SUPPORTING ORGANIZATIONAL ADAPTATION THROUGH SUCCESSFUL STRATEGIC AND OPERATIONAL PROJECT PORTFOLIO MANAGEMENT

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Zusammenfassung

Eine große Herausforderung für das strategische Management von Unternehmen ist der Umgang mit Unsicherheit und die konstante Anpassung an eine turbulente Umwelt. In Unternehmen sind die Projektportfolios die dafür zuständige Einheit, um diese Anpassung zu operationalisieren, indem sie neue Chancen entwickeln und die Implementierung der angepassten Unternehmensstrategie sicherstellen. In dieser Dissertation untersuche ich daher, wie das Projektportfolio- und das Projektmanagement strategisch und operativ mit Unsicherheit umgehen, den Portfolio- und Projekterfolg steigern und dadurch die erfolgreiche Anpassung der Organisation unterstützen können. In Bezug auf die strategische Entscheidungsfindung im Portfoliomanagement zeige ich empirisch, dass Entscheider durch Realoptionsdenken effektiv mit der Unsicherheit von Projekten und der Umwelt umgehen und dadurch den Innovationsgrad und den Erfolg ihrer Portfolios steigern können. Darüber hinaus zeige ich, dass Portfolios, die aus agilen Projekten bestehen, positiv zur wertvollen Erkennung emergenter Strategien beitragen. Zudem hebe ich die wichtige Rolle der unternehmerischen Orientierung und des Innovationsklimas als Einflussfaktoren und Moderatoren der Portfoliomanagemententscheidungen hervor. In Bezug auf die operative Implementierung der Portfoliostrategie untersuche ich, wie Portfolio- und Projektmanager mit der Projektunsicherheit in ihren operativen Entscheidungen umgehen können. Ich zeige, dass der Einsatz von Projektmanagement kausal die Projektprofitabilität steigert und dass der marginale Einfluss des Projektmanagementeinsatzes mit höherer Projektkomplexität steigt. Darüber hinaus zeige ich, dass das Berichtsverhalten von Projektmanagern signifikant mit der zukünftigen Projektperformance zusammenhängt. Die Dissertation liefert neue Erkenntnisse zu Portfolio- und Projektmanagement im Allgemeinen und zur strategischen und operativen Entscheidungsfindung als Teil des Portfoliomanagements im Besonderen. Darüber hinaus bietet sie neue Aspekte zur Interaktion zwischen Portfolio- und Projektmanagement und eröffnet dadurch neue Perspektiven zu verhaltens- und kontextbasierter Entscheidungsfindung im Portfolio- und Projektmanagement.

Abstract

A major challenge for organizations' strategic management is to cope with uncertainty and constantly adapt to a turbulent environment. In organizations, project portfolios constitute the responsible entities to operationalize the adaptation by developing new opportunities and ensuring the implementation of an adapted organizational strategy. Thus, in this dissertation, I investigate how project portfolio and project management can strategically and operationally cope with uncertainty, increase portfolio and project success, and thereby support an organization's successful adaptation. In regards to the strategic decision-making of portfolio management, I empirically reveal that decision-makers can effectively cope with projects' and environment's uncertainty through real options reasoning and thereby increase portfolio innovativeness and success. Furthermore, I show that portfolios consisting of agile projects benefit the valuable recognition of emergent strategies. In addition, I highlight the important role of entrepreneurial orientation and innovation climate as antecedents and moderators of portfolio management decisions. In regards to the operational implementation of a portfolio's strategy, I investigate how portfolio and project managers can cope with projects' uncertainty in their operational decisions. I show that project management effort causally increases projects' profitability and that the marginal impact of project management effort increases for higher project complexity. Furthermore, I show that project managers' reporting behavior is significantly associated with projects' future performance. This dissertation contributes new insights on portfolio and project management in general and portfolio management's strategic and operational decision-making under uncertainty in particular. Furthermore, it adds new aspects to the interaction between portfolio and project management and thereby opens up new perspectives on behavioral and contextual decision-making in portfolio and project management.

Keywords: Project portfolio management, decision-making, project management, uncertainty, real options reasoning, emergent strategy, agile projects, project status reporting

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Chapter 1

Introduction

1.1 Motivation

In today's global and interconnected business environment, firms are constantly challenged to cope with uncertainty and adapt to a changing environment to remain successful (Bennett & Lemoine, 2014; Sarta, Durand, & Vergne, 2021). Although adaptation, owing to its prominent role for strategic management, has been a highly-researched subject in management literature (e.g., Chakravarthy, 1982; Sarta et al., 2021), recent developments have once again highlighted that it remains decisive for organizations' short and long-term success. The advancing globalization consistently enlarges the playing field for firms and increases the challenges for established business models and organizations. In emerging countries, particularly in China, new firms are catching up to once established market leaders (Williamson, Guo, & Yin, 2021). New and drastically advanced technologies disrupt entire industries (e.g., shift to electric vehicles in the mobility sector) and force firms to adjust their product offering (e.g., Yuan & Cai, 2021). Furthermore, the digitization decreases market entry barriers for new competitors, creates entirely new opportunities, and requires established firms to re-think their business models (Chen, Visnjic, Parida, & Zhang, 2021; Verhoef et al., 2021). Lastly, uprising megatrends, very notably sustainability and carbon-neutral production, present firms with

pressing challenges as well (e.g., Reed & Moses, 2021). Thus, it is not surprising that a recent survey revealed that CEOs expect decision-making and implementation agility to become an even more important driver of productivity in the upcoming years (Mischke et al., 2021).

While coping with uncertainty and driving adaptation are key challenges for organizations' top-level management, these challenges also translate to organizations' project portfolio management since project portfolios constitute the entities in organizations to develop new opportunities and implement an organization's adapted strategy (Cooper, Edgett, & Kleinschmidt, 2001; Kopmann, Kock, Killen, & Gemünden, 2017; Petit, 2012). For portfolio management, an organization's overarching strategy sets the boundaries regarding which projects to select, prioritize, and terminate (Meskendahl, 2010). By choosing the suitable selection of a portfolio's projects, portfolio management drives the implementation of an organization's deliberate strategy (Cooper et al., 2001; Kopmann et al., 2017; Unger, Kock, Gemünden, & Jonas, 2012). However, when implementing an intended strategy, portfolio managers are faced with the uncertainty of their portfolio's external environment and projects' future development (Martinsuo, Korhonen, & Laine, 2014). At the time managers decide on the selection of projects to initiate, projects' final success is still unknown and portfolio managers need to make their decisions considering projects' uncertain outcomes (McNally, Durmuşoğlu, & Calantone, 2013). This challenge particularly applies to innovative projects that are especially valuable for a portfolio's future development but are also especially uncertain.

In addition to their key role in enabling organizations to implement intended strategic changes, project portfolios also take a key role in recognizing changes and valuable opportunities (Killen, Jugdev, Drouin, & Petit, 2012). These emergent strategic initiatives are unintended patterns that form independently in the stream of actions and decisions by the actors in an organization (Mintzberg & Waters, 1985). In project portfolios and their management, emergent strategic initiatives also arise and constitute valuable learning opportunities for the organization (Killen & Hunt, 2010) and their recognition is positively associated with portfolio success (Kopmann et al., 2017). Recognizing emergent initiatives could become even more important in the context of elevated uncertainty, since planned and fixed approaches, such as deliberate strategy implementation, then decrease in effectiveness (Kopmann et al., 2017). In this regard, agile practices, which have become increasingly popular in literature and practice as a response to turbulent and uncertain environments, could further increase emergent strategy's relevance

(Dybå & Dingsøyr, 2008). Agile practices as a way to structure and manage projects originally emerged in software development projects as an iterative work structure with close customer interaction and regular interim products (Beck et al., 2001). They have since gained popularity for a variety of project types and their potential benefits for portfolio success have also been suggested (Sweetman & Conboy, 2018). Through agile projects' elevated autonomy and interaction with other agile projects in project portfolios, they could jointly create a more adaptive portfolio and thereby potentially facilitate emergent strategy recognition.

Operationally, the success of an organization's adaptation through its project portfolio depends on projects' success. While portfolio management is required to select suitable projects that contribute to portfolio strategy, it is the projects that ultimately implement the strategy and enable the intended adaptation (Cooper et al., 2001). Thus, successfully completing a portfolio's projects is crucial for its organization. Particularly for the increasingly popular project-based organizations (PBOs) that conduct their business through projects, projects' success is decisive for their economic success (Hobday, 2000). To achieve project success, organizations traditionally rely on the established approaches and methods of project management (Carvalho, Patah, & Souza Bido, 2015; Ika, 2009). However, the challenges of elevated uncertainty and complexity that drive adaptation also increase the challenges for project managers in their day-to-day work regarding how to decide on their project's planning and structuring to achieve their goals and ensure successful project completion (Fortune & White, 2006; Maylor & Turner, 2017). Furthermore, project managers compete with the portfolio's other projects for overall scarce resources. While projects' future development is uncertain, project managers still have an information advantage over portfolio decision makers on their project's current status (Iacovou, Thompson, & Smith, 2009). Being torn between their own and portfolio managers' motivations, they also need to decide on how to present their project towards portfolio management to achieve project success.

Concluding, the management of portfolios and their projects takes a decisive role in organizations' adaptation process by implementing and recognizing strategic initiatives, as well as by delivering the operational value through the successful execution of suitable projects. The pressure for organizations to adapt to and cope with uncertainty also challenges portfolio and project management in their strategic and operational decision-making. Thus, in this dissertation, I investigate how portfolio and project management's strategic and operational

decision-making under uncertainty can support organizations' adaptation to achieve short- and long-term success.

1.2 Research Gap and Research Questions

Following the challenges for organizations to adapt in an uncertain environment, project portfolios and their projects have to be investigated in light of elevated uncertainty and complexity, as well. Prior literature generally emphasizes the vital role of project portfolios in organizations' ability to adapt to a changing environment (McNally, Cavusgil, & Calantone, 2010). Project portfolios need to dynamically adjust to cope with the external and internal uncertainty (Petit, 2012) and are suitable to set dynamic capabilities into action (Killen et al., 2012; Sicotte, Drouin, & Delerue, 2014). Furthermore, project portfolio management through its capabilities, processes, and people, can be considered a dynamic capability itself (Killen et al., 2012). Uncertainty, in turn, constitutes an important challenge for project portfolio decision-making, processes, and success (Behrens, Ernst, & Shepherd, 2014; Killen et al., 2012; Kock & Gemünden, 2016; Kopmann et al., 2017; McNally et al., 2013; Voss & Kock, 2013).

As part of deliberate strategy implementation, portfolio managers are challenged to select, maintain, and successfully complete suitable projects that implement portfolio strategy (Cooper et al., 2001; Killen et al., 2012; Meskendahl, 2010). However, deciding on the suitable project selection becomes increasingly ambiguous with elevated levels of uncertainty since at the time of a project's selection it is yet unknown whether it will ultimately turn out as a success (Criscuolo, Dahlander, Grohsjean, & Salter, 2017; McNally et al., 2013). The challenges of uncertainty particularly apply to innovative projects which offer a higher potential return but are also more uncertain (Midler, 2013; Schultz, Salomo, de Brentani, & Kleinschmidt, 2013). One behavioral approach that has received significant attention in prior literature as a way to cope with the challenges of project uncertainty is real options reasoning (ROR) (e.g., Andries & Hünermund, 2020; Klingebiel & Adner, 2015). ROR means that portfolio managers make tentative, sequential project investments with low commitment to prior resource allocations, terminate projects that turn out unfavorable, and constantly reallocate resources to the most promising projects (Klingebiel & Adner, 2015). Thereby, ROR allows decision makers to reserve the right, but not the obligation, to execute or terminate a project at a later point in time (Adner & Levinthal, 2004b; McGrath, 1997; McGrath, Ferrier, & Mendelow, 2004). Managers

can then rather effortlessly initiate an innovative project and remain only loosely committed. If the project does not develop as planned, portfolio managers can terminate it and use the released resources for more promising innovative projects. While the benefits of ROR have been discussed on an organizational level (e.g., Andries & Hünermund, 2020; Klingebiel & Adner, 2015), its effects as a behavioral approach to cope with uncertainty for portfolio innovativeness and portfolio success, considering a portfolio's characteristics and contexts, are still unclear.

In addition to deliberate strategy implementation, recognizing valuable emergent strategic initiatives in the portfolio also contributes to portfolio success and becomes increasingly important in turbulent environments (Kopmann et al., 2017). Emergent strategic initiatives describe strategic impulses which arise unintentionally in a stream of decisions and actions (Mintzberg, 1978). In project portfolios, emergent strategy recognition might become particularly relevant in the context of the increasing popularity of agile practices. As a potential approach to increase flexibility and shorten development times, agile practices have received significant attention in recent literature on project (Dybå & Dingsøyr, 2008) and portfolio management (Cooper & Sommer, 2016; Cooper & Sommer, 2020; Stettina & Hörz, 2015). However, while agile practices have been discussed for individual projects, the implications of an increasing share of agile projects in portfolios for strategy processes and the relation with a portfolio's contexts have largely been neglected so far (Stettina & Hörz, 2015; Sweetman & Conboy, 2018). Through agile projects' elevated level of autonomy, their frequent interactions with their respective customers and other agile projects in the portfolio, their managers and team members might be particularly conducive to detect and propose valuable strategic initiatives (Malik, Sarwar, & Orr, 2021). However, while studies investigated agile projects (e.g., Gemino, Horner Reich, & Serrador, 2021; Malik et al., 2021; Serrador & Pinto, 2015) and portfolio strategy processes (e.g., Kock & Gemünden, 2021; Kopmann et al., 2017; Unger et al., 2012), and even agile portfolios (e.g., Stettina & Hörz, 2015; Sweetman & Conboy, 2018, 2019), prior literature has not investigated the relevance of agile practices for emergent strategy recognition - despite their potential synergies.

When investigating portfolio management's strategic decision-making under uncertainty, it is necessary to account for portfolios' organizational contexts, since they significantly interact with portfolio processes and shape managers' decision-making (Gemünden, Lehner, & Kock, 2018; Kock & Gemünden, 2021; Kock, Heising, & Gemünden, 2015; Schultz, Salomo,

de Brentani, & Kleinschmidt, 2013). Portfolio management relies on portfolio actors' behavior and decision-making since portfolio managers and project team members through their decisions and actions determine the actual execution of intentions and formal processes (Martinsuo, 2013; McNally et al., 2013; McNally, Durmusoglu, Calantone, & Harmancioglu, 2009). Their attention and behavior, in turn are shaped by their respective contexts (Barnett, 2008; Ocasio, 1997). Thus, in this dissertation, I consider an organization's strategic and cultural contexts for portfolio management's strategic decision-making. On the one hand, portfolios are shaped by the firm's strategic orientation that is set by the firm's overall management (Cooper et al., 2001; Kock & Gemünden, 2021). The portfolio's strategic context describes the organization's overall strategic posture, for example, in regards to an entrepreneurial orientation (Covin & Slevin, 1991). Besides the portfolio's strategic context, the organization's culture also shapes portfolio processes and employees' behavior (Kester, Griffin, Hultink, & Lauche, 2011; Kock et al., 2015; Stock, Six, & Zacharias, 2013). An organization's culture and the empowerment that employees receive also determine their behavior and most likely interact with the aforementioned concepts of portfolio processes (Kester et al., 2011; McNally et al., 2013). An appropriate culture can support employees' interventions and turn each individual's specific knowledge into beneficial influences for strategic initiatives and creative ideas (Amabile, Conti, Coon, Lazenby, & Herron, 1996).

Concluding the literature gap on portfolio management's strategic decision-making under uncertainty, I pose the first research question as follows:

> ***Research Question 1:*** *How can portfolio managers strategically adapt their project portfolio under uncertainty and achieve portfolio success while considering a portfolio's strategic and cultural contexts?*

In addition to a portfolio management's strategic decision-making, portfolio and project managers' successful operational decision-making ultimately delivers portfolio success. Apart from projects' strategic fit, projects' value maximization is one of portfolio management's core goals (Cooper, Edgett, & Kleinschmidt, 2004; Kester, Hultink, & Griffin, 2014; McNally et al., 2009). Ultimately, portfolios' projects are responsible for delivering operational value and turning strategic intentions into action (Jonas, Kock, & Gemünden, 2013). However, portfolio

and project managers also face the challenge to cope with projects' complexity and uncertainty in their operational decision-making to achieve successful project execution (Geraldi, Maylor, & Williams, 2011; Perminova, Gustafsson, & Wikström, 2008). Traditionally, project management has been considered as an effective approach to cope with projects' complexity and ensure project success (Carvalho et al., 2015). However, although it is widely considered as highly effective, a quantitative, causal demonstration of project management's capability is surprisingly missing in extant literature (Thomas & Mullaly, 2007). The majority of research on project management's contribution is limited to correlational findings and does not offer insights into project management's marginal impact on project success (e.g., Carvalho et al., 2015; Fortune & White, 2006; Lappe & Spang, 2014). Furthermore, the potentially varying effectiveness of project management depending on a project's complexity has not been sufficiently investigated, yet. Thus, it remains unclear to what extent project management constitutes an effective approach for organizations to cope with projects' uncertainty and complexity and ensure the successful implementation of adaptation efforts. This gap is highly relevant since projects' popularity is constantly growing (Schoper, Wald, Ingason, & Fridgeirsson, 2018), they implement strategic change, and, increasingly, they affect business success directly. Particularly in project-based organizations (PBOs), business is structured in projects which means that projects' success directly affects the overall organization's business success (Hobday, 2000; Whitley, 2006).

In addition to managing complexity, project managers also constantly need to decide on how to present their uncertain project to portfolio managers who determine whether to continue or terminate it. Portfolios' resources are scarce and projects compete with each other which challenges project managers to be successful (Meskendahl, 2010). While project managers constitute agents for portfolio management and are expected to act in their best interests, they also pursue their own goals and are subsequently tempted to exploit their information advantage on their projects' current status to achieve them (Müller & Turner, 2005). In regular steering committee meetings, project managers present updates on their projects and request portfolio management's approval (Iacovou et al., 2009). In this communication, they might use their information advantage to intentionally or unintentionally report the current project status, which is generally hard to assess, more optimistically or more pessimistically than it actually is (Snow & Keil, 2002). While prior studies on status reporting behavior coherently share the conclusion that skewed reporting behavior, particularly optimistic reporting behavior, negatively affect

project performance (e.g., Park, Im, & Keil, 2008; Smith, Thompson, & Iacovou, 2009; Thompson, Smith, & Iacovou, 2007), a quantitative analysis of optimistic (i.e., presenting the status more positively than it actually is) or pessimistic (i.e., presenting the status as more negatively than it actually is) reporting behavior's performance effects on future project performance is surprisingly missing in prior literature. Thus, it remains unclear how project managers should assess the uncertainty of their project and how they should report their project's current status.

Concluding the literature review on the operational challenges of achieving project success and thereby supporting the successful adaptation of the portfolio and organization, I pose the second research question as follows:

> ***Research Question 2:*** *How can portfolio and project managers successfully cope with projects' uncertainty and achieve project success?*

1.3 Conceptual Background: Portfolio and Project Management

1.3.1 Project Portfolio Management

An organization's project portfolio constitutes the collection of its projects that share the same resources (Meskendahl, 2010). Project portfolio management is responsible for structuring and steering the portfolio and distributing its scarce resources. The portfolio management process can be divided into portfolio structuring, resource management, and portfolio steering phases (Beringer, Jonas, & Kock, 2013). In the portfolio structuring phase, portfolio management aims at a portfolio composition that maximizes the portfolio's value for the organization (Jonas et al., 2013; McNally et al., 2009). In practice, portfolio structuring usually follows a heuristic process that relies on estimations based, for example, on the project's net present value (Dixit & Pindyck, 1994; Nelson & Winter, 1977). As part of resource management, portfolio managers assign resources to the selected projects while considering project interdependencies (Blichfeldt & Eskerod, 2008). Lastly, the portfolio steering phase summarizes the continuous monitoring and guiding tasks regarding the portfolio's ongoing projects (Blichfeldt & Eskerod, 2008; Müller, Martinsuo, & Blomquist, 2008; Unger et al., 2012). At periodic meetings, project

managers present the current project status and can request decision approval for the portfolio steering committee's other planned actions.

The goal of portfolio management is to achieve portfolio success. Portfolio success is a multi-dimensional construct that is highly-established in literature (Cooper et al., 2001; Kester et al., 2014; Kock et al., 2015). Its first dimension, strategic implementation success, describes the degree of alignment between the portfolio's project and the firm's overall strategy (Kock et al., 2015; McNally et al., 2013). Following the overall strategy, portfolio managers should determine suitable project evaluation criteria and select projects that fit and implement the firm's overall strategy. The second dimensions, portfolio balance, describes the degree of balance across portfolio projects' risks, time horizon, or content (Cooper et al., 2001; Kester et al., 2014). While all strategic directions should be covered through respective projects, portfolio managers should strive for an overall diversified portfolio. This allows to use the potential of multiple projects by diversifying their risks and preparing for a variety of potential future developments. The third dimension, realization of synergies, describes that in addition to a diversified portfolio, managers should also realize the potential value synergies between projects (Jonas et al., 2013). Furthermore, the fourth dimension, average product success, refers to projects' commercial success (Cooper et al., 2001; Kock et al., 2015). In general, managers should strive to maximize the overall value across the portfolio's projects by ensuring that projects achieve their individual objectives and deliver successful products. Lastly, the fifth dimension, future preparedness, refers to the longest-term success of a portfolio. In general, portfolio managers should also incorporate highly innovative projects that open up valuable opportunities for the distant future (Meskendahl, 2010; Shenhar, Dvir, Levy, & Maltz, 2001).

The portfolio is part of the organization and interacts with the external environment and its organization's characteristics (Kock & Gemünden, 2016). In this dissertation, I focus on the firm's internal strategic and cultural portfolio contexts since they particularly shape portfolio actors' behavior and decision-making (Barnett, 2008; Kock et al., 2015; Kock & Gemünden, 2016). Regarding the strategic context, I focus on the prominent concept of entrepreneurial orientation, which is highly relevant for firms' strategy, portfolio actors' behavior, and portfolio success (Baker, Grinstein, & Harmancioglu, 2016; Kock & Gemünden, 2021) and constitutes a highly researched construct in entrepreneurship research (Rauch, Wiklund, Lumpkin, & Frese, 2009). It describes the characteristics of a firm that actively pursues innovation, accepts risks,

and deliberately enters new markets (D. Miller, 1983). In this dissertation, I follow the definition of Covin and Slevin (1991) since this is the most applied definition in literature (Rauch et al., 2009; Rosenbusch, Rauch, & Bausch, 2013). Accordingly, three characteristics determine the entrepreneurial orientation of a firm. First, it has to pursue innovativeness (e.g., by constantly innovating their product portfolio), second, it has to act proactively (e.g., by actively pursuing opportunities), and third, it has to accept a certain degree of risk (e.g., the risk associated with new ventures) (Covin & Slevin, 1991).

Besides the strategic context, the cultural context also shapes portfolio actors' behavior and decision-making (Kester et al., 2011). In this dissertation, I focus on two cultural contexts of project portfolios that are particularly relevant in the context of the elevated uncertainty and strategic and operational success. Innovation climate describes the support that employees receive to propose and pursue innovative ideas which is highly relevant for portfolio management (Amabile et al., 1996; Kock et al., 2015; Kock & Gemünden, 2016). Regarding this dissertation's research focus, innovation climate most likely interacts with portfolio actors' behavior when facing uncertainty and discovering promising new strategic initiatives (Barnett, 2008). In addition to innovation climate in general, an organization's voice behavior is also an important contingency factor shaping portfolio actors' behavior. Voice behavior describes the voicing of constructive work-related ideas or concerns to senior management by employees (Morrison, 2011). Following the conceptualization of Liang, Farh, and Farh (2012), voice behavior can be divided into promotive and prohibitive voice behavior. Promotive voice behavior relates to the expression of constructive new initiatives, prohibitive voice behavior relates to raising concerns to stop a certain action that is perceived to be harmful to the organization (Liang et al., 2012). Since voice behavior is a strong determining factors of employees' behavior, it also constitutes a highly relevant factor for the behavior of portfolio actors and thus for portfolio adaptation processes and overall performance.

1.3.2 Projects as parts of the portfolio

Projects constitute portfolios' elements and their development and success strongly determines the portfolio and organization's overall adaptation success (Cooper et al., 2001). Project success is a multi-dimensional construct which has continuously evolved in project management literature (Baccarini, 1996; Ika, 2009). In general, project success differs from the traditional project management success, which is commonly defined as the iron triangle, i.e., the project

management's efficiency in terms of the achieved adherence to planned scope, time, and budget (Atkinson, 1999; de Wit, 1988). Project success, in turn relates to projects' final effectiveness and efficiency and thus to achieving product success (Belout, 1998; Ika, 2009; Shenhar & Dvir, 2007). In this regard, projects' final economic success constitutes a decisive factor for portfolio and also firm success, especially if a firm structures its business in the form of projects (Cooper et al., 2001; Scott-Young & Samson, 2008). The higher the economic success of a project, the higher is the value of the associated portfolio and thus also its contribution to the firm's overall business success. Especially for project-based organizations that undertake their business in the form of projects, each project's economic success is essential for the firm's long-term existence (Hobday, 2000).

The widely established approach to achieve project success is project management (Carvalho et al., 2015; Thomas & Mullaly, 2008). Project management includes a variety of practices, for example, scope, risk, or stakeholder management, that are intended to structure and coordinate work tasks and information, decrease complexity and uncertainty, and ensure an overall successful project execution (Ika, 2009; Project Management Institute, 2017). Many practices of project management, for example risk management, have also been identified as critical success factors; referring to practices that are significantly related to project performance (Fortune & White, 2006). Besides their operational project management tasks, project managers also need to coordinate their project's progress and information with the portfolio steering committee and portfolio managers who have the overview of all portfolio projects and hold the authority to allocate resources and initiate or terminate projects (Iacovou et al., 2009).

One of the key objectives and challenges of project management is to cope with a project's complexity (Maylor, Turner, & Murray-Webster, 2013; Shenhar, 2001). Project complexity is also a multi-dimensional construct that incorporates structural, emergent, and sociopolitical elements (Geraldi et al., 2011; Maylor et al., 2013). The structural components include mainly projects' general characteristics, for example, its size (Shenhar, 2001), interdependence with other projects (Chapman & Hyland, 2004), or its product (Bolaños & Barbalho, 2021). The emergent components then describe the dynamics of the structural elements. The more often project's structural characteristics change and the uncertain they are, the more complex it is to manage (Geraldi et al., 2011). Lastly, socio-political elements include complexity arising through the social interaction with stakeholders, team members and customers (Maylor et al.,

2013). To achieve project success, project managers directly and portfolio managers indirectly need to overcome the challenges arising through complexity in their operational decision-making.

1.4 Overview of Dissertation

This dissertation is structured into two parts, following the two research questions on portfolio and project management's strategic and operational challenges of coping with uncertainty and achieving portfolio and project success. In total, four research studies were executed with two studies covering the strategic and two studies covering the operational perspective of portfolio management. The first part of the dissertation covers the strategic challenges of how portfolio managers can cope with uncertainty and successfully adapt the portfolio considering portfolios' strategic and cultural contexts. Following the established bi-directional deliberate and emergent strategy process in project portfolios, research studies A and B each cover one direction of the strategy process. Research study A investigates how portfolio managers can successfully cope with projects' uncertainty and implement deliberate strategy through ROR. Research study B investigates the relevance of emergent strategy recognition in agile portfolios. Since both studies focus on portfolios and their management, they also consider portfolios' contexts. The second part of this dissertation then focuses on the challenges of portfolio and project managers' operational decision-making to achieve project and subsequently portfolio success. Research study C investigates how portfolio and project managers can successfully cope with project complexity and achieve project success through project management effort. Research study D explores the performance consequences of project managers' optimistic and pessimistic reporting behavior in their communication with portfolio management. Figure 1 summarizes the structure of the dissertation with the two perspectives and the respective studies. Below, I elaborate on each research studies' approach, hypotheses, and findings.

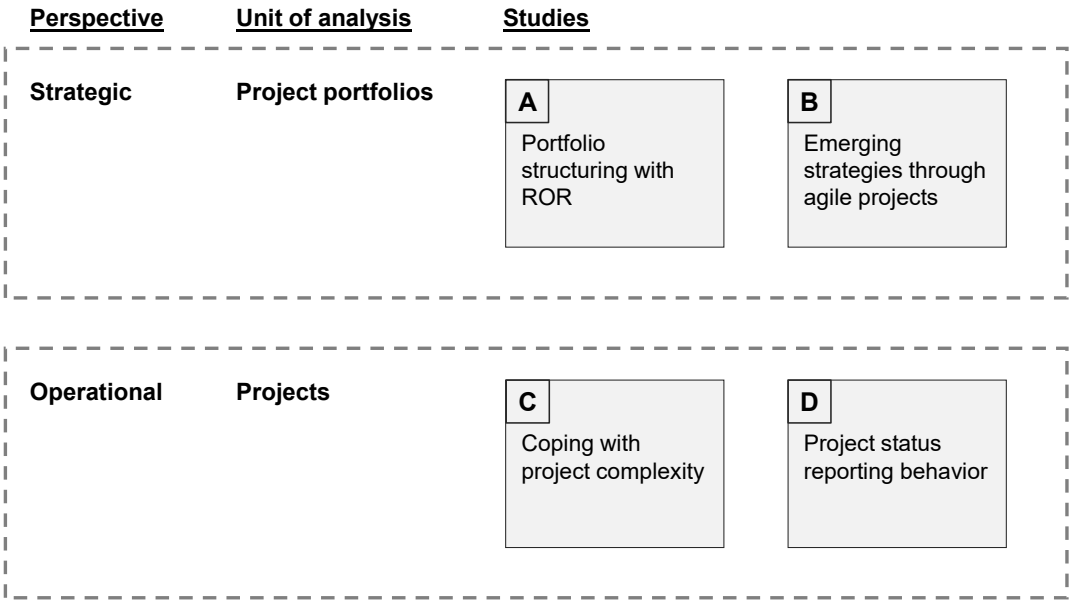

Figure 1. Overview of this dissertation's studies.

A detailed overview of the four studies with their respective research questions, unit of analysis, data sets, and methodical approaches is presented in Table 1. The first two studies contribute insights to the investigation on the strategic perspective. Accordingly, their investigations are based on a dataset of a large project portfolio management survey that constitutes of three informants: One decision-maker who evaluated portfolio success and strategic factors of portfolio management (e.g., business unit leader, CEO), one coordinator who evaluated portfolio characteristics and processes (e.g., manager in the project management office), and multiple project managers who gave their assessment on the respective organizational climate. The two studies on the operational perspective of portfolio adaptation build on a dataset consisting of a large number of project status report data of a PBO that offers complex industrial products. The data is a copy of the company's standardized database in which all project managers log their monthly project status data. We use the accumulated data for each completed project in research study C and the monthly status data of all projects in research study D.

Table 1. Detailed information on this dissertation's studies.

Study	Title	Unit of analysis	Research question	Data	Method
A	Strategic and cultural contexts of real options reasoning in innovation portfolios	Project portfolios	*How do strategic and cultural contextual structures moderate ROR's influence on portfolio innovativeness and, eventually, on portfolio success?*	Project portfolio management survey	Hierarchical regression analysis with 137 project portfolios
B	Emerging strategy recognition in agile portfolios	Project portfolios	*What is the relevance of agile capabilities for strategy emergence and success in project portfolio management?; What are the organizational antecedents of agile capabilities in portfolios?*	Project portfolio management survey	Structural equation modelling with 135 project portfolios
C	Does project management matter? The relationship between project management, complexity, and profitability	Projects	*How does project management effort affect project success for different levels of project complexity?*	Project status reports	Hierarchical regression analysis with 917 project status reports and a control function approach
D	On tomatoes and watermelons – The performance effects of optimistic and pessimistic project status reporting behavior	Projects	*How does optimistic and pessimistic status reporting behavior affect future project development?*	Project status reports	Panel regression analysis with 46,474 project status reports from 1,229 projects

Research Study A investigates the effects of Real Options Reasoning (ROR) as a behavioral approach to cope with innovative projects' uncertainty while considering portfolios' strategic and cultural contexts. The challenge for portfolio management is to effectively manage innovative projects which may offer a higher yet more uncertain return (McNally et al., 2013; Schultz, Salomo, de Brentani, & Kleinschmidt, 2013). At the time of project selection, innovative projects' final success is yet unknown and a fully-committed project investment might ultimately turn out as a loss. As a potential solution, when applying ROR – a behavioral approach based on real option principles – managers follow a tentative, structured project investment approach to cope with project's uncertainty by limiting their risks while simultaneously reserving their full upside potential (McGrath et al., 2004). According to Klingebiel and Adner (2015), ROR comprises three elements that jointly define it: (i) managers split the project investment in multiple tranches sequentially over time; (ii) managers hold a low commitment to prior investment decisions and consequently cancel a project's future investment if it turns unfavorable; and (iii) managers constantly reallocate investment from unfavorable to more favorable project options. This generally increases firms' flexibility and innovation success (Klingebiel & Adner, 2015). However, in the context of project portfolios it remains unclear how ROR, as a behavioral approach relying on portfolio actors' behavior, affects portfolio innovativeness and success (Andries & Hünermund, 2020; Barnett, 2008).

Since ROR is a behavioral approach, its potential contribution depends on portfolio actors' behavior and decision-making, which in turn is determined by a portfolio's contexts (Barnett, 2008). Portfolio actors have a limited attention focus; what they focus their attention on determines their behavior and the organizational contextual structures determine which influences could come to the attention of portfolio actors (Ocasio, 1997). Owing to their relevance for portfolio management, the study focuses on a firm's entrepreneurial orientation as strategic and its innovation climate as cultural contextual structure. In general, we hypothesize that ROR, through its characteristics to cope with uncertainty through a low commitment, constant uncertainty reduction and selection of most promising projects in the portfolio, enables portfolio managers to venture into more innovative but also more uncertain projects. This should increase portfolio innovativeness and ultimately portfolio success. Regarding the contextual structures, we hypothesize that entrepreneurial orientation and innovation climate both positively moderate the relationship between ROR and portfolio innovativeness. A strong entrepreneurial orientation most likely encourages portfolio managers

to select more innovative projects, more actively act on decreasing their uncertainty, and fully committing to them earlier (Barnett, 2008). A strong innovation climate, on the other hand, most likely encourages portfolio employees to propose and managers to approve more innovative projects, as well as provide emotional support for teams that are involved in a terminated project (Barnett, 2008; Shepherd, Haynie, & Patzelt, 2013).

We test our hypotheses with a sample of 137 innovation portfolios with three informants for each portfolio. We find a strong relationship between portfolio innovativeness and portfolio success. This conforms prior findings that innovativeness secures firms long-term strategic success (Schultz, Salomo, & Talke, 2013; Talke, Salomo, & Kock, 2011). Furthermore, we find that ROR is positively related to innovativeness. Thus, ROR indeed enables managers to venture more innovative projects. Regarding a portfolio's contextual structures, we find support for a positive moderation of entrepreneurial orientation. A firm's strong focus on proactiveness, innovativeness, and risk-taking therefore enhances ROR's beneficial effects for portfolio innovativeness. Furthermore, regarding the indirect relationship between ROR through innovativeness on portfolio success, we find that a sufficiently high level of entrepreneurial orientation is necessary for ROR to be positively related to portfolio success. On the other hand, we find no significant moderating effect of innovation climate. Although a high innovation climate supports employees to pursue innovative ideas, it does not elevate ROR's effects for innovativeness. In this regard, it is especially relevant to note that ROR is a financial, rather strict approach that might collide with the creative, more flexible pursuit supported by innovation climate. Overall, this study shows that ROR constitutes a suitable way to cope with innovative projects' uncertainty and venture more innovative projects. Furthermore, the results underline that the organizational context plays a highly relevant role for ROR's indirect effect on portfolio success. Especially entrepreneurial orientation generally elevates ROR's benefits and a sufficiently high level of entrepreneurial orientation is necessary for ROR to indirectly increase portfolio success, too. Thus, ROR might not be suitable universally to all firms but especially to firms that pursue an overall entrepreneurial strategic gestalt.

Research Study B investigates the relationship between agile capabilities (i.e., the competence in and the application of agile practices) and emerging strategy recognition for portfolio success. In addition to deliberate strategy implementation, emerging strategy recognition has been shown to be highly relevant in portfolio management, too (Kopmann et al., 2017). In general,

emergent strategic initiatives describe those strategic initiatives that arise unintentionally, usually bottom-up (Mintzberg, 1978; Mintzberg & Waters, 1985). Through emergent strategy recognition, the proactive identification and implementation of emergent initiatives, portfolio management can recognize valuable strategic opportunities and increase portfolio success (Kopmann et al., 2017). The rising trend of agile practices in projects and portfolios could turn out to be particularly synergetic for emergent strategy recognition. Agile projects have a higher autonomy and its team members interact more frequently with their customers and consistently exchange information with other projects in the portfolio (Sweetman & Conboy, 2018). Through their high level of interactions, a portfolio's agile projects jointly form a complex adaptive system (CAS) which is able to adapt itself to a challenging environment (Holland, 1992; Sweetman & Conboy, 2018). Furthermore, through the dynamic relationships between individuals and projects, valuable strategic initiatives could arise which could benefit portfolio success. Thus, we hypothesize that agile practices enhance emerging strategy recognition which then positively affects portfolio success. An agile portfolio is generally connected to a higher level of interaction within and between agile projects. Through the higher interaction as a CAS, we expect more strategic initiatives to be discovered and to emerge (Uhl-Bien & Arena, 2017). Furthermore, established firms which already apply agile practices at scale specifically implement structures to collect and distribute knowledge (Bäcklander, 2019). Especially in agile portfolios, project members closely work with their customers and therefore are likely to have more thorough and up-to-date understanding of their customers' demands.

Following the hypothesized beneficial consequences of agile capabilities, the question arises how organizations can foster and encourage them. Since projects' individuals take a key role in the network formation, the organization's overall strategic and cultural characteristics shape their thinking and doing. In particular, we expect a firm's entrepreneurial orientation to encourage individuals to propose and accept agile capabilities. The characteristics of a high entrepreneurial orientation match well to the requirements of agile projects (e.g., higher autonomy and self-organization) (Dybå & Dingsøyr, 2008; Ireland, Hitt, & Sirmon, 2003). Thus, we assume individuals in organizations with high entrepreneurial orientation to accept these requirements more readily. Similarly, we expect a firm's voice behavior to drive individuals' communication, the essential element of agile projects (Dybå & Dingsøyr, 2008; Schwaber & Beedle, 2002). A strong voice behavior encourages individuals to speak up about opportunities which should benefit agile capabilities (Liang et al., 2012). In addition, a strong

voice behavior is expected to enhance the exchange of information between a portfolio's agile projects. Lastly, a strong voice behavior of an organization's employees should also lead to a higher demand for agile practices in the portfolio.

We investigate the relationships using a survey sample of 135 project portfolios with multiple informants for each portfolio (one decision maker, one coordinator, and multiple project managers). We find a strong positive relationship both for entrepreneurial orientation and agile capabilities as well as voice behavior and agile capabilities. Furthermore, agile capabilities are positively related to emerging strategy recognition, which again is positively related to portfolio success. The indirect effects of agile capabilities through higher emerging strategy recognition on portfolio success are significant, as well as the indirect effects of entrepreneurial orientation on emerging strategy recognition and portfolio success. The indirect effects of voice behavior on emerging strategy recognition are significant as well, while the indirect effects on portfolio success are not. Overall, this underlines the strategic importance of agile capabilities. Through their high level of autonomy and interaction with their stakeholders and other projects, portfolios consisting of agile projects provide a stimulating environment for emergent strategic impulses. An organization's orientation with a focus on innovation and employee support helps to establish agile practices as well as use agile practices for emerging strategy recognition. This benefits the organization's strategic adaptation process.

Research Study C investigates how portfolio and project managers can successfully cope with projects' complexity and increase their profitability through adequate project management effort. The crucial importance of project management for project success seems self-evident, however, surprisingly few studies have actually investigated the value of project management for projects and organizations (e.g., Thomas & Mullaly, 2007). There is substantial research on selected critical success factors in project management or on the correlational relationship between project management and success (e.g., Fortune & White, 2006; Ika, 2009; Lappe & Spang, 2014). However, the causal impact of project management, its marginal effects, and its interaction with project complexity have not been thoroughly investigated through quantitative studies, yet. Thus, in this study, we investigate the value of project management for organizations offering causal insights into the marginal effects of project management for different levels of complexity.

Following the original intentions leading to the formation of project management as a collection of structuring approaches for task, risk, resource, or team management to achieve project success, we hypothesize that, overall, project management leads to higher project profitability (Belassi & Tukel, 1996). Second, following the theory on performance frontiers, we hypothesize that project management increases projects' performance, however that its marginal effect decreases (Schmenner & Swink, 1998). Initially, project management offers a high improvement potential by providing basic structures and decreasing risks. However, increasing structure and clarity on a project's work decreases further improvement potential and thus the marginal contribution of project management. Regarding project complexity, we hypothesize that project management's effectiveness increases for higher levels of complexity since higher complexity connotes higher improvement potential for project management efforts.

The study uses a sample of objective project status data of 917 projects in a PBO offering engineer-to-order (ETO) products. Thus, for each project, we collected both data on cost and effort and also on the eventual financial success in terms of profitability. For the analysis, we use a control-function approach with instrumental variables to draw causal relationships between project management and project profitability (Wooldridge, 2015). The results show that project management causally leads to higher project profitability. Furthermore, the results also support the hypothesized diminishing marginal effects as well as a positive interaction with project complexity. Overall, the results confirm that project management enables organizations to cope with elevated levels of project complexity and very importantly demonstrate that PBOs can increase their profitability by venturing more complex projects coupled with an adequate level of project management effort. The findings demonstrate project management's causal impact on project success and thereby respond to a major quest in prior literature (Thomas & Mullaly, 2007). Furthermore, we provide empirical evidence for the performance frontier in projects and their management (Schmenner & Swink, 1998).

Research Study D investigates how project managers' different status reporting behavior affects project future development and success. Projects compete with other projects for the same scare portfolio resources (Meskendahl, 2010). This competition also affects the interaction between project and portfolio managers. Operationally, project managers regularly present their project's progress in portfolio board meetings and negotiate for resources and support from portfolio steering committees. As a typical principal-agent problem, project

managers act as agents for portfolio management but have own goals and can exploit their information advantage about the project's current status to achieve them (Eisenhardt, 1989; Iacovou et al., 2009). Consequently, project managers might choose to report their project more optimistically (i.e., presenting the project as more positive than it actually is) or more pessimistically (i.e., presenting the project as more negative than it actually is) to achieve their goals. While prior literature coherently concludes that skewed reporting behavior negatively affects project success, no quantitative investigation on the performance effects of project managers' reporting behavior exists (e.g., Iacovou et al., 2009; Smith et al., 2009; Thompson et al., 2007).

We hypothesize that optimistic reporting behavior negatively affects a project's future success. Optimistic reporting behavior conceals potentially dangerous risks which then have more time to increase in severity (Jani, 2011). To the contrary, we expect that pessimistic reporting behavior positively affects future success since it serves as an early warning to address risks before they are inevitable (Snow, Keil, & Wallace, 2007). Furthermore, we hypothesize that the impact of both optimistic and pessimistic reporting behavior decreases over a project's duration since the degrees of freedom decrease and path-dependence of actions increases (Aaltonen, Ahola, & Artto, 2017). Last, we expect repeated reporting behavior to increase the information gap between portfolio and project managers and, thus, negatively affect project's future success (Iacovou et al., 2009).

We use a sample of 46,474 project status reports in combination with a unique approach to first determine the reporting behavior (i.e., optimistic or pessimistic) for each status report and then calculate the quantitative effect of the reporting behavior on projects' success in three months. Very surprisingly, the results show that optimistic reporting behavior is associated with higher future project success, whereas pessimistic reporting behavior is associated with lower project success. A positive effect of optimistic reporting could mean that project managers can more effectively address risks and critical issues without interference from senior management. Furthermore, project managers who report optimistically might have higher self-efficacy or an information advantage that is not reflected in the quantitative data which allow them to foresee project's development more accurately. On the other hand, raising an alarm early through pessimistic reporting might increase a climate of fear in the project. This climate prevents cautious actors from making bold decisions to tackle project risks and return it to a good health.

Unwanted interference from portfolio management could also counteract with project managers' initiatives.

The results further support the theory of path dependence and confirm that the effect of optimistic reporting behavior decreases over the course of a project (Aaltonen et al., 2017). Pessimistic reporting behavior in turn is negatively associated with project's future performance in its early stages, in later stages, however, pessimistic reporting behavior is actually positively related to future project performance. Thus, in general, it is particularly decisive for a project's performance how managers portray the project in its first stages. In later stages however, pessimistic reporting might help to increase motivation of all involved team members and stakeholders to successfully complete the project. In addition, the results also support that repeated reporting behavior decreases reporting behavior's relationship with performance. Overall, the study provides novel insights into the consequences of status reporting behavior by revealing that optimistic and pessimistic reporting behavior have a significant relationship with projects' future performance.

Chapter 2 Research Study A

Strategic and cultural contexts of real options reasoning in innovation portfolios

Abstract:

Decision makers find creating an innovation portfolio challenging, because more innovative projects are associated with a higher degree of uncertainty. In this study, we investigate the potential benefits of applying real options reasoning (ROR) in innovation portfolio management from an attention-based view. Using a sample of 137 innovation portfolios with multiple informants, we investigate ROR's influence on portfolio innovativeness and, ultimately, on portfolio success in a mediated model. Further, we analyze the moderating influence of an innovation portfolio's organizational context − entrepreneurial orientation and innovation climate − on ROR's application. The results support ROR's positive relationship to portfolio innovativeness and portfolio success. The analysis also supports the positive interaction between entrepreneurial orientation and ROR with respect to portfolio innovativeness. This study contributes to the literature by demonstrating the relationship between ROR and portfolio success, mediated by portfolio innovativeness. In addition, the study's analysis offers an explanation of previously mixed findings regarding ROR's benefits by considering the firm's strategic and cultural innovation contexts. The findings underline the relevance of strategic support for ROR's effectiveness in innovation portfolio management. Furthermore, the findings encourage managers to implement ROR, but also stress the essential contribution an entrepreneurial orientation makes when the managers do so.

Classification in terms of this dissertation:

- **Perspective:** Strategic adaptation
- **Unit of Analysis:** Project portfolios
- **Sample:** Multi-informant project portfolio management survey (n = 137 portfolios)
- **Method:** Hierarchical regression modelling

Publication and Conference:

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Chapter 3 Research Study B

Emerging strategy recognition in agile portfolios

Abstract:

Agile practices become increasingly popular for projects and project portfolios offering firms a higher flexibility to adapt to dynamic environments. This study investigates the antecedents and consequences of agile practices' relevance for strategy formulation in project portfolio management processes. Building on complex adaptive systems theory, we hypothesize a positive relationship between agile capabilities and emerging strategy initiatives and eventually portfolio success. Agile capabilities refer to both the project portfolio organization's intensity of and competence in applying agile practices. Using a sample of 135 portfolios and multiple informants for each portfolio, the results support entrepreneurial orientation and voice behavior as antecedents for agile capabilities. Furthermore, the findings support an agile portfolio's positive relationship with emergence recognition and overall portfolio success. The findings contribute to the literature by identifying two significant antecedents of agile capabilities as well as empirically demonstrating the positive relationship between agile portfolios and emerging strategy recognition. For practitioners, the study encourages the application of agile practices by stressing the general positive influence of agile capabilities and underlines entrepreneurial orientation and voice behavior as important methods of empowerment for agile portfolio processes.

Classification in terms of this dissertation:

- **Perspective:** Strategic adaptation
- **Unit of Analysis:** Project portfolios
- **Sample:** Multi-informant project portfolio management survey (n = 137 portfolios)
- **Approach:** Structural equation modelling

Publication and Conferences:

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Presented at R&D Management Conference 2019, Paris, France. *Best paper of the conference award.*

Chapter 4 Research Study C

Does project management matter? The relationship between project management, complexity, and profitability

Abstract:

The purpose of this study is to explore the causal impact of project management on project profitability for varying degrees of project complexity in an engineer-to-order (ETO) project setting. We use a sample of 917 projects' status reports of a large firm that offers ETO products coupled with a control function approach to empirically investigate the causal effect of project management on projects' profitability. Furthermore, we investigate the marginal impact of project management and its effect for different degrees of project complexity. Our results reveal a positive but diminishing impact of project management effort on project profitability. Furthermore, we find that higher project complexity jeopardizes project profitability. However, project management's marginal impact increases with increasing project complexity, ultimately leading to higher returns of more complex projects. This study contributes to operations and project management literature and is, to the best of our knowledge, the first to demonstrate a causal impact of project management on profitability. The results offer unique insights into the economic benefits of project management while taking into account projects' complexity. The study confirms the benefits of project management efforts regarding project profitability and underlines the high relevance of project management for complex projects. It shows that firms can compensate higher ETO customization and higher project complexity through higher project management effort.

Classification in terms of this dissertation:

- **Perspective:** Operational adaptation
- **Unit of Analysis:** Projects
- **Sample:** Project status reports (n = 917 completed projects)
- **Method:** Hierarchical regression analysis

Publication and Conferences:

Kaufmann, Carsten; Kock, Alexander (2021): Does project management matter? The relationship between project management, complexity, and profitability. *Under review.*

Presented at European Academy of Management Conference 2019, Lisbon, Portugal, *IPMA PMI Best Student Paper Prize.*

4.1 Introduction

Product customization through an engineer-to-order (ETO) manufacturing approach enables firms to offer their customers individually configured products tailored to each customer's specific needs (Fogliatto, da Silveira, & Borenstein, 2012). In contrast to other approaches, ETO products are both engineered and manufactured uniquely according to each customer's requirements (Sousa, 2003). Owing to this uniqueness, firms offering ETO products typically process customer orders in the form of projects (Jalkala, Cova, Salle, & Salminen, 2010). However, with increasing degrees of product customization, ETO projects' complexity increases as well (Bolaños & Barbalho, 2021; Hegde, Kekre, Rajiv, & Tadikamalla, 2005; Salvador, Chandrasekaran, & Sohail, 2014). More sophisticated customer specifications provoke more complex, uncertain, and potentially interrelated engineering tasks (Amaro, Hendry, & Kingsman, 1999; Mello, Strandhagen, & Alfnes, 2015). This complexity can jeopardize ETO projects' success.

The traditional approach to cope with project complexity and achieve project success is project management (Carvalho et al., 2015). Initially, project management emerged to provide basic structuring and scheduling techniques and today includes a variety of managerial practices to maximize projects' outcomes (Belassi & Tukel, 1996; Project Management Institute, 2017). The effectiveness of project management is of fundamental relevance for research in operations and project management and for managers in practice (Thomas & Mullaly, 2007). Yet, literature falls short on essential aspects of project management's impact. First, a demonstration of project management's causal effect on project success is surprisingly missing in extant literature. As Thomas and Mullaly (2007) note on empirical studies on the value of project management, there are "[f]ew rigorous studies [that] have been undertaken and those that exist struggle to provide indisputable and strong evidence" (p. 74). The scarce empirical research on project management and success is mainly limited to correlational evidence regarding project management (e.g., Carvalho et al., 2015; Lappe & Spang, 2014; Zwikael & Sadeh, 2007) or selected project (management) aspects (e.g., Baker, Murphy, & Fisher, 2008; Balachandra & Friar, 1997; Fortune & White, 2006; Pinto & Slevin, 1987). Second, previous research does not consider project management's marginal effect, meaning that project management's impact might depend on the level of project management effort (e.g., Zwikael & Sadeh, 2007). Third, previous research does not consider the vital contingency of project complexity as a moderating

factor. This factor is especially relevant because, in general, project complexity poses a key challenge for project managers (Bolaños & Barbalho, 2021; Maylor et al., 2013), and, in particular, product customization and project-based business have become increasingly feasible and widespread (Haug, Ladeby, & Edwards, 2009).

This study addresses these shortcomings and quantitatively investigates the relationship between project management effort and project profitability while considering projects' complexity. We focus on project profitability as a particular aspect of project success since it constitutes a crucial success measure for external projects (Serrador & Turner, 2014; Shenhar & Dvir, 2007). Especially for firms that process their business through projects (e.g., project-based organizations that offer ETO products), positive project profitability is the deciding success measure to operate successfully in the long run. Furthermore, by incorporating the sales of a project, we can quantify the actual value that project management initiatives provide, which addresses a major quest in project management research (Thomas & Mullaly, 2007). Overall, we formulate the following research question: *How does project management effort affect project profitability for different levels of project complexity?*

We use an objective data sample of 917 projects' status reports in connection with a control function approach and instrumental variables for the possibly endogenous variable project management effort to test our hypotheses. The sample and corresponding procedure allow control for various endogeneity-related issues and establish a causal relationship between project management and profitability (Wooldridge, 2015). Our results show that a higher project management effort indeed leads to higher project profitability. The marginal influence of project management, however, decreases with increasing levels of effort. Furthermore, project management's effectiveness increases for higher levels of project complexity.

This paper offers valuable contributions to literature and practice. First, the study provides new and objective insights into the causal influence of project management effort on project profitability. The results add reliable empirical insights to the previous literature on project challenges and project management's beneficial role for project success (e.g., Choi, Delise, Lee, & Neely, 2021; Scott-Young & Samson, 2008). Second, this paper offers an in-depth analysis of project management's marginal benefits and adds empirical insights to the theory on performance frontiers. The results demonstrate that project management can be a means to

increase project's efficiency towards their frontier but that the law of diminishing returns and synergies applies to projects and their management as well (Schmenner & Swink, 1998). Third, this paper contributes to the literature on project complexity (Bolaños & Barbalho, 2021; Geraldi et al., 2011). While customization can offer firms a competitive advantage, it also comes with the drawback of elevated ETO projects' complexity (Salvador et al., 2014). This paper reveals that project management efforts are a viable means to compensate for the complexity challenges associated with higher customization. Our results intend to encourage firms to venture a higher degree of customization and simultaneously increase project management qualification and effort to maximize returns.

4.2 Conceptual Background

4.2.1 Project Management as means to achieve project success

Project management takes a key role in product development projects since it coordinates the required decisions regarding project goals, planning, and team (Sommer & Loch, 2009). Evaluating and quantifying its value has been a major quest in prior literature (Thomas & Mullaly, 2007). A significant stream of literature that sheds light on the value of project management is the research on critical success factors (CSFs). CSF refer to behavioral approaches and project specifications that are significantly related to project success (Rockart, 1979). Swink, Talluri, and Pandejpong (2006), for example, show that project management experience and the definition of clear goals are associated with a higher degree of project efficiency. Scott-Young and Samson (2008) also find that clear goals are positively related to a project's quality. They further show that project manager continuity and incentives can be associated with higher schedule adherence and that team characteristics, for example, the team's problem-solving potency, are related to lower costs. Other investigations of selected aspects of project management in operations management include planning efforts (Klastorin & Mitchell, 2013), time buffer monitoring (Martens & Vanhoucke, 2017), decrease of uncertainty (Narayanan, Balasubramanian, Swaminathan, & Zhang, 2019), or entrepreneurial orientation (Sabahi & Parast, 2020). Also, there are reviews of success factors in R&D projects (Balachandra & Friar, 1997), product development (Brown & Eisenhardt, 1995; Montoya-Weiss & Calantone, 1994), and general project management (Fortune & White, 2006).

Common CSFs, confirmed across multiple studies, include top management support, project leader influence, and project planning effort (Fortune & White, 2006).

In addition to CSFs, there are multiple studies on the general relationship between project management and project success. Zwikael and Sadeh (2007), for example, investigate the quality of project planning as a mediator between a project's risk level and its final success. Their results show that project planning efforts are generally higher and more sophisticated for high-risk projects, which are then associated with higher success. Badewi (2016) also finds that the standard project management practices of time, cost, and communication planning are positively associated with project success. Joslin and Müller (2015) confirm the positive relationship between project management methods and project success, even when controlling for project managers' experience. Lappe and Spang (2014) demonstrate a correlation between overall costs and benefits of project management. Regarding project management training, Carvalho et al. (2015) find a significant relationship between effort in project management training and schedule adherence and project margins. Lastly, regarding business development, Pollack and Adler (2014) find a significant correlation between project management effort and productivity increase over the following years, and Ekrot, Kock, and Gemünden (2016) demonstrate a strong relationship between average project success and an organization's overall business success.

While these studies highlight the relevance of project management initiatives for project success, they fall short on three essential aspects. First, prior findings are mainly correlational and do not establish causal effects between project management efforts and benefits. Second, previous studies do not control for a variation in project management's marginal effects. Third, they do not account for different levels of project complexity, which is one of the critical challenges for project management, as we elaborate in the next section.

4.2.2 Project management as a means to cope with complexity

Project complexity constitutes a crucial contingency factor for project management and project success (Maylor et al., 2013). Owing to this study's setting, we focus on projects' complexity arising through an ETO manufacturing strategy (Bolaños & Barbalho, 2021; Bozarth, Warsing, Flynn, & Flynn, 2009). Manufacturing strategies are generally distinguished by the location of

their customer order decoupling point (CODP) (Sousa, 2003). The CODP refers to the position in the value chain, where the material flow switches from forecast planning to customer pull (Wikner & Rudberg, 2005). The further upwards on the value chain the CODP is located, the higher are the flexibility and degree of customization. For ETO approaches, the CODP is situated in the engineering design adjustment stage (Olhager, 2003; Porter, Little, Peck, & Rollins, 1999). Thus, in ETO, each customer order constitutes a unique task to engineer and manufacture a customized product in a specified delivery time. These characteristics fit well to the characteristics of projects, which are, by definition, temporary endeavors with unique goals and specific resources (Project Management Institute, 2017).

Maylor et al. (2013) propose distinguishing project complexity into structural, emergent, and sociopolitical complexity. A project's structural complexity depends mainly on its size (Hobday, 1998; Shenhar, 2001), variety (Baccarini, 1996; Eriksson, Lilliesköld, Jonsson, & Novosel, 2002), and interdependence (Chapman & Hyland, 2004; Geraldi et al., 2011). For ETO projects, depending on customers' requests, engineering activities can range from an individual selection of standardized components to more sophisticated engineering adjustments to the entire product (Gosling & Naim, 2009; Hicks, McGovern, & Earl, 2000). The engineered products' complexity is mainly driven by its number of design functions (Griffin, 1997), design decisions during development (Baldwin & Clark, 2000), the included physical modules and their interrelatedness (Kaski & Heikkila, 2002), and the dependence of technologies (Tatikonda & Stock, 2003). A project's emergent complexity refers to the level of uncertainty of its characteristics (Geraldi et al., 2011). Uncertainty's causes are a product's novelty (Shenhar, 2001), a project team's experience (Maylor, Vidgen, & Carver, 2008), and the overall availability of information (Geraldi & Adlbrecht, 2008). For ETO projects, the higher the innovativeness of the requested customization, the higher are the project's complexity and its engineering effort. Lastly, a project's sociopolitical complexity refers to the complexity arising through the interaction of its people, stakeholders, and customers (Maylor et al., 2013). For example, the lower the support of senior management and the lower the project team members' motivation and experience, the higher is the project's complexity. A higher sociopolitical complexity increases coordination efforts and would again materialize in ETO projects' increased engineering efforts.

4.3 Hypothesis Development

4.3.1 Project Management and Project Success

We argue that project management effort positively affects project profitability. First, according to its purpose, project management initiatives should positively influence project success. Initially, project management emerged to provide better scheduling techniques to enable successful project execution (Belassi & Tukel, 1996). Having been extended continuously, project management today offers a variety of practices to increase projects' outcomes. Besides the traditional management of scope, time, cost, and quality, project management includes extended resource, risk, and procurement coordination. Project management supports the proper execution of projects, from defining initial goals and creating structured plans for resources and risks, to the project's continuous monitoring and controlling until closure (Fortune & White, 2006; Kerzner, 2017).

Second, several studies identified project CSFs and demonstrated their association with project success (Balachandra & Friar, 1997; Dvir, Lipovetsky, Shenhar, & Tishler, 1998; Fortune & White, 2006; Thomas & Mullaly, 2008). Since these individual aspects of project management relate to project success, project management, as a whole, should equally do so. Examples of demonstrated CSFs being part of project management include effective planning and scheduling (Dvir et al., 1998; Pinto & Mantel, 1990; Swink et al., 2006), coordination of external stakeholders and allocation of internal resources (Pinto & Slevin, 1987), and effective monitoring and controlling of processes and risks during an ongoing project (Cooke-Davies, 2002; Dvir et al., 1998; Teller, Kock, & Gemünden, 2014). Furthermore, the existing literature argued for a positive influence of project management on project success, albeit without causal evidence (Lappe & Spang, 2014; Serrador & Turner, 2014; Tatikonda & Rosenthal, 2000). We therefore formulate our first hypothesis as follows:

Hypothesis 1: *Project management effort positively affects project profitability.*

4.3.2 Diminishing Marginal Utility of Project Management

We argue that the impact of project management effort on project profitability decreases with increasing levels of project management effort. The law of diminishing marginal returns is a central observation in microeconomics (Coleman, 1990). It has been discussed in operations management as part of the theory on performance frontiers (Schmenner & Swink, 1998). In this study, a project's performance frontier refers to its maximum outcome that a team can achieve based on the project's given characteristics. There are two types of initiatives that increase project performance (Schmenner & Swink, 1998). Improvement refers to removing inefficiencies and, thus, moving the project closer to its performance frontier. Betterment refers to substantial changes in policies or strategies to move or change the shape of a project's performance frontier. Both types increase performance; however, they are also subject to the laws of diminishing returns and synergies (Schmenner & Swink, 1998). The closer a project moves towards its performance frontier, the higher is the additional effort to further increase its performance.

Project management initiatives aim to increase a project's efficiency by moving the project closer to its frontier without altering the given characteristics. According to the law of diminishing returns, the closer the project moves towards its frontier, the lower is these initiatives' marginal impact. Thus, initial basic project management approaches are likely to have a more substantial marginal effect than more advanced approaches. For example, elemental practices such as scope management, scheduling techniques, cost, quality, and risk management, initially contribute to a clear structure of the project with a high impact on project profitability (Zwikael & Sadeh, 2007). However, the higher the level of already applied project management is, the lower is the potential for increasing project profitability by additional project management effort. While additional project management initiatives still contribute to a higher project success, their marginal impact diminishes since further improvement potential diminishes with increasing improvement already achieved by project management initiatives. We therefore formulate our second hypothesis as follows:

> ***Hypothesis 2:*** *The marginal effect of project management effort on project profitability diminishes with increasing project management effort.*

4.3.3 Interaction of Project Management and Complexity

We argue that the positive influence of project management effort on project profitability increases with increasing project complexity. In general, project complexity comprises different aspects that increase coordination and management effort (Geraldi et al., 2011; Maylor et al., 2013). The higher the complexity, the more product design features need to be engineered and coordinated among the project staff. Furthermore, development features can be both novel and interdependent. In case of customized products, product design heavily relies on external customer requirements (Salvador et al., 2014). The customers and the internal engineering staff need to coordinate these requirements. Overall, this is a time-intensive and error-prone process that can jeopardize project success.

However, the additional challenges resulting from higher levels of complexity simultaneously increase a project's potential for efficiency improvement. Project management initiatives can help to cope with the challenges and improve a project's overall efficiency. Exemplary approaches that specifically ease complexity include scope management (Dvir et al., 1998), scheduling (Belassi & Tukel, 1996), communication (Pinto & Mantel, 1990), and risk management (Teller et al., 2014; Teller & Kock, 2013). Their impact should be higher for more complex projects since then there is more potential to ease challenges and improve success. This argument is also supported by Teller et al. (2012), who find that the relationship between project management formalization and average project success is higher in more complex environments. Thus, we formulate our third hypothesis as follows:

> ***Hypothesis 3:*** *Project management effort and project complexity interact to predict project profitability, such that project management effort results in higher project profitability for more complex projects than for less complex projects.*

4.4 Data and Method

4.4.1 Sample

With this study, we aim to investigate the quantitative influence of project management on profitability for different levels of project complexity. Thus, we required a sample that allowed us to precisely attribute the quantitative values for management effort, complexity, and profitability for a high number of projects. We chose a sample of quantitative project status data that originates at a large international company—which in the following we will refer to as *IndustCom*—with > 50k employees and yearly revenues of > 10 billion Euro. *IndustCom* offers customized large industrial and transportation equipment. Each customer order is processed in a separate project following the ETO approach, meaning that products are engineered and manufactured individually according to customers' preferences. Each month, project managers present an overview of their project's current status and key characteristics in a standardized presentation to the portfolio board. The project status data, including all data on costs and sales, is additionally logged in a central, standardized database. For this study, we used a copy of *IndustCom*'s entire project database. We only included completed projects in the analysis since we are interested in the projects' *final* profitability. The resulting sample constitutes project status report data of 917 completed projects, including information on the project content, labor costs, sales, margin, and time. The projects operated in the timeframe between 2006 and 2017. The average project took about three years and had a sales budget of around 50 million Euros. We report an overview of the correlations between the variables used in the regression analysis in Table 11.

Table 11. Correlations (Research study C)

		(1)	(2)	(3)	(4)	(5)	(6)
(1)	**PM effort**	1					
(2)	**Project profitability**	0.25	1				
(3)	**Size[(M)]**	-0.06	-0.09	1			
(4)	**Estimated profitability**	0.22	0.72	-0.12	1		
(5)	**Complexity**	0.02	0.13	-0.04	0.16	1	
(6)	**Planned PM effort**	0.82	0.23	-0.04	0.22	0.04	1
(7)	**Planned risk provisions[(M)]**	0.08	0.01	0.57	-0.03	0.04	0.08

n = 917. All correlations above .07 are statistically significant at the 5 % level. PM = Project management.
[(M)] in million Euros.

4.4.2 Measurement

Project profitability. We calculate the profitability for each project by dividing its final margin (i.e., profit) by its sales. The individual project sales data is especially valuable since it allows us to assess each project's financial performance and removes the need to solely rely on the adherence of planned values (Serrador & Turner, 2014; Shenhar & Dvir, 2007). Especially for our research setting, project profitability is a decisive aspect of project success since firms that process business through projects need to operate profitably in the long run to exist. Another reason for our choice is that project profitability is a *final* project success measure. Succeeding in different traditional dimensions of project management success (i.e., time, scope, and budget) in the course of a project also results in higher final profitability. For instance, if costs decrease and sales stay constant during the project, the eventual profitability increases. Furthermore, we extensively discussed this measure with *IndustCom*'s decision-makers, who confirmed that project profitability is their most important project success measure.

Project management effort. We operationalize project management effort using the total project management labor cost's share of the project's total direct labor costs. Labor is the relevant part of project management effort since human work is the essential resource in project

management (Project Management Institute, 2017). Additional support, for example through software, is possible as well; however, we assume these costs to be negligibly low relative to labor costs in the long run.

Project complexity. We operationalize ETO projects' complexity using total engineering labor cost's share of total labor costs. This share is a reflective measure for projects' complexity, meaning that ETO projects' structural, emergent, and sociopolitical complexity is reflected in the level of relative engineering effort (Bolaños & Barbalho, 2021; Maylor et al., 2013). The more advanced the customer requirements are, the more engineering tasks need to be coordinated and processed. Furthermore, if the requirements are highly innovative, additional engineering labor costs due to higher time exposure or the hiring of external experts occur. The more often the characteristics and client requirements change, the higher is the engineering effort to construct the product. In addition, higher sociopolitical complexity through insufficient support from internal stakeholders or inefficient communication with customers further increases engineering effort to design the product. Overall, these types of complexity eventually result in higher engineering labor effort. We also discussed this choice of operationalization with *IndustCom*'s decision-makers, and they confirmed that relative engineering labor costs best describe their projects' complexity.

Control variables. We control for several potential alternative influences that could explain a project's profitability. First, we include a project's size measured by its sales. While project sales include both cost and margin, they strongly reflect a project's importance for the company. For example, a project with higher sales could receive more attention from senior management, which could positively affect the project's outcome. Second, we include each project's division as a control variable to control for all fixed influences in each division. Based on the offered product, *IndustCom* structures its business in four entirely project-based divisions. Two of the divisions include mainly mechanical, one primarily electrical, and one all service products. The project management style, culture, processes, or project characteristics could potentially differ systematically between divisions. Therefore, we include dummy variables for each division in the regression analysis. Third, we include the project start date in our model to control for potential project external changes, for example, caused by a change in management executives or external economic developments. Finally, we control for the initially estimated project margin (calculated at the start of each project) to exclude a potential endogeneity bias caused

by reverse causality. We explain the precise mechanism of this control variable in the next section.

4.4.3 Dealing with Endogeneity

This study aims to demonstrate a causal relationship between project management and project profitability while considering projects' complexity. Establishing a causal effect of a variable *x* on a variable *y* requires the following three conditions: (i) *x* must temporally occur before *y*, (ii) *x* and *y* must significantly correlate, and (iii) the influence of *x* on *y* must not be explained by other causes (Antonakis, Bendahan, Jacquart, & Lalive, 2010; Baron & Kenny, 1986). The failsafe way to identify causal relationships is the randomized experiment (Antonakis et al., 2010). However, management studies can often only rely on observational data, in which researchers cannot randomly manipulate the independent variable. It is, therefore, potentially correlated with the error term, which could lead to distorted results. The leading causes of endogeneity include omitted variables, reverse causality, and common-method variance (Kennedy, 2008; Podsakoff et al., 2003). In this study, the independent variable project management effort is not assigned randomly and therefore potentially endogenous. Thus, we follow the recommendations by Guide and Ketokivi (2015) and the guidelines by Lu, Ding, Peng, and Hao-Chun Chuang (2018) to address potential endogeneity concerns.

We choose a Control Function Approach (CFA) using instrumental variables (IVs) for the possibly endogenous variable project management effort as described by Wooldridge (2015). Compared to other IV approaches, for example a 2SLS regression, the CFA offers the advantage to more conveniently include interaction and non-linear effects. IVs are exogenous variables explaining the variance of the endogenous variable without directly influencing the model's dependent variable. Chosen IVs must be strong and valid to lead to an unbiased model. An IV is strong if it highly correlates with the endogenous variable; an IV is valid if it affects the dependent variable solely through its influence on the endogenous variable, meaning the IV is unrelated to the error term (Bettis, Gambardella, Helfat, & Mitchell, 2014; Kennedy, 2008).

In this paper, we instrument the actual project management effort through the IVs *planned project management effort at project start* (as share of labor costs) and *planned risk provisions*

at project start. First, the initially planned project management effort should strongly relate to the eventually applied project management effort since managers likely intend to follow their initial plans. Furthermore, this IV is valid since the planned project management effort cannot directly affect the final profitability but strongly affects the actual effort of project management, which, in turn, influences a project's outcome. Second, the initial risk provisions should strongly relate to the actual project management effort since they reflect a project's anticipated risk level. The risk level determines management's actual effort to cope with the risks and their impact. This argumentation is empirically supported by Zwikael and Sadeh (2007) who find that a project's risk level is not directly associated with project success. Rather, they find that the risk level determines the quality of project planning effort. Project managers use more sophisticated project management methods (e.g., a more elaborate definition of a project's deliverables) for riskier projects, which then affect success. Overall, our empirical results in Table 11 validate that both IVs are highly correlated to project management effort. Furthermore, the F-Test of the first-stage results ($F(11, 905) = 93.64$, $p = 0.000$) and the IVs' coefficients ($b_1 = 0.675$, $p = 0.000$; $b_2 = 0.001$, $p = 0.002$) in Table 12 are highly significant.

As additional measures to mitigate endogeneity concerns, we control for a potential reverse causality bias by including the initially estimated project margin in our analysis. In our study's context, reverse causality would imply that the initially estimated project margin influences the applied project management effort. For instance, decision-makers could prioritize projects aiming for high margins and endow them with increased project management resources to accomplish these ambitious goals. We eliminate this bias by including the estimated project margin as percentage of budgeted sales as a control variable in our model.[2]

[2] Since the initial margin has a very strong effect on the end margin, we also calculated a model without it as a robustness test and obtained comparable results to the ones reported below.

4.5 Results

We provide the results of our regression analysis in Table 12. Model 1 contains the first-stage results of the CFA with project management effort as the dependent variable. The results confirm our overall measurement approach. Both IVs are strongly related to the actual project management effort, thus constituting strong IVs (unstandardized coefficient b = 0.675, p = 0.000 and b = 0.001, p = 0.002, respectively). Models 2 - 6 contain the results of the CFA's second stage, with project profitability as the dependent variable and project management effort as the independent variable. As shown in Model 2, the size of a project is not significantly related to its profitability (b = 0.000, p = 0.873). This finding means that larger projects are not necessarily less profitable. However, the estimated project margin at project start is strongly related to the project's final profitability (b = 1.062, p = 0.000). As expected, higher estimated profitability is thus also connected to higher *final* profitability, as well. Regarding complexity, a project's level of complexity negatively relates to the final project margin; however, the coefficient is not significant (b = -0.018, p = 0.445). Model 3 includes the effect of the actual project management effort. The results show that project management effort significantly leads to higher project profitability (b = 0.151, p = 0.002), supporting H1. Thus, in general, projects with higher levels of project management effort are more profitable.

Furthermore, as provided in Model 4, the impact of project management effort on profitability diminishes with increasing project management effort (b = -0.377, p = 0.000). Thus, as hypothesized in H2, while project management effort generally leads to higher final profitability, its marginal impact decreases with increasing levels of project management effort. In Model 5 and 6, we find support for Hypothesis 3. Project complexity positively moderates the influence of project management effort (Model 5: b = 0.650, p = 0.001; Model 6: b = 1.010, p = 0.039). Thus, the higher a project's complexity, the stronger is the impact of project management effort.

Table 12. Regression results (Research study C)

	PM effort	Project profitability				
	(1)	(2)	(3)	(4)	(5)	(6)
	First stage	Controls	H1	H2	H3	Full
Division	YES	YES	YES	YES	YES	YES
Period	YES	YES	YES	YES	YES	YES
Size	0.00	0.00	0.00	0.00	0.00	0.00
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
	{0.21}	{0.87}	{0.73}	{0.77}	{0.44}	{0.62}
Estimated margin	0.01	1.06**	1.05**	1.05**	1.05**	1.05**
	[0.02]	[0.04]	[0.04]	[0.04]	[0.04]	[0.04]
	{0.44}	{0.00}	{0.00}	{0.00}	{0.00}	{0.00}
Complexity	-0.05**	-0.02	-0.01	-0.02	-0.08*	-0.10*
	[0.01]	[0.02]	[0.02]	[0.02]	[0.03]	[0.05]
	{0.00}	{0.45}	{0.80}	{0.52}	{0.02}	{0.04}
Planned PM effort	0.68**					
	[0.06]					
	{0.00}					
Planned risk provisions	0.00**					
	[0.00]					
	{0.00}					
PM effort			0.15**	0.41**	0.07	0.19*
			[0.05]	[0.09]	[0.04]	[0.10]
			{0.00}	{0.00}	{0.13}	{0.05}
PM effort squared				-0.38**		-0.14
				[0.10]		[0.11]
				{0.00}		{0.20}
PM effort x complexity					0.65**	1.01*
					[0.19]	[0.49]
					{0.00}	{0.04}
PM effort squared x complexity						-1.15
						[0.83]
						{0.17}
First-stage residuals		0.13+	-0.02	-0.02	-0.05	-0.04
		[0.07]	[0.09]	[0.09]	[0.10]	[0.10]
		{0.06}	{0.80}	{0.86}	{0.59}	{0.66}
Constant	0.04**	0.03+	0.01	0.00	0.02	0.02
	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]
	{0.00}	{0.07}	{0.38}	{0.88}	{0.16}	{0.32}
R-squared	0.692	0.533	0.540	0.548	0.550	0.553
Adjusted R-squared	0.688	0.528	0.535	0.542	0.544	0.546
Wald chi-squared	93.64[F]	1016.48	1075.56	1101.56	1124.81	1143.55

n = 917; standard errors in parentheses, p-values in curly brackets. All second-stage estimates bootstrapped with 1000 repetitions. PM = Project management. [F] The F-statistics is reported for the first-stage regression.
+ p<0.10, * p<0.05, ** p<0.01.

For further interpretation, we visualize the relationship between project management effort and project profitability in Figure 7. Overall, for all levels of project complexity, project management effort leads to higher profitability. Regarding the effect sizes for a project with average characteristics, a project management increase of one percentage point from, for example, 10 % to 11 % leads to a margin increase of 0.39 percentage points. An increase from 20 % to 21 % leads to a margin increase of 0.29 percentage points. However, regarding the absolute profitability, with a sufficiently high level of project management effort, more complex projects are more profitable compared to less complex projects. Consequently, project management effort allows turning the potential downsides of higher complexity into higher profitability. In Figure 8, we further visualize the moderating effect of project complexity on project management's marginal impact. The higher the degree of project complexity is, the higher is the marginal effect of project management. This result shows that project management initiatives are more effective for more complex projects.

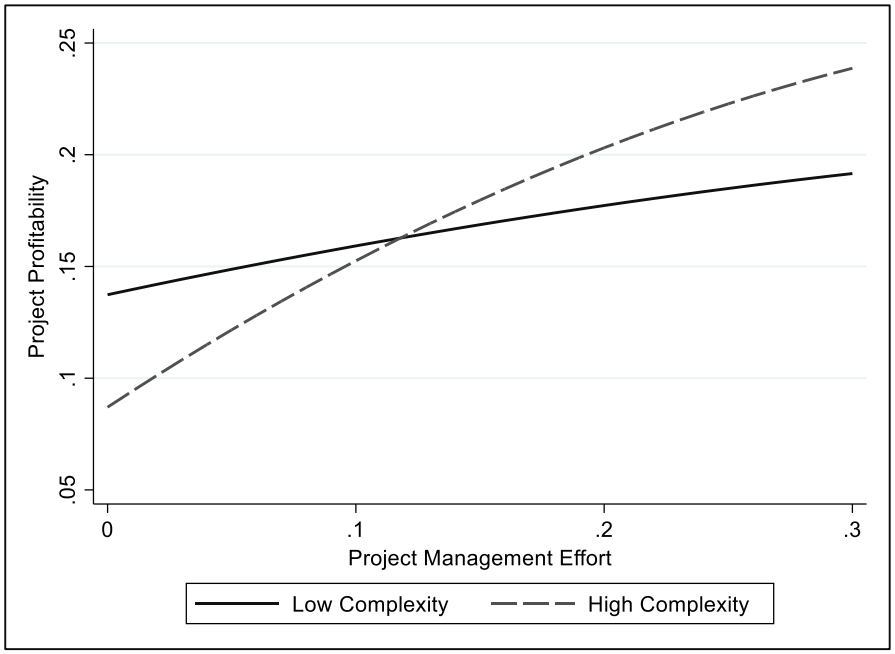

Figure 7. Effect of project management effort on project profitability distinguished between low and high complexity (mean minus/ plus one standard deviation), (Research study C)

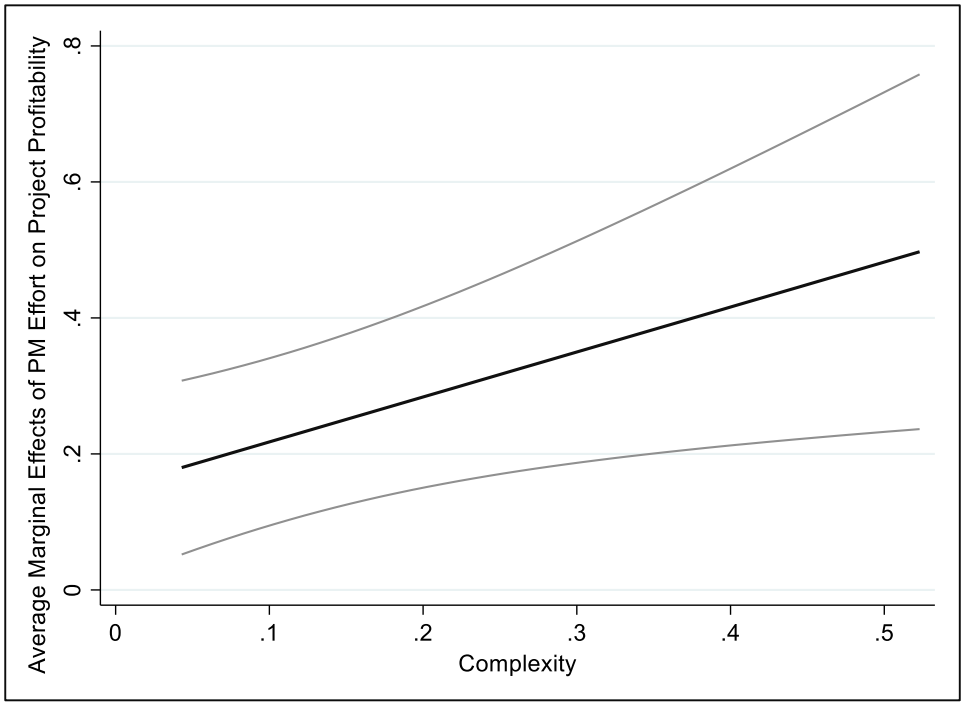

Figure 8. Average marginal effects of project management (PM) effort on project profitability for all levels of complexity (thin lines represent 95%-confidence bands), (Research study C)

4.6 Discussion and research contributions

4.6.1 Research implications

This study investigates the effect of project management on project profitability considering projects' complexity. We choose the setting of ETO projects since this form of external projects allows us to attribute both cost and final sales precisely to each project. By focusing on profitability, we can quantify the value that project management initiatives provide. Overall, our results reveal that project management effort has a positive impact on project profitability. The more project management effort is applied in a project, the higher is its profitability. Furthermore, by using a control function approach with instrumental variables, we demonstrate that this relationship is causal, meaning that a higher level of project management causally leads to higher profitability. Thus, we can confirm that project management initiatives and operational techniques to coordinate tasks and resources, to discover and manage risks, and to

communicate with stakeholders are effective (Pich, Loch, & Meyer, 2002; Sommer & Loch, 2004). This finding contributes the causal demonstration of overall project management efforts to previous literature in operations and project management (Thomas & Mullaly, 2008).

However, while our results show that more project management leads to higher profitability, they also reveal a diminishing marginal impact of project management effort. Thus, the effectiveness of additional project management initiatives decreases with increasing levels of applied project management. While additional project management initiatives still lead to higher profitability, their incremental improvement decreases. Thus, initial project management efforts, for example the breakdown of a project's tasks, risks, stakeholders, and processes, are especially effective. Additional efforts still contribute to success, but their marginal impact is comparably lower. To maximize a project's margin, managers need to compare the *absolute* cost of an additional increase in project management initiatives with the *absolute* increase in the project's margin. While project management will increase the final margin, this is only economically beneficial if the absolute increase in project margin exceeds the absolute cost of an additional project management increase.

In addition, our analysis reveals that the influence of project management effort on profitability increases for higher levels of project complexity. In more complex projects, there is more potential for management approaches to have a positive effect. There are fewer known elements from previous projects and more operative challenges that managers need to address (Bolaños & Barbalho, 2021). More tasks need coordination among more team members, the overall uncertainty is higher, and there are more sociopolitical issues (Maylor et al., 2013). Thus, management initiatives that identify and mitigate those challenges are more effective. In practice, project management helps by reaching consensus fast and establishing clarity among project members and stakeholders. Eventually, as visualized in Figure 7, more complex projects that are met with sufficient project management effort are rewarded with higher profitability. Thus, in this study's research setting, if firms choose to offer customized ETO products, they should increase project management effort to ensure that the opportunities of higher complexity turn into higher financial returns.

This study offers several contributions to operations and project management literature. First, we demonstrate a causal, positive effect of project management on project success. Our unique

approach and sample allow us to precisely account for project costs but also financial returns. Financial returns are especially valuable since they constitute an objective, final measure for project success. While projects can offer additional organizational benefits, for example, learning benefits, overall profitable projects are decisive for firms' long-term survival. The objective data sample further rules out potential distortions due to endogeneity and establishes a causal relationship between project management effort and project success. This adds to previous literature on project management's effectiveness (e.g., Awe, Woodside, Nerur, & Prater, 2020; Lappe & Spang, 2014; Pollack & Adler, 2014; Thomas & Mullaly, 2008; Zwikael & Sadeh, 2007). Our findings further demonstrate that project management efforts in their entirety are effective for project success (Nguyen, Marmier, & Gourc, 2013; Scott-Young & Samson, 2008; Swink et al., 2006). This result justifies and supports project management research and its practical application (Choi et al., 2021).

Second, we contribute to the literature on the theory of performance frontiers in operations management (Schmenner & Swink, 1998; Swink et al., 2006). With this study, we are, to the best of our knowledge, the first to identify and quantify a diminishing marginal return of project management, adding novel insights to the previous literature on project management and success (e.g., Lappe & Spang, 2014; Pollack & Adler, 2014; Zwikael & Sadeh, 2007). The finding also contributes to the theory on performance frontiers by empirically demonstrating the decreasing marginal returns of project management effort (Schmenner & Swink, 1998; Swink et al., 2006). Project management moves the project closer to its performance frontier in two ways (Pich et al., 2002; Swink et al., 2006). Very dominantly, it improves project efficiency by coordination, structuring, and communication effort. But, it also alters the performance frontier by removing barriers or identifying synergies, increasing the potential maximum outcome.

Third, we contribute to the literature on project complexity in general (Jacobs & Swink, 2011) and complexity caused by customization in particular (Bolaños & Barbalho, 2021; Haug et al., 2009; Hegde et al., 2005; Salvador et al., 2014). While prior literature stressed the challenges arising through high project complexity (e.g., Carvalho et al., 2015; Salvador et al., 2014), we add the empirical insight that project management effort constitutes an effective approach to compensate project complexity's adverse effects (Loch & Sommer, 2019; Mishra, Das, & Murray, 2016; Vickery, Koufteros, Dröge, & Calantone, 2016). Instead of focusing on the

negative implications of higher complexity, our results reveal that complexity also offers opportunities. We show that firms can earn a higher compensation for more complex projects by applying more project management. This moderation effect once again underlines the contingency approach of project management (Shenhar, 2001).

4.6.2 Practical implications

The findings of this study are highly relevant for practitioners. In practice, project and top managers face the challenges arising through higher customization and complexity. Higher levels of complexity can be indispensable, especially if the firm's competitive advantage depends on it, for example, in the customized ETO product business. This study's results show that project management effort leads to higher project profitability. On average, an increase in project management effort of one percentage point increases the final margin by 0.15 percentage points. Furthermore, the beneficial influence of project management effort is even stronger for higher project complexity. To maximize success, practitioners should closely evaluate completed projects on the absolute cost for project management and the absolute margin. Achieving the optimal project management level means that the absolute cost of an additional increase in project management effort equals the absolute increase in profitability. Nevertheless, a project's structural characteristics are still key contributors to its success. Project managers should be aware of each project's performance frontier and closely evaluate their management efforts' returns. Overall, this study's results stress the value of project management and justify investments in project management, the professionalization of project management training, and the competence building of project management professionals.

4.6.3 Limitations and future research opportunities

This study is connected to certain limitations that open research avenues for future studies. The sample used in our analysis originates in one single company, which specializes in ETO products. Thus, although we investigate a large number of projects over a long period, this approach cannot differentiate firm-level effects. For example, project management's impact might differ in other firms with different cultures or management styles. In addition, for our setting of external projects, profitability is a strong measure to objectively determine project success. However, especially for other types of projects, for example, internal projects, other dimensions of project success could also be highly relevant (Shenhar & Dvir, 2007).

Furthermore, we measure project management effort with the relative project management labor costs. This operationalization offers valuable quantitative insights into the relationship between project management and profitability for different degrees of ETO customization complexity. However, the measure does not distinguish between different aspects of labor cost intensity. For example, project management effort could depend on the methods applied or the qualification of project management staff. Similarly, our complexity measure reflects the main components of project complexity; however, more detailed measures, for example based on Maylor et al. (2013), could offer further insights on complexity's underlying sources and how project managers can address these operationally.

We encourage researchers to further investigate project management and its influence on success. For example, while we account for all project costs that occur between project initiation and closure, additional costs, say, for proposals to win the project contract, occur before project initiation. Considering these costs could also affect the optimal level of applied project management. In our analysis, the marginal impact of project management decreases but remains positive. Accounting for project winning costs could potentially change the shape of the curve to an inverted u-shape. Furthermore, we see additional potential in investigating quantitative project data on a monthly or even daily basis to provide further insights into the challenges of product customization and the benefits of project management effort. With more incremental data, future research could derive early warning and predictive management implications (Hopmere et al., 2020; Sabahi & Parast, 2020).

Chapter 5 Research Study D

On tomatoes and watermelons - the performance effects of optimistic and pessimistic project status reporting behavior

Abstract:

Project managers often provide status reviews by using traffic light colors (red, amber, green) to convey central project status information to project steering committees and portfolio boards. While the simplicity of these visualizations is potentially helpful for decision-makers, this form of reporting is also prone to biases because the assessment is subjective and project managers might intentionally misreport the current status, for example by portraying the project's health as more optimistic or pessimistic than it actually is. We investigate the impact of this optimistic and pessimistic reporting behavior on projects' future performance using a sample of 46,474 project status reports from 1,229 projects. Surprisingly, and in contrast to previous research, the results suggest that optimistic reporting behavior is positively and pessimistic reporting behavior is negatively related to future project success. We further find that both positive and negative effects of reporting behavior diminish over the course of a project and that reinforced behavior over time negatively affects the impact of both behavior types.

Classification in terms of this dissertation:

- **Perspective:** Operational adaptation
- **Unit of Analysis:** Projects
- **Sample:** Project status reports (n = 46,474 project status reports, 1,229 projects)
- **Method:** Panel regression analysis

Publication and Conferences:

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5.1 Introduction

Project reviews are crucial for an organization's successful portfolio management (Long, Nasiry, & Wu, 2020). As part of project portfolio management's project reviews, visualizations and simplifications enable the portfolio steering committee—the management team that decides on each project's initiation, continuation, and termination—to efficiently gain an overview of each project's current health (Hazır, 2015; Killen et al., 2020; Killen & Kjaer, 2012). Owing to their limited attention capacity, decision makers tend to rely on their intuition or simple rules when deciding on projects' funding (Schiffels, Fliedner, & Kolisch, 2018). To support them to make informed decisions, portfolio steering committee members receive regular project status updates that include an overview of the project's current progress, budget, and cost. In addition to more detailed information, the reviews commonly present an executive summary of a project's current health in the form of a RAG (i.e., red, amber, or green) traffic light color scheme (Lamptey & Fayek, 2012; Project Management Institute, 2017). A green status demonstrates that the project progresses as planned and that no corrective action is needed, whereas a red status represents the highest level of alarm indicating major issues that threaten successful project continuation (Rasmussen, Bansal, & Chen, 2009). Usually, there are pre-defined consequences tied to each project status, which can, for example, include future funding, resource allocation, or auditing (Keil, Smith, Iacovou, & Thompson, 2014).

The situation between project managers and the portfolio steering committee is a typical principal-agent problem. Project managers act as agents for senior management and potentially use their information advantage on the project's current status to act in their own best interests (Eisenhardt, 1989; Müller & Turner, 2005). Owing to a project's structural and emergent complexity, it is difficult to objectively assess a project's current health. As a consequence, project managers' subjectively assess a project's status following general guidelines and metrics (Snow & Keil, 2002). This subjective assessment, however, is highly prone to biasing (e.g., Fink & Pinchovski, 2020). For example, depending on project managers' individual perception and experience, they might unintentionally bias their status assessment and perceive their project to be in a more optimistic or pessimistic state than a detached manager would do. In addition, relying on their information advantage, project managers might also choose to intentionally misreport their project's current status, for example to avoid negative interference from senior management or to boost their personal image (Snow et al., 2007). In this paper,

pessimistic reporting behavior refers to a project manager reporting the status as more negative than the average manager would do; vice versa, optimistic reporting behavior refers to reporting the status as more positive than the average manager would do (Iacovou et al., 2009). In practice, optimistic reporting behavior is also referred to as "Watermelon Reporting"—green on the outside but red on the inside.

Prior studies on status misreporting strongly share the conclusion that status biasing generally negatively affects projects' success (e.g., Iacovou et al., 2009; Johnson, 1999; Keil et al., 2014; Keil, Im, & Mähring, 2007; Keil & Robey, 1999; Park, Keil, & Kim, 2009; Snow & Keil, 2002; Tan, Smith, Keil, & Montealegre, 2003; Thompson et al., 2007). However, prior studies neglected the performance implications of different status reporting behavior on project's future performance. Most of prior studies concern project managers' individual decision-making process on how to report project status and whether to intentionally misreport it (e.g., Keil et al., 2014), general theoretical models (e.g., Smith & Keil, 2003; Smith, Keil, & Depledge, 2001), or moderating factors of projects' and organizations' characteristics that either facilitate or hinder reporting quality (e.g., Park & Keil, 2009; Snow & Keil, 2002). The study of Iacovou et al. (2009) is one of the few that provides an empirical assessment on the consequences of status misreporting for reporting quality and performance. Their survey-based findings suggest that optimistic biasing decreases reporting quality and performance. However, the longitudinal effects of reporting behavior for later project performance have not been investigated in literature. Furthermore, empirical studies using objective project data to determine reporting behavior and performance effects are surprisingly missing. Assessing the quantitative consequences of project managers' reporting behavior requires a longitudinal investigation of reporting behavior and project development. This study addresses this relevant gap in the literature and asks: *How does optimistic and pessimistic status reporting behavior affect future project development?*

This study investigates the performance effects of optimistic and pessimistic reporting behavior using a sample of objective project data consisting of 46,474 project status reports from 1,229 projects. The projects stem from a large international company that offers engineered-to-order products. Since the company's business is structured in external customer projects, we can precisely allocate reporting information and cost and success measures to each project. We use a unique approach to estimate project managers' reporting behavior and its performance effect.

First, for each project and month, we predict a hypothetical average project status which is based on objective data. Then, for each project, we investigate the consequences of optimistic and pessimistic reporting behavior on the project's later performance.

Besides the consequences of pessimistic and optimistic reporting behavior, we further include two additional contingency factors that might influence the relationship between reporting behavior and future project developments. First, the current stage of the project (i.e., the percentage of completion) could affect the consequences of reporting behavior. Skewed reporting behavior in late project stages might be less severe for a project's future performance than in earlier stages because most of the work is already done. Second, previous choice of reporting behavior might have an influence on the consequences of current misreporting. For example, continuously concealing of the project's true health could intensify the adverse effects of biasing over time.

Surprisingly, and in contrast to previous literature, we find a strong positive relationship between optimistic reporting behavior and future project development. Pessimistic reporting, in turn, is negatively related to future project performance. The results further demonstrate that the positive influence of optimistic reporting decreases, while the negative influence of pessimistic reporting turns positive with increasing project completion. Repeated behavior weakens the influence of both reporting behavior types on future project performance.

With this study, we offer multiple contributions to literature and practice. First, this study is, to the best of our knowledge, the first to provide findings on the longitudinal consequences of status reporting behavior on later project performance. The study uses a unique approach to assess managers' status reporting behavior and shows that, contrary to the consensus in previous literature, optimistic reporting is positively related to future project performance (Iacovou et al., 2009). These surprising findings could open up a new view on the consequences of reporting for project and portfolio success. Second, the study sheds light on the important moderating factors that influence the decision-making process of project managers regarding status assessment during the course of a project. Third, the study expands the research of status biasing to general project management with previous research on status misreporting being mainly focused on IS projects. For practitioners, our study offers valuable insights into the consequences of (repeated) status reporting on future project success. This is relevant to project

managers reporting the current project status as well as to steering committee members that interpret and base their decisions on project status reports (Schiffels et al., 2018).

5.2 Conceptual Background

Project status reporting is a form of communication between senior management and project managers. Thus, in this study, we follow prior research and investigate the communication of projects' status reports from a message exchange perspective (Iacovou et al., 2009). According to the message exchange theory (MET), communication is an exchange of messages between multiple actors in an organizational context (Stohl & Redding, 1987). Actors involved in the message exchange pursue their own motivation and goals driven by their unsatisfied needs. While actors could choose to communicate openly and accurately with each other, their individual motivation and subjective goals cause them to intentionally or unintentionally distort and select the information they share with each other to achieve their goals. In the context of project status reporting, the actors involved in the message exchange are project managers on the one hand and senior management in the steering committee on the other hand. Accordingly, MET suggests that project managers have profound knowledge on their projects' current status, but following their unsatisfied needs and hidden personal agenda, they consciously choose the project status information that they report to senior management (Iacovou et al., 2009). In a firm's project portfolio, projects compete for scarce resources and management attention. Furthermore, the performance of the individual project managers is usually judged based on their projects' performance. Thus, being aware of their information advantage and the effects on their personal evaluation, project managers have significant reason to cautiously decide whether and in what form to share their project's current health information based on the organizational surrounding and their project's and personal goals (Iacovou et al., 2009).

There are two forms of project status reporting behavior (Iacovou et al., 2009; Snow et al., 2007). Optimistic reporting behavior means that project managers portray their project's current health as more optimistic than it actually is. Project managers apply optimistic reporting behavior by, for example, not sharing a recent negative development of the project or by overstating positive developments. Operationally, following the established status reporting color scheme, project managers would then report the project's status still as 'green' instead of

'red'. Pessimistic reporting behavior, on the other hand, refers to the opposite type of misreporting. Then, project managers present their project's status as more negative than it actually is, for example, by overstating risks and negative aspects. Operationally, they would do so by reporting the status as 'red' instead of 'amber', or 'green'. In prior literature, these two forms of reporting behavior have also been referred to as biasing, misreporting, or whistleblowing. However, in this study we do not investigate the motivations for different reporting behavior but the consequential performance effects and thus simply refer to optimistic and pessimistic reporting behavior. In the following, we give an overview of the relevant prior literature on project status reporting.

In prior literature, a considerable share of studies focused particularly on pessimistic reporting behavior (i.e., whistleblowing). These studies focus both on establishing a theoretical model of pessimistic reporting's decision-making process (e.g., Smith et al., 2001; Smith & Keil, 2003) and investigating factors that lead to or moderate the decision to pessimistically bias a status (e.g., Keil, Tiwana, Sainsbury, & Sneha, 2010; Park & Keil, 2009; Snow et al., 2007). For whistleblowing in general, Dozier and Miceli (1985) proposed a decision framework that has also been applied to pessimistic status reporting behavior (Smith et al., 2001). According to the framework, multiple decision steps ultimately convince an individual to report wrongdoing. After observing the wrongdoing, the individual assesses whether action is necessary. If so, the individual assesses whether she/he feels responsible for the actions. Lastly, if whistle-blowing is considered as one action alternative, the individual assesses the expected benefits and costs related to blowing the whistle and ultimately chooses to do so (Dozier & Miceli, 1985).

Concerning the motivation of pessimistic project status reporting, a considerable share of prior studies used an experimental approach to identify relevant factors involved in the decision-making process of status reporting behavior (Keil et al., 2007; Park et al., 2009; Park & Keil, 2009; Smith et al., 2001; Tan et al., 2003). For example, personal beliefs regarding the desirability of whistle-blowing generally lead to higher chances of speaking-up (Miceli & Near, 1984). In another study, Smith et al. (2001) find that the assessment whether an unfavorable status should generally be reported is positively related to an individual's assessment whether it is her/his personal responsibility to do so. Furthermore, perceived wrongdoing and perceived project risk increase the assessment that the unfavorable status should be reported. Perceived wrongdoing also increases the personal responsibility to report. In this regard, Park et al. (2009)

find that an individual's personal morality is positively related to the general assessment whether a status should be reported, personal responsibility to report, and willingness to report. Tan et al. (2003) find that organizational climate as well as information asymmetry both have an influence on the whistle-blowing behavior of individuals. Smith et al. (2009) find that self-interest is associated with a higher and rules and codes with a lower level of misreporting.

The literature on the consequences of project status reporting behavior coherently shares the conclusion that status biasing negatively affects project success. Iacovou et al. (2009), for example, use a large survey to investigate antecedents and consequences of selective reporting frequency. They distinguish between reporting quality and task outcome in a mediated model and find that a higher reporting quality is positively related to task outcome. Furthermore, they find that pessimistic reporting does not significantly affect reporting quality, but that optimistic reporting decreases it. While this provides insights into the relationship between reporting bias and project outcome, the authors do not report the indirect effect of reporting bias on project outcome or the quantitative impact on success. Thompson et al. (2007) also investigate the relationship between reporting quality and project outcomes, differentiating between task outcomes, psychological outcomes, and organizational outcomes. The results imply that higher reporting quality is associated with higher outcomes in all three dimensions. The importance of high reporting quality for successful task outcomes also corresponds well to the findings from project portfolio management literature concerning the importance of projects' information availability (Martinsuo & Lehtonen, 2007) and information quality (Jonas et al., 2013; Teller et al., 2012), as well as risk transparency and risk culture (Teller & Kock, 2013).

Concluding the literature review, prior literature focused mainly on investigations on the antecedents of project status misreporting. While previous empirical results shed light on the general motivation and context of reporting decision processes, the relationship between reporting behavior and future project success remains unclear. Furthermore, it remains unclear whether reporting behavior's influence on future project success changes over the course of a project and whether continuous behavior intensifies the effects.

5.3 Hypothesis Development

5.3.1 Reporting behavior and future project success

With optimistic reporting behavior, project managers overestimate a project status and report the current status as more positive than it actually is (Iacovou et al., 2009). We argue that optimistic reporting behavior has a negative influence on future project success since it decreases the effectiveness of appropriate countermeasures to project threats. When a project turns worse and project managers still report an optimistic, more positive depiction of the project, they conceal the project's true status and underlying threats (Harris & Hahn, 2011; Jani, 2011; Meyer, 2014). Then, however, senior management is unable to (early) recognize these potentially harmful project threats and define appropriate countermeasures (Keil & Robey, 1999). This is severe since, in contrast to project managers, senior managers in the portfolio steering committee have more advanced means to respond to project threats (Meskendahl, 2010). For example, they can allocate more resources to the project to solve a temporary shortage in workforce or use their authority to overcome barriers (Engwall & Jerbrant, 2003). However, if senior management is informed too late or not at all, potential countermeasures are likely to lose their effectiveness. Also, a project's underlying threats then have more time to increase in probability and impact, which makes them more difficult or even impossible to respond to. Overall this should decrease projects' future success. The empirical findings of Iacovou et al. (2009) provide support for the negative impact of optimistic biasing. Thus, we formulate our first hypothesis as follows:

> ***Hypothesis 1a:*** *Optimistic project status reporting behavior is negatively related to future project success.*

When applying pessimistic reporting behavior, project managers report their project's status as more negative than it actually is (e.g., reporting an amber or red status instead of a green). They often do so to over-cautiously raise an alarm early and "to create slack for contingencies that may arise later" (Snow et al., 2007, p. 137). An early increase in available resources could become valuable in projects' later phases when potentially troubling threats materialize, since project managers can then instantly rely on the already granted additional resources to resolve

the issues. This cautious and foresighted type of behavior should affect a project's later success positively. If more resources are granted early, as soon as a risk occurs, project managers have sufficient resources at disposal to prevent or fight it. If risks turn into problems, stakeholders and project team members are prepared and can ensure their best response to cope with the impact (Iacovou et al., 2009). In addition to projects' success, this preparedness improves both risk transparency and risk coping capacity, which, as Teller and Kock (2013) demonstrated, are both highly relevant for project portfolio success. Thus, increasing projects' risk management capabilities through early pessimistic reporting should positively affect future project success. By adequately responding to threats, this behavior should benefit both short-term and long-term project success.

> ***Hypothesis 1b:*** *Pessimistic project status reporting behavior is positively related to future project success.*

5.3.2 Reporting behavior over a project's course

Risk management in project and portfolio management refers to the identification, analysis, response, and monitoring of potentially harmful events (Petit, 2012). Risk management processes are an essential part of project management (Bakker, Boonstra, & Wortmann, 2010; Qazi, Quigley, Dickson, & Kirytopoulos, 2016) and positively affect project success (Mu, Peng, & MacLachlan, 2009) and also project portfolio success (Teller et al., 2014). The timing of decisions is crucial in projects' management. For example, previous research shows that budget decisions regarding projects depend on the current project stage, especially regarding decision makers' escalation of commitment (He & Mittal, 2007). Specifically in project management, the timing when managers identify and report risks is decisive. Early risk reporting increases the chance to resolve issues before they inevitably materialize. Thus, we expect the influence of project status reporting behavior on future project success to depend on the project's current stage (i.e., percentage of completion).

The strength of optimistic and pessimistic reporting behavior's effect on future project success likely decreases as a project progresses. We base this assertion on the logic of path dependence in a project's course (Aaltonen et al., 2017). Path dependence describes "a property of a

stochastic process which [is] obtain[ed] under two conditions (contingency and self-reinforcement) and causes lock-in in the absence of [an] exogenous shock" (Vergne & Durand, 2010, p. 741). In a project's early phases, its potential outcomes and the paths to reach them are not determined, yet. Thus, senior managements' and project managers' decisions on how to proceed have a higher impact on the future path of the project. In later stages, through self-reinforcement and based on prior decisions, a project's path becomes more and more determined and ultimately reaches a stable lock-in (Hetemi, Jerbrant, & Mere, 2020; Vergne & Durand, 2010). Management decisions then have comparably smaller impacts on project's further development.

In projects' early phases, pessimistic reporting behavior, serving as an early heads-up to senior management and leading to a joint early plan on how to cope with later-arising potential threats, should be very beneficial for projects' later developments. Then, before problems irreversibly occur, project managers can already assign resources for the remaining project duration and get involved with relevant stakeholders. In turn, concealing a negative current project status through optimistic reporting behavior most likely leads to a harmful simmering of a project's underlying threats. Risks then have a longer time to increase both in probability and impact, which increasingly jeopardizes projects' success. In projects' later phases, however, previous decisions of earlier phases largely determine most of the current available project actions (Aaltonen et al., 2017). Then, the remaining project's future path is locked-in and resistant to endogenous influences. Thus, this path-dependency lowers the absolute influence of concealing negative information (optimistic reporting behavior) or over-cautiously reporting a more negative status (pessimistic reporting behavior).

> ***Hypothesis 2:*** *Reporting behavior and a project's percentage of completion interact to predict future project success, such that the effect of reporting behavior on future project success will be weaker for later project stages compared to earlier project stages.*

5.3.3 Influence of continuous reporting behavior

We argue that a sustained optimistic or pessimistic reporting behavior across a larger share of project reports negatively affects the influence of current reporting behavior on project success. In project portfolios, risk transparency and risk coping are both crucial influences on overall portfolio success (Teller & Kock, 2013). However, also for individual projects, prior literature concludes that effective risk management constitutes a decisive success factor (Bakker et al., 2010). Operationally, project risk management includes the identification, analysis, and management of risks (Project Management Institute, 2017). Among other characteristics of risk management, transparent and inclusive risk identification is highly relevant for project outcomes (Olechowski, Oehmen, Seering, & Ben-Daya, 2016). However, in practice, managers often fail to establish an effective risk management and thereby threaten project success (Bakker et al., 2010; Kutsch & Hall, 2005). One reason that prevents effective risk management is that project managers simply ignore project risks, which prevents properly identifying, assessing, and reporting risks (Kutsch & Hall, 2010). This relates well to the motives of optimistic reporting behavior investigated in this study.

We argue that continuously applying pessimistic or optimistic reporting behavior is detrimental for project success, since it increasingly distorts the information basis shared between senior management and project managers (Iacovou et al., 2009). Ultimately, this sustained behavior prevents effective risk management in individual projects; and also decreases overall the information quality and thus negatively impacts senior managers' decisions regarding projects' future.

With optimistic reporting, project managers conceal projects' harmful threats that cause the true unfavorable status by portraying a project as more positive. However, covering problems and their causes prevents senior management to adequately cope with them, for example, by allocating additional resources to address an issue. The unaddressed issues then have a longer time to exacerbate in terms of their probability and impact (He & Mittal, 2007; Petit, 2012). When they are ultimately discovered, chances are high that their impact has already irreversibly materialized.

With pessimistic reporting behavior, project managers conceal a positive status by reporting the project status in a more negative way. If this behavior continues over a sustained share of project reports, pessimistic reporting behavior is likely to negatively affect success. The potential positive effects argued in H1b, for example, securing additional slack resources, are unlikely to be sustained in the long-run. Furthermore, to maintain additional unneeded slack resources over a longer period ultimately negatively affects projects' efficiency, especially in terms of a project's cost and profitability (Hu & Szmerekovsky, 2017).

Thus, overall we conclude that sustained reporting behavior negatively affects a project's future success. Accordingly, we formulate our third hypothesis as follows:

> ***Hypothesis 3:*** *Previous and current reporting behavior interact to predict future project success, such that the effects of current reporting behavior on future project success are reduced with increasing previous reporting behavior.*

5.4 Data and Method

5.4.1 Sample

Quantitatively investigating the performance effects of status reporting behavior requires a large sample of quantitative project status data that contains all information on projects' current and future performance and allows to assess project managers' individual reporting behavior. We found a suitable sample for our investigation in the entire project database of an international company (> 50k employees, yearly revenue of > 10 billion USD) that offers customer-specific complex machinery and transporting applications. The company's overall business is structured in projects because they create an individual project for each customer order that incorporates all customer-specific engineering, manufacturing, and production tasks as well as all sales data for the order. Project managers monthly present a status update of their respective project to senior management in the portfolio steering committee and additionally log the presented data in the company's central project database. The status reports are standardized; meaning that project managers enter their current status information in a standardized presentation format and in the respective, standardized fields of the database.

Each project status presentation includes a prominent executive summary that presents current status information in the color scheme ‘green’, ‘amber’, and ‘red’ as well as current key figures on the project including overall project characteristics (e.g., size) and current information (e.g., percentage of completion, current margin, risk/ opportunity cost, and contingencies). For our analysis, we used the company’s entire project database with longitudinal data of 46,474 monthly project status reports of 1,229 projects that were executed in a timeframe between 2006 and 2016.

5.4.2 Approach

In this paper, we apply a unique approach to predict project managers’ reporting behavior based on projects’ objective data and then assess the quantitative consequences of different reporting behavior for projects’ future success. We present the approach in Table 13 below. The first two steps relate to the assessment of the reporting behavior while the third step describes the main analysis of performance effects. Consequently, we will begin by explaining the measurement of reporting behavior (i.e., Step 1 and 2), which then constitutes the independent variable of the main analysis in Step 3.

Table 13. Approach to predict reporting behavior and assess its performance effects (Research study D)

	Description	**Dependent Variable**	**Independent Variable**	**Method**
Step 1	Prediction of average status for each project based on its objective data	Project status (red, amber, or green)	Objective project data (e.g., current risks)	Multinomial logit panel regression
Step 2	Assessment of reporting behavior by comparing predicted and actual status	-	-	Logical coding
Step 3	Assessment of reporting behavior’s performance effect	Project margin in three months	Reporting behavior and control variables	Fixed-effects panel regression

5.4.3 Measurement: Independent variable

Status reporting behavior. Operationally, status reporting behavior is difficult to assess since projects' true status is generally hard to determine and project managers are not necessarily willing to disclose intentional biasing (Snow & Keil, 2002). Thus, we choose an objective two-step approach (i.e., Step 1 and 2 in Table 13) to assess project managers' individual reporting behavior by comparing their actual status reporting to a predicted status reporting based on all projects' objective key characteristics. This unique approach allows us to identify all project reports for which project managers reported a different status than the average project manager based on project's key data would have reported.

In Step 1, we predict a hypothetical average reported status (i.e., red, amber, or green) for each project based on the objective data of all 46,474 project reports. We use this predicted project status as the baseline for the later comparison with the status that project managers actually reported. To calculate the predicted status, we use a multinomial logit panel regression and regress the reported project status color on the project status variables that are reported on the executive summary slide of the status summary in projects' monthly status reports. To avoid a circular calculation in the later main regression analysis, we used the variables' one month lagged values. We present the regression results in Table 14. The results imply that an increasing project margin is related to a decrease in probability of an amber or red status. The further a project has progressed since its start, the lower are the chances of a project status turning amber and the higher are the chances of it turning red. Larger projects are rather connected to an amber and a red status.

Table 14. Results of multinomial logit panel regression to predict the status (Research study D)

	Status amber	**Status red**
Time since project start	-0.003**	0.017**
	(.001)	(.001)
Size	0.002**	0.002**
	(.000)	(.000)
Division (a)	-0.456**	-0.491*
	(.169)	(.220)
Division (b)	-0.573**	-0.185
	(.162)	(.211)
Division (c)	-0.610**	-0.705*
	(.159)	(.208)
Lag1 margin	-0.006**	-0.011**
	(.001)	(.001)
Lag1 contingency costs	0.001	0.001
	(.003)	(.003)
Lag1 risk and opportunity costs	0.002	-0.001
	(.002)	(.002)
Constant	-0.256*	-0.849**
	(.119)	(.156)

Standard errors in parentheses; n = 46,474 reports of 1,229 projects. + p<0.10, * p<0.05, ** p<0.01. Lag1 means variables are lagged by one month.

In Step 2, we then calculate for each report the deviation between the predicted status from Step 1 and the status that project managers actually reported. For each monthly report, the multinomial logit regression returns an estimated probability for each status color that in sum equal 100 %. We determine the status with the highest probability as the predicted status for each project report. This status then represents the average status that project managers would report based on the objective, quantitative information provided on the executive summary. We use a categorical variable to distinguish between three cases of reporting behavior. (i) If the reported status and the predicted status are equal, we interpret this as neutral, non-biased reporting behavior. (ii) If the reported status is more optimistic than the predicted status, we interpret this as optimistic reporting behavior. In this case, a project manager would, for example, report a green status while the predicted status indicates a red status. (iii) If the reported status is more pessimistic than the predicted status, we interpret this as pessimistic reporting behavior. In this case, project management would, for example, report a red status while the predicted status is still amber or green. We present an overview of the distribution of reporting behavior in Table 15. For 68 % of the project reports, the predicted and the actual project status are the same, which translates to an alignment between average reporting

behavior in these reports. We identify in 18 % of the project reports a pessimistic and in 14 % an optimistic reporting behavior.

Table 15. Overview of predicted objective status and reporting behavior (Research study D)

	Predicted average status			
Reporting behavior	**Green**	**Amber**	**Red**	***Total***
Neutral	34.35%	9.03%	25.05%	*68.42%*
Pessimistic	14.93%	3.16%	-	*18.09%*
Optimistic	-	3.04%	10.44%	*13.49%*
Total	*49.28%*	*15.23%*	*35.49%*	

n = 46,474.

5.4.4 Measurement: Dependent variable

Monthly project success. For the longitudinal analysis of the status reporting behavior's influence on future project success, we required a monthly, reliable, comparable, and quantitative success measure. In previous literature, multiple forms of project success operationalization have been proposed (e.g., Atkinson, 1999; Baccarini, 1999; Cooke-Davies, 2002; Ika, 2009; Shenhar, Levy, & Dvir, 1997). We deem the projects' profitability measured by the current margin estimated-at-completion (EAC) (i.e., the estimated final project margin at project completion, taking into account a project's prior, current, and projected cost and sales) as appropriate dependent variable for four key reasons. First, the financial project profitability is a definitive and final measure for success. Succeeding in the traditional measures of budget, schedule, and scope ultimately results in higher project profitability. Second, the projects' financial success is of essential importance for the overall company's existence since a positive profitability is ultimately needed for its long-term existence. Third, this measure is especially relevant in the context of external, customer projects such as our sample's projects (Cooke-Davies, 2002; Shenhar & Dvir, 2007). Lastly, the management of the company confirmed to us that this measure was the key success indicator for senior management. Furthermore, since projects often had a duration for multiple years, the estimated margin EAC was also used for controlling and external reporting.

5.4.5 Measurement: Moderator variables

Percentage of completion. We include the variable percentage of completion (POC) to account for whether the reporting behavior occurs in early or late phases of a project. POC is calculated as ratio of the cumulated actual project cost until the reporting date divided by the total planned project cost. We use the POC based on cost rather that time to also include projects in our analysis that were not yet completed. Furthermore, we argue that the percentage of costs spent more accurately reflects the actual progress compared to a time-based measure since it also includes actual developments and not just time passed.

Previous status reporting behavior. We include two variables in the analysis to account for project managers' previous status reporting behavior. The variables separately assess the share of previous project reports in which the status was optimistically and the share of project reports in which the status was pessimistically reported.

5.4.6 Measurement: Control variables

In our main regression analysis, we use a fixed-effects panel regression model that by its design controls for all time-invariant project specifications (e.g., initial contract size, project complexity, division). In addition to time-invariant influences, we control for several time-varying variables that are both relevant for status reporting behavior and future margin development. First, we include the currently *approved project margin*. This controls for previous margin developments that might influence the future margin. Second, we include *risk and opportunity costs* that reflect changes in the risk situation of the project. Third, we include the *contingencies costs* that were used to estimate the financial effects of potentially threatening project developments. Furthermore, we control for two variables that indicate the current and previous health of the project. The *predicted project status* was coded as categorical variable similar to the actual project status variable. Lastly, we also included the variable *mean predicted status* to account for the average previous project development. This variable is the sum of the previous predicted status divided by the amount of previous project months. We report an overview of the correlations between the variables used in the regression analyses in Table 16.

Table 16. Correlations (Research study D)

	Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1)	Margin in three months	1						
(2)	Current margin	0.15	1					
(3)	Risk and opportunity costs	-0.03	0.30	1				
(4)	Contingency costs	-0.02	0.12	0.22	1			
(5)	Percentage of completion	-0.09	-0.08	-0.11	-0.08	1		
(6)	Mean predicted status	-0.46	-0.07	0.09	0.03	0.18	1	
(7)	Share previous pessimistic reporting behavior	0.22	0.05	-0.08	-0.03	0.07	-0.43	1
(8)	Share previous optimistic reporting behavior	-0.16	0.02	0.10	0.04	-0.12	0.65	-0.38

n = 46,474. All correlations are statistically significant at the 1 % level.

5.5 Results

We present the results of the main regression analysis in Table 17. The first regression includes the control variables and the independent variables. The higher the currently approved margin (b = 0.025, p = 0.000) and the lower the risk and opportunity cost (b = -0.054, p = 0.000) and the contingencies (b = -0.004, p = 0.030), the higher is the project margin in three months. In turn, the higher the average predicted status over all previous reports (i.e., the more often the status is red), the lower is the future project margin (b = -1.592, p = 0.000).

Regarding Hypothesis 1, optimistic reporting behavior is positively (b = 3.008, p = 0.000) and pessimistic reporting behavior is negatively (b = -0.175, p = 0.028) related to future project margin. This rejects Hypothesis 1a and 1b, in which we expected a negative relationship between optimistic reporting behavior and future project success, and a positive relationship between pessimistic reporting behavior and future project success. Thus, contrary to our expectations, optimistic reporting behavior seems to actually benefit future project success, while pessimistic reporting behavior hinders future project development. Regarding Hypothesis 2, the project's percentage of completion negatively moderates the relationship between optimistic reporting behavior and future project margin (b = -3.191, p = 0.000), and

positively moderates the relationship between pessimistic reporting behavior and future margin ($b = 3.327$, $p = 0.000$). This confirms our Hypothesis 2 which proposed that the absolute influence of both types of reporting behavior decreases over the course of the project. We visualize the average marginal effects of the reporting behavior for each level of POC in Figure 9. The effect of optimistic reporting behavior on future margin remains positive over the course of a project, however, it decreases towards project completion. The effect of pessimistic reporting behavior on future margin is significantly negative for the first half of a project. In the second half of a project, however, the effect's direction changes and pessimistic reporting behavior is positively related to future project success.

Table 17. Main regression results (Research study D)

	Margin estimate-at-completion in three months			
	(1)	**(2)**	**(3)**	**(4)**
	H1	**H2**	**H3**	**Full**
Margin approved	0.03**	0.03**	0.02**	0.02**
	(0.00)	(0.00)	(0.00)	(0.00)
Risk and opportunity costs	-0.05**	-0.05**	-0.05**	-0.06**
	(0.00)	(0.00)	(0.00)	(0.00)
Contingencies costs	-0.00*	-0.00*	-0.00**	-0.01**
	(0.00)	(0.00)	(0.00)	(0.00)
Predicted status = Amber	-0.22	-0.33	-0.74**	-0.89**
	(0.25)	(0.25)	(0.24)	(0.24)
Predicted status = Red	-0.80**	-0.57**	-1.80**	-1.79**
	(0.22)	(0.22)	(0.22)	(0.22)
Mean previous predicted status	-1.59**	-1.28**	-3.65**	-3.32**
	(0.09)	(0.10)	(0.10)	(0.10)
Percentage of completion (POC)	-0.07	-0.32*	1.97**	1.77**
	(0.12)	(0.13)	(0.12)	(0.14)
Reporting = Optimistic	3.01**	4.44**	2.22**	3.82**
	(0.09)	(0.15)	(0.16)	(0.23)
Reporting = Pessimistic	-0.17*	-1.91**	0.84**	-0.24
	(0.08)	(0.14)	(0.13)	(0.17)
Optimistic x POC		-3.19**		-2.45**
		(0.25)		(0.25)
Pessimistic x POC		3.33**		2.08**
		(0.23)		(0.22)
Share previous optimistic			15.90**	15.89**
			(0.32)	(0.32)
Share previous pessimistic			4.39**	4.00**
			(0.28)	(0.29)
Optimistic x Share previous optimistic reporting			-1.10**	-2.30**
			(0.34)	(0.36)
Pessimistic x Share previous pessimistic reporting			-3.63**	-3.58**
			(0.34)	(0.34)
Constant	17.03**	16.60**	16.81**	16.47**
	(0.16)	(0.17)	(0.16)	(0.17)
Within R-squared	0.07	0.08	0.13	0.14
Between R-squared	0.19	0.17	0.15	0.14
Overall R-squared	0.18	0.15	0.18	0.16
F	351.70**	332.13**	523.42**	470.03**

Standard errors in parentheses; n = 46,474 reports of 1,229 projects. + p<0.10, * p<0.05, ** p<0.01. Predicted status and bias are categorical variables. Thus, the indicated coefficients show the difference to the respective variable base (i.e., predicted status = green, bias = no bias).

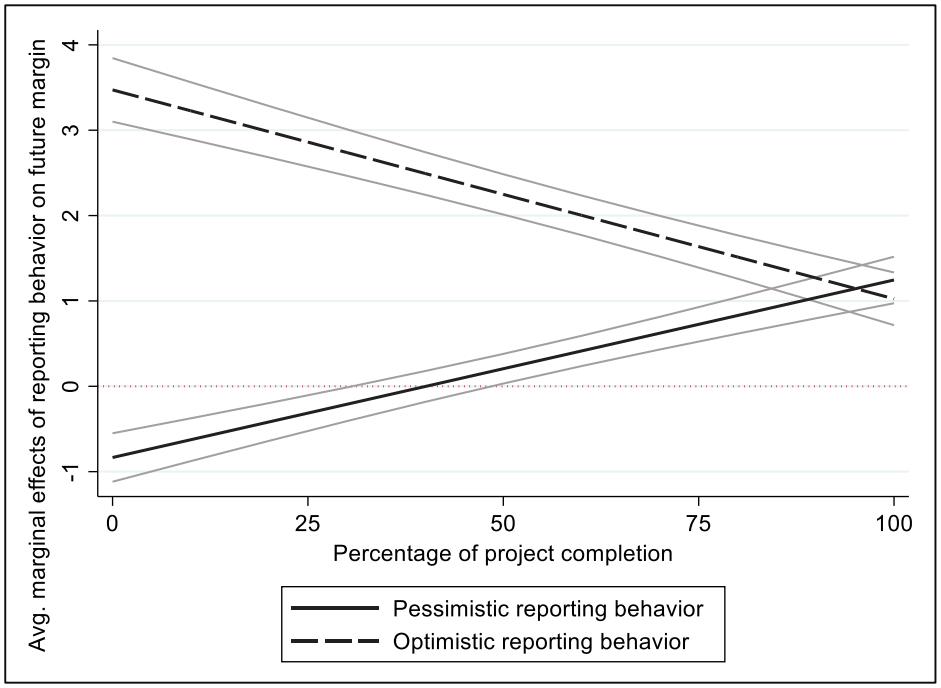

Figure 9. Average marginal effects of reporting behavior on three months future margin for all levels of project completion (thin lines represent 95%-confidence bands), (Research study D)

The results of the interaction between previous and current reporting behavior are presented in Model 3. The share of previous optimistic reporting behavior negatively moderates the relationship between current optimistic reporting and future project developments (b = -1.103, p = 0.001). For previous pessimistic reporting, the connected share negatively moderates current pessimistic reporting's relationship with future project margin (b = -3.627, p = 0.000). This confirms our Hypothesis 3. Continuous reporting behavior is negatively related to future project margin. For further interpretation, we again visualize the average marginal effects of the moderation terms for optimistic reporting behavior in Figure 10 and pessimistic reporting behavior in Figure 11. Regardless of the share of previous optimistic reporting, current optimistic reporting still has a positive relationship with future margin. However, this effect decreases with increasing share of previous optimistic reporting behavior. The marginal effect of pessimistic reporting behavior is significantly positive for low previous pessimistic reporting, however, it turns negative for larger levels of previous pessimistic reporting (> 30 %).

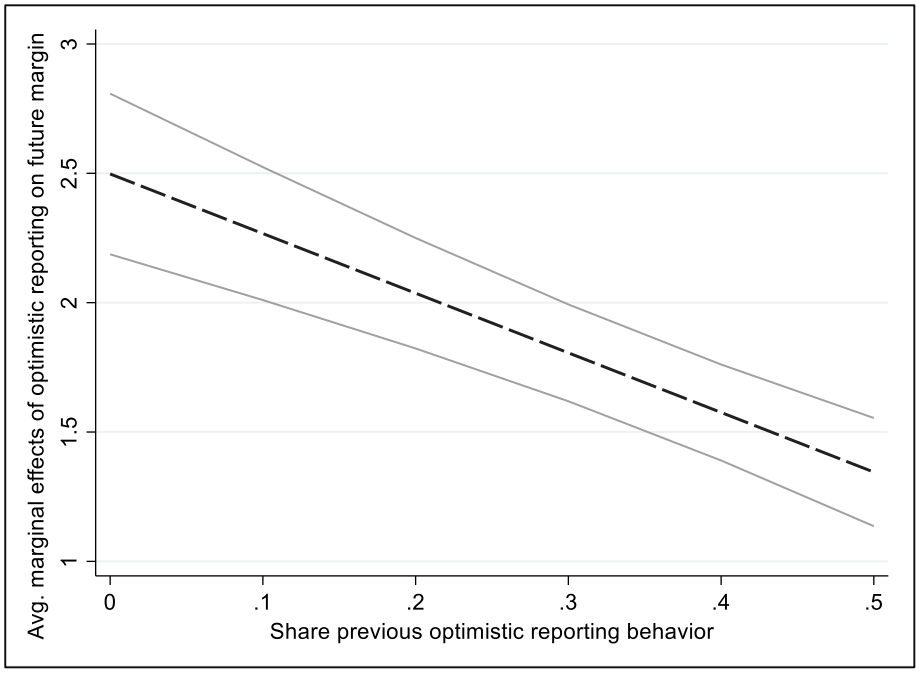

Figure 10. Average marginal effects of optimistic reporting behavior on three months future margin for all levels of previous optimistic reporting (thin lines represent 95%-confidence bands), (Research study D)

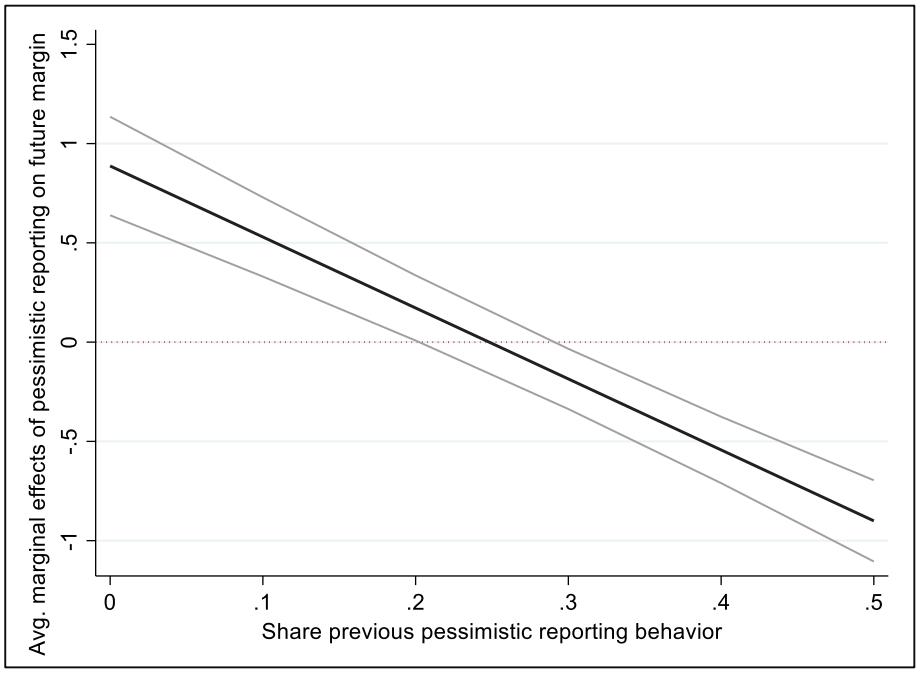

Figure 11. Average marginal effects of pessimistic reporting behavior on three months future margin for all levels of previous pessimistic reporting (thin lines represent 95%-confidence bands), (Research study D)

5.6 Robustness checks

To assess the robustness of our results, we tested multiple variations to our aforementioned models' and variables' specifications. The main performance effects of optimistic and pessimistic reporting behavior are supported across all robustness checks. Regarding the main regression models, we tested several different variations to assess whether the main effects remain stable regardless of control variables and dependent variable specifications. First, we calculated two alternative sets of regression models, one without the variable *mean previous predicted status* and one without the variable *predicted status.* The main results remained the same with the exception of the models without the *predicted status* for which the effect of pessimistic reporting behavior in Model 1 and the interaction effect between previous and current optimistic reporting behavior in Model 3 were insignificant. Second, we tested different time lags for the dependent variable. We used the six months', nine months', and twelve months' margin prediction. These specifications led to comparable results to the ones reported above. Third, we replaced the variable *status reporting behavior* (e.g., optimistic or pessimistic) with the actual categorical status variable that codes the project manager's actual status decision (e.g., 'red', 'amber', or 'green'). The results again supported our main findings. For example, the results imply that if our model predicts a 'red' status for a specific month but the responsible project manager demonstrates an optimistic reporting behavior and actually reports an 'amber' or 'green' status, this is connected to a significantly higher future margin compared to a neutral reporting behavior with an actually reported 'red' status. Lastly, to further assess the overall robustness of our results, we calculated the average status reporting behavior across all monthly status reports for each completed project and regressed it on its respective final project margin. The results confirm that on average optimistic project status reporting behavior correlates with higher and pessimistic reporting behavior with lower final project margin.

5.7 Discussion

This study's goal was to investigate the relationship between status reporting behavior and future project success using quantitative, objective project data. Calculating a predicted status variable across the sample data allowed us to estimate an objective measure for status reporting

behavior. Furthermore, the longitudinal approach of analyzing the panel data of monthly project reports gave in-depth insights into the consequences of optimistic and pessimistic reporting behavior on future project development.

The findings of this study oppose the former consensus in literature that reporting bias in general and optimistic reporting behavior in particular negatively influence project success (Iacovou et al., 2009; Johnson, 1999; Keil et al., 2007; Keil et al., 2014; Keil & Robey, 1999; Park et al., 2009; Snow & Keil, 2002; Tan et al., 2003; Thompson et al., 2007). Instead, we find a positive relationship between optimistic reporting behavior and future project success. Presenting a project's health in a more pessimistic way, in turn, is related to lower future project success. In the following, we will discuss potential explanations for these surprising findings.

Concerning optimistic project reporting, we identified that this behavior is connected to a higher future project margin. This could have several reasons. First, optimistic reporting could allow project managers and their corresponding project to "fly under the radar" of the steering committee. Then, project managers can avoid the aforementioned consequences of higher surveillance and senior management involvement which is usually connected to a negative status. This freedom could allow project managers to follow their intended measures to resolve the reasons for their project's negative health without interference (e.g., additional justification and explanation) by the steering committee. In contrast to the steering committee, the project manager has more in-depth knowledge of the project and its issues and could therefore be more competent in getting the project back to a good health. Second, reporting a more positive status could lead to additional resources assigned to the project. In accordance with portfolio selection and real options reasoning in portfolios, resources will preferably be assigned to promising projects with a positive track record (Klingebiel & Adner, 2015). These additional resources could then be helpful in getting the disguised project back to good health. Lastly, more competent project managers might have a higher self-efficacy and confidence in their abilities (Harris & Hahn, 2011; Jani, 2011; Meyer, 2014). They will therefore have a more optimistic view on the project's future development compared to the average project manager. Thus, while the average project manager estimated the project as worse, a more competent and experienced project manager might correctly estimate that "it will all work out in the end" (Snow et al., 2007, p. 133). Owing to the higher competency, the experienced project manager might then actually be able to bring the project back to a good health.

The negative consequences of pessimistic reporting behavior for project success could be caused by the managerial practices that usually follow the reporting of a red status. Alerting the steering committee of a potential negative project development usually leads to repercussions and scrutiny for project's manager and members. This, however, could then result in a climate of fear with a decreased confidence of project team members and managers to take decisions and proceed. As Snow et al. (2007) identified, this climate of fear is among the main reasons why project managers conceal a negative project status in the first place. Highlighting a project's negative status could lead to micromanagement intervention from the steering committee (Wang, Kunc, & Bai, 2017). With the committee, however, most likely not having inside knowledge on the troubling project to the full extent and all decisions having to be validated by this additional committee, the project's processes are further slowed down. In addition, with all decisions and their impact being closely monitored by senior management, project managers and employees might be even more afraid to take decisions. In the long run, this shift of competencies probably leads to a decrease in confidence of the project managers and an overall decrease in trust. Keil et al. (2014) found that if the response to the reporting of negative project developments is heavier auditing, this leads to a comparable "reinforcing cycle of distrust" (Keil et al., 2014, p. 879). Project managers are then additionally reluctant to report a deterioration of the project's health. Concerning a project's percentage of completion, the consequences of these negative effects should be less severe. This also could be the reason why the negative influence of pessimistic reporting decreases with increasing project duration. As presented above, the marginal effects of pessimistic reporting behavior on project success turn positive for a project's second half. This could be explained by the engagement of project members and management. The later project managers choose to present the project in a more pessimistic way, the higher could be the engagement of top management to finish the project in the last phases. When project managers, team members, and upper management all realize that the project's success might be in danger so close to its completion, their motivation to resolve the issues by additional resources or just higher work efforts is most likely enhanced.

This study offers multiple contributions to literature and practice. First, this study is unique in offering insights into the consequences of status reporting behavior on projects' future development. This form of analysis corresponds more accurately to the previously developed models of the decision-making process concerning status reporting for each individual project

(e.g., Smith et al., 2001; Smith & Keil, 2003) than the analysis of average effects for completed projects only (e.g., Iacovou et al., 2009). The results of this study contribute new insights to the discussion on the consequences of status reporting behavior. In contrast to previous literature's consensus that reporting biasing negatively affects project success, the results of our study provide a starting point for a more nuanced exploration of potential positive and negative influence of reporting behavior (Snow et al., 2007). The study offers insights into moderating factors of status reporting behavior that are important over the course of a project. This further extends the prior debate on status reporting behavior. For example, our analysis provides additional information on how the influence of reporting behavior changes over the course of the project from negative to positive. Second, this study contributes to the extensive literature on project success factors and project success (Belassi & Tukel, 1996; Fortune & White, 2006; Serrador & Turner, 2014). Project misreporting and status biasing have previously been formulated as an important reason for project failure (Smith & Keil, 2003; Thompson et al., 2007). The results of this paper shed light on this phenomenon and its relationship with project success. This further opens up the discussion on the organizational practices that are tied to negative project reports and thus potentially increase intentional misreporting. Third, previous literature argued for an increased relevance of biases in information system projects due to the complexity in assessing the impact of changes and the actual project state (Fink & Pinchovski, 2020; Smith et al., 2001). The context of this study, however, are external projects for large industry applications, which demonstrates that the issue of reporting behavior goes further than just information systems. Thus, this study extends the relevance of status reporting behavior and its performance influences to general project management literature and thereby also contributes novel insights to prior work on decision-making in project and portfolio management (Kock & Gemünden, 2016; Stingl & Geraldi, 2017).

For practitioners, our study offers valuable insights into the consequences of (repeated) status reporting behavior on future project success. Very prominently, we offer the new insights that reporting behavior cannot generally be considered as a negative influence for individual projects. Thus, we recommend project managers to more consciously scrutinize their reporting decisions and their motivations for each status decision. Especially in projects' early phases, when projects' future path is less determined yet, project managers should be aware that status

reporting behavior has a large impact on projects' future development. However, overall, project managers should refrain from a continuous optimistic or pessimistic reporting behavior since this erodes the shared information base between senior management and themselves. Regarding project portfolios, we intend to expand the discussion on organizational practices for status reporting behavior. As discussed above, negative consequences for troubled projects and their managers could unintentionally promote adverse reporting behavior. This is relevant to project managers reporting the status as well as to steering committee members that interpret and base their decisions on status reports. We recommend portfolio steering committees to use the received status information as a baseline for discussions with the project managers. This could then allow them to understand the project managers' individual motivations and future project plans, especially regarding a project's risks.

This study is connected to certain characteristics that need to be considered when interpreting the conclusions that we draw. Although the sample contains a large number of projects over a timeframe of eleven years, it stems from a single company. Thus, while we account for all time invariant fixed-effects in our analysis, this could still limit the findings' external validity. Furthermore, owing to our unique dataset, we investigate external projects only. For internal projects, for example IT or R&D projects, that do not have a final margin but rather success measures based on the adherence of time or cost, project managers' reporting behavior and its consequences for project success could differ.

We encourage researchers to further investigate the phenomenon of project status reporting behavior. With this study's results partially opposing prior research, there is a lot of potential in further investigating the reasons for our surprising findings. For example, we recommend future research to investigate the decision-making process of an individual project manager *during* the course of a project both for optimistic and pessimistic reporting. In this regard, we see particular potential in investigating project managers' psychological traits, for example risk-taking behavior or goal determination, and their potential shift in importance over the course of the project. Furthermore, the influence of organizational practices on status reporting should also be taken into account. We expect these practices to interact with the project managers' psychological traits and their incentives to accurately report their projects' health. Furthermore, we encourage researchers to investigate the consequences of status reporting behavior for project portfolios (e.g., Hopmere et al., 2020). If project managers pursue the

strategy to secure more resources by intentionally misreporting the project status, this might affect other projects' resource allocation, too. In this regard, the influence of prevalent misreporting behavior on portfolio success could be of particular interest.

Chapter 6

Discussion

This dissertation investigates how project portfolio and project management can support an organization's continuous adaptation to a changing environment in the context of elevated levels of uncertainty. While the four studies presented in the previous chapters each include a discussion of their respective findings, in this chapter, I discuss the empirical findings and implications in their entirety following the dissertation's overall research goal and questions. Furthermore, I elaborate on future research potential derived from the discussed findings.

6.1 Conclusion

The goal of this dissertation was to investigate how organizations can successfully drive their adaptation through their project portfolios by effectively implementing deliberate strategies, recognizing emergent strategic initiatives, and ensuring operational project success while considering heightened levels of uncertainty and complexity in their decisions. Following a deductive research approach, two empirical studies on the strategic adaptation of project portfolios and two empirical studies on the operational success of projects were performed.

Regarding the first research question on portfolios' strategic adaptation, the empirical results of research study A confirm ROR as an effective approach to cope with innovative projects' uncertainty in deliberate strategy implementation. ROR allows decision makers to remain flexible and constantly increase their portfolio's efficiency and thereby enables organizations to venture more innovative projects, increase portfolio innovativeness and success. However, owing to the behavioral characteristic of ROR, the portfolios' strategic and cultural contexts determine ROR's successful application. Especially an organization's entrepreneurial orientation, besides its strong direct benefit for portfolio success, also positively moderates ROR's relationship with innovativeness. Furthermore, a sufficiently high level of entrepreneurial orientation is necessary for ROR, through higher innovativeness, to also benefit portfolio success. While a highly developed innovation climate also benefits portfolio innovativeness, it surprisingly does not significantly enhance or hinder ROR's application. In addition to deliberate strategy implementation, the results of research study B confirm that emergent strategy recognition benefits portfolio success, as well. Furthermore, agile capabilities, i.e., the competence in and the application of agile practices in the portfolio, particularly benefit emerging strategy recognition. Through the higher interaction between agile projects' team members, they are particularly inspired to discover valuable strategic opportunities. Furthermore, agile capabilities facilitate the creation of a complex-adaptive system which supports a portfolio's adaptation, as well. Again, a portfolio's strategic and cultural contexts hold an important role. Both entrepreneurial orientation and voice behavior support agile capabilities and thereby the creation of a portfolio that is able to remain flexible and adaptive, that facilitates the recognition of valuable emergent strategic initiatives, and that achieves higher portfolio success.

Regarding the second research question on ensuring projects' operational success, the results of research study C confirm that project management causally leads to higher project profitability and that its effectiveness increases for elevated project complexity. Furthermore, the results show that more complex projects achieve higher profitability than less complex projects when coupled with adequate project management effort. In addition, the results of research study D reveal that project managers' reporting behavior is significantly related to their project's future success. While pessimistic reporting behavior is associated with a lower future project profitability, optimistic reporting behavior is surprisingly associated with a

higher future profitability. Owing to an increasing path dependency, optimistic and pessimistic reporting behavior most strongly influence a project in its early phases. Repeated skewed reporting behavior, however, decreases the relationship between reporting behavior and project performance. The findings of both studies underline the importance of project managers' decision-making for projects' success.

Overall, this dissertation's studies highlight the relevance of portfolio management's and project managers' strategic and operational decision-making under uncertainty to support and drive an organization's adaptation. Portfolio management needs to successfully set the portfolio's strategic direction, while portfolio and especially project managers need to ensure portfolio projects' successful delivery to achieve the intended strategy and goals. While there are approaches and formalized processes to structure project portfolios, in the context of uncertainty, portfolio actors' individual perception and decision-making in their respective organizational context determine ultimate portfolio and project success.

6.2 Implications for Research

This dissertation and its studies offer multiple contributions to prior research on strategic and operational portfolio and project management decision-making in the context of uncertainty. While each research study already includes an elaboration of its specific theoretical implications, in this subchapter, I elaborate the overall implications for project portfolio research that jointly arise of this dissertation's studies.

First, this dissertation contributes to literature on project portfolio strategic decision-making under uncertainty as a driver of the overall adaptation of an organization (Cooper et al., 2001; Kester et al., 2011; Kock & Gemünden, 2016; McNally et al., 2009; McNally et al., 2013). The studies show that although uncertainty remains a challenge for decision makers, venturing uncertainty and complexity can ultimately benefit portfolio and project success and thereby support an effective organizational adaptation. This contributes to prior research on portfolio innovativeness by confirming that higher innovativeness is also associated with higher success (Behrens et al., 2014; Criscuolo et al., 2017; Schultz, Salomo, & Talke, 2013). A higher portfolio innovativeness benefits organizational adaptation by recognizing and systematically

developing beneficial opportunities which allow organizations to maintain their competitive position in the future.

Furthermore, the results also add to the research on portfolio management and uncertainty (Korhonen, Laine, & Martinsuo, 2014; Martinsuo et al., 2014; Petit, 2012). On the one hand, the results show that ROR enables portfolio managers to successfully cope with projects' uncertainty, which adds new insights on ROR's effectiveness specifically in project portfolios (Andries & Hünermund, 2020; Klingebiel & Adner, 2015). On the other hand, the results further show that agile practices scaled across the portfolio directly and through their facilitating role for emergent strategic initiatives enable portfolio managers to successfully cope with uncertainty, recognize opportunities, and adapt the portfolio, as well. This not only enlarges the knowledge on agile practices' benefits in terms of strategy development in project portfolios (Stettina & Hörz, 2015; Sweetman & Conboy, 2018) but also contributes new insights to prior research on portfolio structuring (Cooper, 2008; Cooper & Sommer, 2016; Unger et al., 2012) and emergent and deliberate strategy portfolio processes (Kopmann et al., 2017). In addition, the results add to the literature on project sequences (Kock & Gemünden, 2019; Maniak & Midler, 2014; Midler, 2013). Both ROR and agile practices could serve as facilitators for portfolio management to venture uncertain explorative endeavors with limited adverse potential. In subsequent exploitative projects with more strictly defined objectives and less autonomy, promising opportunities could then be systematically exploited.

Second, this dissertation contributes to the literature on project portfolios' contexts (e.g., Gemünden et al., 2018; Kock et al., 2015; Kock & Gemünden, 2016; Korhonen et al., 2014; Martinsuo et al., 2014; Martinsuo & Geraldi, 2020; Petit, 2012), which previously showed that project portfolios' internal and external contexts constitute important contingency factors for project portfolio management. This dissertation confirms that a portfolio's context shapes portfolio processes both as a driver and as a moderator. Concerning portfolio structuring approaches, such as ROR, this dissertation empirically demonstrates that suitable organizational contexts not only shape but are decisive for structuring approaches' ultimate success (Adner & Levinthal, 2004b). Concerning agile practices in portfolios, this dissertation adds the relevant insight that the organizational contexts constitute important antecedents of agile initiatives in organizations (Bäcklander, 2019; Stettina & Hörz, 2015; Sweetman & Conboy, 2018). As such, this dissertation confirms contingency theory in project portfolio

management (Martinsuo, 2013; Shenhar, 2001; Teller et al., 2012). Furthermore, it adds to prior research on portfolio management that portfolios' internal contexts shape the attention and perception of individual portfolio actors in portfolios and its projects (i.e., both decision makers and project team members) and thus also determine the success of decision-making approaches (Barnett, 2008; Stingl & Geraldi, 2017). This also adds to the theory on the attention-based view by demonstrating its importance for research on project portfolios (Ocasio, 1997).

In addition, the results also contribute to the literature on entrepreneurial orientation and innovation climate. This dissertation adds to the literature on entrepreneurial orientation by confirming its direct link with portfolio success but also by showing its decisive role as a moderator for portfolio decision-making and as a driver of agile practices (Kock & Gemünden, 2021; Rauch et al., 2009; Wales et al., 2013). A strong entrepreneurial orientation encourages decision makers and portfolio actors to venture bold, innovative ideas which ultimately results in higher portfolio success. Similarly, the results also contribute to the literature on innovation climate and voice behavior by demonstrating their importance for successful portfolio management, too (Ekrot, Rank, & Gemünden, 2016; Liang et al., 2012; Stock et al., 2013). This dissertation confirms the positive association of innovation climate with portfolio success. A climate that encourages employees to propose innovative ideas and also new approaches and processes supports portfolios' competitiveness and increases its success. This supports the organization's adaptation in terms of innovative ideas and processes.

Third, this dissertation contributes new insights to the literature on the operational challenges of coping with projects' complexity and uncertainty and ensuring their success (e.g., Floricel, Michela, & Piperca, 2016). Specifically, this dissertation provides causal evidence that project management approaches are indeed capable to counter the challenges arising through complexity and uncertainty (Floricel et al., 2016; Lechler, Edington, & Gao, 2012; Zwikael & Sadeh, 2007). By using the unique measurement of project profitability and thereby accounting for projects' economic value, the studies provide an actual quantification of project management's value contribution (Thomas & Mullaly, 2008) and further support the collection of project management's critical success factors (Fortune & White, 2006; Ika, 2009). Furthermore, the results show that venturing more project complexity coupled with adequately higher levels of project management effort can increase project profitability. This promotes a

positive perspective of project uncertainties (Lechler et al., 2012), meaning that uncertainties can indeed constitute opportunities if met with adequate effort to cope with them. This quantifies the challenges and opportunities of project complexity (Geraldi et al., 2011; Maylor & Turner, 2017).

In addition, research studies C and D jointly reveal the performance effect of project managers' decisions in general project management approaches and status communication, which additionally underlines the importance of project managers' decision-making and communication with portfolio management (Blichfeldt & Eskerod, 2008; Hodgson & Paton, 2016). By showing that project management in general, and project managers' status decisions in the steering committee are relevant for projects' profitability, this dissertation highlights the importance of project management research and capability building in practice (Ekrot, Kock, & Gemünden, 2016; Farashah, Thomas, & Blomquist, 2019). Furthermore, this dissertation specifically contributes to the emerging literature on PBOs by demonstrating the effectiveness of project management approaches in light of elevated project complexity; thereby stressing the importance of competence-building in PBOs (Kwak, Sadatsafavi, Walewski, & Williams, 2015; Loufrani-Fedida & Missonier, 2015; Miterev, Mancini, & Turner, 2017). Jointly, the results support the general importance of project management as a relevant research field and the investigation of project success and project management approaches in particular.

Overall, this dissertation highlights the relevance of behavioral aspects, individual sensemaking, and collaboration in strategic and operational decision-making in project portfolio and project management (Martinsuo, 2013; Martinsuo & Geraldi, 2020; Stingl & Geraldi, 2017). With rising ambiguity and uncertainty, rational decision-making becomes increasingly difficult to strictly adhere to (Martinsuo et al., 2014). This dissertation suggests that portfolio decision processes should rather be interpreted from a behavioral and contextual perspective, considering individuals' sensemaking, their organizational context and information availability, and the interaction and negotiations between portfolio actors (Martinsuo, 2013; Martinsuo et al., 2014; Martinsuo & Geraldi, 2020). The findings show that portfolio managers' individual decision-making remains decisive when adhering to behavioral approaches intended to cope with uncertainty (e.g., ROR), and that their individual organizational contexts shape their decisions and thereby influence portfolio success (e.g., Christiansen & Varnes, 2008; Kester et al., 2011; McNally et al., 2009; McNally et al., 2013).

However, this dissertation also shows that project managers' and team members' individual decision-making increases in relevance for success. They are responsible for coping with operational complexity challenges in their day-to-day work. In addition, they are responsible for discovering valuable opportunities and proposing them as initiatives to portfolio management (Kopmann et al., 2017) which becomes even more relevant with agile practices' rising popularity (Sweetman & Conboy, 2018). Furthermore, through their in-depth work in their projects, they possess a performance-relevant information advantage over portfolio management which highlights the importance of information sharing and cooperation in portfolio management's decisions on single projects, too (Blichfeldt & Eskerod, 2008; Iacovou et al., 2009; Martinsuo et al., 2014; Thompson et al., 2007). Overall, this dissertation's findings highlight the importance of portfolio actors' individual decision-making and collaboration for portfolio and project success; and simultaneously demonstrates that portfolios' organizational contexts are important drivers and moderators of these decision processes.

6.3 Implications for practice

In addition to its contributions to research, this dissertation offers relevant implications to practitioners, as well. Below, I elaborate the implications for portfolio managers who decide on portfolio structuring, project managers who cope with projects' uncertainty in their day-to-day work, and organizations' top-level management who is responsible for setting project portfolios' contexts.

This dissertation highlights for portfolio managers that both deliberate strategy implementation and emergent strategy recognition constitute relevant drivers of portfolio success. To support an organization's adaptation, portfolio managers should regularly (e.g., every two months) review and, if necessary, adapt the portfolio strategy to match the overall organization's strategy and external market requirements (Nadkarni & Herrmann, 2010). Furthermore, portfolio managers should constantly monitor that the portfolio's projects align with the intended portfolio strategy (Cooper et al., 2001; Kopmann et al., 2017). Simultaneously, portfolio managers should systematically recognize relevant new strategic opportunities discovered by portfolio actors. They should harness their projects' capabilities to recognize shifts in their customers' behavior or general trends in the market. As this dissertation revealed,

emergent strategy recognition is especially supported in a portfolio with agile projects. Thus, portfolio managers should also support the application of and the competence in agile practices in portfolio's projects and systematically recognize valuable initiatives discovered by agile projects' members. Furthermore, to facilitate the successful creation of a complex-adaptive system even without the explicit application of agile projects, portfolio managers should generally foster projects' autonomy and interactions with each other (Sweetman & Conboy, 2018).

Regarding projects' uncertainty, this dissertation encourages portfolio managers to venture more innovative projects to increase portfolio innovativeness and portfolio success. A higher portfolio innovativeness enables organizations to capture long-term opportunities, for example, by achieving competitive advantages and developing new markets (Schultz, Salomo, & Talke, 2013). Thus, portfolio managers should actively venture innovative projects and, to cope with their uncertainty, systematically design and treat them as options (McGrath et al., 2004). Instead of placing one-time definitive project investments, portfolio managers should hold tentative project investments in project options and constantly shift investments to the most promising project options. This creates a flexible, adaptive portfolio and thereby supports the organization's adaptation to changing external and internal characteristics (Klingebiel & Adner, 2015). Furthermore, portfolio managers should systematically exploit successful, highly innovative projects through longitudinal project sequences (Kock & Gemünden, 2019; Maniak & Midler, 2014). Thus, large innovative endeavors should be split up into multiple project options that are distributed sequentially over time. This allows to systematically cope with their potential losses and produces earlier (interim) products that already contribute business value. In this regard, agile projects by means of their high autonomy and close customer collaboration are particularly suitable to serve as early exploratory projects in project sequences.

In addition, this dissertation highlights the relevant role of portfolios' internal strategic and cultural contexts that portfolio managers should be aware of when taking their decisions. Owing to their performance effects, portfolio managers should make themselves aware of their respective organization's contexts when assessing situations and taking decisions. Very importantly, this dissertation's results reveal that portfolios' contexts constitute not only a contingency but also a driver for portfolio initiatives. A suitable cultural support of employees through distinct voice behavior encourages them to initiate agile practices and propose valuable

innovative ideas. Similarly, this dissertation highlights the important role of entrepreneurial orientation for portfolio success. A strong entrepreneurial orientation also encourages employees to support agile practices and propose innovative ideas, and is further necessary for ROR to also benefit portfolio success. Thus, portfolio managers should assess, utilize, and promote an organization's entrepreneurial and innovation characteristics and utilize their benefits to promote innovative processes and ideas.

In regards to operational decision-making under uncertainty, which ensures that the strategic intentions and overall goals are ultimately implemented and achieved, portfolio and project managers should cooperate to jointly ensure project success. They should systematically assess projects' complexity and uncertainty and adequately assign project management effort to cope with the associated challenges. This dissertation's results demonstrate that managers can indeed reap innovative but complex projects' potential by applying sufficiently high project management effort. In regards to the collaboration between project and portfolio managers, project managers should conscientiously use project status reporting to transfer the information on project's current health to portfolio management. While portfolio managers should still hold authority to evaluate projects' progress and consistently terminate unfavorable projects, both portfolio and project managers should work towards a common understanding of the portfolio's overall strategic goals and current project health. Both parties should make themselves aware of the information on projects' status reporting and the reasons for status decisions, and should effectively negotiate on resource allocation decisions (Blichfeldt & Eskerod, 2008; Martinsuo, 2013; Martinsuo & Lehtonen, 2007). Ideally, portfolio managers combine their higher organizational authority (e.g., overcoming barriers through authority or additional resources) with project managers' in-depth project knowledge.

Overall, this dissertation demonstrates the relevant role of project and portfolio management for organizations and thereby supports its professionalization in research and practice. Thus, professional project management associations, practitioner guides (e.g., Project Management Institute, 2017), and management certifications should be further expanded to support the relevant education of project managers (Farashah et al., 2019). In addition, organizations should also support their internal long-term development of their project management capabilities. Owing to project management's essential role for achieving project, portfolio, and ultimately also organizational success, project management capabilities should be

systematically planned and developed in organizations. For example, organizations could implement dedicated project management career tracks to systematically develop project managers and create long-term incentives and perspectives for them (Ekrot, Kock, & Gemünden, 2016). Furthermore, a systematic internal knowledge exchange between project managers should also facilitate further development of the organization's project management capabilities (Bäcklander, 2019). This particularly applies to PBOs in which project managers take a central role in delivering business success.

To an organization's top-level management that defines the overall strategy and sets a portfolio's boundaries, this dissertation highlights the central role that project portfolios take in their organization's adaptation process. Very importantly, the results show that contextual influences and portfolio and project managers' behavioral decision-making gain in relevance in light of elevated uncertainty. In this regard, top-level management should particularly promote an entrepreneurial gestalt of their firm. A distinct entrepreneurial orientation not only directly benefits portfolio success, but relevantly shapes portfolio managers' behavioral approaches and decision-making. It supports the application of option-thinking through ROR and encourages portfolio actors to support beneficial new approaches, for example agile practices, and discover strategic opportunities. In addition to an entrepreneurial orientation, top-level management, together with portfolio managers, should support an overall innovation climate in the organization, too. This further enhances portfolio innovativeness and supports emergent strategy recognition. Overall, top-level management should be aware not only of the relevant position of the project portfolio to implement intended change, but also use the dynamic construct to recognize valuable strategic opportunities, systematically evaluate them, implement them in the organization's strategy, and scale them across the organization (Killen & Hunt, 2010).

6.4 Future Research

This dissertation investigated how project portfolios can strategically and operationally drive the organizational adaptation in the context of an uncertain and turbulent environment. While the results provide insights into how portfolio management can successfully cope with uncertainty and maintain a flexible and adaptive portfolio, and how project and portfolio

managers can jointly achieve operational success, there is still a large potential for future research to investigate how project portfolios can enhance organizations' adaptation process. In this chapter, I elaborate the future potential for research in portfolio and project management derived from this dissertation's findings.

Building on this dissertation's findings on ROR, future research could additionally explore how rational strategic decision-making approaches interact with initiatives that encourage autonomy and freedom of portfolio actors and projects. While this dissertation provides initial insights into the relevance of behavioral approaches to cope with projects' uncertainty in portfolio management, future research could address how these rather rigid, financially-oriented approaches, for example ROR, could successfully interact with a strong innovation climate and initiatives to promote employees' freedom and creativeness. On the one hand, prior literature stresses the importance of innovation climate for portfolio success (Kock et al., 2015; Kock & Gemünden, 2016). Through the closer collaboration with customers and the feedback on the projects' results, team members and project managers can contribute valuable strategic initiatives to portfolio management. However, on the other hand, this dissertation did not identify a significant interaction effects between innovation climate and ROR. While this does not necessarily exclude an interaction, the characteristics of an innovation climate could potentially collide with the rigid managerial approaches intended to cope with uncertainty. Thus, future research could further investigate how the general freedom and diversity of ideas supported by a distinct innovation climate interact with strict approaches of portfolio decision-making under uncertainty.

Furthermore, future research could investigate the antecedents, consequences, and contextual influences of project termination in more detail. Project terminations remain an important part of portfolio management, especially if portfolio managers apply option-thinking and constantly reallocate resources to the most favorable projects (Klingebiel & Adner, 2015; McGrath et al., 2004; Unger et al., 2012). However, option abandonment and project termination decisions in practice are shaped by a multitude of rational and non-rational influences. For example, portfolio management's decisions in practice are also driven by managers' subjective motivations for certain pet projects, the prospects of project alternatives, or their respective organizational contexts (Martinsuo, 2013; McGrath et al., 2004; Unger et al., 2012). In addition, project terminations place an emotional burden on involved actors (Shepherd et al., 2013).

Furthermore, with increasing collaboration and negotiation between portfolio and project managers, the strict adherence to option-thinking and option abandonment could be put at risk (Christiansen & Varnes, 2008; Martinsuo, 2013). Thus, in the context of increased uncertainty, option-thinking, and collaboration between portfolio and project managers, future research could further investigate the antecedents and consequences of project termination decisions.

Furthermore, while this dissertation highlights the beneficial contribution of agile practices in portfolios regarding emergent strategy recognition, agile practices in project portfolios in general and strategy processes in agile portfolios still constitute largely unexplored research areas. An increasing share of agile projects in the portfolio challenges established portfolio management approaches to evolve, as well. Owing to agile projects' different characteristics compared to traditional projects, established approaches of portfolio structuring and resource allocation (e.g., Kopmann, Kock, Killen, & Gemünden, 2015; Meskendahl, 2010) could potentially clash with agile projects (Sweetman & Conboy, 2018). Thus, there is a large potential to investigate the interaction of established portfolio management approaches with agile projects and to develop new portfolio management approaches that can be applied to hybrid and agile portfolios, too (e.g., Cooper & Sommer, 2016). Furthermore, in regards to strategy processes in agile portfolios, particularly deliberate strategy implementation as baseline for portfolio structuring could be investigated by future research. Owing to agile projects' higher autonomy and flexibility, implementing a deliberate strategy through a collection of agile projects could be particularly difficult to achieve. This challenge is especially difficult over the long-time, since agile projects with multiple autonomous actors then have more freedom to adapt themselves to their individual customer needs and could distort the overall strategic focus. In this regard, future research could also explore the applicability of option-thinking with agile projects. While, agile projects' characteristics of regularly producing interim products could facilitate managers' adherence to ROR's principles, their freedom and autonomy could also obstruct ROR's effectiveness.

Furthermore, there is still large potential for future research to investigate how the interactions and negotiations between portfolio and project managers should be configured to ensure projects' operational success (Christiansen & Varnes, 2008; Martinsuo, 2013; Stingl & Geraldi, 2017). The findings of this dissertation underline the importance of portfolio managers' decisions in selecting suitable projects and stress project managers' importance for portfolios'

operational success. Prior literature already stressed that information availability on single projects is critical for portfolio managers (Blichfeldt & Eskerod, 2008; Martinsuo & Lehtonen, 2007), that behavioral and contextual aspects are relevant for decision-making (e.g., Andries & Hünermund, 2020; Criscuolo et al., 2017; Martinsuo, 2013), and that portfolio decisions can also be interpreted as negotiations between project and portfolio management (Christiansen & Varnes, 2008; Martinsuo & Geraldi, 2020). Thus, future research could follow this research stream and shed additional light on the interaction and negotiation between project and portfolio managers. Especially in regards to projects' resource decisions, there is additional potential to investigate the critical balance of portfolio managers' authority. They need to provide a safe space for project managers to share their information advantage on their project's health but simultaneously need to act as strict decision authorities that control projects and assign resources to the most favorable options. Thus, future research could explore the reasoning of project and portfolio managers' behavior in steering committees and how portfolio managers can achieve a successful balance between collaboration and authority. Furthermore, in regards to the rising popularity of agile projects, future studies could explore how agile projects could be included in portfolio steering committees and how they should compete with traditional projects.

Last, the advancing field of decision support through algorithms and artificial intelligence constitutes a relevant and interesting field for future research in portfolio and project management (e.g., Elmousalami, 2021; Wauters & Vanhoucke, 2017). One key challenge for portfolio management currently is to constantly evaluate new and ongoing uncertain projects, and maximize the portfolio's overall value (Cooper et al., 2001; Meskendahl, 2010). Especially in regards to ROR, options' valuation is particularly difficult to estimate and thus hardly applicable in practice (Bowman & Moskowitz, 2001). Managers are thus often forced to rely on behavioral approaches, subjective assessments, and heuristics when taking portfolio decisions (Martinsuo, 2013; Stingl & Geraldi, 2017). However, with increasing digitalization of projects and portfolios in combination with smart algorithms, human decision-making influence and potentially harmful biases could be decreased. In a recent study, Kock, Schulz, Kopmann, and Gemünden (2020), for example, provide a first demonstration of the benefits of information systems in portfolio management. However, the untapped potential of smart algorithms in project and portfolio management is much larger. Predictive algorithms could

become warning systems that identify troubling projects early and thus enable decision-makers to establish countermeasures before non-reversible impacts materialize (Hopmere et al., 2020). Furthermore, in the future, information systems could not only support decision-makers by visualizing and collecting existing information (e.g., Killen et al., 2020), but also by proposing and executing decisions (e.g., in regards to project initiation and termination). In addition, through scenario modelling and forecasting, portfolio software could help portfolio and project managers to better cope with uncertainty and increase their overall decision-making quality and thereby additionally improve organizational adaptation.

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The dissertation is provided by me with a list of all sources used. I declare that I have written the thesis on my own - apart from the help explicitly mentioned in it.

The thesis has not been published anywhere else nor presented to any other examination board.

Die Dissertation ist von mir mit einem Verzeichnis aller benutzten Quellen versehen. Ich erkläre, dass ich die Arbeit – abgesehen von den in ihr ausdrücklich genannten Hilfen – selbstständig verfasst habe.

Die Arbeit wurde bisher weder einer anderen Prüfungsbehörde vorgelegt noch veröffentlicht.

Carsten Kaufmann

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