Greenberg et al., 1982; Perkins, 1982) and field research (Oxley & Barrera, 1984; Vecchio & Sussmann, 1981) showed that people working in a group of insufficient relative size tend to have a higher job satisfaction and perceive a higher level of job enrichment which, in turn, are likely to facilitate creative thought and innovative behavior. For example, Amabile (2002) concluded that when being faced with high workloads and tight deadlines, these positive aspects were supportive for employees being creative by providing a feeling like “being on a mission” (Amabile et al., 2002:56). This is in line with findings from cognitive psychology, stating that creative thinking is supported by positive feelings such as satisfaction, meaningfulness, and joy (Fredrickson, 2001; Isen, Daubman, & Nowicki, 1987; Isen, Johnson, Mertz, & Robinson, 1985). The explanation behind this observation is that these positive feelings broaden the attentional scope on perceptual and conceptual level (Fredrickson & Branigan, 2005; Friedman & Förster, 2010) and thus expand people’s attention when trying to create novel ideas (Carver, 2003). Such a broader and expanded scope of attention is very likely to facilitate the development of novel combinations of concepts and product attributes, resulting in a higher degree of novelty of the developed products (Gill & Dube, 2007).

An insufficient relative team size is also likely to prohibit the application of established working procedures and routines during project work, which makes necessary

developing alternative procedures or modifying features of the product. This is accords a robust finding of cognitive psychology, namely that when generating ideas, people try to reduce cognitive effort and uncertainty in the outcome and therefore tend to follow a path of least resistance, i.e., applying the first solution that comes to mind which is usually based on prior (successful) experience or a category exemplar (Finke et al., 1992; Marsh, Ward, & Landau, 1999; Smith et al., 1993; Ward, 1994). Not being able to follow established procedures and routines in project work is assumed to force team members off the path of least resistance and to search for alternative ways to accomplish the tasks at hand. In this vein, a number of authors provide evidence for the creativity stimulating effect of time constraints (e.g., Burroughs & Mick, 2004; Moreau et al., 2005; Ridgeway & Price, 1991; Stokes, 2001), which are quite likely to occur in teams possessing an insufficient relative team size.

Finally, Greenberg et al. (1982) reported workgroups possessing an insufficient relative team size to also possess higher levels of autonomy than workgroups with an adequate relative team size did. As there is common agreement in literature that autonomy fosters employees' creativity and innovation (Amabile et al., 1996; George, 2007; Shalley et al., 2004), we expect this activation of an elevated degree of autonomy to further strengthen the tendency to develop products of higher novelty in project teams being of an insufficient relative size. Therefore we propose:

Hypothesis 1: Relative team size is negatively related to new product novelty.

5.2.3. Relative team size and new product quality

With regard to the effects of relative team size on the activation of traits and processes obstructing or supporting new product quality, some results from research on group conflict and decision making appear to be of particular importance. Insufficient relative team sizes suggest less time being available for communication among project team members. This also means less time being available for discussion, agreement, and disagreement, which all represent team processes which were found to foster developing solutions of superior quality (Kelly & McGrath, 1985). Further, an insufficient relative team size may influence the way how innovation project teams process information. This is likely to result in undesirable consequences like concentration of information traffic, bottlenecks, and slowing-down of

information flow, because members cannot carry out their information-processing tasks as they would do in teams possessing an adequate relative size, a situation which is usually referred to as describing “structural holes” (Burt, 1992). Such structural holes entail some important consequences for teamwork, e.g., an increased propensity to take risks for implementing new ideas, increased difficulties in coordinating teamwork (Balkundi, Kilduff, Barsness, & Michael, 2007), and a decreasing level of transactive memory of team members (Brandon & Hollingshead, 2004), i.e., the “knowledge held within the group about its members’ differential knowledge, skills, and roles” (Brodbeck et al., 2007: 469). All these aspects activated by insufficient relative team sizes are likely to run counter the quality of products under development. First, an increased proclivity to develop and implement risky new ideas, which is likely to be further reinforced by the mechanisms explained in the previous section on product novelty, counteracts the core principle of quality orientation which is to minimize variations in organizational processes (Sethi, 2000; Sethi & Sethi, 2009). Second, coordination of team processes has been frequently mentioned as being an important determinant of teamwork outcomes’ quality (e.g., Hoegl & Gemuenden, 2001; Stewart, 2006). Third, the transactive memory of work teams and similar constructs like meta-knowledge have been linked with the quality of teamwork outcomes by numerous empirical studies in the past (e.g., Austin, 2003; Faraj & Sproull, 2000; Lewis, 2004; Ren, Carley, & Argote, 2006).

A further aspect which is expected to impede the activation of traits associated with the quality of newly developed products in innovation project teams of insufficient relative team size follows from the quantitative stress which is likely to be induced by the increased task load and uncertainty in such teams (Wicker et al., 1976). Quantitative stress is defined as “conditions that consist of accumulating demands, time pressures, and overload such as when employees are given too many tasks to complete in a given period of time” (Drach-Zahavy & Freund, 2007: 424). Such quantitative stress has been found to be related in a direct way with reduced team performance (Drach-Zahavy & Freund, 2007), as well as with inferior decision making (Preston, Buchanan, Stansfield, & Bechara, 2007; Starcke, Wolf, Markowitsch, & Brand, 2008), and with higher rates of fatigue and burnout among team members (Cini et al., 1993), which are likely to make team members more prone to commit latent errors that have an adverse impact on new product quality (Ramanujam & Goodman, 2003). The latter point seems to be of particular importance in settings of insufficient relative team sizes when

already less time than usual is available for monitoring activities, and when a tendency for shortcutting and omitting quality controls is at least subliminally present. Moreover, such time pressure and task overload leaves little opportunity for team reflective behaviors (West, 1996), i.e., “the extent to which group members overtly reflect upon the group’s objectives, strategies and processes, and adapt them to current or anticipated endogenous or environmental circumstances” (West, 1996: 559). Such reflective behaviors have been frequently reported to be positively related to the quality of team outcomes in extant literature (Carter & West, 1998; De Jong & Elfring, 2010; Gurtner, Tschan, Semmer, & Nägele, 2007; Hoegl & Parboteeah, 2006b). Therefore, we posit:

Hypothesis 2: Relative team size is positively related to new product quality.

5.2.4. Relative team size and project efficiency

Task overload and time pressure commonly prevailing in teams of insufficient relative size are also important determinants that are assumed to suppress traits and processes related with project efficiency, i.e., the degree to which project teams adhere to previously set budgets and schedules (Hoegl & Gemuenden, 2001). First of all, in such conditions there appears to be a tendency of work teams’ members to lose the “big picture” of the team task and, instead, concentrating on one’s own responsibilities (Driskell, Salas, & Johnston, 1999). In this regard, Hollenbeck, Ellis, Humphrey, Garza, and Ilgen (2011) found that such a loss of the greater team context of one’s individual tasks and neglecting interdependencies with other team members’ tasks led to a considerable decline in teams’ efficiency. They report the redundancy of actions and imbalanced workload distributions as major causes of this reduced efficiency in teamwork (Hollenbeck et al., 2011). Both of these aspects are highly related to the assumed negative relationship between relative team size and team coordination outlined in the preceding section, which is also expected to hamper efficiency of innovation project teams’ work processes (Hoegl & Gemuenden, 2001). Moreover, these aspects make it more difficult for team members to effectively share their knowledge with other team members by engaging in shared problem solving, i.e., the “process of ongoing mutual effort that the partners undertake to diagnose and overcome obstacles that are blocking project effectiveness” (Bstieler & Hemmert, 2010: 487). This engagement is supposed to help the earlier elimination of hindrances in project work that might reduce team effectiveness and

efficiency (Narus & Anderson, 1995), thus avoiding time-consuming reworks of products and concepts in later project stages (Verworn, 2009). Consequently, such shared problem solving was found to accelerate the product development process in innovation project teams (Bstieler & Hemmert, 2010).

A further aspect potentially impeding the activation of traits and processes that might spur teams' efficiency in innovation project work is the problem that team members have to carry out more diverse tasks than in adequately staffed teams in order to keep the project running when the team possesses an insufficient relative size (Heston, 1996). While exerting a positive influence on perceptions of job enrichment as mentioned above, these tasks, however, are also likely to include such ones in which team members are not proficient in. This seems especially problematic in cross-functional innovation project teams in which team members usually are highly specialized (Denison et al., 1996). Given that considerable effort is necessary to get familiar with the additional tasks team members face in insufficiently staffed teams, efficiency is expected to suffer from this time and effort not disposable for the actual project tasks. Moreover, an insufficient relative team size is very likely to activate modified work procedures and routines which, while representing a nutrient for creativity and innovativeness, afford time to get familiar with, thereby further hampering efficiency of project work. Therefore we posit:

Hypothesis 3: Relative team size is positively related to project efficiency.

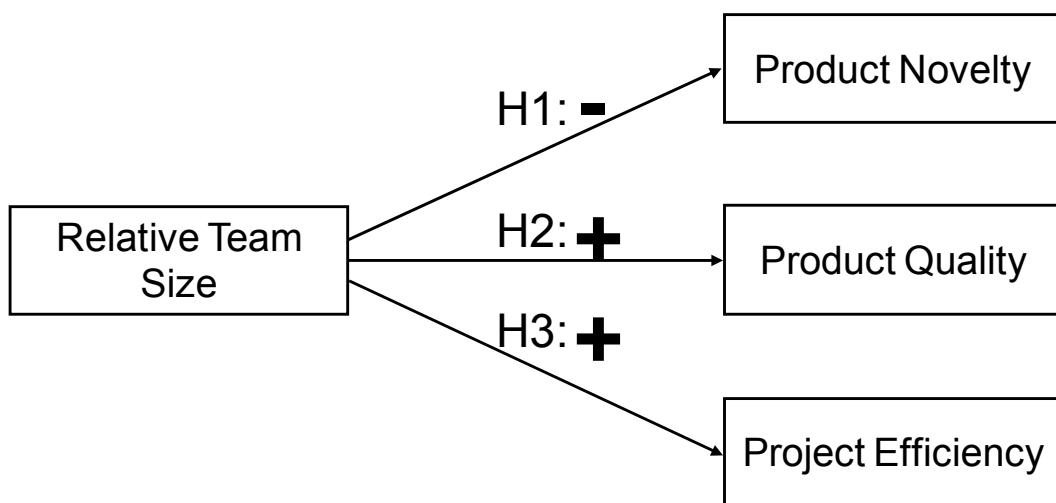


Figure 5-2: Hypothesized relationships.

5.3. Methods

5.3.1. Sample and data collection

The empirical analyses of the hypothesized relationships depicted in Figure 5-2 are based on data pertaining to 121 innovation project teams from 35 companies from the electronics industry in Germany, Austria, and Switzerland. The electronics industry was chosen for its high innovation pressure. We selected a single industry because companies in the same industry share strategic factor markets (Barney, 1986) and industry attributes that influence strategy decisions (Mascarenhas & Aaker, 1989).

Upon request, the companies provided the researchers with lists of innovation projects including names, contact information of project members, etc. and the employees were informed that a study about team management was to be conducted. All innovation projects were completed within one year prior to the time of data collection. E-mail links to the online-questionnaire were sent to all team leaders and team-external managers as well as randomly-chosen team members. Respondents' participation in this study was strictly voluntary. The respondents were assured that the researchers would maintain their anonymity and the confidentiality of the completed questionnaires. Given the premise of surveying a minimum of two team members from each project team (in addition to the team leader and a team external manager), a total of 614 invitations to participate in the survey were sent out. The final sample consisted of 121 innovation projects, with a total of 497 individual responses, resulting in a response rate of 81 %. Although some companies delivered more than one innovation project in the sample, we do not expect organizational affiliation of the innovation projects exerting a systematic influence on the statistical models since the average number of innovation projects per firm was quite small (3.46), thereby suggesting ample variance within the sample. Likewise, there should be no systematic international differences due to the high level of similarity between the countries in which this study was conducted (Szabo et al., 2002). Nonetheless, following recommendations by Cohen et al. (2003), we checked for potential systematic effects of organization and country on the results. We have partialled out any effects that organization and country had on any of the variables in the calculated models and re-ran the models, a similar approach as taken in a number of previous studies (e.g., Hoegl et al., 2004; Lynn & Akgün, 2001). As expected, in these analyses no significant

influences were detected, thus not indicating systematic differences between the organizations or the countries in which the study was conducted.

5.3.2. Multiple informants

To ensure content validity and to avoid common source bias, data from different groups of respondents were used to measure the different variables. Variables measuring innovation project outcomes, i.e., new product novelty, new product quality, and project efficiency were measured using data from team-external managers. Team external managers were the line managers responsible for the innovation projects, i.e., to whom the innovation project leaders reported. In line with previous research taking the same approach (Faraj & Sproull, 2000; Hoegl et al., 2004; Zhang et al., 2007), we believe that the line managers were in an ideal position to rate the innovation project outcomes without being biased by team-internal processes. A small number of the team-external managers rated more than one innovation project's outcomes. However, as the average number of innovation projects rated by one team-external manager was as small as 2.28, we do not expect any systematic differences to introduce a bias. Using the same procedure as described above (Cohen et al., 2003), we also have partialled out effects that the team-external managers had on any of the variables in the models and re-ran the models and neither found any significant influences. Relative team size was measured using responses from team members of the innovation projects. The applied control variables, i.e., team size, project duration, task interdependence, general evaluation, as well as experience, expertise, and creativity of the innovation project teams are based on data collected from team leaders.

5.3.3. Measures

All constructs considered in this investigation refer to the team as the unit of analysis. Accordingly, all measures were specified at the team-level. The questionnaire was administered in German language. The measurement scales were based on measures of related constructs in the literature, as detailed below. If not specified otherwise, all items were rated on 5-point Likert-type scales (1 = *strongly disagree*, to 5 = *strongly agree*). The individual items used to measure the variables described above are shown in Table 5-1.

Variable	Items
Relative team size	In this project, staffing was sufficient (e.g., team members, temporary employees).
New product novelty	The new product followed a completely new technological principle. Existing technologies will be crowded out by this innovation. This innovation created entirely new customer benefits. This innovation offers unique benefits to the customers in comparison to competitive products. We had barely any experience regarding the technical components applied to this innovation. The design of this innovation differed substantially from previous products.
New product quality	The project result was of high quality. The customer was satisfied with the quality of the project result. The product required little rework.
Project efficiency	Overall, the project was done in a cost efficient way. Overall, the project was done in a time efficient way. The project was within schedule. The project was within budget.
Task interdependence	In this project, team members could not accomplish their tasks without information or materials from other members of the team. Members of this team depended heavily on each other. This task required a great deal of communication and coordination.
Experience	Prior to this project, team members had extensive experience with working on innovative team tasks. Prior to this project, team members had extensive experience with working in this area of R&D. Prior to this project, team members had extensive experience working together as a team through other tasks they have accomplished together.
Expertise	Some team members lacked certain specialized knowledge that was necessary to do their task. (reverse coded item) Some team members did not have the necessary knowledge and skills to perform well - regardless of how hard they try. (reverse coded item) Some people on our team did not have enough knowledge and skills to do their part of the team task. (reverse coded item)
Originality	Team members had original ideas. Team members proliferated ideas. Team members were stimulating. Team members coped with several new ideas at the same time. Team members always thought of something when stuck. Team members would have sooner created than improved. Team members had fresh perspectives on old problems.
General evaluation	Going by the results, this project can be regarded as successful. From the company's perspective, all project goals were achieved. From the company's perspective one could be satisfied with how the project progressed.

Table 5-1: Items used for the variables.

5.3.3.1. Innovation project outcomes

For the present study, innovation project performance was measured as described by the variables new product novelty, new product quality, and project efficiency (Hoegl & Gemuenden, 2001; Madhavan & Grover, 1998). To measure new product novelty, six items (Cronbach's alpha = .87) from the scale of Salomo, Weise, and Gemuenden (2007) were adapted, a measure of innovativeness that covers aspects of product and process technology, market characteristics, and fit with internal and external capabilities (Salomo et al., 2007). New product quality refers to the degree to which expectations regarding the quality of the outcome were met by the team and was measured using three items (Cronbach's alpha = .86) from Hoegl and Gemuenden (2001). Project efficiency relates to the team's adherence to schedules and budgets (Hoegl & Gemuenden, 2001; Swink, Talluri, & Pandejpong, 2006). To measure project efficiency four items were used from the scale developed by Hoegl and Gemuenden (2001) (Cronbach's alpha = .87).

5.3.3.2. Relative team size

Team members' evaluations of relative team size were obtained using a single item measure in analogy to Hoegl and Parboteeah's (2006a) measure of material resource adequacy. This is in line with the practice of Ganster and Dwyer (1995), who showed that a single item captured an ample amount of variance of teams' relative size compared to a four-item measure, as well as with the notion of Bergkvist and Rossiter (2007) that single item measures do not fall short of multi-item measures in their predictive validity when measuring concrete attributes. Prior to aggregating team members' evaluations of relative team size to the team level, interrater agreement (Lindell & Brandt, 1999) was assessed using the r_{WG} estimator for within-group interrater agreement as proposed by James, Demaree, and Wolf (1984). This test yielded an r_{WG} value of .71. Given this homogeneity of within-team ratings, aggregation of the data to the team-level appeared justified (George & James, 1993) and was conducted by calculating the arithmetic mean.

5.3.3.3. Control variables.

We controlled for absolute team size, as this number of an innovation project team's absolute headcount constitutes an important structural variable with potential influences on its social and task processes (Campion et al., 1993; Gladstein, 1984; Hackman, 1987) as

explained in detail above. Furthermore, we controlled for the duration of the innovation projects (in months), as longer innovation projects are most probably managed and monitored in a different way than innovation projects of shorter duration and are likely to include a wider scope of project goals (Katz, 1982; Van der Vegt & Janssen, 2003). Having been argued that differences in teams' task interdependence may affect the relationships under study (e.g., Bachrach, Powell, Collins, & Richey, 2006; Van der Vegt & Janssen, 2003), we controlled for task interdependence, i.e., the degree to which "group members interact and depend on one another to accomplish the work" (Campion et al., 1993: 827). To measure task interdependence, we used Campion et al.'s (1993) three item scale (Cronbach's alpha = .81). We also controlled for the overall success of the innovation projects, as the perception of a generally (un)successful innovation project could override the perception of relative team size. In order to control for such a hindsight bias, i.e., the tendency of individuals to judge past situations in line with the outcome of these situations (Carli, 1999; Louie, 2005; Mussweiler, 2003), we included a three item scale based on a measure from Hoegl, et al. (2004) for a general evaluation of the projects' success (Cronbach's alpha = .87). Additionally, we controlled for attributes of the innovation project team which are usually seen as determinants of staffing adequacy in a non-quantitative but qualitative fashion. Specifically, we included experience, expertise, and originality of the innovation project teams' members in the equations in order to purify the influence of relative team size on innovation project outcomes from such non-quantitative aspects. Experience was measured using a three item scale basing on the conception provided by Quiñones, Ford, and Teachout (1995), consisting of one item each for measuring task experience, job experience, and experience of working in the present team (Cronbach's alpha = .80). Expertise of the team members was operationalized by applying three items taken from Faraj and Sproull (2000) (Cronbach's alpha = .85). Team members' originality, finally, was measured using seven items from the originality scale of Kirton's (1976) Adaptors and Innovators Questionnaire (Cronbach's alpha = .76). Descriptive statistics and correlations for all variables are provided in Table 5-2.

Variable	Source	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
1. Absolute team size	PLD	8.64	6.78	-										
2. Project duration	PLD	21.83	15.04	.31**	-									
3. Task interdependence	PLD	4.04	0.66	.24**	.06	-								
4. General evaluation	PLD	4.01	0.78	-.01	-.07	.02	-							
5. Experience	PLD	3.82	0.82	-.18	-.11	-.11	.34**	-						
6. Expertise	PLD	3.78	0.95	-.11	-.09	.00	.13	.26**	-					
7. Originality	PLD	3.47	0.68	-.03	.07	.17	.23*	.20*	.00	-				
8. Relative team size	PTM	3.24	1.01	-.08	-.12	-.13	.16	.19*	.19*	-.07	-			
9. New product novelty	TEM	2.94	0.81	.06	.11	.25**	.08	-.18*	-.11	.04	-.25**	-		
10. Project efficiency	TEM	3.24	0.98	.07	-.12	-.05	.29**	.15	.10	.01	.26**	-.19*	-	
11. New product quality	TEM	3.69	0.83	0.02	-.10	.00	.38**	.20*	.25**	-.07	.36**	-.09	.53**	-

N = 121; *p < .05; **p < .01 (two-tailed); PTM = project team members; PLD = project leader; TEM = team external manager.

Table 5-2: Descriptive statistics and correlations between variables.

5.4. Results

Multiple regression analysis was applied to test the hypotheses (Cohen et al., 2003). Since a number of significant correlations among the independent variables were found, we also checked for collinearity. Variance inflation factors ($VIF < 1.3$) indicate no distortion of results due to collinearity. Table 5-3 shows the relationships between relative team size and the three indicators of innovation project performance. The regression analyses yielded a significant negative relationship between relative team size and new product novelty, supporting Hypothesis 1. For new product quality and project efficiency, the results show a positive relationship with relative team size, thus supporting Hypothesis 2 and 3.

As some studies on understaffing theory found evidence for curvilinear relationships between relative team size and a number of performance related variables (e.g., Heston, 1996; Hill & Christine Green, 2008; Vecchio & Sussmann, 1981), we also checked for such a quadratic relationship between relative team size and the outcome variables. However, for new product novelty, new product quality, and project efficiency neither a significant quadratic relationship among these variables was found, nor did the inclusion of the respective quadratic terms yield noteworthy increases in R-squared.

	New product novelty		New product quality		Project efficiency	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Control variables						
Absolute team size	-.07 (.01)	-.07 (.01)	.06 (.01)	.06 (.01)	.14 (.01)	.14 (.01)
Project duration	.11 (.01)	.09 (.01)	-.06 (.01)	-.04 (.01)	-.13 (.01)	-.11 (.01)
Task interdependence	.24* (.11)	.22* (.11)	.02 (.11)	.04 (.11)	-.07 (.14)	-.05 (.14)
General evaluation	.16 (.10)	.18 (.10)	.37** (.10)	.34** (.10)	.27** (.12)	.25** (.12)
Experience	-.18 (.09)	-.16 (.09)	.07 (.09)	.04 (.09)	.06 (.11)	.04 (.11)
Expertise	-.08 (.08)	-.05 (.08)	.19* (.08)	.15 (.07)	.05 (.10)	.03 (.10)
Originality	-.02 (.11)	-.04 (.11)	-.16 (.11)	-.14 (.10)	-.04 (.14)	-.03 (.13)
Main effect						
Relative team size		-.20* (.07)		.27** (.07)		.20* (.09)
R ²	.12	.16	.22	.29	.12	.16
Δ R ²		.04*		.07**		.04*
F-Value	2.24*	2.65*	4.53**	5.60**	2.24*	2.65*

N = 121; *p < .05; **p < .01 (two-tailed); standardized regression coefficients with standard errors in parentheses.

Table 5-3: Results of regression analyses.

5.5. Discussion

The results from this study show that relative team size of innovation project teams differentially affects the examined indicators of innovation project performance. Notably, we found a negative relationship between relative team size and new product novelty, and a positive effect of relative team size on new product quality as well as on project efficiency. Thus, in contrast to the prevailing belief in innovation management literature (Ancona & Caldwell, 1992b; Damanpour, 1991; Hackman, 1987; Sicotte & Bourgault, 2008), new product novelty (but not new product quality and project efficiency) benefits from an insufficient relative team size. As will be discussed below, these empirical insights entail conceptual and practical implications for staffing and managing innovation projects.

5.5.1. Theoretical implications

First of all, what do those results imply for staffing innovation projects? Addressing the considerable research gap on team staffing issues in the literature (Ployhart, 2004), this study provides evidence that the number of team members in relation to the team tasks to be accomplished, i.e., relative team size, indeed significantly influences the performance of innovation project teams. This adds a new perspective to the scarce literature on team staffing, which so far has mainly concentrated on how team composition influences team performance. While there has been performed considerable research on the effects of certain qualities of team members (Hargadon & Bechky, 2006; Leonard-Barton, 1992; McComb et al., 2007), and of absolute team headcount (e.g., Bettenhausen, 1991; Hülshager et al., 2009; Levine & Moreland, 1990; Stewart, 2006) on the performance of innovation project teams, this research underlines that staffing for innovation projects does also depend on the relative team size of innovation project teams. Controlling for major aspects of the qualitative dimension of staffing adequacy in innovation project teams (expertise, originality, and experience) as well as for absolute team headcounts, the results showed that relative team size explains an important portion of incremental variance of teams' innovative performance in addition to the aforementioned variables.

In this regard, it seems also important not to evaluate team staffing operationalized as the sum of individual team members' attributes, but to specifically operationalize this variable on the team level because the sum of the parts, i.e., of individual KSAOs, is unlikely to equal

the whole, i.e., staffing adequacy. This insight has been stressed by empirical studies revealing that both group intelligence (Woolley, Chabris, Pentland, Hashmi, & Malone, 2010) and group creativity (Taggar, 2002) does not resemble the average, sum, or product of the individual scores. Rather, the effect of individual KSAOs depends largely on how these are integrated and amplified within teams (Ployhart & Moliterno, 2011). What appears somehow self-evident at first glance, i.e., conceptualizing a team-level variable on the team level, actually does not represent common sense in this research stream (e.g., Hackman, 1987; Stevens & Campion, 1994; Stevens & Campion, 1999). This state of the art led Ployhart to the notion that extant research in the field of human resource management on team staffing has “not considered how such KSAOs aggregate into team composition. Thus, this research is really more similar to individual level staffing research” (Ployhart, 2004: 139). By shedding light on the adequacy of relative team size, the results of this investigation point to an influential aspect of team staffing for innovation projects that has gone largely unnoticed in research on innovation and human resource management so far. Further controlling for a general evaluation of innovation project performance, the obtained results are purified from possible hindsight biases which might cause perceptions of relative team size being actually shaped by the outcomes of the innovation project. Thus, the results obtained from the analyses in this paper seem to reflect quite robust findings.

What also becomes clear from the results of this study is the considerable difference between absolute and relative measures of innovation projects' team size. While in many studies and meta-analyses on determinants of team success absolute headcount numbers are included as the only measure of team size (e.g., Bettenhausen, 1991; Hülshager et al., 2009; Levine & Moreland, 1990; Stewart, 2006), this absolute measure alone appears inappropriate as a proxy for determining the entirety of team size's effects. Moreover, as the data suggest, absolute headcount numbers of innovation project teams seem less influential on innovation projects' success than relative team size is, casting into doubt the explanatory power of raw headcount numbers of teams compared with relative measures of team size. Nonetheless, with some exceptions (e.g., Sicotte & Bourgault, 2008), most research efforts in literature on innovation management confined themselves to consider only the seemingly less meaningful aspect of absolute team headcounts either as control variable (e.g., Akgün, Keskin, & Byrne, 2010), or as focal variable (Hülshager et al., 2009; Stewart, 2006), thereby neglecting the important influence of relative team size. Drawing on the results of the analyses performed in

this paper, it appears highly recommendable to include measures of relative team size in further studies dealing with the topic of teamwork in innovation.

Moreover, the results provide evidence for differential effects of relative team size on innovation project performance depending on the indicators used for measuring the outcomes of an innovation project. This contributes necessary detail to studies that have outlined team staffing conditions that are either conducive or detrimental to innovation (Ancona & Caldwell, 1992b; Damanpour, 1991). The present research adds to this by focusing attention on the conceptualization and measurement of output variables (new product novelty, new product quality, and project efficiency). By applying more fine-grained outcome variables, substantial differences between the different indicators of innovation project performance are identified. In less detailed analyses, these might cancel each other out and thus lead to blurred or inconclusive results.

Furthermore, the results partially confirm findings from research on understaffing theory. Specifically, and in accordance with prior work in this field, the results indicate that innovation project performance not necessarily suffers from an insufficient relative team size, given the case that an innovation project's major focus is on new product innovativeness. This finding may also be seen in the light of trait activation theory which states that personality traits need to be activated by trait-relevant cues (Tett & Guterman, 2000). Hence, when there is no certain need for the expression of creativity-relevant traits, e.g., openness to novelty (Feist, 1998; Schilpzand et al., 2011) or risk taking propensity (Dewett, 2006), to be activated and established approaches and procedures will do, these traits are less likely to be actually expressed (Kim et al., 2010), thereby inducing some kind of creativity hindering inertia. In this vein, one may also interpret the findings on new product quality and project efficiency. When an innovation project team possesses an insufficient relative team size, the major task of the team is to maintain project work itself, no matter how effectively and efficiently this is done in the first place. However, given that relative team size is adequate and not jeopardizing the viability of the innovation project itself, then the requirement of quality and efficiency should come to the fore, which is expected to activate those personality traits of team members facilitating effectiveness and efficiency, like, e.g., consciousness or elaborateness (Barrick & Mount, 1991; Barrick, Mount, & Gupta, 2003).

Finally, our statistical analyzes did not detect any curvilinear relationships between relative team size and the three indicators of innovation project performance. In this connection, in several disciplines of behavioral science that applied understaffing theory for empirical research, e.g., in sports science (Hill & Christine Green, 2008), cognitive psychology (Heston, 1996), and organizational science (Vecchio & Sussmann, 1981), an inverse-U shaped relationship between relative team size and performance-related variables was reported, with slightly insufficient relative team sizes representing the optimum. Apparently, in contrast to teams pursuing routine tasks which were analyzed in the empirical studies mentioned here, this inverse-U-shaped relationship does not hold in a context affording innovative behavior from team members or does not come to bear until more extreme values of relative team size are reached. This, again, points to the unique characteristics of project teams dealing with innovative tasks (Edmondson & Nembhard, 2009; McDonough, 2000).

5.5.2. Practical implications

For those who have to set up teams for innovative projects, the question which number of team members or which relative team size should be aimed for in order to foster innovation project performance cannot be answered with one general recommendation. Rather, this seems to depend on what the innovation project is actually focused on. For projects aiming at radical innovation, maximizing the degree of novelty of the product to be developed (McDermott & O'Connor, 2002), e.g., predevelopment projects or pilot projects, a relative team size below what team members perceive as adequate appears instrumental. In contrast, innovation projects focusing on a high level of efficiency (Swink et al., 2006), e.g., innovation projects facing extremely tight budgets or deadlines, or at incremental innovation and at maximizing the quality of the product to be developed (Bessant & Caffyn, 1997), e.g., quality improvement projects, may be well advised to ensure a relative team size perceived as being adequate by the members of the innovation project team.

One aspect of the relationships unveiled by this study that appears to be of particular importance for the practice of team staffing for innovation projects is the positive relationship found between relative team size and innovation project efficiency. At first glance, a negative relationship between those variables might seem more reasonable. After all, increasing efficiency is exactly what most managers aim at when reducing team headcounts (Kessler,

2000; McKinley, Zhao, & Rust, 2000), particularly in innovation projects facing tight budgets (DeRue, Hollenbeck, Johnson, Ilgen, & Jundt, 2008). Having a closer look at this relationship and the consequences insufficient relative team sizes bring about, however, the dysfunctional tendencies outlined in the theory section come articulately to the fore and the negative relationship between relative team size and project efficiency makes perfectly sense. Thus, managers struggling to increase the efficiency of their innovation projects should rethink the intuitive practice to reach this goal by cutting headcount of the innovation project teams. Rather, an expansion of relative team size appears to be promising in this respect. To get this straight, this effect will definitely have its own limits and adding ever more members to an innovation project team will hardly time and again enhance project efficiency. However, the problem of finally engaging too much members in an innovation project team surely marks a rare exception in today's reality of corporate innovation.

Finally, the results of the present study may also be seen in context of the different stages of the innovation process (Cooper & Kleinschmidt, 1986), suggesting that team members' perception of an insufficient relative team size may be beneficial in generating more innovative concepts during the initial stages of the innovation process. In contrast, during later stages of the innovation process new product quality and project efficiency may be enhanced by an adequate relative team size. In this vein, the data suggest that some level of challenge or pressure may be beneficial for the development of innovative solutions, in this case induced by perceiving the relative team size as being insufficient. This is in line with literature suggesting the innovation supporting influence of challenge (Amabile et al., 2002; Hoegl et al., 2008; McDermott & O'Connor, 2002). Hence, one could speculate that at the early stages of the innovation process insufficient relative team sizes provide team members with the needed challenge to create an innovative idea, but the final development of that idea and the efficient process of turning the idea into a high quality product, however, require perceiving the relative team size as being adequate.

5.5.3. Limitations and outlook

Some limitations of this study should be noted, along with directions for future work. First, the data for this research are cross-sectional rather than longitudinal. While this study demonstrates associations between variables, it cannot establish causality. A longitudinal research design would further our knowledge about team members' perception of relative

team size over the entire duration of an innovation project and toward causality of relationships and the effects of relative team size on the different indicators of innovation project performance over time. In particular, which consequences changes in relative team size during an innovation project, e.g., in the course of organizational downsizing measures, entail for its outcomes (DeRue et al., 2008) and the question how team members react upon a persistently insufficient relative team size seems to be of great interest. Especially for the latter aspect literature comes up with contradicting suggestions for this relationship, predicting either positive adaptation of team members through a stress-rigidity mechanism (Corbett, Neck, & DeTienne, 2007) or a negative spiral through a stress-vulnerability mechanism (Moore, Grunberg, & Greenberg, 2004). Future empirical research may provide evidence which of these concurring assumptions actually holds in the realm of innovation project teams. Second, examining potential moderator effects could complement this study's results regarding differential effects of relative team size on different indicators of innovation product performance and reveal conditions that might counteract or strengthen the observed relationships. Third, this study was conducted in companies located in Austria, Germany, and Switzerland, raising the question of generalizability to other cultures (Henrich et al., 2010). While this study is not internationally comparative in nature and cannot offer any answers to this question, the theoretical considerations presented in this article are not country-specific, but rather based on international scholarly work and empirical findings. Further research in other countries is encouraged to increase our understanding of the possible influences of cultural contexts on the investigated relationships (House et al., 2002; Muethel & Hoegl, 2010). In this connection, examining which factors actually constitute team members' judgments of relative team size and whether these factors differ between national and organizational cultures seems also to be of concern for advancing literature on team staffing. In this regard, results from cognitive psychology suggest that such perceptions are highly prone to socio-cognitive influences (Ackerman et al., 2010; Balcetis & Dunning, 2007; Barsalou, 2008). Despite or because of these limitations, we hope that the present research stimulates further investigations into the role relative team size plays in project teams dealing with innovative tasks.

6. GENERAL DISCUSSION

6.1. Summary of empirical findings

The empirical analyses provided the insight that, in contrast to the widely established assumption on the relationship between tangible resource adequacy and innovation project performance, there is no uniformly positive, nor negative, relationship between those variables. Rather, a more complex and differential picture of tangible resources' effects on innovation project performance emerges, showing context and team dependent contingencies, as well as pointing to the pivotal role of how of innovation project performance is actually defined and operationalized.

First, regarding the evaluation of tangible resources in innovation projects, the results suggest that a core finding of cognitive psychology also holds in innovation projects. The empirical analyses show that the perception of material resources' adequacy seems to be significantly influenced by team-endogenous socio-cognitive factors like the innovation project teams' potency, their team action repertoire, and the workload these teams face during the execution of the innovation projects, as well as by team-exogenous factors like the attributes of an organization's culture.

Second, regarding the management and deployment of tangible resources, the results of the empirical analyses highlight a specific condition under which innovation project teams can perform successfully despite tangible resource constraints. They show that an organizational culture less oriented toward material resources, as being frequently the case in family businesses, is associated with innovation endeavors being less resource elastic, i.e., less sensitive to differences in material resource provisions. Thus, evidence is provided that neither abundance nor scarcity of tangible resources is per se a reliable lever to control innovation project performance in general. This relationship is actually contingent upon certain moderating (cross-level) conditions.

Third, with regard to specifying innovation project outcomes, this research reveals highly differential effects of perceptions of tangible resource (in)adequacy on innovation project performance, depending on which outcome measure is actually considered. While adequacy perceptions of tangible resources, i.e., material resources and relative team size, have been found to foster the quality of new products, perceptions of less-than-adequate

tangible resources were, in contrast, shown to be drivers of product novelty. These differential relationships which turned out to be quite stable even across different types of tangible resources (material resources and relative team size) point to robust mechanisms underlying these observations. An overview of all hypotheses tested in this thesis and the results of these tests is provided in Table 6-1.

Hypothesis	Result
Chapter 3 – The perception of material resource adequacy: Antecedents and consequences	
Team potency is positively related with the perception of material resource adequacy.	✓
Breadth of team action repertoire is positively related with the perception of material resource adequacy.	✓
Workload is negatively related with the perception of material resource adequacy.	✓
Perceived adequacy of material resources is negatively related to new product novelty.	✓
Perceived adequacy of material resources is positively related to new product quality.	✓
Chapter 4 – A cross level study on the role of firm ownership and material resources in innovation projects	
Innovation project teams in family businesses perceive higher material resources adequacy than innovation project teams in non-family businesses.	✓
Material resource orientation of an organization's culture will mediate the positive relationship between family influence and innovation project teams' perception of material resource adequacy.	✓
The relationship between material resource adequacy and innovation project performance is moderated by family influence in that this relationship is stronger for non-family firms.	✓
Chapter 5 – Effects of relative team size on the performance of teams with innovative tasks	
Relative team size is negatively related to new product novelty.	✓
Relative team size is positively related to new product quality.	✓
Relative team size is positively related to project efficiency.	✓

Table 6-1: Summary of hypotheses tested in the thesis.

6.2. Theoretical implications

6.2.1. A multi-level perspective on tangible resources in innovation

These insights on tangible resources' role in innovation projects mark a significant difference to what we know about the role tangible resources play in innovation on the organizational level. Here, an inverse U-shaped quadratic relationship between tangible resources and a firm's innovation performance is quite established in the literature with a certain amount of slack tangible resources being seen as optimal for innovation (Geiger & Cashen, 2002; Nohria & Gulati, 1996, 1997). Furthermore, on this level of inquiry, tangible resource slack is associated with more explorative or radical innovation as opposed to exploitative or incremental innovation (Geiger & Makri, 2006). Hence, this notion supports basically the "resource driven" view of innovation on the organizational level since tangible resources in excess of those actually needed are suggested to foster innovation (Nohria & Gulati, 1996, 1997). The major driver of this observation seems to be that tangible resource slack on organizational level allows companies to take higher risks (Bromiley, 1991; Singh, 1986) since they are cushioned by this tangible resource slack in case of failure (Bourgeois, 1981; Geiger & Makri, 2006). Therefore, managers are assumed to be less concerned about failures and more likely to pursue innovative endeavors which inheres a higher degree of uncertainty (Bromiley, 1991; Cyert & March, 1963).

Similarly, this study's results differ from the literature on the individual level, where tangible resource scarcity was repeatedly shown to facilitate creativity, and thus innovation, by itself (Dahl & Moreau, 2007; Moreau et al., 2005; Stokes, 2006, 2007; Ward, 1994). This observation is argued to be rooted in the initial reluctance of individuals to implement truly novel ideas, as long as they are not pushed off a path of least resistance (Finke, 1990; Finke et al., 1992; Ward, 1994, 2004) and forced to overcome their avoidance of cognitive effort (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Gray, 2000; Reichle & Carpenter, 2000) by tangible resource constraints.

Representing the meso-level between the individual and organizational level of inquiry (Anderson et al., 2004; Chen & Kanfer, 2006; Mathieu & Taylor, 2007), the project level resembles response patterns to the stimulus of tangible resource constraints from either neighboring level. Here, the relationship between tangible resources and innovation project

performance is contingent on certain moderating variables like team climate for innovation (Weiss et al., forthcoming) or the material resource orientation of an organizations' culture. Hence, the results point to moderating conditions that explain when tangible resource constraints are indeed likely to lead to superior performance of innovation projects. The flip side of this finding also becomes clear from the results presented in this doctoral thesis: there also seem to exist some contingency variables explaining when innovation project teams succeed that are able to dispose of abundant tangible resources. Being no less important as the identification of contingency variables for the reverse case, i.e., tangible resource scarcity, this thesis may provide first cues regarding which capabilities of innovation project teams are necessary to capitalize on a richer tangible resource base. Showing the resource-inelasticity of innovation projects in family firms and thus confirming these businesses' tendency not to benefit from additional or more easily accessible capital reported in the literature (Akyuz & Gore, 1996; Carney & Gedajlovic, 2002), family firms' repeatedly shown difficulties in divesting unnecessary resources (Kellermanns, 2005; Sharma & Manikuttu, 2005) may represent such a problem being responsible for inferior performance despite (or because of) adequate tangible resources at hand. Such problems are also expected to be shared by innovation project teams struggling to leverage a rich tangible resource base. Identifying in detail the team attributes that cause these problems in shedding superfluous tangible resources, and which capabilities of innovation project teams may help overcoming such problems, however, is beyond the scope of this dissertation and should be addressed in future research endeavors.

Thus, neither tangible resource abundance nor tangible resource scarcity alone exerts a direct effect on innovation project performance. Simply cutting tangible resources would therefore lead to the same limitations as the traditional "resource driven" mindset (Gibbert et al., 2007). Importantly, this notion challenges the prevailing view in innovation management, that the adequacy of tangible resources per se positively influences the success of innovation projects (Amabile et al., 1996; Ancona & Caldwell, 1992b; Cooper & Kleinschmidt, 1995). A view, however, that has never been verified empirically, after all. Even Amabile et al. (1996) received mixed results of resources' effects on team creativity when validating their KEYS-inventory of work environments' support for creativity (what actually did not deter them from continuing to rank sufficient resources among the six major characteristics of a work environment that facilitate creativity). Nonetheless, numerous scholars build on this intuitive

logic when reasoning about antecedents of success in innovation projects. General statements in theory sections such as “financial resources are probably the most necessary, if not sufficient, element in ensuring the translation of creative ideas into new processes, products or services” (Herold et al., 2006: 372), or “adequate resource reserves are a critical success factor in a project development environment that is complex and uncertain” (Dillon et al., 2005: 382) without substantial foundation are no exception in manuscripts on the management of innovation projects. Given the contingent influence of tangible resources on the performance of innovation project teams found in this thesis and by Weiss et al. (forthcoming), it appears to be more appropriate reconsidering this taken for granted view of anticipating a generally positive influence of adequate tangible resources. Rather, more attention should be put on potential contingency variables when reasoning on success factors of innovation projects. Thus, the results of the empirical analyzes provided in this thesis also confirmed the view of Hoegl et al. (2008), who proposed that the direction and the slope of the material resource-innovation project performance relationship depends on certain contingency variables.

Moreover, the relationship between perceptions of tangible resource adequacy and innovation project success showed to depend on how innovation project success is actually specified, i.e., which outcome of an innovation project is focused on. While the results revealed the robust finding that constraints in tangible resources provide a stimulus to develop more novel and thus more uncommon solutions, quality of the new products and project efficiency is likely to suffer from this departure of the path of least resistance. This suggests that constraints in tangible resources are likely to provide more advantages in innovation projects the more innovative the products to be developed are. Empirical evidence by Gemünden, Salomo, and Hölzle (2007) supports this notion, showing that top management support, which manifests itself to a notable degree in the provision of tangible resources, may negatively affect innovation project performance, and that this is increasingly so as the products being developed in these projects get more innovative.

In sum, this thesis takes a first step in systematically analyzing the role of tangible resources in innovation on the project level and added to the literature by integrating and reconciling findings from other levels of analysis, thereby supporting the development of a multi-level theory of the influence of tangible resource availability on innovation. Synthesizing the results from this research on project level with extant knowledge on the

relationship between tangible resources and innovation success on the levels above and below, a coherent picture emerges, spanning the three major levels of organizational innovation. In sum, it seems as if on organizational level, firms should assure a certain level of tangible resource slack in order to provide the necessary conditions to launch innovation projects, even if they are connected with a high level of risk and uncertainty. In these projects, however, idea generation executed by individuals appears to benefit from constrained tangible resources in order to generate more creative ideas. This aspect seems of particular importance in the early stages of an innovation project (Griffiths-Hemans & Grover, 2006; Reid & De Brentani, 2004; Verworn, 2009). How innovation project teams process and implement the ideas generated by the individual team members and how they react to perceiving varying degrees of tangible resource adequacy (which is substantially influenced by team-endogenous as well as team-exogenous socio-cognitive factors), finally, is contingent upon variables like the team climate for innovation, the team members' attitude toward material resources rooting in their organization's culture, and the different outcome variables. Furthermore, the results regarding the effect of family influence on perceptions of material resource adequacy via material resource orientation highlight reciprocal influences between the different levels. For example, firm-level influences like the material resource orientation of an organization's culture materialize on the team level in specific attitudes and behaviors of innovation projects' team members (Glisson & James, 2002) when evaluating and managing tangible resources which, in turn, may affect a firm's innovation performance through the successful development of new products (Ernst, 2002; Henard & Szymanski, 2001).

6.2.2. Perceptual aspects of tangible resource adequacy in innovation projects

Regarding the human factor in the tangible resources-innovation project performance relationship (Badir, Perret, & Tucci, 2007; O'Connor & McDermott, 2004), the evaluation of tangible resources was shown by the results of this thesis to be of crucial importance. In this regard, the empirical results shed first light on which socio-cognitive factors influence how people perceive the adequacy of the material resources at hand. While the notion of the subjectivity of resources' value can look back on a long standing tradition in the literature (Penrose, 1959) and on plenty of evidence (e.g., Baker & Nelson, 2005; Garud & Karnoe, 2003; Kor et al., 2007), the empirical analyzes conducted in this thesis for the first time provide insights which specific aspects influence the formation of perceptual differences causing this subjectivity.

In this respect, the empirical results of this doctoral thesis reveal intriguing parallels between individual and team perception. While the core tenet of cognitive science is understanding the individual mind as some kind of information processor (Bermúdez, 2010; Posner, 1989), increasing evidence points to a deeply rooted social cognition within the human mind (Schippers, Roebroek, Renken, Nanetti, & Keysers, 2010) that leads beyond the notion of team cognition being merely the sum of individual cognition (Woolley et al., 2010). Extant research on teams as distinctive cognitive systems so far revealed a number of interesting attributes of team cognition. For example, the intellectual capability of a team, i.e., team intelligence, was recently shown not only to depend on the individual intelligence of team members (independent from operationalizing team intelligence by the sum, product, the minimum, or the maximum of the individual team members' intelligence), but even more so on team members' social skills (Woolley et al., 2010). Similarly, Sebanz et al. (2006) point to the value of studies aiming to explain group cognitive processes underlying joint action such as showing the importance of reciprocally including one's expectations what others will do into individual cognition. This social influence on cognition has been found to exert considerable influence on people's cognition, even in situations when such social cognition actually is not needed (Kovács, Téglás, & Endress, 2010). Following these insights on human cognition, teams may be seen as information processors as well, processing a wide range of input information, which results in a collective behavioral response (Moreland, Argote, & Krishnan, 1996; Paulus, Levine, Brown, Minai, & Doholi, 2010; Tsai, Sebanz, & Knoblich, 2011) that cannot be predicted solely from the attributes of individual team members making up the team.

This becomes also clear from the results of this thesis, which indicate team cognition being highly similar to the processing characteristics of individual cognition in suffering from comparable socio-cognitive influences on perceptions of object (or material resource) favorability. Specifically, teams appear to include the team's potency, action repertoire, and workload in their processing of the evaluation of material resources' adequacy in relation to the task at hand. This strong analogy of teams' perception of material resource adequacy with individuals' perception of object favorability may surprise at first glance, leaving one in bewilderment of the relation between such perceptions of visual stimuli and perceptions of material resource adequacy. However, a vast amount of literature in cognitive science suggests that higher cognitive processing, such as dealing with abstract concepts is strongly

linked to perceptual processing (Barsalou, 1999; Derryberry & Tucker, 1994; Van Dantzig, Pecher, Zeelenberg, & Barsalou, 2008). Therefore, most kinds of cognitive processing of the human mind are assumed to function and to be influenced in a similar way, no matter what kind of processing is focused on (Förster & Dannenberg, 2010). Most importantly in this regard, Förster and Dannenberg (2010) summarize evidence that the systems underlying perceptual processing like visual or auditory perception are highly similar to the systems underlying conceptual processing, or as Morewedge, Huh, and Vosgerau put it: “perception and mental imagery differ in their source (the senses and memory, respectively), but there is great overlap within modalities” (Morewedge, Huh, & Vosgerau, 2010: 1531). For example, positive mood has not only been shown to broaden individuals’ attentional scope to recognize visual stimuli that are likely to be overlooked in neutral mood state (Reeves & Bergum, 1972; Schmitz, De Rosa, & Anderson, 2009), but also to expand the scope of attention on conceptual levels (Fredrickson & Branigan, 2005; Friedman & Förster, 2010) like the recognition of novel ideas (Carver, 2003). The results obtained in this thesis are in line with these findings and thus provide further support for the existence of a distinctive team cognition.

Identifying drivers of teams’ perception of material resource adequacy also extends research on efficacy beliefs (Bandura, 1977; Stajkovic et al., 2009), in particular regarding the topic of means efficacy (Eden, Ganzach, Flumin-Granat, & Zigman, 2010). Means efficacy is defined as “the individual’s belief in the utility of the tools available for performing the job” (Eden et al., 2010: 688). Similar to the notion that the value of tangible resources is in the eye of the beholder, so too a person’s perception of a certain tool’s utility may well differ from a tool’s more objectively evaluated utility (Eden et al., 2010), e.g., based on expert ratings. This research stream, however, mainly focuses on how beliefs of means efficacy held by individuals may be manipulated by external influences such as leaders, consultants, or experimenters (Eden, 2001; Eden et al., 2010; Eden & Sulimani, 2002) and the impact of such manipulations on performance (Chen, Westman, & Eden, 2009). As this dissertation’s core variable perceptions of tangible resource adequacy can also be seen as some kind of means efficacy, the degree of adequacy team members ascribe to the tangible resources that are available in an innovation project comes quite close to the definition of means efficacy presented above. Hence, the identified team-internal drivers of tangible resource adequacy perceptions seem potentially applicable to perceptions of means-efficacy as well. This nicely

complements extant literature on means efficacy, which has concentrated on the individual employee, by extending the framework of means efficacy to teams as the focal entity, and by including influencing factors from multiple levels of organizational enquiry. Moreover, the results of this dissertation show that in the context of innovation, an elevated confidence in the material resources at hand (which corresponds to a high level of means efficacy) has no uniformly positive effect on performance. This effect rather depends on the performance dimension focused on. This may be due to being overly confident of the utility of certain procedures or a certain tool might cloud the view of other or novel tools and procedures that might match the purpose at hand in a novel way. This seems to mark a significant difference to the context of routine tasks, in which the study of means-efficacy exclusively took place so far and which consistently yielded positive relationships between means-efficacy and performance (Chen et al., 2009; Eden et al., 2010; Eden & Sulimani, 2002).

6.2.3. Resource based view of the firm

By taking first steps toward a multi-level theory on the role of tangible resources in innovation and by opening the black box of socio-cognitive influences on team perception, this dissertation also adds to the literature on the resource-based view of the firm. Research on the RBV has been executed on the organizational level so far, basically isolated from lower levels of observation. In expanding the RBV's scope of application to the project level, this dissertation provides micro foundations of the RBV in the context of innovation (Katila & Shane, 2005; Kellermanns et al., 2010; Verona, 1999) by detailing out the role of material resources in innovation projects and showing which capabilities are necessary in order to (over-)compensate a lack of material resources. Traditional approaches in the framework of the RBV would rank such capabilities themselves among (immaterial) resources; the resource of knowing how to successfully make do with a material resource based being perceived as inadequate (Amit & Schoemaker, 1993; Barney, 1991; Barney, 2001; Wernerfelt, 1984). A resource that would surely fulfill the VRIN criteria defined in the early days of RBV (Barney, 1991). However, in keeping to the distinction provided by Kraaijenbrink et al. (2010), in this dissertation a firm's capabilities are not seen as firm resources in order to allow determining resources and capabilities independently from each other. In so doing, tautologies that tend to inhere traditional reasoning within the framework of the RBV (Kraaijenbrink et al., 2010; Priem & Butler, 2001) may be avoided. Otherwise, there would be no reason why not "to

regard having an sustainable competitive advantage a resource as well” (Kraaijenbrink et al., 2010: 358).

Furthermore, the results of this doctoral thesis support and flesh out the extended framework of the RBV as provided by Sirmon, Hitt, and colleagues (Sirmon et al., 2008; Sirmon & Hitt, 2003; Sirmon et al., 2007). This extended framework points to the need for including aspects of resource evaluation and resource management in order to determine when the presence of certain resources actually leads to competitive advantages and superior performance. While empirically backing this assumption by showing that the management and deployment of resources indeed has an explanatory value in addition to the mere presence of valuable resources (Sirmon et al., 2008), knowledge about the capabilities needed for such a successful management of the resources at hand has been missing so far. The results presented in Chapter 3 and 4 now provide first insights which capabilities innovation project teams should possess in order to properly evaluate and manage the resources at hand. Specifying these capabilities on the project level makes a lot of sense, representing the level on which innovative endeavors are predominantly executed after all (Edmondson & Nembhard, 2009; McDonough, 2000; Wuchty et al., 2007).

While the preceding Chapter 6.2.2 discussed the theoretical underpinnings of the role of perceptions in the evaluation of tangible resources, the findings regarding influences on the management of tangible resources’ effects on innovation project success can be seen in the light of goal setting theory. The core message of goal setting theory is that specific and difficult goals are positively related with resulting performance (Locke & Latham, 2002; O’Leary-Kelly, Martocchio, & Frink, 1994). A necessary condition for goal setting effects to emerge in full strength is that people are committed to the goal (Klein, Wesson, Hollenbeck, & Alge, 1999), possess self-efficacy beliefs in their capability to do so (Bandura & Locke, 2003), and that they actually have the capabilities to do so. Quite similarly, having less than adequate tangible resources at hand in contrast to being adequately equipped with tangible resources corresponds the setting of a more difficult goal which, according to goal setting theory, should lead to higher performance (Hoegl et al., 2008). However, in order to unleash performance enhancing effects of tangible resource constraints, several conditions have to be fulfilled. Specifically, in order to successfully manage and deploy constrained tangible resources at hand innovation project teams must actually be able to overcome additional and higher barriers of capability and will in the innovation process. Hence, facilitating to do

exactly that might represent the core value of the contingency variables that have been empirically confirmed so far, i.e. an organizational culture less oriented toward material resources (see Chapter 4), and the team climate for innovation (Weiss et al., forthcoming).

Such goal setting effects in the relationship between tangible resource adequacy and innovation project performance, might be explained by theory on avoidance of cognitive demand. This theory bases on Hull's law of less work which says that "if two or more behavioral sequences, each involving a different amount of energy consumption or work, have been equally well reinforced an equal number of times, the organism will gradually learn to choose the less laborious behavior sequence leading to the attainment of the reinforcing state of affairs" (Hull, 1943: 294). This principle of avoidance of demand was then transferred from physical demand to cognitive demand in that decision makers are proposed to weigh the expected effort-related costs against the anticipated gains of additional cognitive effort (Kool, McGuire, Rosen, & Botvinick, 2010). In support of this assumption, decision makers have been frequently shown to seek reducing the effort of processing information more than it is actually necessary for an optimal decision rule (Shah & Oppenheimer, 2008). This suggests that they trade off the effort linked to the necessary processing effort with the benefits expected to be gained by a higher level of decision rule optimality (Smith & Walker, 1993). Hence, if people have the choice, they are expected to adjust their behavior when working on a certain goal in such a way that minimizes the cognitive effort to reach this goal. Reaching for higher goals, as induced by tangible resource constraints, will thus stimulate higher efforts.

6.2.4. Activation theory

The literature on activation theory (Gardner & Cummings, 1988; Scott, 1966) also offers a suitable environment in which to embed innovation project teams' differing responses to varying levels of tangible resource provisions. In a nutshell, the concept of activation theory states that experienced activation levels have significant effects on individual behavior (Gardner, 1986; Gardner & Cummings, 1988; Scott, 1966). In this connection, activation level refers to the level of neural activity in the reticular activation system (RAS) of an individuals' central nervous system. This activation may result from various stimuli, e.g., external stimuli like temperature, internal stimuli like respiration activity, or cerebral stimuli like thoughts (Gardner, 1990). The relevance of this neurologic finding arises from the

proposition that activation levels are supposed to significantly influence task performance level and task satisfaction at work in a curvilinear way. At a certain level of activation, the so called characteristic level of activation (Gardner & Cummings, 1988) (which usually represents a moderate level of activation) the human central nervous system is able to function most effectively, thus leading to increased behavioral (e.g., reaction time) and cerebral (i.e., information processing) performance (Eysenck, 1985; Humphreys & Revelle, 1984; Lindsley, 1961). Pronouncedly high and low levels of activation, in turn, are proposed to cause lower cerebral effectiveness (Corlett & Mahadeva, 1970; Duffy, 1972). Following these propositions, activation theory predicts an inverted-U shaped relationship between activation level and individual performance (see Figure 6-1).

Further, the activation resulting from certain stimuli on individuals is contingent upon several factors that represent attributes of the RAS, e.g., extraversion (Gardner & Cummings, 1988), thus causing individual differences regarding the response to identically experienced stimuli. Extraverts, for example, are less arousable than introverts (Eysenck, 1967; Smith, 1983; Stelmack & Plouffe, 1983) and exhibit stimulation-seeking behaviors more than introverts (e.g., Geen, 1984). As a consequence, extraverts and introverts are assumed to display significant behavioral differences when responding to certain levels of stimulation caused by their job (Gardner & Cummings, 1988). In this regard, extraverts are assumed to tolerate jobs with a relatively high level of stimulation better than introverts since extraverts are less sensitive to stimulation. With regard to jobs that cause comparably low levels of stimulation the converse should be the case. Hence, extraverts (introverts) are predicted to perform better in high (low) stimulation jobs as these jobs are more likely to provide the stimulation needed to reach their characteristic level of activation. Furthermore, the experience of an activation level differing from the characteristic level of activation causes individuals to enact in compensatory behaviors that are not related to their job tasks in order to raise and lower, respectively, their activation level. The more a person engages in such non task related behaviors, however, the lesser the extent to which this person is able to engage in behaviors necessary to perform the tasks he or she is actually assigned with (Fisher, 1993; Gardner, 1990), which consequently is expected to result in a further decrease of performance.

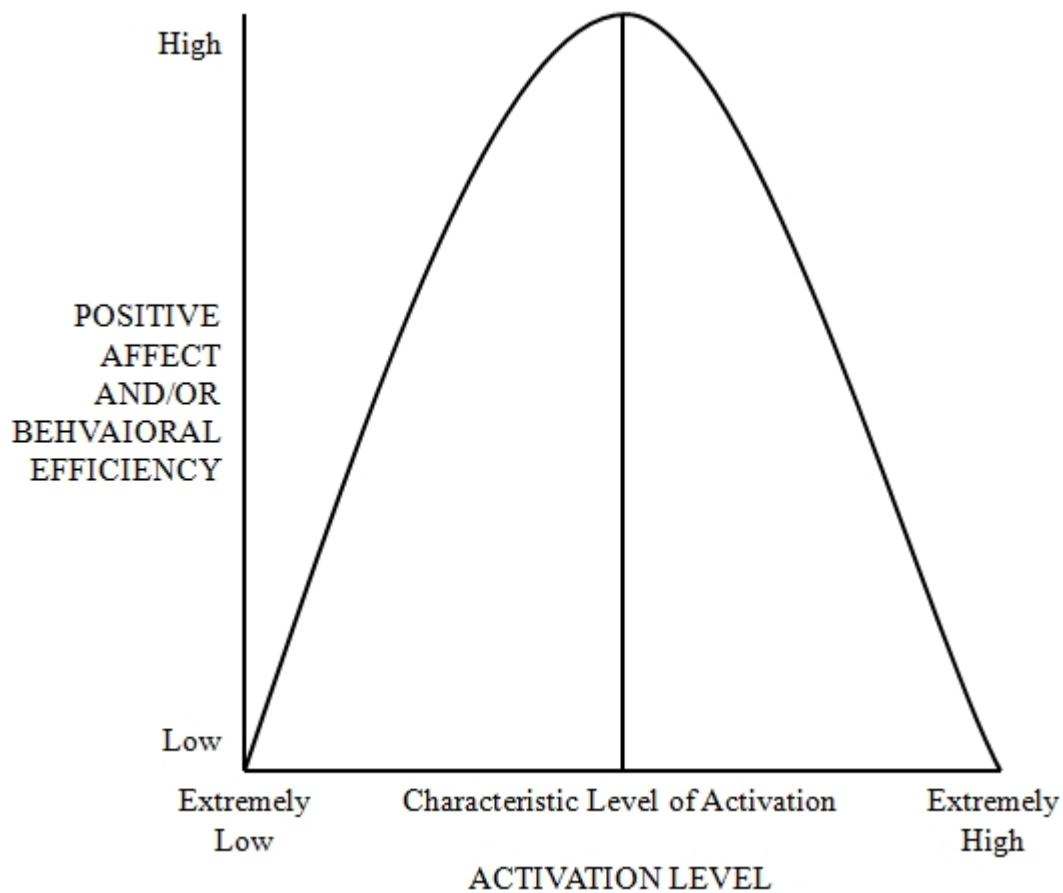


Figure 6-1: The relationship between level of activation and individual performance (Gardner & Cummings, 1988: 85).

The parallel to innovation project teams is that here also identical stimuli, i.e., an equally adequate level of tangible resource provisions, may cause considerably varying responses in terms of these teams' performance. While in activation theory the level of activation depends on the external, internal, and cerebral stimuli described above, in the setting of innovation projects this stimulation is assumed to be caused mainly by the characteristics of an innovation project team's tasks, among which also resides the adequacy of provided tangible resources. The higher the extent to which constrained tangible resources complicate the tasks an innovation project team is assigned with, the higher the team's resulting stimulation is expected to be. As we have seen in the previous chapters of this thesis, some innovation project teams are highly successful being provided with abundant tangible resources, while other innovation project teams cannot make use of such tangible resource

abundance and fail to come up with satisfying outcomes. Similarly, some innovation project teams make do with scarce tangible resources at hand, in contrast to others that starve from such an inadequate tangible resource base. Hence, in analogy to activation theory, some innovation project teams seem less sensitive to task demands and may need the additional stimulation induced by less adequate tangible resources to reach their team's characteristic level of activation. In contrast, other innovation project teams may be aroused more easily and seemingly need to be provided with more adequate tangible resources in order not to induce an exaggerated activation level by being overly stimulated by their task.

This analogy may be carried further in combination with the concept of resource elasticity introduced by Hoegl et al. (2008). This concept's relevance in practice was already empirically demonstrated in Chapter 4 of this doctoral thesis. On this note, positively resource elastic innovation project teams appear to correspond to introverts in activation theory in that they seem to be more sensitive to stimulation. In case the rather low stimulation needs of those positively resource elastic teams are not satisfied because constrained tangible resources cause an activation level above their characteristic level, these teams, just like introverts, are supposed to exhibit stimulation avoiding behaviors (Eysenck, 1967, 1976; Gardner & Cummings, 1988). Potentially perceiving their hands tied by inadequate tangible resources, they are likely to reduce their task related effort or will disengage completely from their task (Bandura, 1977; Gibson, 1999; Gully, Incalcaterra, Joshi, & Beaubien, 2002; Katz-Navon & Erez, 2005). Indeed, such innovation project teams have a strong tendency to excuse weak performance by complaining about inadequate resources, indicating a strong material resource orientation and becoming self-declared victims of inadequate tangible resources (Hoegl et al., 2008; Kornai, 1979; Shostack, 1988). On the other hand, if those innovation project teams perceive the tangible resources at hand as adequate, the resulting lower level of stimulation enables them to reach their characteristic level of activation. As a consequence, team members are expected to focus on task related behaviors due to the needlessness of stimulation avoiding behavior, thereby making them more likely to succeed in their innovative endeavors.

In contrast to positively resource elastic teams, negatively resource elastic teams seem to benefit from less adequate tangible resources as they offer the increased stimulation needed to reach their characteristic level of activation. These innovation project teams apparently correspond to extraverts in the framework of activation theory. Being less sensitive to

stimulation, they are more likely to suffer from a too low activation level which they are expected to counteract through stimulation seeking behaviors (Eysenck, 1967, 1976; Gardner & Cummings, 1988). Such stimulation seeking behavior is very likely to result in non task-relevant behavior, such as engaging in technological experimenting not related with the innovation project's tasks (Fisher, 1993; Gardner, 1990). A number of frequently observed phenomena in innovation project teams' behavior may be ranked among such stimulation seeking behaviors. For example, some teams start to aim for increased functionality or visual attractiveness of the product to be developed, even though this may be outside its initial duties (Hoegl et al., 2008). Usually best intentions inhere these or alike activities and sometimes such non task-relevant behavior may result in highly successful bootlegging endeavors (Augsdorfer, 2005). For example, the post-it notes by 3M originated from such bootlegging activities. If not institutionalized like at 3M, however, such activities normally are assumed to exert a detrimental effect on innovation performance, at least on that of the concerned innovation project. On the other hand, such negatively resource elastic teams appear to benefit from the stimulation induced by scarce tangible resources to elevate their activation to the characteristic level.

From the results of the empirical analyzes performed in this doctoral thesis, a first specification of the characteristics that distinguish positively and negatively resource elastic innovation project teams can be derived. Specifically, it seems that material resource oriented attitudes may increase the sensitivity to be activated by tangible resource constraints, while possessing a team climate supportive for innovation may lower this sensitivity. Importantly, these attributes may be influenced by management or project leaders. In reality it may be easier to determine a priori whether an innovation project team is provided with more or less adequate tangible resources in relation to its assignments than to estimate whether a team is rather positively or negatively resource elastic. Moreover, inadequate resource provisions frequently result from the need of a company to reduce project budgets in times of less favorable corporate financial conditions, thus not being defined arbitrarily but being the result of tight calculations. Hence, by knowing the moderating variables of the relationship between tangible resource adequacy and innovation project performance, project managers could shape team characteristics in order to adjust them to the prevailing scenario of tangible resource availability, e.g., by training or development activities (Eisenbeiss, van Knippenberg, & Boerner, 2008; Pirola-Merlo, Härtel, Mann, & Hirst, 2002).

6.3. Practical implications

6.3.1. Management of innovation projects

First, the results of this research point to specific conditions under which product developers indeed can come up with more innovative solutions despite, or even because of tangible resource constraints and these results encourage managers to reconsider the taken-for-granted effectiveness of resource investments in R&D. Neither abundance nor scarcity of tangible resources is by itself a reliable lever to control innovation project performance in general. Particularly, empirical evidence shows that certain contingency factors like an organizational culture less oriented toward material resources or a team climate for innovation are likely to help unleash positive effects of tangible resource constraints. Managers and leaders of innovation projects should consequently focus on improving such contingency factors rather than concentrating on making ever more tangible resources available. This knowledge may particularly provide helpful insights how to make the most out of scarce tangible resources in innovation projects to such firms not being able to dispose of a large tangible resource base and naturally suffering from constraints in tangible resources, such as small and medium sized companies, start-ups, or companies hit hard by the recent global financial crisis. Thus, not being provided with adequate tangible resources seems not inescapably limiting the success of innovation projects. It may be a burden, but making virtue of necessity can also stimulate the development of superior solutions.

To improve these contingency factors of the relationship between tangible resource constraints and innovation project performance, there are many ways to reach the goal. First, team climate for innovation may be enhanced by establishing a transformational leadership style within the innovation projects (Eisenbeiss et al., 2008), which can be supported by selecting project leaders depending on their ability to lead in a transformational way and by providing training and development measurements to improve leadership behaviors of innovation project leaders (Avolio, 1999; Barling, Weber, & Kelloway, 1996). Also removing obstacles of TCI like team member relationship problems (Pirola-Merlo et al., 2002) appears instrumental. Doing so, however, should preferably occur right from the start of a project, since climates and shared norms in teams have proven to be quite hard to modify once established (MacNeil & Sherif, 1976). Second, an organizational culture being less oriented toward and dependent on material resources can be promoted by strengthening the feeling of

community among members of innovation project teams in order to enhance their level of involvement, emotional attachment, and motivation (Miller & Le Breton-Miller, 2007; Miller et al., 2009), e.g., by paying attention to team members needs beyond immediate work requirements (Miller et al., 2009), or by sponsoring regularly joint activities outside the work setting (Dessler, 1999; Gratton & Erickson, 2007).

6.3.2. Innovation project budgeting

The results of this study also have implications for an innovation supporting practice of innovation project budgeting (Weber & Zayer, 2007). Despite the many changes ongoing in the field of budgeting and controllership (Weber, Voußem, & Rehring, 2010), tangible resource provisions to innovation projects still depend mainly on the innovation projects' probability of reaching a certain threshold of success and the expected achievement (Blanning, 1981; Gerchak, 1998), the expected lifetime revenue of the newly developed products (Hartmann, Myers, & Rosenbloom, 2006), or on the innovation project's stage and the survival rate of innovation projects on this stage (Albala, 1977; Grossman & Shapiro, 1986; Sethi & Iqbal, 2008). Hence, those approaches all have in common the assumption that those projects considered being most important and/or from which the largest profits may be expected should consequently be prioritized when it comes to assign tangible resources to innovation projects. This implies, however, the very "resource driven" mindset that provisions of adequate tangible resources generally have a facilitating effect on innovation projects or that "the random achievement of each team is (stochastically) increasing in its budget allocation" (Gerchak, 1998: 305). With regard to the finding that constrained tangible resources showed a positive relationship with the innovativeness of newly developed products and a negative relationship with new product quality, recommendations of innovation project funding might be modified in that the degree of novelty aimed at and the importance of novelty in relation to other innovation project outcomes should be included in budgeting decisions. Thus, innovation projects targeted at radical innovation should preferably be provided with less than adequate tangible resources, even if they are of high priority and expected value for the company, while the contrary should consequently be the case for innovation projects focusing on quality improvement. Hence, in line with Marginson and Ogden (2005) who explicitly recognize the potential value of constrained tangible resource provisions, budgetary pressure might sometimes actually doing more good for innovators than they might be willing to accept at first glance.

6.3.3. Brainstorming effectiveness

Stimulation of novel ideas by constrained tangible resources may prove particularly beneficial in order to improve the effectiveness and efficiency of brainstorming sessions (Osborn, 1957). Being a widely practiced technique with a long-standing tradition to enhance creative ideation (Bouchard & Hare, 1970; Runco, 2007; Sutton & Hargadon, 1996) and being applied in a variety of tasks and domains that go well beyond the scope of innovation projects, the brainstorming approach nonetheless suffers from a number of profound drawbacks. Among others, the major downsides of brainstorming are recognized to be the considerable productivity loss when conducted in groups (Diehl & Stroebe, 1987; McGlynn, McGurk, Sprague Efland, Johll, & Harding, 2004), the tendency to stick to category exemplars of existing solutions (Finke et al., 1992; Ward, 1994; Ward et al., 2000), and the production of an idea overload that may choke creative processes (Goldenberg & Mazursky, 2000; Goldenberg, Mazursky, & Solomon, 1999b). To address and mitigate these shortcomings of brainstorming, a number of interventions on brainstorming activities have already been developed. For instance, Dugosh, Paulus, Roland, and Yang (2000) enhanced group brainstorming productivity by exposing probands to ideas on audiotape during the brainstorming session. Diehl and Stroebe (1991) achieved a similarly positive effect on brainstorming productivity in groups by expanding the duration of brainstorming sessions.

To add further recommendations how to counter the shortcomings of the brainstorming approach, it appears very likely that imposing some kind of tangible resource constraint on brainstorming groups will cause the participants to move away from existing solutions and category exemplars (Stokes, 2006; Ward, 1994, 2004). Similarly, these constraints may then function as some kind of guidance through the ideation process, narrowing down the sometimes detrimental excess of ideas (Goldenberg & Mazursky, 1999; Goldenberg et al., 1999b). This approach represents a bounded “thinking inside the box” (King, 1997) approach to creativity that contrasts the unbounded “thinking outside the box” approach that brainstorming normally represents (Goldenberg & Mazursky, 2000; Hoegl et al., 2008). Implementing such a bounded approach within an originally unbounded technique such as brainstorming, which may seem counter-intuitive at first sight, is in line with Juarrero’s notion that constraints not only reduce the range of alternatives, but that they also “must simultaneously create new possibilities” (1999: 133) and may thus enable to have the best of both worlds in idea generation. Constraints of tangible resources could be easily

implemented in brainstorming sessions, e.g., by constraining options of choice when using electronic brainstorming devices (Dennis & Reinicke, 2004; Gallupe et al., 1992). Moreover, these potential benefits of applying tangible resource constraints in brainstorming seem not restricted to group brainstorming as they tackle problems that are also associated with individual brainstorming (Paulus et al., 2010; Street, 1974).

6.3.4. Team performance in non-innovative tasks

Furthermore, managers may want to apply the knowledge gained about drivers of adequacy perceptions of material resources for teams being assigned with non-innovative tasks. Similar to the diverse types of efficacy beliefs like self-efficacy (Locke, Fredrick, Lee, & Bobko, 1984; Stajkovic & Luthans, 1998), collective efficacy (Gibson, 1999; Stajkovic et al., 2009; Zaccaro et al., 1995), and, in particular, means efficacy (Eden, 2001; Eden et al., 2010), which express the confidence of actors in their capabilities and tools, the confidence of having at hand adequate material resources is also expected to exert an important positive influence on individuals' or teams' performance. Indeed, as stated above, this confidence in the adequacy of material resources at hand may be even seen as some special kind of means efficacy. These performance effects showed to be ambiguous in the case of innovation projects, depending upon whether new product novelty or new product quality and project efficiency are used as outcome measure, though. However, in non-innovative tasks, where the novelty of solutions usually plays a minor role compared to quality and efficiency, higher confidence in one's resources is expected to boost performance like an enhanced level of means-efficacy was shown to do (Eden et al., 2010). Thus, managers may shape the perception of material resource adequacy and thus means-efficacy by enhancing the drivers of these perceptions that have been identified in Chapter 3 as recommended in Chapter 3.5.2 of this thesis.

6.3.5. Sustainability of innovation

Finally, these insights also provide a good starting point for inducing innovation in regions and communities characterized by material resource scarcity and thus bridging the socio-economic divide between those above and below the poverty line. It is not surprising that the prevailing approach when it comes to unleashing creativity and innovation at the base of the economical pyramid has been a "resource driven" one and oftentimes comprises the provision of equipment, raw materials, or money to those who are lacking such material

resources (Välikangas & Gibbert, 2008). This approach, at first sight, makes intuitive sense; to provide (rather than withdraw or withhold) the needed material resources because “lack of material resources” constitutes the very definition of poverty (Hagenaars & de Vos, 1988). The finding of this doctoral thesis that constrained material resources can act also as enablers of innovation, however, may help turning necessity into the proverbial mother of invention in such material resource scarce environments. This lends support to approaches that do not focus on giving material resources to those who lack them in order to foster innovation at the base of the economical pyramid (Prahalad, 2004), but that instead aim at leveraging in creative ways whatever limited material resources may already be present and that rather focus on the capabilities of the involved actors (Prahalad & Hammond, 2002; Prahalad & Mashelkar, 2010).

7. FUTURE RESEARCH

This dissertation sheds light on how differences in evaluating and managing tangible resources may affect innovation project outcomes, painting a more detailed and differential picture of the role tangible resources play in innovation projects. However, as with all research efforts, the solutions this dissertation gives to the questions it set out to answer inevitably lead to the emergence of further questions which should be addressed in subsequent research endeavors. In this chapter, I will therefore discuss potential future research efforts on the topic of tangible resource constraints in innovation.

7.1. Broadening the scope of analysis

In this dissertation, only completed innovation projects have been examined. This selection results in cutting off that part of the distribution of the complete set of innovation projects representing the least successful projects, since those projects usually are terminated before completion (Brockhoff, 1994). Although less may sometimes be more for innovation projects, there certainly exists some threshold of tangible resource availability (which is assumed not to be some fixed amount but to vary between innovation project teams) below which innovation projects just cannot be maintained any more. Future research may therefore want to find out how to include terminated innovation projects in analyzes similar to these conducted in this dissertation, e.g., by implementing a longitudinal study design to observe innovation projects right from their start. Such a study design might also provide an excellent opportunity to examine whether the adequacy of tangible resource provisions may influence the timing of when failing innovation projects are terminated (Balachandra, Brockhoff, & Pearson, 1996; Mahlendorf, 2010; Schmidt & Calantone, 2002), and which consequences such a termination subsequently entails for the team members of the terminated innovation project (Shepherd & Cardon, 2009; Shepherd, Wiklund, & Haynie, 2009; Välikangas, Hoegl, & Gibbert, 2009). Especially the latter aspect seems of high theoretical and practical relevance since this “human cost” of innovation project terminations and measures to counter such negative impacts on the affected employees are usually neglected in the vast part of extant literature on innovation project terminations (e.g., De Reyck & Leus, 2008; Schmidt & Calantone, 2002). Prior research on innovation project terminations seems to quietly assume that project members just “function” as before and rather focuses on the direct consequences of managerial decisions on profitability and organizational performance (Kester, Hultink, & Lauche, 2009). Losing sight of potentially negative inter-temporal effects of an innovation

project termination, i.e., influences on subsequent innovation projects, however, might hurt firm performance and profitability even more in the long term.

Furthermore, the innovation project teams in the sample all stem from the electronics industry. This industry was chosen, as detailed out in Chapter 2, since in electronics industry a high pressure to innovate prevails, and because a high diversity regarding company size and ownership structure is present in this industry. The advantage of this strategy is to control for industry specific characteristics and their potential influences on innovation projects, thereby increasing the internal validity of findings. This advantage is gained, however, at the expense of the external validity of findings and thus the generalizability to other contexts (Schnell, Hill, & Esser, 2008). While the literature comes up with some differences in organizational innovation between electronics industry companies and firms from other industries (e.g., Motohashi & Yuan, 2010), these deviations do not appear so important to generally call into question the transfer of results to innovation projects executed in other industries. Nonetheless, the results of this study have to be interpreted in the light of natural differences between industries (e.g., Arbussà & Coenders, 2007; Elango, 2010; McGahan & Porter, 1997) that might limit its generalization, particularly regarding “low-tech” industries (Lee, 1995) or industries that deal with nonphysical products such as software (He et al., 2007; Hoegl, Parboteeah, & Gemuenden, 2003). Because of that, similar studies studying the relationships revealed in this dissertation using samples from different industries, or comparative studies with samples consisting of firms from multiple industries appear worthwhile to investigate whether the results presented in this dissertation indeed can be generalized to the whole bandwidth of innovation projects.

Bearing in mind that the sample of innovation projects examined in this study completely consisted of projects dealing with new product development, it remains unclear whether its results can also inform the context of research projects. On the one hand, the basic theoretical underpinnings of this dissertation seem to apply in the context of research teams as well, since research projects also (probably even more) deal with ill-defined tasks demanding a high level of creativity (Payne, 1990). On the other hand, there are also important differences between new product development projects and research projects. For example, new product development projects are usually more formally organized (Katz, 1982) and they tend to be more focused, while research projects normally are more universal in nature (Katz, 1982). Furthermore, research projects regularly have an easier time integrating ideas from

outside their project or organization since, in contrast to new product development projects, they are less advanced in the innovation process and thus less dependent on certain aspects of the product design already nailed down, which allows them more flexibility for conceptual changes (Tushman & Katz, 1980). Certainly, analyzing the role of tangible resources in research projects would provide an important contribution, since in research projects the importance of novelty is even more emphasized while the weight of potential products' quality in these early stages of the innovation process normally is less pronounced and since constrained tangible resources in research projects are quite common. The scarce empirical research on this topic is inconclusive so far, nonetheless, it points to complex relationships between tangible resource provisions and research project performance (Averch, 1989; Payne, 1990) which might be systematically examined in future research efforts.

Moreover, while the empirical analyzes executed in this study showed the influences different types of tangible resources, i.e., material resources and relative team size, had on innovation project outcomes (which turned out to be quite similar), the question of the interplay between those tangible resources and the time available for the innovative tasks remains unsolved. This appears of high importance in order to develop recommendations as to how to compensate for constraints in material resources and relative team size. Results from experiments on the individual level reported by Moreau et al. (2005), who incorporated time as a further explanatory variable in their studies on the effects of material resource constraints on individual creativity may provide first cues in this regard. They showed that individuals being constraint in material resources were able to create products of higher novelty when being provided with additional time for product design, suggesting an interaction effect between time and material resource adequacy with regard to new product novelty. In contrast, available time did not show to mark a difference with regard to the appropriateness of products developed under material resource constraints (Moreau et al., 2005). Given these findings, the investigation of time (Ancona, Okhuysen, & Perlow, 2001) as a further resource in the present framework appears highly promising and may help further pinpointing the effect of tangible resource constraints on innovation project outcomes.

7.2. Nature of constraints

Another question which emerges from the results of this dissertation is whether effects of constraints in tangible resources during new product development are different from effects

that constraints in the product under development itself entail for innovation project outcomes. In this thesis, I concentrated on constraints in tangible resources during the work on innovation projects. In the framework provided by Allen Newell and Herbert Simon in their seminal work on human problem solving (Newell & Simon, 1972), they developed the idea of a problem space that consists of an initial stage which refers to the problem to be solved, a goal state which represents the solution of the problem, and a set of operators which represent the means that may be applied to get from the initial state to the goal state (Newell & Simon, 1972). In the context of innovation projects, the goal state refers to the newly developed product, while the sum of tangible resources accessible for the problem solver (in this context represented by the innovation project teams) can be categorized (albeit not exclusively) among the operators to be applied in order to develop the new product and thus reach the goal state. In contrast to well-structured problems, ill-defined problems like the development of new products do not include one single correct goal state, i.e., a correct solution like it is the case, e.g., for most mathematical problems (Runco, 2004). Therefore, for ill-defined problems initially an infinite set of operators as well as an infinite set of goal states exists. When working on such ill-defined problems, constraints then structure the problem space, while each constraint automatically precludes certain shapes of the goal state (Stokes, 2001, 2007).

The finding of this thesis that constraints in tangible resources may stimulate novelty can be interpreted as the consequence of a constrained set of operators that obstructs some otherwise accessible goal states of the products under development, thereby fostering the creation of more innovative products in case that solutions of minor innovativeness are precluded by the very constrained set of operators. An example nicely illustrating this mechanism is provided by Gibbert and Scranton (2009), who showed that the design of modern jet engines originated from the constrained access to certain raw materials German engineers faced during the final stages of World War II. Not being able to dispose of heat resistant alloys for the jet engines precluded the dominant design features of jet engine prototypes at that time. Hence, they had to find a way to design these engines in an alternative way that allows their construction without such heat resistant materials which they actually did by manipulating the way air streams through the jet engine (Gibbert & Scranton, 2009). A similar effect is expected to result from constraints in the goal state, i.e., when certain features of a product under development are directly precluded, e.g., by legal constraints. Another

example from aircraft development shows a similar novelty enhancing effect of such constraints. In the treaty of Versailles following World War I, Germany was pledged to abandon construction and use of motor powered aircraft. In order to use aircraft despite this ban, German engineers and aircraft enthusiasts started to think about how planes can be built that are able to fly without powertrain, and working around this constraint finally led to the invention of modern sailplanes (Short, 2005). The unanswered question so far is if effects or moderating conditions differ depending on whether constraints in the set of operators (i.e., the tangible resources at hand) or in the goal state (i.e., the features of the product under development) are active and if so, how.

The interplay between these two sources of constraints is deemed of particular importance. If constraints in the set of operators as well as constraints in the goal state are active, will they amplify each other's novelty-stimulating effect or will they interfere with each other and diminish such effects? Or is this interplay contingent upon other moderating variables still? So far, literature offers only anecdotal evidence in this regard. Hoegl et al. (2009a), for instance, presented the case of the small start-up company Loremo which has been severely constrained in tangible resources while developing a highly efficient automobile. The automobile to be developed in this endeavor was highly constraint in its goal state by the premise to limit fuel consumption to a maximum of two liters per 100 kilometers without abandoning comfort, handling performance, and features such as air conditioning or car stereo. Considering that this endeavor produced a highly novel and unusual (see Figure 7-1), yet promising prototype that contrasted the many failures innovation endeavors in big automobile companies suffered from when trying to develop super-efficient cars (Hoegl et al., 2009a) suggests a fruitful interplay between constraints of tangible resources and constraints in the goal state of the product under development. Whether this case example represents an exception to the rule or indeed is representative for a systematically positive interplay between such constraints of differing nature, however, remains to be confirmed by future empirical research efforts. This would be of particular interest for improving the development processes of much needed "green" products (Chen, 2008; Dangelico & Pujari, 2010) that enable a higher efficiency in the consumption of natural resources and a reduction of green house gases, as it does not seem to make intuitive sense expecting innovation projects with an inefficient usage of tangible resources to come up with highly efficient products. After all, providing society with such efficient products forms a part of companies' social responsibility

(McWilliams & Siegel, 2001), fulfilling which not only serves the greater good, but is also likely to have a positive impact on companies' profits (Lacey & Kennett-Hensel, 2010; Orlitzky, Schmidt, & Rynes, 2003).



Figure 7-1: The Loremo.

With regard to constraints in the set of operators and in the goal state as outlined above, another interesting aspect to investigate is whether the source being perceived to cause the constraints makes a difference for the resulting effects. While from this thesis no insights on this issue can be derived, it seems highly likely that the source that is attributed to originate the constraints may entail different behavioral patterns of the innovation projects' team members. In this context, literature comes up with two theoretical frameworks that suggest how the perceived source of constraints might influence their consequences.

First, regarding constraints in tangible resources, Mone et al. (1998) proposed a contingency model how the influence of decline – and thus the reduced availability of tangible resources – on innovation is contingent on how people attribute the cause of the constraints and whether the constraints are perceived to be controllable or not. Albeit focusing on the organizational level, their theorizing offers some insights that may also hold for innovation on the project level. Specifically, they argue that the attribution of decline to be controllable (vs. uncontrollable) and permanent (vs. temporary) should exert a positive moderating influence on the relationship between decline and organizational performance (Mone et al., 1998). Whether these relationships can be empirically verified on the organizational level – so far, this contingency model has been empirically tested only in part

by Latham and Braun (2009) – and on the project level seems to be a worthwhile topic for future studies.

Second, regarding constraints in the goal state, Goel and Pirolli (1992) distinguish between two types of sources these constraints may originate from. One type, which they call “nomological” constraints, comprises innegotiable aspects such as natural laws, while the second type of constraints comprises negotiable constraints such as economic constraints (Goel & Pirolli, 1992). Whether these different sources of constraints and the resulting attributes of the constraints, i.e., negotiable or not, indeed entail distinct consequences for the tangible resource constraints-innovation project performance relationship has to be shown in future research.

7.3. Team ambidexterity

A further interesting question arises from the unrelatedness of the different innovation project outcomes’ antecedents. The results of this dissertation show that perceptions of adequate tangible resources tend to facilitate new product quality and, at the same time, tend to impede new product novelty. Moreover, these two performance dimensions are found to be largely uncorrelated with each other ($r = -.09$; non-significant). The question that consequently comes to the fore is whether there are innovation project teams that are able to achieve a high degree of novelty in newly developed products while maintaining a high level of quality of these products; and if so, which are the key attributes those teams have in common? Results from other research areas show that counteracting aspects may well share a common ground under certain circumstances, such as evolutionary robustness was shown not only to impede variability but sometimes also to facilitate variability and novelty, depending on certain moderating conditions (Draghi, Parsons, Wagner, & Plotkin, 2010).

Building on the analogy to research on organizational ambidexterity, i.e., the capability of companies to successfully engage in explorative as well as exploitative innovation activities (Gupta, Smith, & Shalley, 2006; He & Wong, 2004), these attributes may be seen as antecedents of what might be termed as “team ambidexterity”. First cues toward potential candidates for such antecedents of team ambidexterity may be taken from organization level research on ambidexterity (Raisch & Birkinshaw, 2008). This literature so far has identified the organization-level variables trust in the relationships between managers

and employees (Adler, Goldoftas, & Levine, 1999), a common vision (Tushman & O'Reilly, 1996), or top management team diversity (Beckman, 2006; Smith & Tushman, 2005) as antecedents of organizational ambidexterity that might suit the context of innovation project teams. Detecting antecedents and moderating conditions of team ambidexterity is not only expected to offer new insights on drivers of innovation project performance, it might also contribute to the pursuit of a multi-level theory of ambidexterity in organizations by identifying micro foundations of ambidexterity. This appears worthwhile since a large part of the extant literature on organizational ambidexterity still struggles to develop actionable recommendations how to facilitate ambidexterity in those organizational entities in which innovations actually are created, i.e., innovation projects (Edmondson & Nembhard, 2009; Wuchty et al., 2007). Moreover, with regard to the context of tangible resources' role in innovation projects, it might be of particular interest to search for moderating variables that determine which innovation project teams are able to develop products that are innovative and of high quality when being constrained in tangible resources.

7.4. Conclusion

The key learning for innovation projects from this dissertation is quite straightforward: Providing access to adequate tangible resources alone will not help succeeding in the respective endeavors. Sometimes less indeed appears to be more. Therefore, managers striving for innovations would be well advised to guard themselves against the urge to fund projects proportionate to their importance on corporate agendas. If the project is deemed strategic enough, too much money often is too easily spent, thus pre-empting the very need to be innovative. Being rich in tangible resources sometimes goes along with being innovation-poor. Rather than just "throwing money at the problem" it is at least equally important to adequately lead an innovation project team and to support and empower it in order to give team members confidence in their abilities. This allows adopting an alternative mindset that focuses on the capabilities of the actors involved in an innovation project instead of being too much oriented toward and dependent on tangible resources. How such mindsets can be successfully implemented in organizations can be learnt from many family businesses. Therefore, shaping an innovation project team's perceptions of tangible resources and helping these teams to overcome barriers of capability and will points to the critical role of leadership in ensuring the effectiveness of investments in innovation projects. Thus, when it comes to innovation, there are things money just can't buy.

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