R&D MANAGEMENT

How entrepreneurial orientation can leverage innovation project portfolio management

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Innovation project portfolio management (IPPM) is a key task in R&D management because this decision-making process determines which R&D projects should be undertaken and how R&D resources are allocated. Previous research has developed a good understanding of the role of IPPM in R&D strategy implementation and of successful IPPM practices. But the fundamental orientations that drive the strategy formation and implementation process have never been investigated in the context of IPPM, and it is unclear whether successful practices are equally valid for different strategic orientations. This study, therefore, investigates the moderating impact of a firm's entrepreneurial orientation on the relationship between strategic portfolio management practices and portfolio success. An empirical analysis of 257 firms shows that both innovativeness and risk taking as entrepreneurial orientation's dimensions positively moderate the relationship between managerial practices and performance. Specifically, we find that firms high in innovativeness profit more from stakeholder engagement compared to firms low in innovativeness. Firms high in risk-taking profit more from a clearly formulated strategy. With increasing innovativeness and risk-taking propensity, firms also profit more from business case monitoring and agility in portfolio steering. The results suggest that a firm's entrepreneurial orientation can leverage the effect of IPPM practices. Vice versa, a lacking entrepreneurial orientation can render these practices ineffective. Strategic orientation and IPPM practices should, therefore, be aligned with each other to enable firms to better implement their strategy and generate competitive advantage.

1. Introduction

The management of research and development takes place at three different levels: (1) the strategic level, on which managers develop strategic innovation goals and the roadmaps how to reach them (Salomo et al., 2008; Talke et al., 2011); (2) the tactical level of innovation project portfolio management, on which managers determine which R&D projects are undertaken and how resources are allocated to them (Floricel and Ibanescu, 2008; Spieth and Lerch, 2014); and (3) the operational level of single R&D projects, on which innovative development and research tasks are executed (Keller, 2017; Chappin et al., 2019). The current paper concentrates on the connection between the strategic and the tactical

level, by analyzing how the effectiveness of portfolio management practices at the tactical level is affected by characteristics of the strategic level. Such an investigation is useful because R&D divisions work on many projects simultaneously, and the selection of the right candidates, the allocation of scarce resources to projects, and the management of interdependencies between projects has become a critical process for the overall innovation success (Spieth and Lerch, 2014; Kock and Gemünden, 2016; Clegg et al., 2018).

Innovation project portfolio management (IPPM) is a dynamic decision-making process to screen, select, and prioritize project proposals, as well as to allocate resources to projects according to priorities (Cooper et al., 2001b). Quite a few studies have investigated what constitutes success in portfolio management (Cooper et al., 2001a; Jonas et al., 2013; Kester et al., 2014; Martinsuo and Killen, 2014) and what organizational levers affect success (Müller et al., 2008; Lerch and Spieth, 2013; Spieth and Lerch, 2014; Kock et al., 2015). Since not all practices are likely to be effective in all contexts, many authors call for a contingency perspective to investigate the boundary conditions of successful portfolio management (Floricel and Ibanescu, 2008; Petit, 2012; Martinsuo, 2013; Kock et al., 2016).

Previous research has mainly concentrated on contingency factors such as portfolio characteristics (Teller et al., 2012; Kopmann et al., 2015) or the external environment (Floricel and Ibanescu, 2008; Petit, 2012; Kopmann et al., 2017) and largely neglected boundary conditions stemming from the strategic level (an exception is Rank et al., 2015). Specifically, an important, yet neglected contingency factor is the *strategic orientation* of the firm (Mintzberg, 1973; Miller, 1983; Venkatraman, 1989; Covin and Slevin, 1991). This is surprising, because research on portfolio management emphasizes that portfolios are important vehicles for strategy realization in that they represent the connection between strategy and operational projects (Meskendahl, 2010; Kopmann et al., 2017; Clegg et al., 2018). Although there is empirical evidence that firms with a strong innovation orientation have more innovative portfolios, which in turn leads to higher success (Talke et al., 2011), little is known whether and how successful IPPM practices actually differ for these firms. To the best of our knowledge, so far, no empirical study investigated whether portfolio management practices have different performance effects under different strategic orientations.

In the current study, we resort to the concept of entrepreneurial orientation (EO) as a particularly important form of strategic orientation (Rauch et al., 2009; Anderson et al., 2015) and empirically investigate its moderating impact on the relationship between portfolio management and success. Therefore, the research question is: *How do IPPM practices differ in their performance impact depending on the entrepreneurial orientation of the firm?*

The paper contributes to both literatures on portfolio management and on EO. First, the study contributes to a better understanding of the boundary conditions for successful strategy implementation by portfolio management. Previous conceptual research stressed the strategy formation process's importance in portfolio management and the possible role of strategic orientation (Meskendahl, 2010). This study provides the first empirical test of this role by showing that portfolio practices differ in their relationship to performance depending on the firm's EO. The results suggest that a firm's EO can leverage the performance impact of IPPM practices and that these practices should be aligned to the firm's EO to enable firms to better implement their strategy and generate competitive advantage. In showing the moderating effect of EO, this study identifies a new and important strategic contingency factor for IPPM.

Second, we follow the call for more empirical research on moderators of the EO-performance link (Rauch et al., 2009; Rosenbusch et al., 2013). EO is one of the most studied concepts in the Entrepreneurship literature, yet most studies concentrate on its *direct* performance effects. Since reported performance relationships are heterogeneous (Rauch et al., 2009), 'research needs to reconsider models of the role of third variables in the relationship between EO and performance' (Rosenbusch et al., 2013, p. 651). By introducing a portfolio management perspective to the EO field, we also enrich this stream of research and investigate IPPM as a possible enabler.

2. Conceptual background

2.1. Entrepreneurial orientation

The entrepreneurial orientation (EO) concept is rooted in the strategy-making literature and can be described as 'the entrepreneurial strategy-making processes that key decision makers use to enact their firm's organizational purpose, sustain its vision, and create competitive advantage(s)' (Rauch et al., 2009, p. 763). Already Mintzberg (1973) argued that firm performance is largely dictated by gestalts comprised of strategic choices, organizational structure, and environmental requirements. As one such gestalt is entrepreneurial, Miller (1983) characterized entrepreneurial firms as those that pursue innovation,

aggressively enter new markets, and accept a measure of strategic risk. Based on this work, Covin and Slevin (1991) suggested that a firm's strategic behavioral proclivities range on a continuum from more conservative to more entrepreneurial. They posited that the entrepreneurial end of the continuum is evidenced by innovativeness, proactiveness, and risk taking. Although alternative approaches have been developed (e.g., Lumpkin and Dess, 1996; see also the similar construct of strategic orientation by Venkatraman, 1989), meta-analyses show that the conceptualization by Covin and Slevin is the dominant perspective (Rauch et al., 2009; Rosenbusch et al., 2013).

Conceptually, firms should profit from adopting an EO, because a rapidly changing environment renders future revenues from existing business uncertain and firms need to constantly identify new opportunities (Lumpkin and Dess, 1996; Rauch et al., 2009). Empirically, Rauch et al. (2009) can confirm the positive relationship between EO and firm performance in their meta-analysis. However, they also observe a large variance in effect sizes and consequently suggest that future research should investigate, how EO interacts with other variables in their relationship with performance. So far, only few studies investigated the moderating influence of EO (Walter et al., 2006; Wu et al., 2008; Wales et al., 2013; Rank et al., 2015). Since portfolio management is a central means of strategy implementation (Meskendahl, 2010; Kopmann et al., 2017; Clegg et al., 2018), we investigate whether and how EO leverages the performance of strategic portfolio management practices.

There is considerable debate in the literature regarding EO's proper dimensionality and measurement (e.g., Covin and Wales, 2012; Lomberg et al., 2017). Lomberg et al. (2017) demonstrated a high overlap between the dimensions innovativeness, proactiveness and risk taking, as well as their effect on performance. With regard to this conceptual and empirical overlap, Anderson et al. (2015, p. 1,580) suggest a reconceptualization along only two dimensions and argue that 'entrepreneurial behaviors and managerial attitude towards risk jointly and in totality comprise the conceptual domain of firm-level EO' (Anderson et al., 2015, p. 1,580). In order to keep our model parsimonious and avoid redundancy in our investigation, we follow this approach. We, therefore, investigate *innovativeness* (which includes proactiveness) and *risk taking* as the two defining dimensions of entrepreneurial orientation. *Innovativeness* is the forward-looking predisposition to engage in creativity and experimentation, characterized by the introduction of new products ahead of the competition, and *risk taking* involves taking bold actions by venturing into the unknown and committing resources to ventures in uncertain environments. Strategic portfolio management practices will likely differ in their performance impact depending on the firm's positioning along these dimensions of EO.

2.2. Portfolio management

Innovation project portfolio management is a dynamic decision-making process in which projects are evaluated and selected and in which resources are allocated (Cooper et al., 2001b). Cooper et al. (2001b) summarize the purpose of portfolio management as *doing the right things* and contrast it with the purpose of project management – *doing things right*. According to their initial studies, the right projects are the ones that provide maximum value, achieve a balance, and align with strategy. Since then, researchers developed a comprehensive understanding of portfolio success (Martinsuo and Lehtonen, 2007; Müller et al., 2008; Jonas, 2010; Meskendahl, 2010; Martinsuo and Killen, 2014). Recent research conceptualizes portfolio success as a multidimensional construct with the following dimensions (Jonas et al., 2013; Kester et al., 2014; Kock et al., 2015; Kopmann et al., 2017): strategic implementation success, portfolio balance, average product success, and synergy exploitation.

Strategic implementation success is defined by the strategic fit of the portfolio (Meskendahl, 2010) and the perceived implementation success of the strategy (Kopmann et al., 2017). *Portfolio balance* concerns the equilibrium of risks, long- and short-term opportunities, and the steady utilization of resources within the project portfolio's execution (Killen et al., 2008; Teller et al., 2012). *Average product success* is measured by the commercial success of project outcomes, which determine in their entirety the quality and success of the strategy implementation. *Synergy exploitation* represents the added value that emerges from dedicated portfolio management, over and above contributions from individual projects by capitalizing on interdependencies and avoiding redundancies (Jonas, 2010; Meskendahl, 2010).

Portfolio management has been characterized as a phase-based decision-making process (Jonas, 2010; Beringer et al., 2013; Jonas et al., 2013). Although different phase models with different level of detail exist, we will concentrate on the two most generic phases *portfolio structuring* and *portfolio steering* to extract those management practices that most likely dependent on the firm's strategic orientation in their performance impact.

The *portfolio structuring* phase refers to the target portfolio's composition that contributes the highest

value to the organization and is aligned with the strategy. Structuring comprises the innovation projects' evaluation, prioritization, and selection. The main objective in this phase is to ensure that the portfolio optimally reflects the organization's strategy. Based on previous literature (Morris and Jamieson, 2005; Salomo et al., 2008; de Brentani et al., 2010; Meskendahl, 2010; Turner and Zolin, 2012), we argue that adequately involving critical stakeholders and defining a clear strategy are essential strategic management practices in portfolio structuring. *Stakeholder involvement* is defined as the extent to which different relevant firm-internal portfolio stakeholders (such as functional managers, division heads) have the possibility to engage in and affect the development of the portfolio strategy (Turner and Zolin, 2012; Beringer et al., 2013). In the long run, portfolio decisions affect nearly all corporate functions (Kester et al., 2011). Integrating different internal stakeholders in the strategy process is, therefore, necessary to obtain diverse perspectives and a greater variance of alternatives – resulting in a more holistic portfolio assessment – and to simultaneously gain consensus and joint commitment (Meskendahl, 2010; Turner and Zolin, 2012). *Strategic clarity* means that the company or business unit has a clearly formulated strategy, which is communicated and understood within the organization. A clearly formulated strategy is a necessary condition for effective implementation of deliberate strategy (Meskendahl, 2010; Kopmann et al., 2017). Firms with a clear and focused strategy make better portfolio decisions (Kock and Gemünden, 2016) and more effectively implement the right projects (Salomo et al., 2008; de Brentani et al., 2010).

The *portfolio steering* phase comprises the portfolio's ongoing coordination and control. This includes re-prioritizing or terminating projects, re-allocating resources, and exploiting synergies (Blomquist and Müller, 2006; Blichfeldt and Eskerod, 2008; Unger et al., 2012; Kock and Gemünden, 2016). Successful portfolio management depends on the right type of controlling activities (Müller et al., 2008). High-performing firms not only track time, cost, and scope adherence, but also continuously monitor the validity of each project's business case (Kopmann et al., 2015). An essential managerial practice is, therefore, *business case monitoring* – the 'revalidation of a project's business case considering changing project scope and timing as well as changing environmental conditions' (Kopmann et al., 2015, p. 532). Equally important in the portfolio steering phase is the organization's ability to quickly adapt the portfolio in a dynamic environment (Floricel and Ibanescu, 2008; Petit, 2012). *Agility* describes the extent to which a firm is able to quickly adapt its innovation portfolio to changing conditions (Kester et al., 2011; Kock and Gemünden, 2016). Kester et al. (2014) have shown that the ability of the firm to make agile portfolio decisions and implement them is positively related to portfolio success.

While we are aware that there are other potentially relevant IPPM practices, we concentrate on these four specific practices for the following reasons. First, we deliberately chose the two most salient practices from the portfolio structuring phase (i.e., stakeholder involvement and strategic clarity) and the portfolio steering phase (i.e., business case monitoring and agility), respectively, to capture relevant practices along the whole portfolio process. Second, all four practices are highly relevant in IPPM, because they have been repeatedly shown to be related to portfolio success in different studies. Finally, the practices do not show conceptual overlap and are, therefore, not expected to be highly correlated. They, therefore, capture a wide spectrum of managerial activity, without being unspecific indicators of overall portfolio management maturity. In order to control for omitted practices, we also include portfolio management formalization in the empirical model.

Although all practices will likely be related to portfolio success, we will refrain from formulating hypotheses for their average effects and concentrate in the following on how the relationship may be affected by the firm's EO.

2.3. Hypotheses

The overall framework is depicted in Figure 1. We expect that the performance impact of IPPM practices in the structuring phase (i.e., stakeholder engagement and strategic clarity) and steering phase (i.e., business case monitoring and agility) is stronger for firms with a high EO characterized by innovativeness and risk taking.

2.4. Portfolio structuring

Firms with a high EO strive for more innovative projects and are willing to take higher risks (Anderson et al., 2015). They face higher uncertainty regarding their environment: In highly innovative projects, customers are often not known in advance, and critical innovative contributions often come from new and previously unknown external partners (O'Connor and Rice, 2013). Firms with a high EO will thus, more likely search for new partners and lay more stress on assessing the risks they may induce. More active search in a firms' market-related and technology-related environments means an increasing

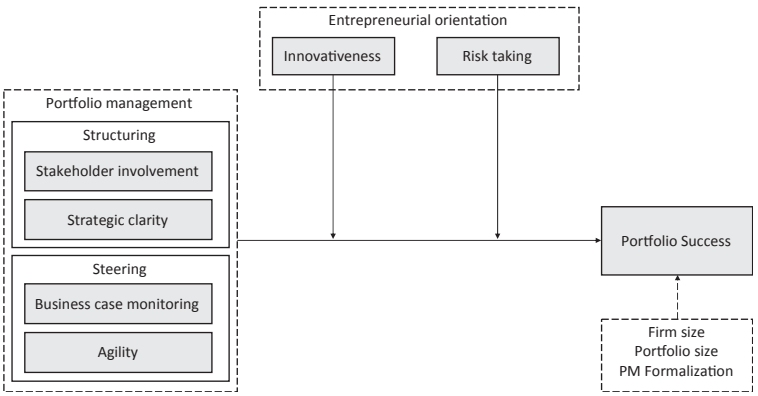

Figure 1. Research framework.

specialization and segmentation of their marketing, R&D, and production functions. It also means higher uncertainty and more turbulence regarding new technology, new customers, new suppliers, and new competitors.

According to contingency theory (Lawrence and Lorsch, 1967; Donaldson, 2001), a higher level of specialization implies that a higher level of integration helps to avoid otherwise increasing coordination losses between the more specialized functions. This is confirmed by Ahmad et al. (2013) who showed that for increasing complexity functional integration is beneficial for NPD success (see also Troy et al., 2008). The collaboration between different functions provides a common understanding of the underlying assumptions, and therefore likely fosters the commitment to the formed project portfolio. Moreover, the involvement of different functions in portfolio decisions will limit the risk of one perspective's dominance and will promote the consideration of long-term objectives (Talke et al., 2011). Integrating these functions' stakeholders in the portfolio decision-making process is, therefore, likely beneficial for potfolio success (Beringer et al., 2013). This integration can happen at an operational level through cross-functional expert teams in projects (Nakata and Im, 2010) and at the strategic level governing resource allocation in project portfolios (Cooper et al., 2001b; Beringer et al., 2013).

We assume that firms with a higher EO are often already working in more turbulent high-tech industries and/or move their firms toward such environments. In turbulent and complex environments, where data are incomplete or inaccurate, cross-functional integration has been shown to be particularly important for effective decision making (Ancona and Caldwell, 1992). This is also shown in the meta-analysis of Troy et al. (2008) who finds that cross-functional integration is more strongly related to success in high-tech industries than in low-tech industries.

In addition to the *horizontal* cross-functional integration, the *vertical* integration of different management levels has been shown to be related to project portfolio success (Kopmann et al., 2017). Breaking down strategic goals to specific operational objectives can guide project selection and prioritization (Meskendahl, 2010). However, in turbulent times, the premises of such top-down developed strategies may get eroded and unanticipated strategic opportunities are likely to be better recognized by middle and lower managers who can better access information on new technology- and market-related growth paths (Kopmann et al., 2017). Firms with a high EO give more autonomy to lower and middle managers (Lumpkin and Dess, 1996) and more likely encourage the development of bottom-up emerging strategd market-related uncertainties as opportunities. These firms often use specific activities to sense and seize opportunities, and transform their organization to exploit them (Teece, 2007). A better integration of internal stakeholders in order to process the information and generate new concepts improves sensing and seizing functions. The returns for sensing and seizing opportunities are likely to be higher than the cost of performing these activities. Consequently, firms with a high EO should realize a higher portfolio value from stakeholder involvement than firms with a low EO:

H1: *The relationship between stakeholder involvement and portfolio success is stronger for firms with an EO that is (a) high in innovativeness and (b) high in risk-taking propensity.*

Extant research documents that a higher *strategic goal clarity* positively influences project portfolio success, because it allows to channel creativity for generating ideas and to better identifiy opportunities (Kock et al., 2015), and thus select those projects which promise a high strategy contribution (Meskendahl, 2010; Unger et al., 2012). This is in

line with goal setting theory positing that challenging and more specific goals lead to higher performance (Locke and Latham, 2002).

For more innovative projects, higher uncertainty regarding technological feasibility and customer preferences makes it more difficult to derive these goals (Salomo et al., 2007). Firms with a high EO should, therefore, require more learning processes regarding technology and application and should on average have less clear goals. However, we argue that they will profit more form an increase in strategic clarity than firms with a low EO. Three arguments underly this moderation hypothesis.

First, market and technology visioning for radically new products direct the attention on new challenging goals, energize innovators and motivate them intrinisically to engage themselves for new products and services that enable important new functionalities. Reid and de Brentani (2012) show a positive impact on early performance regarding the motivation of innovating teams, attraction of innovating customers, and attraction of new financial capital.

Second, a major problem in radically new products is that their resources are often cannibalized by less innovative products with known customers. Innovation leaders often implement strategic buckets for highly innovative projects to protect them against such a cannibalization by incremental projects (Hutchison-Krupat and Kavadias, 2015). Salomo et al. (2008) analyze how innovative topics are bundled in innovation fields, which implement strategic iniatives for major innovation themes. This activity structures portfolios and clarifies visible goal commitments. The authors show that these activities increase the innovativeness of product portfolios and eventually portfolio performance. We assume that these strategic iniatives not only coordinate innovative projects toward common goals but also motivate managers and knowledge workers to engage in such activities.

Third, innovative portfolios require a pipeline of valuable ideas. Firms engaging in initiatives to create such an ideation portfolio realize a higher front-end success (Kock et al., 2015). They give their employees more support and autonomy, and apply transparent and fair processess to pick the best ideas. In doing so, firms learn what new technologies are able to deliver and how customers value new functionalities. Such pro-active ideation leads to higher project portfolio success. Firms with a risk-taking orientation, profit more from pro-active ideation practices if the expected gain is high (Kock et al., 2016).

Firms with a sustained innovation orientation are more likely to invest in such practices and improve them over time as innovation competences. This will allow them to motivate and coordinate better and to learn faster. Overall, we, therefore, expect a positive moderation effect:

H2: *The relationship between strategic clarity and portfolio success is stronger for firms with an EO that is (a) high in innovativeness and (b) high in risk-taking propensity.*

2.5. Portfolio steering

Formal control and coordination of a portfolio through regular monitoring of project performance have been repeatedly related to higher portfolio performance (Cooper et al., 2001a; Müller et al., 2008; Teller et al., 2012). However, steering projects according to the iron triangle of budget, time, and scope adherence is likely not sufficient and potentially harmful in the case of highly innovative projects. For example, Salomo et al. (2007) show that formalized planning and process control is only benefical for incremental new product development projects but harmful for highly innovative projects. The more firms adapt an EO, the more they will aim for more innovative and more risky projects, thus the less useful will be traditional portfolio control mechanisms.

Kopmann et al. (2015) suggest that instead of monitoring operational project performance, managers should rather control the created value, which innovative solutions consequently exploit, and prefer business case control over iron-triangle control. The authors have shown that the combination of business planinng over the whole project cycle, clear responsibilities and accountability for the results, as well as result-oriented incentives increases portfolio success (Kopmann et al., 2015). The higher the innovativeness and risk of the projects in the portfolio, the higher is the likelihood that the initial business case will change in the course of a project. Therefore, business case monitoring likely becomes more valuable than in portfolios of incremental, low-risk projects. In support of this argument, Kopmann et al. (2015) find that the impact of business case control on portfolio success increases when the firm environment is characterized by strong technological and market-related changes. We, therefore, assume:

H3: *The relationship between business case monitoring and portfolio success is stronger for firms with an EO that is (a) high in innovativeness and (b) high in risk-taking propensity.*

Being able to adapt the portfolio to changing environments has been identified as an important ability in project portfolio management (Floricel

and Ibanescu, 2008; Kock and Gemünden, 2016; Petit, 2012). Kester et al. (2014) accordingly find a positive relationship between agility and portfolio success. Arguably, the stronger the environmental dynamism (i.e., the higher the uncertainty and unpredictability of future market and technology developments), the more relevant will agility become for firms.

Since rapid change and unpredictability provide opportunities for firms but also make existing business obsolete, firms in dynamic environments more likely adopt an EO. The meta-analysis of Rosenbusch et al. (2013) confirms this by finding a strong positive relationship between EO and environmental dynamism. We, therefore, assume that being able to quickly adapt the portfolio to new opportunities or risk will be even more advantageous for firms adopting an EO (Kester et al., 2011). Firms with a strong EO observe their environment more carefully and recognize changes earlier, so they are more likely to make timely decisions and inform their organization about the necessary measures for adaptation. These changes are enabled by flexible resources, a high strategic and operational transparency, and a shared understanding that learning from mistakes is necessary – conditions that are more likely present in an organization with a strong EO (Lumpkin and Dess, 1996). We, therefore, argue:

H4: *The relationship between agility and portfolio success is stronger for firms with an EO that is (a) high in innovativeness and (b) high in risk-taking propensity.*

3. Method

3.1. Sample

We test the proposed hypotheses on a cross-industry sample of firms. The business unit's innovation project portfolio is the unit of analysis. For each portfolio, we contacted two informants of different management levels. The senior management informant had decision authority over the project portfolio regarding initiation, prioritization, and termination of projects. Typicial titles of senior managers were CEO, head of bussiness unit, or head of R&D. The middle management informant had a good overview of the portfolio and the management processes used in the firm. Middle managers had titles such as portfolio managers, innovation managers, or head of project management office. By contacting two informants in each firm, we obtained differing perspectives within the firm's hierarchy and reduced common method bias.

Table 1. Sample characteristics

Industry		Revenue	
Automotive	26%	<100 million €	24%
Electronics/IT	18%	100–500 million €	28%
Finance	16%	501–2,000 million €	20%
Construction and utility	11%	>2,000 million €	28%
Health care	8%		
Logistics	7%		
Pharmaceuticals/ chemicals	5%		
Others	9%		
Employees		Portfolio budget	
<500	37%	<10 million €	26%
500–2,000	28%	10–30 million €	21%
>2,000	35%	30–100 million €	26%
		<100 million €	27%

We contacted medium-sized and large German firms, explained the study, and requested participation. After the mailing, we made follow-up phone calls to identify the correct informants. Registered informants received an e-mail with a letter explaining the multi-informant design and the questionnaires with an introduction describing the terms and definitions. Again, follow-up phone calls ensured increased participation. To provide an incentive for participation, we promised an individualized report and an invitation to a practitioner conference, where the study results were presented. We received 268 senior manager questionnaires and 279 middle manager questionnaires from 286 firms, resulting in 261 matched dyads with data from both types of informants. Some questionnaires had missing data; thus, the final sample comprised 257 firms. We did not find any significant differences between the first 25% and the last 25% of responding firms in any variable used in this study ($P > 0.05$), so response bias most likely did not affect the results. Table 1 shows some characteristics of the sample firms and their project portfolios. The firms were from diverse industries and reflective of a reasonable spread according to size.

3.2. Measurement

We used multi-item scales for the constructs, which were taken from existing literature and in some cases adapted to the context of IPPM. Decision makers assessed the dependent and moderator variables and coordinators assessed the independent variables. This approach reduced common method variance because different informants assessed dependent and independent variables. We validated the scales using confirmatory factor analysis

Table 2. Confirmatory factor analysis for project portfolio success

Construct/*Dimension*/Item	**Factor loading**
Project portfolio success (second-order construct)	
Strategy implementation (Cronbach's α = 0.88)	*0.82*
The project portfolio is consistently aligned with the future of the company	0.85
The corporate strategy is implemented ideally through our project portfolio	0.93
Resource allocation to projects reflects our strategic objectives	0.78
The implementation of the strategy is considered a great success in the organization	0.74
Portfolio balance (α = 0.86)	*0.64*
There is a good balance in our project portfolio…	
… between new and old areas of application	0.86
… between new and existing technologies	0.92
Average product success (α = 0.82)	*0.62*
Please assess the average success of completed projects:	
Our products/project results achieve the target costs defined in the project	0.57
Our products/project results achieve the planned market goals (e.g., market share)	0.66
Our products/project results achieve the planned profitability goals (e.g., ROI)	0.95
Our products achieve the planned amortization period	0.84
Synergy exploitation (α = 0.77)	*0.73*
During the project execution, development synergies (e.g., shared use of modules, platforms, technologies etc.) between projects are rigorously exploited	0.80
After project completion, exploitation synergies (e.g., shared marketing/sales channels, infrastructure, etc.) between projects are rigorously exploited	0.85
We hardly ever have double work or redundant development	0.60

7-Likert-type Scale; χ^2 = 126.88 (df = 61; $P < 0.00$); RMSEA = 0.065; SRMR = 0.055; CFI = 0.97; n = 256.

(CFA). Cronbach's Alpha and composite reliability is used to assess scale reliability with acceptable values larger than 0.7. The CFA confirmed the measurement model and the second-order structure of portfolio success.

Portfolio success was measured as a multidimensional second-order construct using dimensions and their items from existing literature (Jonas et al., 2013; Teller and Kock, 2013; Voss and Kock, 2013): strategy implementation (four items), portfolio balance (three items), average project outcome (four items), and synergy exploitation (four items). Table 2 contains the results of the CFA, which shows an acceptable fit (χ^2 = 126.88 (df = 61; $P < 0.00$); RMSEA = 0.065; SRMR = 0.055; CFI = 0.97). Similar to previous research on portfolio management (Kock et al., 2015), the results suggest that portfolio success is a multidimensional construct. We also nomologically validated the construct by relating it to business unit performance, which was measured by three items assessing overall business success, sales growth, and profitability in comparison to competitors (alpha: 0.78). The two constructs showed a high correlation (0.38, P = 0.000), which gives further indication to the validity of our portfolio success measure.

Stakeholder involvement determines the degree to which different portfolio stakeholders have the possibility to engage in and affect the development of the portfolio strategy. Three items adapted from Turner and Zolin (2012) were used. *Strategic clarity* was measured using a three-item scale that assessed whether the firm had a comprehensible and well communicated strategy. The items were based on a related scale developed by Bates et al. (1995). We measured *business case monitoring* with three items from Kopmann et al. (2015). *Agility* describes the extent to which a firm is able to change and adapt its portfolio to changing conditions (Kester et al., 2014). Items were taken from Kock and Gemünden (2016).

The *innovativeness* dimension of EO is the forward-looking predisposition to engage in creativity and experimentation, characterized by the introduction of new products ahead of the competition. We measured innovativeness with three items (Anderson et al., 2015). *Risk taking* involves taking bold actions by venturing into the unknown and committing resources to ventures in uncertain environments. We measured risk-taking propensity using three items (Kock et al., 2016).

We controlled for three variables that might affect portfolio success. First, we included *formalization*, which is defined as the extent to which the portfolio management process is clearly defined and specified. Previous research has shown that formalization affects portfolio success and captures the maturity of project portfolio management (Cooper et al., 2001a; Martinsuo and Lehtonen, 2007; Teller et al., 2012). It is, therefore, necessary to control for portfolio management formalization when investigating the performance effect of strategic antecedents to portfolio success, so that observed effects are not only due to differences in portfolio management maturity. The items were taken from previous research (Teller et al., 2012) and were assessed by the middle manager. Furthermore, we control for firm size, measured as the logarithm of the number of employees. Larger firms might differ in their portfolio management approaches and also their strategy processes. Finally, we control for portfolio size, measured as the logarithm of the portfolio budget in million Euros, to account for the importance of the portfolio.

Table 3 shows the results of the CFA for all independent variables and Table 4 displays all variables' descriptives. The average variance extracted and composite reliability showed values above 0.5 and 0.7, respectively. Overall, the measures showed an acceptable reliability and validity according to the standards proposed by Bagozzi and Yi (1988). We further tested for discriminant validity by examining the square root of the average variance extracted for each construct. All the values were greater than the respective correlations with other constructs, supporting sufficient discriminant validity.

4. Results

We used hierarchical regression to test the proposed hypotheses. Table 5 presents the results in nine different models with portfolio success as dependent variable. Model 1 includes control variables and the direct effects of the independent and moderator variables. Regarding controls, only project portfolio management formalization was positively related to portfolio success (unstandardized regression coefficient $b = 0.05$, $P = 0.086$), while firm size and portfolio budget were not. Confirming previous research, we found that management practices along the phases of the portfolio process were related to portfolio success: the coefficients of stakeholder involvement ($b = 0.21$, $P = 0.000$), strategic clarity ($b = 0.08$, $P = 0.032$), business case monitoring ($b = 0.06$, $P = 0.043$), and agility ($b = 0.09$, $P = 0.030$) were all positive and significant. Innovativeness was positively related to portfolio success ($b = 0.20$, $P = 0.000$), while the direct effect of risk taking was not significant. This partly corresponds to the meta-analytical results by Rauch et al. (2009), who finds a stronger positive effect of innovativeness and proactiveness than of risk taking. The overall model explains 34% of the variance in portfolio success and serves as the base model to test the hypothesized interaction effects.

Models 2 to 5 include the interaction effects between the management practices and the EO dimension innovativeness. We mean-centered each of the interacting variables and built product terms that were subsequently introduced in the models. Innovativeness significantly moderated the association of stakeholder involvement ($b = 0.07$, $P = 0.032$), business case monitoring ($b = 0.08$, $P = 0.004$), and agility ($b = 0.08$, $P < 0.027$) with portfolio success, respectively. Innovativeness, however, did not significantly moderate the relationship between strategic clarity and portfolio success ($b = 0.04$, $P = 0.201$).

Models 6 to 9 include the interaction effects with risk taking. We did not find a significant interaction with stakeholder involvement ($b = 0.05$, $P = 0.130$). However, risk taking positively moderated the relationship between portfolio success and strategic clarity ($b = 0.06$, $P = 0.032$), business case monitoring ($b = 0.08$, $P = 0.002$), and agility ($b = 0.07$, $P = 0.031$). Overall, the empirical data support all hypotheses except 1b and 2a.

We use plots to illustrate the nature of the significant interactions. Instead of referring to simple slope plots, we apply marginal plots that show the marginal effects of the independent variable for each possible value of the moderator variable. This allows an assessment over all moderator values and the determination of the value of the moderator variable, at which the marginal effects become significant or changes direction. Figure 2 shows all relevant marginal plots, the short-dashed lines represent 95%-confidence intervals for the marginal effect. The long-dashed lines show at which value the confidence interval touches zero and the marginal effects changes in significance. It can be seen, for example, that already for a relatively low value of approximately three on the innovativeness scale (mean is 4.2), the effect of stakeholder involvement becomes significant. Overall, the plots show that all investigated portfolio management variables' performance effect disappears for firms with below-average values in innovativeness and risk taking. In the case of business case monitoring, the relationship with portfolio

Table 3. Confirmatory factor analysis for independent variables

Construct/Item	Factor loading
Stakeholder involvement (Cronbach $\alpha = 0.86$)	
All key stakeholders have been engaged in developing the portfolio strategy or have had the opportunity to influence it	0.92
All stakeholders have been given the opportunity to express their views on the project portfolio strategy	0.98
All key people engaged in portfolio projects know who decided their objectives	0.60
Strategic clarity ($\alpha = 0.86$)	
We have a written mission, long-term goals and strategies for implementation	0.80
Goals and strategies are communicated in our company	0.89
Our long-term competitive strategy is clear and understandable	0.79
Business case monitoring ($\alpha = 0.83$)	
We check the business case for validity at specified points in time or events in the course of the project and adjust if necessary	0.83
Once a project is approved a review of the objectives is rare. (reversed)	0.59
We check on a regular basis for each business case whether the necessary conditions are still valid	0.94
Agility ($\alpha = 0.82$)	
We quickly adapt our project portfolio to changing customer needs and competitive conditions	0.83
We quickly adapt our project portfolio to changing resource situations	0.69
We quickly adapt our project portfolio to new technologies	0.73
We quickly adapt our project portfolio to changing strategic goals	0.71
Innovativeness ($\alpha = 0.72$)	
Through the introduction of innovation we always try to be one step ahead of our competitors	0.63
We rely more on radical (high degree of novelty) than on incremental (continuous improvement) innovation	0.66
We often break new ground (e.g., technologically) with our projects	0.81
Risk taking ($\alpha = 0.71$)	
We are not afraid to take risks when we have to make significant portfolio decisions	0.67
We frequently support projects, even if the expected market success is uncertain	0.57
Within our strategic boundaries we are prepared to take high risks	0.85
PM formalization ($\alpha = 0.93$)	
Essential project decisions are made within clearly defined portfolio meetings	0.70
Our project portfolio management process is divided in clearly defined phases	0.90
Our process for project portfolio management is clearly specified	0.94
Overall, we execute our project portfolio management process in a well-structured way	0.94

7-Likert-type Scale; PM = Portfolio Management; $\chi^2 = 381.21$ (df = 209; $P < 0.00$); RMSEA = 0.057; SRMR = 0.058; CFI = 0.95; $n = 257$.

success even becomes negative for firms with an extremely low entrepreneurial orientation.

5. Discussion

The objective of this study was to investigate, whether and how a firm's strategic orientation leverages the performance impact of strategic innovation project portfolio management practices. Overall, the results confirm previous IPPM research that the investigated practices (i.e., stakeholder involvement, strategic clarity, business case monitoring, and agility) are positively related to portfolio success. The findings are also in line with previous research that a firm's strategic orientation, specifically its EO, is an important antecedent to success (Rauch et al., 2009). More precisely, innovativeness is directly related to portfolio success, but risk taking is not. This demonstrates the relevance of EO for innovation portfolio management. The most important finding, however, is that EO is an important contingency factor for the performance of strategic portfolio management practices.

Results show that both components of EO have positive moderating effects in three of four postulated cases, meaning they both leverage the efficacy of portfolio structuring and portfolio steering management

Table 4. Descriptives

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Portfolio success	1.00									
(2) Firm size (ln)	−0.06	1.00								
(3) Portfolio budget (ln)	0.01	0.36	1.00							
(4) PM formalization	0.24	0.08	0.05	1.00						
(5) Stakeholder involvement	0.43	−0.07	0.04	0.30	1.00					
(6) Strategic clarity	0.26	0.00	0.09	0.11	0.14	1.00				
(7) Business case monitoring	0.25	0.06	0.10	0.20	0.14	0.28	1.00			
(8) Agility	0.37	−0.09	−0.13	0.30	0.32	0.23	0.24	1.00		
(9) Innovativeness	0.30	−0.04	−0.11	−0.10	0.08	0.08	0.05	0.24	1.00	
(10) Risk taking	0.17	−0.06	−0.01	−0.09	0.11	0.09	0.01	0.21	0.42	1.00
Mean	4.51	6.82	3.48	4.82	5.25	5.39	4.10	3.97	4.20	4.14
Standard deviation	0.83	1.97	1.67	1.66	1.23	1.27	1.51	1.18	1.05	1.14
Minimum	1.81	2.30	0.00	1.00	1.33	1.67	1.00	1.25	1.33	1.33
Maximum	6.60	11.54	7.31	7.00	7.00	7.00	7.00	6.50	6.67	7.00
Cronbach's alpha	–	–	–	0.93	0.86	0.86	0.83	0.82	0.72	0.71
Composite reliability	–	–	–	0.93	0.88	0.87	0.84	0.83	0.74	0.74
Average variance extracted	–	–	–	0.77	0.72	0.69	0.64	0.55	0.50	0.50

n = 257; PM = portfolio management; all correlations larger than 0.12 are significant at the 5%-level.

practices. In case of the practice business case monitoring, the influences are significantly negative for very low levels of innovativeness or risk taking and become significantly positive for higher levels. The moderation effects are, therefore, substantial and EO's component risk taking cannot be neglected, despite its non-significant main effect. This is an important finding for the use of strategic IPPM practices. Business case monitoring appears to unfold its impact only if the firm is willing to invest additional money and to take more risks to seize promising opportunities. The benefits outlined in a business case require a motivation to reach ambitious goals and to implement solutions, once a proof-of-concept is given.

The two non-significant moderation effects deserve further explanation. We derived several arguments that EO should positively moderate strategic clarity's effect but did not find significant support for the innovativeness dimension. In the framework by Locke and Latham (2002), goal clarity and goal difficulty are considered as drivers, which direct and motivate goal-oriented behavior and the persistence of efforts. However, the effect of goal clarity is nearly twice as high for simple tasks as for complex tasks (Locke and Latham, 2002, p. 209). If we assume that innovative tasks are more difficult this implies that we should expect a significant *negative* moderation effect. Locke and Latham argue that in more complex tasks a larger variety of strategies are applied – and that influence of goal setting on performance can only work if *effective* task strategies are used. They make a plea to assign learning goals for effective task strategies instead of performance goals. In the derivation of our hypothesis we made a plea for learning practices, that is, implementing ideation pipelines to find better task strategies, structuring innovation fields for scoping strategic buckets, and develop visions, which motivate but leave open a variety of task strategies. We argued that not goal clarity itself, but the processes of developing sub-goals and learning goal-attainment strategies are important. However, we have not measured this variable in our test – there is room for future research to do this.

It is interesting that risk taking positively moderates strategic clarity. A high strategic clarity also implies that a strategy is focused. This may imply a higher risk, particularly in innovative situations, where strategies are not validated by experience. Implementing such strategies implies that the decision makers are willing to take a higher risk, because they trust in their strategic reasoning. The interaction with innovativeness is significantly positive. An explanation might be that an innovative task motivates stakeholders to cooperate because they see more alternatives that support a win-win-distribution of expected returns.

Table 5. Results

	Project portfolio success								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Controls									
Firm size (ln)	−0.02	−0.01	−0.02	−0.02	−0.02	−0.01	−0.02	−0.02	−0.02
Portfolio budget (ln)	0.01	0.02	0.02	0.01	0.01	0.02	0.02	0.03	0.01
PM formalization	0.05†	0.05†	0.05†	0.06*	0.04	0.05†	0.05†	0.06*	0.05
Independent variables									
Stakeholder involvement	0.21**	0.20**	0.20**	0.20**	0.21**	0.20**	0.20**	0.19**	0.21**
Strategic clarity	0.08*	0.07*	0.08*	0.08*	0.07*	0.07*	0.09*	0.08*	0.07*
Business case monitoring	0.06*	0.06*	0.06*	0.05	0.06*	0.06†	0.06*	0.05†	0.07*
Agility	0.09*	0.10*	0.09*	0.09*	0.10*	0.10*	0.09*	0.11*	0.10*
Moderators									
Innovativeness	0.20**	0.19**	0.19**	0.22**	0.20**	0.20**	0.20**	0.21**	0.20**
Risk taking	−0.00	−0.00	−0.00	−0.01	−0.01	−0.00	−0.01	−0.03	−0.01
Interactions with innovativeness									
Stakeholder involvement		0.07*							
Strategic clarity			0.04						
Business case monitoring				0.08**					
Agility					0.07*				
Interactions with risk taking									
Stakeholder involvement						0.05			
Strategic clarity							0.06*		
Business case monitoring								0.08**	
Agility									0.07*
Constant	4.32**	4.26*	4.30**	4.31**	4.32**	4.29**	4.29**	4.26**	4.33**
R^2	0.34	0.35	0.35	0.36	0.35	0.35	0.35	0.37	0.35
R^2 (adjusted)	0.32	0.33	0.32	0.34	0.33	0.32	0.33	0.34	0.33
Delta R^2		0.01	0.00	0.02	0.01	0.00	0.01	0.03	0.01
F	14.24**	13.47**	13.01**	14.02**	13.51**	13.11**	13.47**	14.28**	13.47**

Hierarchical OLS regression; n = 257; mean-centered variables; unstandardized regression coefficients are reported; PM = Portfolio Management.
$^{\dagger}P < 0.10$ (two-sided), *$P < 0.05$ (two-sided), **$P < 0.01$ (two-sided).

In contrast, the interaction of stakeholder involvement and risk taking was not significant. We assume that firms will more intensively involve market- and technology-related stakeholders, if they have created trust with these partners, and their previous actions have been successful. If so, a willingness to invest more in a new joint activity would be driven by the prospects of this activity, and innovativeness might be a driver of value creation. The willingness to take more risks may not be as decisive because the sharing of resources and expected returns may already limit expected gains and losses – compared to an activity that the firm would do without a partner requiring higher investments.

5.1. Implications

To the best of our knowledge this is the first study that investigates strategic orientation as a *contingency* factor for IPPM practices. The results support the proposition that portfolio management capabilities aligned to the firm's strategic orientation enable

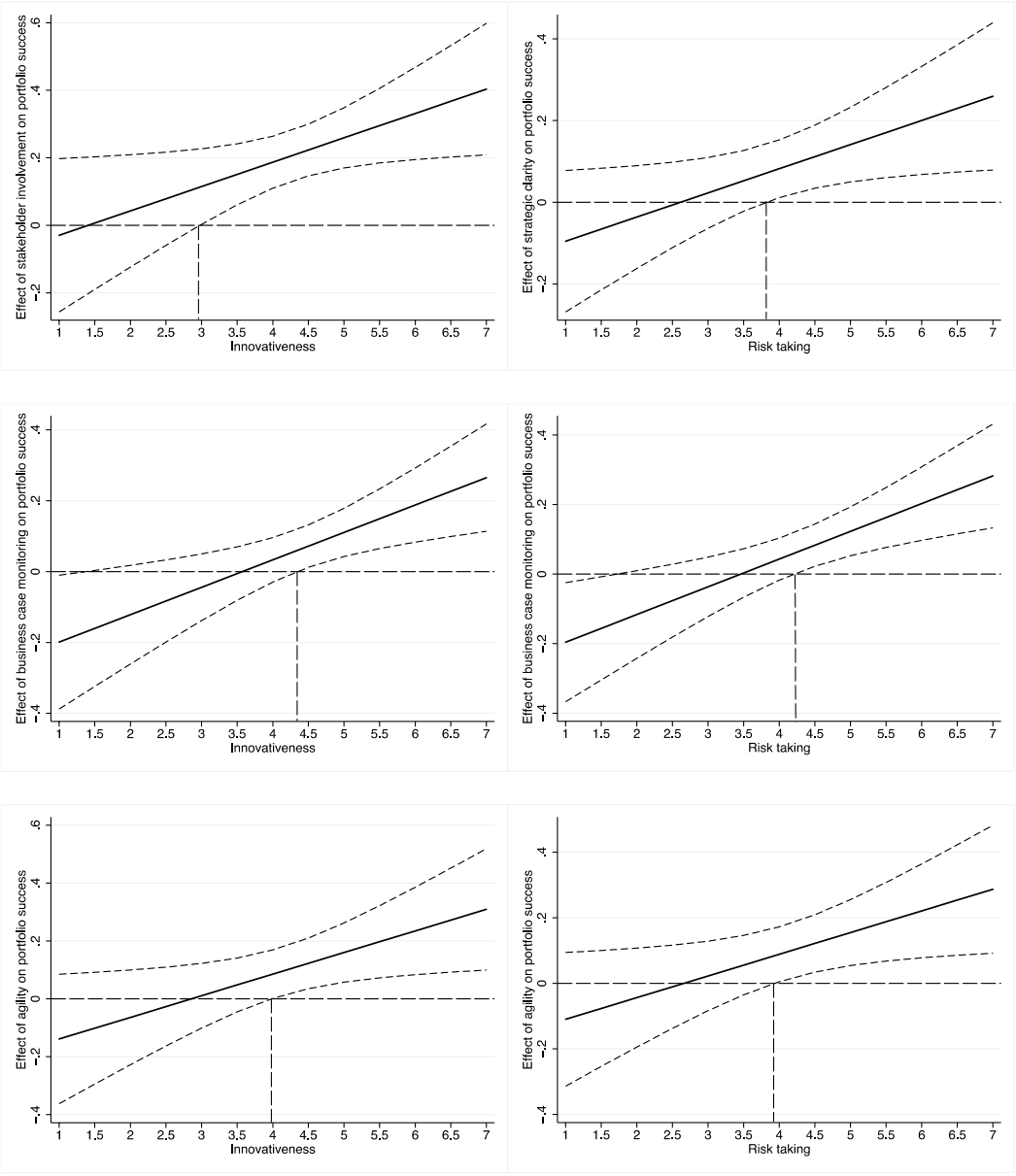

Figure 2. Marginal plots of interaction effects (dotted lines are 95%-CI intervals).

firms to better implement their strategy and generate competitive advantage. This paper, therefore, integrates and contributes to both literatures on portfolio management and entrepreneurial orientation.

First, previous work on portfolio management stresses that portfolio management practices largely depend on the context and calls for more work on contingency factors for effective portfolio management (Blomquist and Müller, 2006; Martinsuo, 2013). In response, studies have investigated important contingency factors such portfolio complexity (Teller et al., 2012; Voss and Kock, 2013; Kopmann et al., 2015), portfolio size (Voss and Kock, 2013; Kopmann et al., 2015), the type of projects (Müller et al., 2008; Voss and Kock, 2013), or environmental turbulence (Müller et al., 2008; Petit, 2012; Voss and Kock, 2013; Kopmann et al., 2015). Although one of the most important objectives in portfolio management is the implementation of strategies, surprisingly, no previous study on portfolio management has investigated strategic contingency factors. We show that certain strategic success factors of IPPM increase in importance for firms with a high EO. This means that although firms with a high EO do not necessarily invest more resources and energy to increase the intensity of IPPM practices (EO and IPPM factors did not strongly correlate), they can effectively leverage

their benefits. More importantly, as the marginal plots in Figure 2 suggest, a certain threshold of EO is necessary for IPPM practices to have any effect at all. Known success factors, may thus become irrelevant for firms with a conservative orientation. This study, therefore, contributes to a better understanding of the boundary conditions for successful innovation project portfolio management and shows that success factors can be further leveraged by an appropriate strategic orientation. These findings may inspire further research to identify other leveraging factors such as organizational culture or the coherence and fit between managerial practices.

Second, researchers of the EO-performance relationship try to identify the conditions under which EO contributes to firm performance. Based on their meta-analysis, Rauch et al. (2009) call for more research on possible moderators on the EO-performance relationship. Our results also contribute to this stream of literature by introducing a portfolio management perspective to this field. Certain project portfolio management practices better support implementation of a more entrepreneurially oriented strategy. Put differently, if a firm strives to adopt a more entrepreneurial posture, it is useful to know which practices at the middle management level are necessary to optimally complement this posture. Future research investigating the performance effects of strategic orientations should, therefore, also consider the implementation-related aspects of strategy, for example, practices of portfolio management.

This study has also some important managerial implications. Portfolio managers need to be aware that there are no universally successful IPPM practices, but that practices should fit the context. Managers need to consider the firm's strategic orientation when they try to find the optimal portfolio governance and align managerial practices accordingly. In other words, they do not necessarily have to further intensify these practices to increase success, but they can leverage the effectiveness of IPPM practices by nurturing an EO. Vice versa, it does not pay off to invest in IPPM practices if the firm's EO has not reached a certain minimum threshold. Specifically, if the firm has a highly innovative strategic posture, the integration of portfolio stakeholders becomes one of the most important success factors. As can be seen in Figure 2, the relationship with portfolio success is almost twice as strong for firm's high in the innovativeness dimension of EO as compared to firms of average innovativeness posture. For firms with a highly risk-affine posture, a clearly formulated strategy becomes even more relevant for portfolio success. Generally, business case monitoring and agility become more important for higher levels of EO. However, business case monitoring might not be beneficial in all circumstances. With decreasing EO in either dimension, the positive effect of business case monitoring diminishes and eventually even becomes negative. Since establishing business case control for all projects is connected with considerable efforts (Kopmann et al., 2015), it might, therefore, not be worth the effort in firms with a relatively low EO, and managers should concentrate their efforts on other practices.

5.2. *Limitations and avenues for future research*

There are a few limitations worth noting when interpreting this study's findings. First, the data are cross-sectional and based on subjective assessments by key informants. While we tried to reduce common method bias using multiple informants for different constructs, we cannot prove the causality with cross-sectional models. In addition, although or study investigates EO as a contingency variable, a firm's strategic orientation is not exogenous and depends on environmental conditions (Rosenbusch et al., 2013) or even on past success. Previous studies on IPPM have investigated the relevance of environmental variables such as turbulence (e.g., Kock and Gemünden, 2016), but future research on IPPM could consider the fit between EO and environmental conditions.

Second, our analysis concentrated on four central managerial practices along the portfolio process: involving portfolio stakeholders, formulating a clear strategy, monitoring the portfolio using business cases, and adapting the portfolio to changes. While these constructs represent core strategic activities in the portfolio formation and steering phases and jointly explain a large variance in portfolio success, other non-process-related variables could be considered. Future research could investigate, for example, how EO influences the effectiveness of leadership, teamwork or competence development in innovation project portfolio environments.

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