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in Innovation Portfolio Management**

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**Antecedents to Decision-making Quality and Agility
in Innovation Portfolio Management**

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Abstract

Innovation portfolio management (IPM) is a dynamic decision-making process, in which projects are evaluated and selected, and resources are allocated. Previous research has developed an understanding of IPM success and its influencing factors. However, little research investigated the quality of the decision-making process and the ability to quickly adapt the portfolio. This study focuses on the antecedents of decision-making quality and agility (i.e., responsiveness to changes in the environment). Based on a decision-making framework, five structural and cultural IPM components are derived as important antecedents of decision-making quality, which in turn influences agility. The structural components (1) clarity of strategic goals, (2) formality of the IPM processes, and (3) controlling intensity serve a coordinating function. The cultural components (4) innovation climate and (5) risk climate serve a motivating function in IPM. An analysis of a sample of 179 firms and their innovation portfolios through structural equation modeling using a double-informant design documents that these five components all positively influence portfolio decision-making quality which in turn positively influences agility. Results further show that environmental turbulence moderates some of these relationships. While the positive effect of process formality is weakened under increasing turbulence, the effects of controlling intensity and climate for innovation are strengthened by environmental turbulence. The findings have theoretical implications for the understanding of IPM as a dynamic capability and practical implications for the management of portfolios in turbulent environments.

Practitioner Points

- This article empirically investigates, which features increase transparency, stability, effectiveness, and agility of strategic and operational decisions in Innovation Portfolio Management.
- Decision-making quality and agility is increased by a clear innovation strategy, formal portfolio processes, frequency of portfolio monitoring and a climate fostering innovation and open communication of risks.
- In turbulent environments, formal organizing becomes less important for decision-making quality and agility, whereas monitoring frequency and innovation climate become more impactful.

Antecedents to Decision-making Quality and Agility in Innovation Portfolio Management

Innovation portfolio management (IPM) is a dynamic decision-making process in which projects are evaluated and selected, and resources are allocated to them (Cooper, Edgett and Kleinschmidt, 1999; Jonas, Kock and Gemünden, 2013). A balanced and strategically aligned portfolio of innovation projects, capturing portfolio value, leveraging synergies, and reducing risks at the portfolio level is decisive for a firm's success (Kester et al., 2011; Kester, Hultink and Griffin, 2014). Previous research has developed a good understanding of IPM success and investigated the factors influencing success within the IPM system (Cooper, Edgett and Kleinschmidt, 2001; de Brentani and Kleinschmidt, 2015; Jonas et al., 2013; Kock, Heising and Gemünden, 2015; for literature reviews see Martinsuo, 2013; Meifort, 2015).

Most prior research, however, concentrates on success factors and neglects the decision-making processes underlying IPM. For example de Brentani and Kleinschmidt (2015) assume that IPM success factors can be classified into two groups: (1) '*Resources*', which are the background factors residing in the firm, and (2) '*Capabilities*', which entail more specific routines that firms develop and adjust in line with the dynamics of the situation. In combining both types of factors, the authors propose several models that provide insights into the success factors of global NPD programs. However, even this comprehensive approach does not open the black box of the complex dynamic decision-making processes inherent to IPM.

Recently, interest in IPM decision-making has increased (Behrens and Ernst, 2014; Behrens, Ernst and Shepherd, 2014; Christiansen and Varnes, 2008; Kester et al., 2011; Kester et al., 2014; Kester, Hultink and Lauche, 2009; McNally, Durmuşoğlu and Calantone, 2013; McNally et al., 2009). For example, in a qualitative study, Gutiérrez and Magnusson (2014) show that rational

and formal decision-making processes experience higher acceptability than informal ones. McNally et al. (2013) find that managers' disposition, including their leadership style, need for cognition or risk perceptions, affects the importance afforded to decision-making criteria. Similarly, in a conjoint experiment, Behrens and Ernst (2014) show that experienced middle managers differ from senior managers in that the former place greater emphasis on the strategic context and less emphasis on uncertainty in decisions to initiate innovation projects. Another experiment on go/stop decisions indicates that managers are more likely to terminate failing projects when they use consultant advice and visual decision aids (Behrens et al., 2014). Jonas et al. (2013) focus more on the interaction processes between the involved actors in portfolio management decision-making. Using a longitudinal, multi-informant study, they show that the quality of processes in portfolio management regarding information availability, allocation of resources, and mutual collaboration positively affects portfolio success. Unger et al. (2012) show that firms that are able to make tough decisions on project termination can achieve a higher strategic fit in their portfolio.

In their qualitative study, Kester et al. (2011) identify three constructs that describe decision-making effectiveness: portfolio mindset, agility, and focus. Although the study is descriptive, the statements about the constructs are rather normative: Portfolio mindset implies that decisions are based "on a complete understanding of all of the projects in the NPD portfolio and how each is aligned to the firm's strategy" (Kester et al., 2011: 647). Decision-making agility means that a "firm can quickly shift its development focus to incorporate a new technology into its product line" (Kester et al., 2011: 648). In a quantitative follow-up study, Kester et al. (2014) find a positive relationship between these capabilities and IPM success measures. These findings show that firms differ in their ability to adapt their portfolio to changing environmental conditions and that this ability is important for success in IPM.

Overall, existing research on IPM decision-making describes the performance relevance of effective decision-making and of adapting to changing environmental conditions but does not investigate organizational factors that favor or hamper this desired behavior. We still lack understanding about the *antecedents* of agility in IPM that managers can influence. Furthermore, there is a dearth of research investigating IPM under *dynamic conditions* (Martinsuo, 2013; Petit, 2012). In her review of empirical studies, Martinsuo (2013) suggests that portfolio management research should focus more on portfolio dynamics and their behavioral and organizational influences.

The current study aims to develop and test a conceptual model explaining the organizational antecedents of two central organizational constructs of IPM: *decision-making quality* and *agility*. *Decision-making quality* is defined as the degree to which portfolio management decisions—such as the initiation, (re)prioritization or even termination of projects—are made in a transparent, stable, comprehensible, and rigorous manner (Behrens and Ernst, 2014; Behrens et al., 2014; Kester et al., 2014; Kester et al., 2009; Unger et al., 2012). *Agility* is defined as the ability to quickly adapt the firm’s innovation portfolio to changing customer needs and competitive conditions, changing resource situations, changing technological opportunities and threats, and changing strategic goals (Kester et al., 2011).

Decision-making quality is a central construct in IPM because the way decisions are made influences whether the right projects are chosen and staffed appropriately, whether an innovation portfolio is aligned to strategy, and whether the right balance of incremental and radical innovations is implemented. Cooper et al. (2001) 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 these seminal

studies on IPM, other researchers have developed a more comprehensive understanding of innovation portfolio success (Martinsuo and Killen, 2014; Martinsuo and Lehtonen, 2007; Meskendahl, 2010; Müller, Martinsuo and Blomquist, 2008) and the associated success factors (Jonas et al., 2013; Kester et al., 2014; Killen, Hunt and Kleinschmidt, 2008; Spieth and Lerch, 2014; Teller and Kock, 2013; Teller et al., 2012; Voss and Kock, 2013).

A first conclusion from these studies is that a high decision-making quality is a pivotal condition for reaching success. However, a high decision-making quality is only a necessary condition for IPM success. IPM is a *dynamic* decision-making process (Cooper et al., 1999). The *premises* on which decisions were originally based may change - and therefore new decisions to *adapt* to these changes are needed. The earlier decision-makers discover the need for changes, and the faster their organization adapts, the better the chances that this will lead to a successful correction. The current study proposes that a high decision-making quality allows better agility and aims to explain how organizational antecedents influence decision-making quality and ultimately agility. Hence, the overall research question is: *What are organizational antecedents of agility and decision-making quality in IPM?*

In the following, a conceptual framework of five critical organizational components of an IPM system is developed that positively influence decision-making quality, which in turn affects agility. In particular, this study examines three structural organizational components that improve coordination in IPM, i.e. *the clarity of a firm's innovation strategy* (de Brentani, Kleinschmidt and Salomo, 2010), *the formality of the portfolio process* (Teller et al. 2012) and *the intensity of controlling*, defined as the effort and quality of continuous screening and monitoring of the portfolio (Müller et al., 2008; Schultz et al., 2013a); and two cultural components that improve the motivation to deliver valid and current information in IPM, i.e. *the organizational innovation climate* (Kock et al., 2015) and *the extent of its open risk climate* (Teller and Kock, 2013).

Furthermore, following the call for more research on dynamics in portfolio management (Martinsuo, 2013), this article investigates the degree to which external turbulence strengthens or weakens these relationships.

This study aims to contribute to IPM research by understanding which factors enable firms to make better decisions and implement them more quickly and comprehensively. While previous studies have investigated the performance of portfolios in terms of strategic fit, balance, and value contribution, the present study analyzes what enables firms to make better decisions in their IPM and to better respond to environmental turbulence. To the best of the authors' knowledge, this is the first large-scale empirical study on the antecedents to agility in IPM. Using a sample of 179 firms and a dual-informant research design, this article investigates structural antecedents that increase strategic and operational clarity, and cultural antecedents that enable better information. The study thus contributes to a better understanding of the drivers of decision-making quality and agility in IPM and provides quantitative evidence on the nature of IPM as a dynamic capability.

Conceptual Framework

From a behavioral and leadership perspective, IPM decision making does not merely involve making a specific choice at a single point in time. Rather, decision-making is a *process*: decisions need to be communicated to and followed by others, and this process needs to be planned and controlled. Decision-making quality is an assessment of this process and includes aspects of making comprehensible and stable decisions, which are rigorously implemented. Agility describes how *quickly* decision-makers adapt the firm's innovation portfolio to changes of customer needs and competitive conditions, resource situations, technological opportunities and threats, or strategic goals.

Decision-making quality and agility are both behavioral constructs that describe a characteristic of the decision-making process. They describe neither the specific decision situation nor the success of the portfolio decisions. The decision situation comprises the projects and their expected outcomes as alternatives, the resources as constraints, the strategic goals as decision criteria, and the uncertain reactions from others on the decisions. Decision processes with a higher decision-making quality are assumed to use more and better information about the decision situation, and to exploit this information in a more rigorous and rational way. Decision-making quality is conceptually distinct from decision effectiveness (Dean and Sharfman, 1996) because the former does not necessarily imply that decisions actually result in desired outcomes (Eisenhardt and Zbaracki, 1992).

The literature on IPM shows that there is a wide variety in decision-making behavior in IPM, and that many factors can influence the decision-making process (Behrens and Ernst, 2014; Behrens et al., 2014; Christiansen and Varnes, 2008; Kester et al., 2011; Kester et al., 2014; Kester et al., 2009; McNally et al., 2013; McNally et al., 2009). Differences in innovation portfolio decision-making can be explained by individual decision-making styles, group dynamics, organizational politics and cultural factors. These factors either prevent people from making rational decisions, or support them. The focus of the current study lies in *organizational factors* of the IPM system that enable managers to make better decisions and implement them more quickly and consistently. While we acknowledge that decision are made under incomplete, ambiguous, and uncertain information, and that communication suffers from equivocality, and information processing capacity is limited, we argue that some decision makers strive for more rational decision-making than others, and that a substantial share of firms have actively created organizational IPM systems that provide them with better information and allow them to make

higher quality decisions. The current study investigates which components such a system comprises and how these components interact.

IPM has become a central theme in innovation management (Meifort, 2015), because the number of projects and the relationships between them regarding resources, risks, and synergies have substantially increased. This phenomenon called “projectification” of organizations (Lundin, 2015; Midler, 1995) makes IPM more complex. An IPM system must address the following five challenges to enable effective decision-making and responsiveness to external changes.

(1) *Strategy implementation*: Traditionally, strategy development has been a process where the strategic goals have been developed by the top-management team and were then broken down the hierarchical lines (Floyd and Wooldridge, 1992; Noble and Mokwa, 1999). However, with an increasing amount of work done in projects these mechanisms are not effective anymore. Strategies are no longer implemented within lines but within cross-functional projects, and strategic goals should be broken down to the portfolio level of these projects. This means that organizations require a critical amount of transparency on strategic goals that they want to fulfill in a certain planning period with their stakeholders and lower ranked management levels (Meskendahl, 2010). Without valid and sufficiently accurate information about where organizations want to go, and which projects are needed, people lack orientation and motivation, and alignment of innovative projects with the innovation strategy becomes difficult. *Strategic clarity* is therefore the first necessary component of an IPM system.

(2) *Resource allocation*: Traditionally, resources were allocated to line units, but in a project-oriented world, resources are allocated to cross-functional projects that need highly competent human resources from several lines. Innovations will only be successful, if qualified and motivated people work well together. The identification of skilled people, who match the

requirements of the projects and are available at the right time, is more complex than determining financial resource requirements. Rational decision-making for innovative portfolio requires much more information, because projects increasingly compete for resources, single project risks can accumulate in portfolios, synergies between projects need to be leveraged, and decision-makers need to balance radical and incremental innovation. In order to accomplish this, decision-makers need *operational clarity* about the amount and kind of resource requirements of projects and the corresponding resource capacities. Implementing formalized IPM processes is a means to achieve operational clarity (Cooper et al., 2001; Schultz et al., 2013a; Teller et al., 2012).

(3) *Adaptation to Changes*: Increased turbulence in a globalized world requires that firms need to respond to changed situations more quickly and appropriately—IPM must become responsive and agile. Portfolio decisions can be based on more comprehensive information from all projects and resources, and on all desired strategic goals. However, reaching operational and strategic clarity increasingly takes time, because both processes need to be coordinated. Strategic goals need to reflect operational constraints, in order to stay feasible, but they also challenge the existing state. There will always be constructive tension between vision and mission on the one hand, and operational constraints on the other hand. The resulting need for coordination implies that information may already be inaccurate when decisions are made. In order to maintain strategic and operational clarity, portfolio controlling should therefore occur sufficiently often and intensively (Müller et al., 2008; Petit, 2012). Thus, the frequency and intensity of portfolio controlling cycles is a third desired component of an IPM system, which fosters decision-making quality and enables higher agility.

(4) *Motivation for Innovation*: Innovation cannot be commanded. It depends to a large extent on personal intrinsic motivation of the innovating people, who see a need and potential for value creation (Zhang and Bartol, 2010). Innovation management can only foster initiatives for

innovations, enable and recognize them, and support people to implement these solutions. Good decision-making processes about which projects should be realized in a project portfolio start early. This means that organizations should proactively work on a good pipeline of project ideas leading to concepts and well-founded business plans of project proposals (Kock et al., 2016). If this pipelining work is done in an innovation fostering climate, creating trust, that the initiatives for innovation have a fair and realistic chance to get selected and supported, then there is a higher chance that people will disclose their ideas and work on them (Amabile et al., 1996; Kock et al., 2015). There is also a higher chance that people will provide necessary information for making decisions once the projects are underway. If this information is not communicated, firms will suffer from “lost opportunities”. Therefore, a *climate for innovation* is an important motivating component an IPM system.

(5) *Motivation for Open Communication of Risks*: The literature on innovators describes the champions and promoters that actively support innovation processes (Gemünden, Salomo and Hölzle, 2007; Griffin et al., 2009). These innovators are challenged by opponents, who question the validity of their claims, detect informational gaps, emphasize potential negative side-effects, and point out which barriers may hamper implementation and diffusion. Already Witte (1976) discussed the productive role of innovation opponents, who challenge innovators and thus improve the innovation. Otherwise, project benefits are exaggerated and risks are downplayed. In order to avoid such flaws, firms need a strong professional culture that is aware of the risks of the projects, willing to communicate risks, and willing to take concerns seriously (Teller, 2013).

Hence, the last motivating component of the IPM system is an *open risk climate*.

Insert Figure 1 about here

Figure 1 presents the overall conceptual framework of this study. We argue that a firm's agility in IPM is mainly affected by decision-making quality, which is the central mediating factor in the framework. Following the preceding discussion of IPM challenges, five organizational components of an IPM system are proposed that enable better decision-making quality and agility. The first three structural components serve a coordinating function by providing strategic and operational transparency: (1) *Strategic clarity* means that goals and objectives are clearly formulated, (2) *process formality* assures operational clarity about the current portfolio and resources, and (3) *controlling intensity* means continuous monitoring of the portfolio to maintain this transparency. The climate components serve a motivating function to actively search for opportunities and threats, to analyze them and exchange information about them: (4) a *climate for innovation* and (5) an *open risk climate*. These two climate conditions increase the likelihood that more and better information about projects and the overall portfolios will be delivered to decision-makers. They also express shared values about striving for high performance goals and securing their realization.

Finally, the strength of the relationships between decision-making quality and its antecedents likely depends on *environmental turbulence*. The more turbulent the environment, the stronger should be the effects of strategic clarity, controlling intensity and both climate factors, while process formalization is argued to be negatively moderated by turbulence. The following section will present arguments regarding each hypothesis in more detail.

Hypotheses

Decision-making quality and agility in IPM

Decision-making quality is defined as the degree to which portfolio management decisions—such as the initiation, (re)prioritization or even termination of projects—are made in a

transparent, stable, comprehensible, and rigorous manner. Only if portfolio decisions are based on valid and sufficient information, derived in a transparent way, clearly formulated, and rigorously enforced will firms be able to quickly adapt their innovation project portfolio to changing customer needs and competitive conditions, changing resource situations, changing technological opportunities and threats, and changing strategic goals.

Transparent but tough decisions also allow for uncomfortable changes such as the termination of innovation projects (Behrens and Ernst, 2014). For example, Unger et al. (2012) show that firms making rigorous termination decisions achieve a better strategic fit of their portfolio, because they can more quickly reallocate resources and refocus the portfolio. We therefore hypothesize the following:

Hypothesis 1: Decision-making quality is positively related to agility in IPM.

Strategic clarity

Innovation strategies are primarily implemented by the innovation projects that a firm pursues and the current portfolio of innovation projects is thus a manifestation of the firm's innovation strategy (Meskendahl, 2010). Portfolio management can therefore be considered the main vehicle for strategy implementation. Successful implementation of strategy requires that the intended strategy, with its goals and objectives, be transparent to the organization (Noble and Mokwa, 1999), and that its implications be communicated and understood by all relevant functions of the firm (Floyd and Wooldridge, 1992). Often, significant parts of the organization do not know or understand their firm's strategy and thus fail to execute it (Loch and Tapper, 2002). Strategic clarity means not only that the company or business unit *has* a clearly formulated strategy but also that this strategy is communicated and understood within the organization. This form of transparency is a central prerequisite to portfolio decision making. A clearly formulated

innovation strategy enforces a commonly agreed interpretation (Noble and Mokwa, 1999), which will improve joint decision-making processes and facilitate the legitimization of portfolio decisions (Gutiérrez and Magnusson, 2014). Only with valid information on the firm's strategic goals and direction, will portfolio decisions be comprehensible for all stakeholders. Strategic clarity provides guidance and focus to innovation activities (Spanjol, Mühlmeier and Tomczak, 2012; Talke, Salomo and Kock, 2011). For example, Kock et al. (2015) show empirically that a clear ideation strategy can channel creativity for generating ideas for new projects and allows new opportunities that fit into the scope of the firm to be better identified, which will improve project initiation decisions. Furthermore, a clear and joint understanding of the firm's goals and objectives will improve effective prioritization of projects and early detection of unnecessary projects that do not fit into the firm's innovation strategy. We therefore posit the following hypothesis:

Hypothesis 2: Strategic clarity is positively related to decision-making quality in IPM.

Process formalization

Process formalization means that the IPM process of selection, prioritization, resource allocation and portfolio control is clearly specified. Previous studies by Cooper and colleagues show that top performers in IPM use formal portfolio processes (Cooper et al., 2001). Kleinschmidt, Brentani and Salomo (2007) find that formal NPD processes increase the quality of information integration as well as homework and launch activities (see also de Brentani and Kleinschmidt, 2015). Teller et al. (2012) empirically show that formal project portfolio processes increase portfolio transparency and the quality of collaboration, which in turn increase portfolio success. Process formality in IPM will increase decision-making quality for several reasons.

First, formal processes introduce structure, sequence, and clarity to all projects (Tatikonda and Montoya-Weiss, 2001). Clear rules and guiding principles will ensure more complete and higher quality information on project proposals, project status, and resource demands, as well as transparent evaluation criteria and better comparability between projects (Cooper, 2008). Formality will therefore lead to higher operational transparency (better information on single projects as well as required and available resources), which is a central condition for making high-quality decisions. The study of Martinsuo and Lehtonen (2007) shows that information availability from single projects is highly important to portfolio managers' decision making.

Second, formal processes go hand in hand with all stakeholders having clearly defined responsibilities (Beringer, Jonas and Kock, 2013), which might reduce conflicts regarding portfolio decisions and thus enable faster implementation. Formality will also increase the comprehensibility of decisions and might thus increase procedural fairness—"fairness in the methods used to plan and implement resource allocation decisions" (Wiesenfeld et al., 2007: 1235). Gutiérrez and Magnusson (2014) show empirically that formality contributes to better acceptance and legitimization of portfolio decisions. Furthermore, formality might reduce portfolio politics—individual actions to influence decisions with the aim of furthering one's own self-interests.

However, formalized portfolio processes may also lead to bureaucracy and rigidity. For example, Sethi and Iqbal (2008) show that stage-and-gate systems can lead to project inflexibility. Schultz et al. (2013a) further find that for highly innovative NPD programs, formal stage-gate controls can negatively affect NPD decision clarity. Despite these possible negative effects of formalization on decision-making quality, the positive effects of increased operational transparency and procedural fairness are likely to be stronger. We thus propose the following hypothesis:

Hypothesis 3: Process formalization is positively related to decision-making quality in IPM.

Controlling intensity

Strategic clarity and operational clarity through formalized processes are both necessary for decision-making but they need to be coordinated since there will be tensions between the strategic goals and objectives on the one side and operational realities and constraints on the other side. It is therefore necessary to update operational and strategic information regularly through portfolio controlling. Controlling intensity refers to the effort and quality of continuous screening and monitoring of the portfolio to react to changes (Müller et al., 2008). Portfolio controlling includes not only the regular monitoring of individual innovation projects in order to determine whether they are adhering to their initial goals and whether their business case is still valid but also the continuous evaluation of the overall portfolio composition and alignment, as well as interdependencies between innovation projects (Beringer et al., 2013; Blau et al., 2004; Kopmann et al., 2015; Loch and Kavadias, 2002). Case study research on portfolio management suggests that portfolio changes and uncertainties have a considerable impact on a portfolio, which stresses the importance of continuous monitoring and controlling activities (Petit, 2012). The more often and the more intensively the portfolio is analyzed and assumptions are scrutinized and questioned, the more likely decision-making quality will increase: poor performing projects, which no longer fulfill their business case because customer preferences or technological state-of-the-art have changed, are identified much more quickly.

Hypothesis 4: Controlling intensity is positively related to decision-making quality in IPM.

Innovation climate

A climate for innovation is defined here as the managerial support and autonomy that is given to employees to allow them to pursue creative tasks (Amabile et al., 1996; Kock et al., 2015). Managerial support means encouraging individuals to voice new ideas and providing positive feedback (Oldham and Cummings, 1996). Granting autonomy means encouraging individuals to engage in trial-and-error experimentation and giving them the resources and time to spend on new ideas. Organizational encouragement and perceived freedom are understood as central prerequisites for supporting an innovative environment that fosters creative and innovative performance (Zhang and Bartol, 2010). Encouragement will support risk taking by employees because they will feel psychologically safe to experiment if innovative activity is accepted and appreciated (Baer and Frese, 2003). In the context of portfolio management, Kock et al. (2015) show that creative encouragement positively affects the generation of valuable ideas for the portfolio. A strong climate for innovation can therefore be expected to result in more catalysts for new project ideas and to challenge and change running innovation projects.

Hypothesis 5: A climate for innovation is positively related to decision-making quality in IPM.

Open risk climate

Risk is central to IPM and portfolio risk management allows portfolio managers to take an aggregated view on risks, transfer knowledge about risks between projects, and consider strategic issues at the portfolio level (Blau et al., 2004; Olsson, 2008; Teller, Kock and Gemünden, 2014). However, effective portfolio risk management requires a strong culture (Teller, 2013). An open risk climate encompasses the general awareness of risks, the acceptance and commitment to risk management procedures and open and honest communication about risks (Teller, 2013). Such a

climate can sharpen stakeholders' awareness that projects are tainted with risks that need to be managed. The commitment of the portfolio manager and single NPD project managers to consistent risk management procedures increases trust, strengthens the sense of responsibility, and encourages problem solving and innovative solutions. Managers who fear disclosing bad news, however, may deny the existence of risks or tend to downplay risks to an acceptable level to prevent the potential termination of a project.

Previous empirical findings support the notion that a risk climate has a positive effect on decision-making quality. Teller and Kock (2013: 20) empirically find that a risk culture is the strongest predictor of risk transparency, i.e., "the capability to identify the major risks, recognize the risk sources as well as detect cross-portfolio risks due to interdependencies within the project portfolio." Risk transparency allows managers to realize potential issues, understand the feasible impact of potential events on business objectives, make realistic assumptions, and recognize and understand interdependencies (Teller, 2013). As these aspects in turn will lead to better decision-making, we posit the following:

Hypothesis 6: An open risk climate is positively related to decision-making quality in IPM.

Moderating effects of environmental turbulence

Agility is only necessary given a certain degree of turbulence, which is mainly triggered by market and technology changes and/or uncertainty (Dess and Beard, 1984). Consistent with the understanding of IPM as a dynamic capability (Petit, 2012), the strategic, organizational and cultural antecedents of decision-making quality are likely to be affected by the extent of turbulence in the firm's environment.

A clear innovation strategy will become more important in turbulent environments, as it provides a higher-level orientation in the form of boundary conditions for idea search (Kock et al., 2015; Spanjol et al., 2012). Making transparent, comprehensive and rigorous portfolio decisions under high external turbulence is difficult, because reliable information on market requirements and technological feasibility is highly uncertain and ambiguous. Although the longevity of an innovation strategy will be shorter in turbulent environments, clearly formulated objectives will provide the necessary guidance and priorities so that decision-makers will stay consistent.

Hypothesis 7a: Environmental turbulence positively moderates the influence of strategic clarity on decision-making quality.

Process formality is likely to become less important for effective decision making when turbulence is high. As argued above, process formalization has both positive and negative effects. The negative effects of increased bureaucracy and rigidity will be much stronger under high external turbulence. Formal evaluation processes are less flexible, and they require time and effort, which are disadvantageous features in turbulent environments (Sethi and Iqbal, 2008). We therefore argue that the positive effect of process formalization will be diminished the more volatile the firm environment is.

Hypothesis 7b: Environmental turbulence negatively moderates the influence of process formality on decision-making quality.

Conversely, the positive effects of controlling intensity are more likely to increase with turbulence. Despite the increased effort required by highly intensive and frequent monitoring, such monitoring is likely to detect deviations in a fast moving world. Qualitative research on portfolio management in highly turbulent environments also suggests that under these conditions the importance of controlling activities increases (Martinsuo, 2013; Petit, 2012).

Hypothesis 7c: Environmental turbulence positively moderates the influence of controlling intensity on decision-making quality.

Finally, under high technological and market turbulence the motivating elements of the IPM system (open risk climate and climate for innovation) can be argued to become more important. High turbulence will generally increase the number, severity and likelihood of risks affecting the portfolio (Florice and Ibanescu, 2008; Petit, 2012), but will also increase the potential for innovation opportunities. Consequently, it becomes more important that NPD project managers and team members actively communicate potential risks and that they are encouraged to voice suggestions for improvements or new opportunities (Kock et al., 2015). We therefore expect the effects of an open risk climate and a climate for innovation to become stronger when turbulence is high.

Hypothesis 7d: Environmental turbulence positively moderates the influence of an open risk climate on decision-making quality.

Hypothesis 7e: Environmental turbulence positively moderates the influence of a climate for innovation on decision-making quality.

Method

Data collection and sample

The framework of hypotheses is tested on a cross-industry sample of German firms with the innovation portfolio of the business unit as the unit of analysis. For each firm, two informants of different management levels were contacted. The senior management informant had decision authority over the innovation portfolio regarding initiation, prioritization, and termination of projects. These informants had titles such as CEO, Head of Business Unit, and Head of R&D. The middle management informant had a good overview of the portfolio and the management

processes used in the firm. These informants typically had titles such as department manager, portfolio manager, or innovation manager. By contacting two informants in each firm, differing perspectives were obtained within the hierarchy of the firm on the practices, competencies, and consequences seen in portfolio management. Furthermore, this approach reduced common method bias, as the senior manager assessed the dependent and moderator variables, while the middle manager assessed the other variables.

Medium-sized and large German firms from different industries were contacted explaining the study and requesting participation. After the mailing, follow-up phone calls were made to identify the correct informants and to register for the study. 466 of 1017 contacted firms responded with interest and thus 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, participants were promised an individualized report and an invitation to a practitioner conference, where the study results were presented and participants could network with one another. 189 senior manager questionnaires and 195 middle manager questionnaires were returned from 200 firms, resulting in 184 matched dyads with data from both types of informants. Some questionnaires had missing data; thus, the final sample comprised 179 firms (response rate 18%). No significant differences between the first 25% and the last 25% of responding firms were found 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 innovation portfolios. The firms were from diverse industries and reflective of a reasonable spread according to size (employees and revenue).

Insert Table 1 about here

Measurement

The constructs used relied on existing scales taken from the literature when available, or they were adapted from previous conceptual work. All scales were pretested with 12 representatives from academia and industry to assure the face validity of constructs, improve item wording, and remove ambiguity. All measures used seven-point Likert scales (1 = “strongly disagree” to 7 “strongly agree”) unless stated otherwise. The Appendix shows the exact item wordings for each construct.

Dependent variable. Agility describes the extent to which a firm is able to change and adapt its portfolio to changing conditions. Four items were developed to capture agility and were assessed by both the middle and the senior manager. Both assessments correlated highly ($r = .60, p < .00$), giving confidence in the measure. However, only the rating of the senior manager was used in the model. Furthermore, agility was significantly related to dimensions of portfolio management performance, such as strategic fit ($r = .52, p < .00$), portfolio balance ($r = .36, p < .00$), and the average economic value of all projects in the portfolio ($r = .38, p < .00$), as well as overall business unit success ($r = .35, p < .00$). These results are comparable to findings from previous research on the consequences of agility in IPM (Kester et al., 2014) and thus confirm the criterion validity of the construct. Even more importantly, these relationships show the performance relevance of IPM agility.

Mediator variable. Decision-making quality is defined as the degree to which portfolio management decisions—such as initiation, (re)prioritization or even termination of projects—are made in a transparent, stable, comprehensible, and rigorous manner. Five items were developed based on conceptual ideas in previous literature on the rigor of portfolio decisions (Cooper et al., 2001) and project termination in portfolio management (Unger et al., 2012). Since senior managers were the decision makers and since they should not evaluate their own decisions, the

middle managers were chosen to be informants for these items.

Independent variables. 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). Process formality captured the extent to which the portfolio management process was clearly defined and specified. The items were taken from previous research (Teller et al., 2012). Controlling intensity measured the frequency and diligence of portfolio monitoring along three items. Risk climate was measured using three items taken from Teller and Kock (2013) to assess the extent of open risk communication and organizational commitment to risk management. Innovation climate was measured using three items taken from Kock et al. (2015) to assess whether the organization gives employees sufficient autonomy and psychological safety to engage in innovative activity. All independent variables were assessed by the middle managers.

Moderator and control variables. Environmental turbulence captured the degree of market and technology change in the industry using six items from Sethi and Iqbal (2008). The senior manager assessed these items. The model furthermore controls for portfolio size and innovativeness as important portfolio characteristics that might affect decision-making quality as well as agility. Previous research on portfolio management has identified that the size of the portfolio might affect portfolio management processes and outcomes (Beringer et al., 2013; Jonas et al., 2013; Kock et al., 2015; Teller and Kock, 2013; Teller et al., 2012). Portfolio budget was therefore introduced as a control, which was measured as the natural logarithm of the annual overall portfolio budget in million Euros. Similarly, portfolio innovativeness has been identified as an important influence factor in IPM (Schultz, Salomo and Talke, 2013b; Spieth and Lerch, 2014; Talke et al., 2011). Portfolio innovativeness was measured as the percentage (from 0 to 1=100%) of innovation projects that were completely new to the company. The middle manager

assessed control variables.

Insert Table 2 about here

Measurement assessment

Table 2 shows descriptive statistics and correlations of all variables used in the analysis. As shown, Cronbach's alpha for all variables was above .7. A confirmatory factor analysis (CFA) was performed with all latent variables. The average variance extracted and composite reliability showed values above .5 and .7, respectively. Overall, the measures showed an acceptable reliability and validity according to the standards proposed by Bagozzi and Yi (1988). Furthermore, discriminant validity was tested by examining the square root of the average variance extracted for each construct. Table 2 shows that all the values are greater than the respective correlations with other constructs, supporting sufficient discriminant validity (Fornell and Larcker, 1981). According to the criteria defined by Hu and Bentler (1998) the measurement model also achieved an acceptable overall fit ($\chi^2[230] = 413.00$; CFI = .91; RMSEA = .067; SRMR = .066). These results indicate that the overall measurement model is satisfactory and that subsequent analysis with structural equation modeling is adequate. Although two informants were used, many of the associations are potentially subject to common method bias. Harman's single-factor test was conducted using a CFA with all items loading on a single factor (Podsakoff et al., 2003). This model had an extremely poor fit ($\chi^2[252] = 1575.32$; CFI = .38; RMSEA = .171; SRMR = .135), which suggests that common method bias was not a threat to the validity of the results.

Results

Main effects

Hypotheses were tested using structural equation modeling with STATA 13. The basic model excluding interaction terms but including control variables had an acceptable fit ($\chi^2[269] = 465.32$; CFI = .91; RMSEA = .064; SRMR = .065). The results of the hypothesis tests are depicted in figure 2.

Insert Figure 2 about here

Decision-making quality was positively and significantly related to agility (.41, $p < .01$), supporting hypothesis 1. Hypothesis 2 suggested that decision-making quality was positively affected by strategic clarity. The results support this hypothesis by showing a significant path coefficient (.15, $p < .05$). The effect of process formality, however, was much stronger (.46, $p < .01$), which is in line with hypothesis 3. Controlling intensity also had a positive and significant effect on decision-making quality (.27, $p < .01$), supporting hypothesis 4. An innovation-friendly climate (.16, $p < .05$) and an open risk climate was instrumental to better decision-making quality (.19, $p < .05$), supporting hypotheses 5 and 6. A model with direct paths from all independent variables to agility was also tested. Since all paths were nonsignificant, they were eliminated to make the model more parsimonious. This finding also supports the main premise of the model, namely, that decision-making quality acts as the central mediating factor.

Moderating effects

To test the proposed moderation effects with turbulence, a separate model using latent interactions was estimated (Marsh, Wen and Hau, 2004; Marsh et al., 2007). The indicators of both interacting constructs were mean-centered and moderation indicators for each model were

created by multiplying matched pairs of indicators from each construct (Marsh et al., 2004). This new interaction construct was added to the main effects of the independent and moderator constructs. In contrast to moderated hierarchical regression analysis, this procedure allows to test interactions and simultaneously account for measurement error, which should lead to better results.

The direct effect of turbulence on decision-making quality was included—but not significant in every interaction model. Regarding strategic clarity, the interaction effect was in the predicted positive direction, but not strong enough to reach the required significance level ($.10, p > .05$). Strategic clarity therefore is not more important for better decision-making processes in more turbulent environments. The positive effect of process formality on decision-making quality decreased with increasing environmental turbulence ($-.13, p < .05$), which supports hypothesis 7b. The interaction between turbulence and controlling intensity was significantly positive ($.14, p < .05$), as predicted by hypothesis 7c. Thus, intensive portfolio control is more strongly connected to better decision-making quality in more turbulent environments than in less turbulent environments. In line with hypothesis 7d, an innovation climate was more strongly connected to decision-making quality under conditions of high turbulence ($.14, p < .05$). Contrary to hypothesis 7e, there was no significant interaction regarding risk climate ($.04, p > .05$). Thus, apparently, an open risk climate is important for decision-making quality independent of turbulence.

Discussion

This study aimed to elucidate how firms' IPM can increase decision-making quality and become more responsive to external changes. Decision-making quality and ultimately agility are suggested to be mainly affected by coordinating and motivating components of IPM that increase

strategic and operational transparency as well as provide motivation for employees to voice opportunities or threats.

The empirical analysis confirms that decision-making quality fully mediates the influence of the five organizational antecedents on agility. Process formality has the strongest influence on decision-making quality, followed by controlling intensity. Strategic clarity and the two organizational climate variables possess a smaller influence. The identified moderation effects qualify this picture, because with increasing environmental turbulence the influence of process formality decreases, whereas the influence of controlling intensity and innovation climate increases. But the central tendency remains that the two organizational components promoting operational clarity (process formality and controlling intensity) explain most of the variance. Thus, coping with salient resource allocation and prioritization problems appears to be the major challenge in innovation portfolio decision-making. However, more distal consequences of the decisions also matter, because strategic clarity, innovation climate, and risk climate explain additional variance in decision-making quality. Decision-makers with a high decision quality also lay stress on implementing strategic goals, pursuing upcoming opportunities for additional innovative ideas, and avoiding risks. The study also finds that decision-makers, who demonstrate a higher decision-making quality, adapt their innovation portfolios more quickly to changing situations. Making better founded decisions does not imply that decision-makers need more time to make their decisions, because they have developed better coordination systems which make them more agile and they also appear to foster innovation and risk climates that motivate people to deliver more and higher quality information.

Some hypotheses could not be supported and deserve further discussion. The non-significant moderation effect of strategic clarity can be explained by the fact that we explicitly asked for the clarity of *long-term* goals and competitive strategy, and they are less strongly influenced by

short-term turbulences. Another explanation might be that increasing turbulence may erode the validity of the strategic premises and that the strategy may favor existing customers and technologies, which become irrelevant after turbulent events (Christensen and Bower, 1996).

Furthermore, environmental turbulence increases the importance of a climate for innovation for decision-making quality but not the importance of an open risk climate. An explanation might be that new opportunities *and* threats both stimulate the search for innovative solutions and the willingness to use them—and that both types of environmental changes lead to more innovative adaptations, when they meet an organizational culture that fosters innovations. An open risk culture will only get activated if additional *threats* are discovered—and even in this case, it is possible that the portfolio remains unchanged—it may be sufficient to secure claims and exert them.

Implications for research

The current study contributes to our understanding of IPM and IPM decision-making in several ways. First, most studies analyze the impact of IPM management variables in combination with internal and external factors on IPM success or business success (de Brentani et al., 2010; Killen et al., 2008; Teller and Kock, 2013; Teller et al., 2012; Voss and Kock, 2013). Comparatively few quantitative studies investigate the influence of managerial decision-making behavior on IPM success or business success (noteworthy exceptions are Jonas et al., 2013; Kester et al., 2014; McNally et al., 2013; Unger et al., 2012). However, these studies have not yet developed an understanding of organizational antecedents of decision-making quality and agility. The central concern of this study was therefore to understand how organizational components of an IPM system—that can be influenced by management—increase decision-making quality and eventually agility. To the best of our knowledge, this is the first large-scale empirical study on antecedents to agility in IPM. This study therefore complements prior research on the

performance consequences of agility in IPM (Kester et al., 2014) in that it sheds light on the organizational features of IPM that enable better agility.

Second, the study follows the call of Martinsuo (2013) and extends prior research on the role of IPM in turbulent environments. Previous research explicitly considered IPM to be a dynamic capability (Florichel and Ibanescu, 2008; Petit, 2012) in that it reorchestrates organizational resources and enables firms to respond to environmental changes (Teece, 2007). However, only few studies have actually investigated how far environmental dynamics affect IPM processes. The qualitative case study of Petit (2012) highlights the importance of coping with turbulence in IPM and Florichel and Ibanescu (2008) show that firms adopt different IPM practices under higher turbulence. However, no previous study investigated, which IPM practices are more beneficial under high turbulence. The present study is the first to analyze which organizational antecedents become more or less important for IPM decision-making quality with increasing environmental turbulence. In particular, controlling intensity and a climate for innovation become more relevant for effective decision making when turbulence is high. This result quantitatively confirms the qualitative findings of Petit (2012). On the other hand, the positive effects of process formality decrease with rising turbulence. This result complements the findings of Sethi and Iqbal (2008), who found that project inflexibility through overly rigid rules enables learning failure in stage-gate systems. The opposing interaction effects of formalization and controlling intensity lead us to the conclusion that under high turbulence managers should not over-specify processes, but enable more frequent controlling cycles, which provide more current information and a more solid foundation for required changes.

The findings can also be interpreted through a dynamic capability lens. Teece (2007) differentiates between sensing, seizing, and transforming capabilities that are needed to orchestrate and re-configure existing resources, in order to gain competitive advantages. This

study's model can be interpreted through this lens in that "*seizing*" represents the IPM decisions. In order to make good and timely decisions, decision-makers need to apply IPM practices to *sense* potential opportunities, and create action plans (i.e. projects) to pursue them. The decision-makers need good information about opportunities and risks of these projects. A delivery of such information is supported by the five organizational IPM components. They reinforce the sensing function of an organization, which includes a systematic information processing. The *transformation* function comprises the implementation of the projects and the usage of their results. Thus, our model provides quantitative evidence on the nature of IPM as a dynamic capability that complements prior qualitative research in this area (Petit, 2012).

Managerial implications

The findings of this study enable portfolio managers to improve portfolio decision making and the overall agility of their firm by not only implementing formal and regular portfolio processes but also fostering an open risk climate in which project managers escalate problems sooner and an innovation climate in which employees can voice new ideas. In turbulent environments, formal portfolio processes become less important, and fostering an innovation climate becomes more important. However, continuous monitoring of the innovation portfolio also increases in importance for effective decision making under turbulent conditions. A conflict might arise when increasing portfolio controlling intensity while simultaneously fostering a climate of risk awareness and acceptance as well as a climate that encourages innovative efforts. These factors might be conflicting, and they would then have to be balanced carefully. However, previous research on ideation has shown that formal control and an encouraging climate are not necessarily at odds with each other and can even behave complementarily (Kock et al., 2015).

Avenues for future research

As in every empirical study, some limitations must be taken into account when interpreting the results. First, a cross-sectional research design was used, which does not allow us to observe the actual changes within the portfolios over time. Portfolio dynamics should therefore ideally be investigated in a longitudinal study over several years. This poses a serious practical challenge, and such an investigation might not be feasible with such a large sample of firms. However, in-depth qualitative case studies of several portfolios with differing degrees of environmental turbulence might further reveal how firms and their decision makers adapt their portfolio in response to environmental changes.

Second, this study concentrated on the characteristics of the decision-making process but not on the decision content. As conceptualized here, decision-making quality does not include an assessment of whether the decisions were actually correct. Future research could analyze specific decisions to investigate how they came to pass and their impact.

Third, this study investigated only linear and direct effects of antecedents to decision-making quality. It might be for example that coordinating and motivating components of the IPM system are conflicting or complementary. Interactions were analyzed in exploratory analyses with no significant effects. Nevertheless, investigating possible interactions of the observed antecedents could be another fruitful avenue for further research.

Finally, the empirical analysis concentrated on organizational components of IPM that increase strategic and operational transparency for better decision-making quality. Other important factors that could not be accounted for in this study might exist. For example, the findings of McNally et al. (2013) suggest that aspects of managers' disposition such as their leadership style, need for cognition or risk perceptions, affect their decision making. Future research could incorporate decision makers' personalities or decision-making styles and

investigate how these factors affect portfolio decision making in firms through field studies. Any such study, however, should consider that IPM decision making is collective, since portfolio decisions are rarely made by a single person. Previous experimental studies on IPM decision making could not consider this important characteristic (Behrens and Ernst, 2014; Behrens et al., 2014). It might be interesting to investigate the interactions of the stakeholders involved in the negotiation and enforcement of IPM decisions, or the consequences of centralized versus participative decision-making processes. Additionally, previous qualitative research suggests that IPM decisions are often the result of nonrational behavior (Christiansen and Varnes, 2008; Gutiérrez and Magnusson, 2014; Kester et al., 2011; Mosavi, 2014). Future research could address this issue in quantitative studies and examine, for example, under what circumstances intuitive approaches might be more favorable for effective decision making.

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Figures and Tables

Figure 1. Conceptual Framework

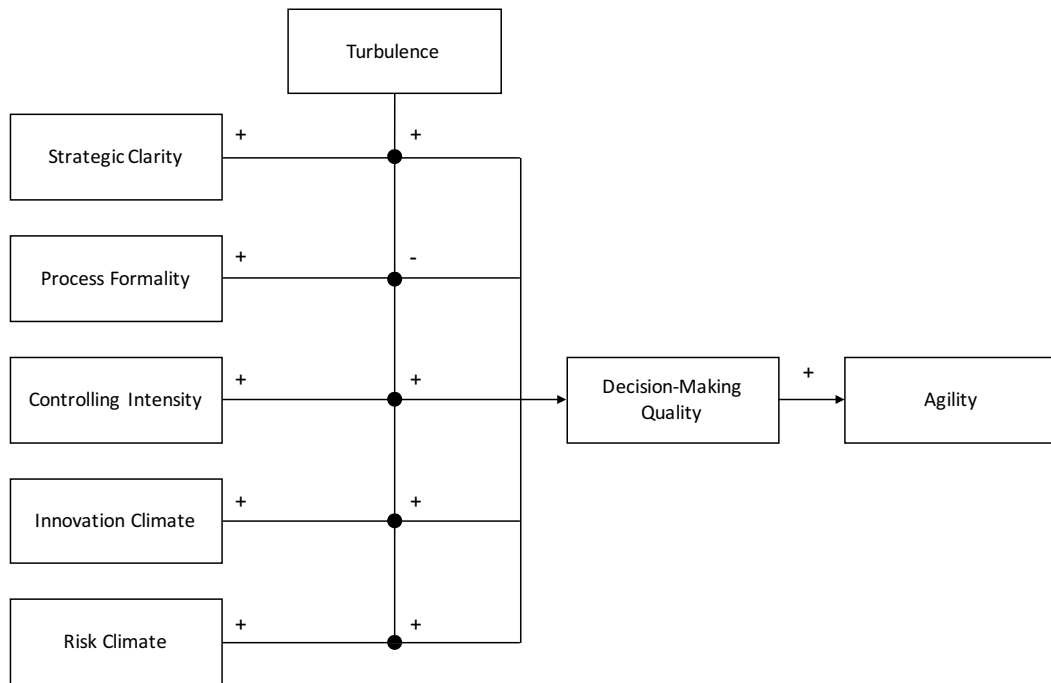
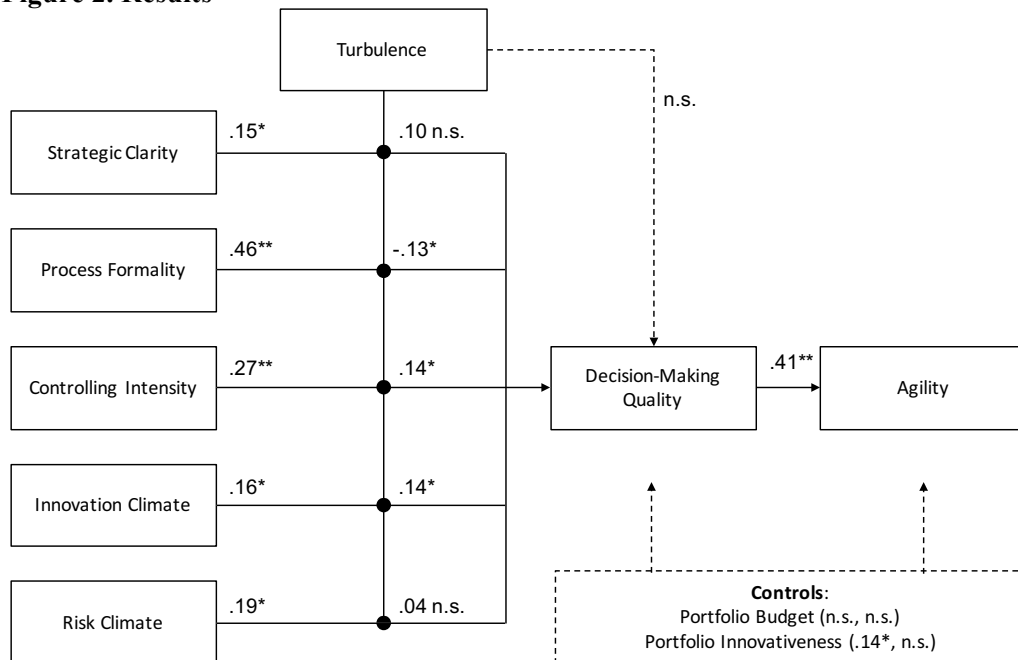


Figure 2. Results



$\chi^2(269)=465.32$; RMSEA=.064; SRMR=.065; CFI=.91; $n=179$; * $p<.05$; ** $p<.01$. Moderation effects were calculated in separate models.

Table 1. Sample characteristics

Industry		Revenue	
Automotive	26%	<100 million €	15%
Electronics/IT	18%	100-500 million €	27%
Finance	16%	501-2,000 million €	20%
Construction and utility	11%	>2,000 million €	38%
Health care	8%		
Logistics	7%		
Pharmaceuticals/chemicals	5%		
Others	9%		
Employees		Portfolio budget	
<500	32%	<10 million €	25%
500-2,000	29%	10-30 million €	29%
>2,000	39%	30-100 million €	22%
		<100 million €	24%

Table 2. Correlations and descriptive statistics

Variables	M	SD	α	CR	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Agility	4.43	1.15	.84	.82	(.73)								
(2) Decision-making quality	4.35	1.03	.81	.82	.33	(.71)							
(3) Strategic clarity	5.42	1.31	.87	.87	.13	.36	(.83)						
(4) Process formality	4.80	1.74	.89	.90	.22	.46	.13	(.87)					
(5) Controlling intensity	3.90	1.37	.79	.79	.18	.45	.30	.46	(.75)				
(6) Innovation climate	4.47	1.08	.72	.74	.22	.34	.36	.19	.24	(.72)			
(7) Risk climate	3.98	1.35	.87	.87	.17	.35	.31	.12	.19	.38	(.84)		
(8) Turbulence	4.02	1.08	.85	.86	.31	.06	.00	.04	-.05	.14	.09	(.71)	
(9) Portfolio budget	3.42	1.63	-	-	-.08	.04	.04	.14	.18	.01	.06	.07	-
(10) Portfolio innovativeness	.19	.16	-	-	.05	.09	.05	-.05	.01	-.04	-.15	.02	-.16

n=179; M = mean, SD = standard deviation, α = Cronbach's alpha, CR = composite reliability. All correlations larger than .15 are significant ($p < .05$). Diagonal elements in parentheses are the square root of average variance extracted for constructs measured with multiple items.

APPENDIX – MEASURES

Construct	Items	λ
Agility $\alpha = .84$ CR = .82 AVE = .53	1. We quickly adapt our portfolio to changed customer needs and competitive conditions	.76
	2. We quickly adapt our portfolio to changed resource situations	.59
	3. We quickly adapt our portfolio to new technologies	.73
	4. We quickly adapt our portfolio to changed strategic goals	.81
Decision-Making Quality $\alpha = .81$ CR = .82 AVE = .51	1. Portfolio decisions are usually transparent and comprehensible	.74
	2. Portfolio decisions are rigorously enforced	.76
	3. Once made, portfolio decisions are consistent and only rarely change	.68
	4. Unnecessary projects are identified early enough	.67
	5. Unnecessary projects are rigorously terminated	.71
Strategic Clarity $\alpha = .87$ CR = .87 AVE = .69	1. We have a written mission, long-term goals and strategies for implementation	.80
	2. Goals and strategies are communicated in our company	.90
	3. Our long-term competitive strategy is clear and understandable	.79
Process Formality $\alpha = .89$ CR = .90 AVE = .76	1. Essential project decisions are made within clearly defined portfolio meetings	.74
	2. Our project portfolio management process is divided in clearly defined phases	.94
	3. Our process for project portfolio management is clearly specified	.91
Controlling Intensity $\alpha = .79$ CR = .79 AVE = .56	1. We frequently examine our portfolio objectives (e.g., strategic alignment, net return, risk)	.62
	2. Within portfolio controlling, we analytically examine plan/actual performance deviations	.80
	3. Within portfolio controlling, we systematically analyze all single projects	.82
Innovation Climate $\alpha = .72$ CR = .74 AVE = .52	To foster the capabilities of our employees to generate project ideas...	.38
	1. ... we allow them to conduct their own innovation projects besides their main job tasks	.86
	2. ... we give them sufficient responsibility, resources, and freedom to work independently	.81
	3. Employees who contribute their own ideas receive constructive feedback, regardless of whether the idea in question is pursued or not	.81
Risk Climate $\alpha = .87$ CR = .87 AVE = .71	1. The individual risk managers communicate risks openly and honestly	.82
	2. The individual risk managers feel responsible for the risks and the associated measures for their resolution	.96
	3. Employees at all levels regard risk management as a part of their everyday business activities	.71
Turbulence $\alpha = .85$ CR = .86 AVE = .50	1. The technology in our industry is changing rapidly	.86
	2. A large number of new product ideas have been made possible through technological breakthroughs in our industry	.90
	3. Technological changes provide big opportunities in our industry	.71
	4. In our industry, it is difficult to predict how customers' needs and requirements will evolve	.55
	5. In our kind of business, customers' product preferences change quite a bit over time	.59
	6. In our industry, it is difficult to forecast competitive actions	.58
Portfolio Innovativeness	What is the percentage of projects in your portfolio with which you enter uncharted territory?	
Portfolio Budget	What is the annual budget of the portfolio in million Euros?	

α = Cronbach's alpha, CR = composite reliability, AVE = Average Variance Extracted