Agile projects in nonagile portfolios: how project portfolio contingencies constrain agile projects' teamwork quality

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Abstract

Agile practices present one approach for firms to adapt to an increasingly dynamic and competitive environment. Although prior studies have investigated performance outcomes of agile projects, agile practices' consequences on a project team's collaborative processes have not yet been thoroughly analyzed. It also remains unclear whether practices on a higher organizational level, such as project portfolio management, support or constrain agile practices' benefits, especially if a firm simultaneously conducts traditionally managed and agile projects. Therefore, this study investigates the role of agile practices for a project's teamwork quality (TWQ) and project success and examines the influence of organizational contingencies. Specifically, we conceptually and empirically analyze the moderating impact of project portfolio management (PPM) practices on the relationship between agile practices, teamwork quality, and project success. A multi-informant analysis of 378 projects nested in 100 portfolios shows that agile practices positively relate to project success through TWQ. We find that traditional PPM practices such as business case existence, strategic clarity, and operational control constrain this relationship. Our study contributes to the literature on project teams and portfolio management by providing empirical insights on the interaction between project and portfolio management practices.

Managerial relevance statement:

The study demonstrates the relevance and the beneficial influence of agile practices for team-internal collaboration and eventually project success. We find that agile practices are connected to a higher teamwork quality and higher success. Thus, we recommend project managers consider agile practices in terms of iterative planning and execution cycles, continuous customer feedback, and minimum viable products when selecting a project management approach for a project. Additionally, even if project managers choose not to use a

specific agile approach, they can learn from agile principles and implement parts of them in traditionally managed projects. However, decision makers should be cautious when introducing agile practices to an otherwise traditionally managed project portfolio. Agile practices differ highly from traditional project management practices and, therefore, interact differently with established portfolio approaches. Our results show that established portfolio management approaches constrain the benefits of agile practices for teamwork quality and success. Thus, portfolio managers need to be aware of the differences between agile and traditional project management approaches. They should carefully consider adopting well-established portfolio management routines (e.g., business case control) to agile projects' requirements.

Keywords: Agile Project Management, Teamwork Quality, Project Portfolio Management, Project Success, Project Portfolio Process

I. INTRODUCTION

Agile practices recently received significant attention in the literature on project management [1], [2], [3], especially because they allow firms to flexibly react to environmental changes and reduce overall time-to-market [4], [5]. Agile practices are usually conducted by small, autonomous project teams [6] that work in iterative planning and execution cycles and regularly present minimum viable products [2]. In general, agile practices stand out due to their strong focus on customer value. Agile teams intensively communicate not only within their team but especially with external stakeholders to identify customer needs and obtain regular feedback on prototypes [7].

Previous studies suggest that agile practices positively relate to performance outcomes [8], [9], [10]. Compared to traditional project management practices, agile practices (e.g., Scrum) count on a team's internal collaboration rather than the plan-driven execution of tasks given by the project manager [6], [11]. In particular, agile practices promote teams' internal collaboration processes, which could be a decisive driver of agile projects' success [12]. Yet,

empirical evidence on agile practices' consequences for a project team's collaboration processes is still limited [2], [13]. Previous research used qualitative approaches (e.g., case studies or grounded theory methodology) and considered only one or a few agile software teams [6], [14], [15]. One exception is Lindsjørn et al. [16], who investigated teamwork quality (TWQ) in agile software teams and showed that TWQ positively relates to team performance, confirming findings in other teamwork studies [17], [18], [19]. However, their sample did not allow them to compare agile and non-agile teams. Therefore, it remains unclear whether, first, agile practices increase project performance through elevated TWQ and, second, if agile practices are also beneficial for other project types besides software development. Thus, we formulate our first research question: *What is the relevance of agile practices for teamwork quality and, eventually, project success?*

A neglected perspective is that agile projects are not per se successful [9]. As projects can be seen as temporary organizations, they depend on their external context [1], [3], [20]. Besides external contingency factors like uncertainty or the dynamic environment, also organizational factors can influence the performance of a project [21]. Therefore, the interplay between agile projects and project portfolio management (PPM), as the context in which a project operates, is recently discussed by research, which confirms that implementing agile practices poses new challenges to PPM [1], [3], [20]. Prior empirical literature, which refers to portfolios consisting of traditionally managed projects, agrees on PPM success factors, for example, monitoring activities [22], [23] [24]. When organizations introduce agile projects, project portfolios typically still contain traditionally managed projects. However, agile projects strongly differ from traditionally managed projects in terms of planning, goal-setting, execution, and collaboration. It remains unclear how established portfolio-level factors influence individual agile projects and their activities. To the best of our knowledge, no study analyzed PPM practices' influence on agile projects' processes or success. This is a highly relevant gap in the literature because agile projects' popularity is strongly growing. Established

PPM success factors could potentially support agile project teams as those factors give agile teams orientation and help them to state their added value to the project portfolio [24], [25], [26], [27]. We follow contingency theory to better understand how portfolio factors affect projects. This is highly suitable since we investigate organizational practices that might not be optimal for every context. We choose established success factors along the PPM process to determine the projects' organizational context. For the portfolio structuring phase, in which decision makers prioritize and select projects, we focus on business case existence and strategic clarity [28]. We focus on operational and strategic control for the portfolio steering phase, in which projects are monitored [20], [29]. Therefore, our second research question is: *How do PPM contingencies of the portfolio structuring (business case existence, strategic clarity) and steering phase (operational and strategic control) interact with agile practices to predict teamwork quality?*

We test our hypotheses using a cross-industry, multi-informant, multi-level survey sample of 378 project teams nested in 100 project portfolios of medium- to large-sized firms. This study adds new insights to agile project management literature by providing quantitative empirical findings on how agile practices increase teamwork quality and thereby contribute to project performance [8], [14], [16]. Previous research investigated team processes only qualitatively [15] or did not consider the impact of agile practices on TWQ [16]. This study's results suggest that the relationship between agile practices and the economic performance of a project is mediated through teamwork quality and that this finding applies to not only software but all project types. Second, we contribute to PPM literature by expanding contingency theory [26] and answering the call for research on agile practices' interplay with their organizational context, namely the project portfolio [1], [15]. We find a negative moderating influence of business case existence, operational control, and strategic clarity on the relationship between agile practices and teamwork. When introducing agile projects into conventional project portfolios, portfolio managers must be aware that factors relevant for portfolio success in

traditional portfolios might lead to conflicts in agile project teams since they restrict their required flexibility. For practitioners, the study encourages the use of agile practices; however, the results simultaneously highlight the constraining influence of established organizational characteristics and the need to adapt portfolio processes when introducing agile projects [1], [3].

II. CONCEPTUAL BACKGROUND

A. Teamwork in projects

"A team is a collection of individuals who are interdependent in their tasks, who share responsibility for outcomes, who see themselves and who are seen by others as an intact social entity embedded in one or more larger social systems (for example, business unit or the corporation), and who manage their relationships across organizational boundaries" [30, p. 241]. Project teams are temporary entities embedded in project portfolios, which only remain together until they fulfilled their purpose [19]. They operate beyond a department's routine work and tackle new tasks contributing to an organization's strategy [31].

Achieving project success requires members of a project team to get along with each other well. To define a common understanding of good team collaboration, Hoegl and Gemuenden [17] conceptualize teamwork quality (TWQ) along six dimensions: communication, coordination, balance of member contributions, mutual support, effort, and cohesion. Overall, the TWQ construct is an established predictor of team performance [18], [32], [33]. Communication describes the exchange of information among team members and is characterized by openness and frequency. It is one of the most important factors for team and project performance [34]. Coordination means that team members agree on individuals' work packages and subtasks and delegate them accordingly. Coordination routines include, for example, plans or simply scheduled meetings. Balance of member contributions refers to the respectful treatment of team members' knowledge. If team members can present their full

potential to the team, contributions are balanced, considering team members' strengths and weaknesses. Hoegl and Gemuenden [17] define mutual support as another important aspect of TWQ in interdependent tasks. Effort is the intensity or persistence individuals are willing to put into their tasks or activities. When their effort is high, team members are committed and have agreed to put their best into the common tasks. Last, team cohesion is a prerequisite for good TWQ [35]. Team members with strong cohesion are proud to be part of the team. Thus, a team spirit might arise, leading to a stronger bond and greater productivity [35].

Prior research demonstrates that collaboration or dimensions of teamwork quality mediate several antecedents of project performance. Many antecedents of TWQ are behavioral and include, for example, a team's prosocial behavior [36], motivational attitude towards the team [37], trust [38], or different leadership styles [39]. For processual antecedents, Chen [40] demonstrated that a working IT infrastructure and a decentralized organization structure lead to a higher interaction among team members and, lastly, to better NPD performance. Another study by Pinto et al. [19] identified several factors that positively relate to team cooperation, the strongest being shared superordinate goals, team members' colocation, and common agreement on project team rules and procedures.

B. Agile Project Management and Agile Project Teams

Turbulent environments and competitive pressure require fast innovation processes for new products and services and the ability to adapt more quickly to new challenges. Nagel et al. [41] describe agility as a firm's ability to recognize opportunities for competitive action and mobilize the necessary resources to take advantage of them. Agile project management methods were established to achieve this [8], [42]. Whereas traditional project management strives to follow an initial plan and meet time, budget, and quality goals [43], agile methods—which originally evolved from software development—do not predefine a final outcome and time. Instead, one main characteristic of agile project management methods is "the ability to adapt to

changes and divide the work into distinct iterations throughout the project" [44, p. 2]. A recent study by Bianchi et al. [9] defined agile methods as the combination of the elements feedback, sprints, and specifications. We follow their definition; however, since they focused solely on software development projects and investigated agile projects in general, we define three universal underlying components of agile practices [44]. First, agile methods are characterized by *iterative planning and execution cycles*. Second, the iterations lead to a *regular presentation of interim results* of the projects (e.g., in the form of prototypes or minimum viable products). And third, agile methods *continuously gather customer or user feedback* to improve their product within the next planning cycle [2], [9].

Agile project management has two main advantages over traditional project management. First, product development is accelerated with the help of an iterative method characterized by iterative planning cycles [45]. Second, after each cycle, the team creates a usable product and obtains direct feedback from the customer, which increases alignment with the customer and ensures higher chances of project success. Agile teams are often seen as collaborative working groups by nature [46]. The iterative working cycles force people to work closely together. What is more, the team is encouraged to self-organize and work autonomously [9]. Team members collectively decide which tasks to work on in the next iterative cycle and what steps are necessary to present the next interim result [11].

In general, project teams that collaborate well also perform well and contribute to a project's internal and external success and, consequently, to the organization [47]. A project's success can be determined in several ways, which also depend on the perspective of the different stakeholders [1], [48]. For example, success can be measured from a project manager's perspective or the perspective of the owner or investor [49]. The former is often labelled project management success and concerns time, budget, and quality adherence (i.e., achieving the project plan) [48]. From an investor's perspective, project success concerns the business success that can be measured by monetary indicators like market goals, profitability, and

payback period [48], [49]. As mentioned above, agile projects do not follow an initial plan but rather iteratively evaluate the specifications of the project outcome. Although project managers can eventually review an agile project's time and budget dimension [9], it can be problematic to compare traditional and agile projects according to plan adherence. Agile projects are also often customer and not organization oriented [1]. As the present study wants to compare agile and traditionally managed projects and adopt an overarching management perspective, an investor's perspective to project success is more appropriate. Therefore, in the following, we refer to the business success when using the term project success.

C. Project Portfolio Management as Organizational Context for Projects

Contingency theory states that relationships between an organization's characteristics and its performance depend on the environment in which the organization operates [50]. Accordingly, no single form of organizing can be ideal for every environmental setting; we require a fit between environment and organization [51]. This underlying argument also applies to projects because a project is a temporary organization usually embedded in a larger organization, for example, the project portfolio of a company [52], [53]. The project portfolio (the collection of a company's projects) is governed by project portfolio management and thus constitutes the projects' context and environment. PPM overarchingly coordinates these projects and is a dynamic decision-making process supporting companies to identify, select, and execute the right projects in line with their strategy [54], [26]. A project portfolio is effective if it reflects the firm's strategy, its projects are well balanced, and its overall value is maximized [54], [55]. Multiple stakeholders need to jointly execute the PPM process well to achieve those goals [31]. This process' characteristics essentially constitute the organizational environment for the projects. A project's organizational form, for example, shaped by agile practices, should fit this environment. In the following, we identify factors that characterize the portfolio management process and thus constitute suitable contingency factors for the team

processes and performance of projects operating in the portfolio. Prior literature considers two main phases of PPM [24]: *portfolio structuring* and *portfolio steering* [56], [57].

In *portfolio structuring*, portfolio management aims at a portfolio composition that maximizes the organization's value. In practice, portfolio structuring usually follows a heuristic process relying on estimations (e.g., based on the project's net present value) that are sometimes contradicting and challenging to prioritize [58]. In this phase, stakeholders bring their views into the selection process, elevating the need for PPM to be transparent [57]. *Business case existence* and *strategic clarity* are two fundamental and highly established practices of portfolio structuring that both support transparency [22], [28], [59]. The *existence of business cases* refers to the systematic use and evaluation of business cases in project selection and the obligation for projects to argue their business case even if the project is considered mandatory [22]. *Strategic clarity* means that the strategy is communicated and understood within the organization [28], [60], which is necessary to achieve a balanced and strategy-oriented portfolio. For example, a transparent strategy can support important portfolio decisions, which projects to select or terminate [60], [61].

As part of *portfolio steering*, portfolio managers continuously monitor and coordinate ongoing projects throughout their life cycle [56], [62], [63]. Managers need to monitor individual projects and the accumulated portfolio status in terms of strategic alignment [29] or cross-project risks [23]. To achieve sufficient information quality across the portfolio, project managers need to regularly deliver reliable project information [55], [62]. At periodic meetings, project managers present the current project status and can request decision approval for the portfolio steering committee's other planned actions. In this regard, *operational control* describes portfolio managers' frequent examination of single projects' targets to check for changes and possible adjustments within the portfolio. Projects' strategic alignment is monitored before their start and during their execution [64], [65]. Operational control is important since firms otherwise often discover difficulties or delays too late due to changing

conditions and cannot take emendatory actions [66]. This becomes more important in turbulent environments, where more frequent portfolio control is necessary [60]. Apart from monitoring projects, managers also need to regularly review if the strategy is still valid or if changed premises demand a reconsideration. *Strategic control* challenges the implemented strategy based on the gained information from projects. Early research called for continuous strategic control, meaning that the strategy is critically scrutinized at the strategy formulation and after the strategy implementation, instead of just controlling for potential deviations from the planned strategy [67].

Only a few studies empirically considered the interaction of project and portfolio levels, and they mainly concentrated on how project-level actions affect portfolio-level decisions and outcomes. Martinsuo and Lehtonen [55] demonstrated that an effective PPM also requires highly effective project management. Teller et al. [68] showed that standardized management routines and processes on the project level and formalization of PPM have complementary effects on PPM quality, meaning one is ineffective without the other [68]. Nguyen et al. [29], vice versa, show that certain portfolio-level mechanisms influence decision-making processes on the project level. They revealed that operational control and the application of business cases are negatively connected with effectuation on the project level. These studies show the deep connection between projects and PPM, in that project teams are not only agents of the project portfolio but make decisive contributions to the portfolio management process. This stresses the relevance of an investigation of single agile project management processes in the context of higher-level PPM contingency factors.

III. HYPOTHESES

A. Agile Practices and Teamwork Quality

We argue that the underlying values and routines of agile practices positively affect teamwork quality through three mechanisms. First, routines of agile practices lead to higher

intrateam communication. In common agile practices, team members attend regular meetings. For example, Scrum's daily stand-up meetings, retrospectives, and backlog meetings enable fast and iterative planning, leading to frequent information exchange between team members [13], [15]. These routines force team members to work together intensively [4], [5], [69].

Second, agile practices improve team coordination, a central dimension of TWQ. They follow structured processes that encourage presenting intermediate results (i.e., minimum viable products) and thus facilitate effective task coordination [3]. Additionally, roles in agile project management are clearly defined. The team moderator, for example, is in charge of the team members' external problems and of maintaining an effective working climate [2]. In traditionally managed teams, roles with responsibility focus more on delegating tasks, whereas comparative roles in agile project teams follow a more help-oriented approach [14].

Third, members' effort most likely will grow in teams using agile practices. De Jong and Elfring [38] explored a strong relationship between trust and team effort, arguing that "trust promotes effort because it affects a combination of the rational, normative, and affective considerations that codetermine team members' motivation to work hard on team tasks" [38, p. 539]. Trust between team members is often found in agile project teams due to the underlying values of agile practices and especially the frequent team meetings [2], [14], [15]. Thus, we conclude that agile project teams also put a high effort into their work.

Conclusively, the intensity of agile practices should be beneficial for the quality of teamwork since their underlying values and routines presents a suitable environment for collaborating teams. We formulate our hypothesis as follows:

H1: Agile practice intensity is positively related to TWQ.

B. TWQ as a mediator of agile practices on project success

Prior research consistently shows that TWQ positively relates to performance outcomes [16], [17], [18], [19], [70]. As teamwork describes the interaction among team members, a

highly collaborative team works effectively and is well coordinated [37]. Consequently, it is more likely that the project accomplishes its objectives and is successful. However, agile project management changed the projects' requirements so that measuring project success with conventional indicators (e.g., time, budget, quality) does not adequately consider the benefits of agile practices [46]. Therefore, we define a project as economically successful if its product meets its market and profitability goals (market share, ROI, payback period).

Adding to the hypothesis above of agile practices' positive effect on TWQ and the already proven benefits of TWQ for project success, we hypothesize that TWQ mediates the positive effect of agile practices to project success. Agile project management is important for projects because it strengthens teamwork through its practices and consequently enhances project success. This mediating role is important for two reasons. First, by iteratively acquiring the product through agile practices, the project team remains flexible. Hence, coordination among tasks and team members becomes easier as the planning horizon can be divided into short incremental cycles, and a change in the project scope does not automatically lead to more coordination effort. The flexibility can then indirectly affect a project outcome through better team coordination. Second, presenting minimum viable products leads to more satisfied customers and team members, who will then put more effort into their work and behave more cohesively [2]. Early validation of the team's work by users and decision-makers, combined with the intensive feedback culture, leaves team members little room for doubt. This ultimately produces better products as fewer mistakes are made. So, user focus and the presentation of interim results likely lead to higher TWQ and, eventually, better project outcomes. Thus:

H2: Teamwork Quality mediates the relationship between agile practices and project success.

C. The Moderating Effects of Portfolio Management

Following organizational contingency theory, the effectiveness of organizational practices, such as agile practices, depends on the context. Since portfolio management practices determine the context in which projects operate, the portfolio processes' characteristics constitute contingency factors for single projects. A "contingency is any variable that moderates the effect of an organizational characteristic on organizational performance" [50, p. 7]. Therefore, we investigate the moderating effect of established practices in a portfolio's structuring phase—specifically, business case existence and strategic clarity—and steering phase—specifically, operational control and strategic control.

1) Business Case Existence

The business case is an established instrument for project prioritization and funding in the portfolio structuring phase [71]. It is a document containing information about "estimates of the benefits, timescales, resource requirements (including costs), and risks of a project" [22, p. 530]. Kopmann et al. [22] empirically show that business case control is an essential portfolio management control mechanism that positively relates to project portfolio success. Effective business case control consists of three dimensions. First, *business case existence* describes the use and intensive analysis of project proposals' business cases in the portfolio structuring phase. Second, *business case monitoring* in the portfolio steering phase means continuously monitoring projects' business cases for changes in the project due to, for example, environmental dynamics to respond to them in a timely manner. Third, *business case tracking* determines the added value of the project for the company. Business case control is especially useful to track a project's realized outcome and customer value instead of only reviewing operational goals such as cost, quality, and time.

As the necessary dimension of business case control, we hypothesize that business case existence constitutes a central element for value and benefits realization empowering agile teams to demonstrate agile practices' benefits. A business case fulfills its central purpose in

proving a project's value and recognizing changes early, which is particularly helpful for agile projects. A business case orientation in portfolios should leverage TWQ in agile teams for two reasons.

First, a business case increases the overall transparency in project portfolios: business cases create transparency in resource allocation because each project must justify its resource needs before initiation. Transparent resource allocation promotes cooperation on the company level and within the team because team members agree on transparent values [31]. Transparency in teams is an antecedent for team integrity, which ultimately leads to trust among team members [72]. Consequently, if agile practices are positively related to TWQ, the existence of business cases will strengthen this relationship as transparency is a common value in agile teams and positively affects collaboration [3], [14]. If portfolio management did not use business case control at all, it would have trouble validating and tracking the fast changes in agile teams. Hence, it would be harder for project teams to prove their value, and disagreements in the team might occur.

Second, business cases are a widely used instrument in PPM and an integral part of PPM standards [22]. Thus, business cases are often mandatory for projects. Commitments everyone has to make stand for equality in the company. If project managers feel they are equally treated when creating the business case, cooperation quality at the company level is better because the business case forms a basis for discussion. This initial structure should be helpful for agile projects to clarify their value and justify their existence to management and competing projects [1]. Business cases also provide senior management and project portfolio coordinators with a degree of certainty in project selection decisions and can avoid potential conflicts arising in the project's course [29]. Without business cases, project portfolio and senior management might not even know that the project uses agile practices, setting incorrect expectations [1]. When teams feel misunderstood by portfolio management, team members can become insecure and dissatisfied, which mitigates agile practices' advantages for better coordination.

Therefore, we propose that the positive relationship between agile practice intensity and TWQ increases when there the portfolio applies business case control.

H3a: BC existence on portfolio level positively moderates the relationship between agile practice intensity and TWQ.

2) Strategic Clarity

PPM aims to select the right projects that fit the company's strategy [65]. Ultimately, a portfolio's project should reflect the company's strategic goals. Strategic clarity supports this implementation and is therefore essential for project portfolio success [28], [73].

We argue that strategic clarity on the portfolio level further strengthens the relationship between agile practice intensity and TWQ. As an agile project's final outcome is often unclear at the beginning, a clearly communicated corporate strategy provides an orientation to the project teams [1], [10]. The main purpose of project portfolio management is identical for traditional and agile projects: linking projects to strategy and regularly reviewing them [3]. Serrador and Pinto [8] showed evidence that the quality of a company's vision and goals positively moderates the relationship between agile practices and project success. They argued that projects that are more aligned with the company's strategy are supported better through PPM. Employees feeling supported by the organization are further encouraged. In their meta-analysis, Kurtessis et al. [74] demonstrated that organizational support is positively related to trust, commitment, organizational identification, and self-efficacy. Thus, we argue that agile teams working in a company with a clearly formulated and transparent strategy will put more effort into their work and have a higher team cohesion. They are aware of the company's overall strategic path and can derive general expectations for their project team. Therefore, we propose:

H3b: Strategic clarity on the portfolio level positively moderates the influence of agile practice intensity on TWQ.

3) Operational control

Continuous monitoring of the project portfolio means to analytically examine deviations between the planned and actual performance of the projects and the portfolio [29]. With operational control, we refer to the project portfolio monitoring intensity. Kock and Gemünden [60] found that operational control is positively related to decision-making quality in project portfolios, especially for a turbulent firm environment. Therefore, portfolio-level control is helpful to detect mismanagement or risky developments early in projects.

We hypothesize that a project portfolio's operational control positively moderates the relationship between agile practices and TWQ for two reasons. First, Sweetman and Conboy [1, p. 12] point out that "[p]ortfolio managers must find the appropriate balance between control and autonomy in agile projects." They argue that the project team feels safer when they know that not all the responsibility rests on them. With higher operational control, team members should feel less weight on their shoulders, which allows them to better focus on their work and collaborate better. However, this advantage might decrease if the portfolio and its projects gain experience in agile project management, and project members learn how to act autonomously [13].

Second, through operational control, portfolio managers detect risks and interdependencies between projects that might not be visible on the single project level. This can lead to optimized resource allocation and the use of synergies among projects [75] when portfolio managers make project teams aware of synergies and facilitate sharing of experiences to minimize risks. Agile project teams can particularly benefit from this because their environment is more volatile and not predictable. Early warnings of mismanagement from portfolio management enhance collaboration on the team level as team members can concentrate on their work rather than firefighting arising risks. We propose:

H4a: Operational control on the portfolio level positively moderates the relationship between agile practice intensity and TWQ.

4) Strategic Control

Strategic control consists of premise control (i.e., validating strategic assumptions) and implementation control (i.e., scrutinizing the pursued strategy) and focuses on internal and external environmental changes that might affect the strategy [59]. It ensures that the intended strategy is not only implemented properly but also challenged on a regular basis. Strategic control enables managers to recognize emergent strategies in particular from projects due to changed external or internal conditions at the portfolio level. Therefore, a strategic control that takes place regularly not only implements the strategy top-down but is also willing to change the strategy due to new, bottom-up impulses.

We assume that strategic control strengthens the relationship between agile practice intensity and TWQ. Sweetman and Conboy [1, p. 2] recognized that difficulties arise with agile projects if a project portfolio is enacted "in a top-down, centralized, and plan-driven way." They argue that such portfolios lack adaptive behavior and are overwhelmed in dealing with agile projects. This would restrict the advantages of agile practices on TWQ because agile teams are less flexible in their project or product outcome. This problem could be counteracted by strategic control. Kaufmann et al. [20] link emergent strategy recognition with agile capabilities and show that agile capabilities on a portfolio level enhance the recognition of emergent strategy because they enable intensive knowledge exchange and relationship quality among employees. A company with an adaptive strategy enabled through strategic control understands that agile projects do not have a set goal at the beginning. Also, firms with strong strategic control are more aware of emergent strategies and are supportive of agile teams as they know that emergent strategies are also needed for their success. Thus, we argue:

H4b: Strategic control on portfolio level positively moderates the relationship between agile practice intensity and TWQ.

Figure 1 summarizes the conceptual model of the study.

Insert Figure 1 about here

IV. METHOD

A. Sample

The data was collected as part of a large cross-industry study that observed best practices and success factors in project portfolio management. First, we contacted the portfolio coordinators (e.g., portfolio managers, heads of PMO) from medium and large organizations and provided information about the study design, terms, and definitions. These managers were in charge of managing the project portfolio and were typically part of the project management office. Each portfolio coordinator answered a survey with questions relating to their business unit and its project portfolio. They were further instructed to approach a senior manager and three or more project managers in their portfolio to also participate in the study. The senior manager provided information on the portfolio's business environment. The project managers (median of four per portfolio) answered a survey referring to their most recently completed project to reduce a positive selection bias. The three-informant approach enabled us to evaluate both portfolio-level as well as single project constructs. The final sample comprised 378 projects of various types (R&D projects, investment and construction projects, IT and (re-)organization projects) nested in 100 portfolios/firms (on average 3.8 projects per portfolio, median of four). Table 1 provides an overview of the sample characteristics.

Insert Table 1 about here

B. Measurement

This study's variables were measured with multi-item scales derived from previous literature. The informants rated the constructs on seven-point Likert scales ranging from 1 ("strongly disagree") to 7 ("strongly agree"). We validated reflective items using principal components factor analysis (PCFA) followed by confirmatory factor analysis (CFA) [76], [77]. To determine scale reliability, we used Cronbach's Alpha and Composite Reliability following previous recommendations [77]. We assessed discriminant validity using the Fornell-Larcker criterion, which was fulfilled for all constructs. Cut-off criteria were taken from Hu and Bentler [78] to evaluate the structural equation models. Because data were collected on the project and the portfolio level, we conducted two different CFAs. The CFA on the portfolio level ($\chi^2[df = 278] = 448.50$; $RMSEA = 0.068$; $SRMR = 0.070$; $CFI = 0.919$) and the CFA on the project level ($\chi^2[df = 125] = 324.31$; $RMSEA = 0.065$; $SRMR = 0.056$; $CFI = 0.934$) both had a good fit. All item wordings are shown in the Appendix.

Project success ($\alpha = 0.914$) was measured with a three-item scale (planned market and profitability goals, planned payback period) taken from previous literature [48], [79]. Project managers assessed this variable.

Project managers assessed *teamwork quality* ($\alpha = 0.848$) with a six-item construct from Hoegl and Gemuenden [17] using one item per dimension: communication, coordination, balance of member contributions, mutual support, effort, and cohesion.

Agile practice intensity was operationalized with three items that each assess one of the essential practices underlying all agile approaches as described in the literature [9], [12]. The project managers specified how intensively these agile practices were applied: (1) *During our project, we continuously gathered customer/user feedback*; (2) *the project was characterized by iterative planning and execution cycles; (3) we regularly presented interim results of our project (e.g., in the form of prototypes or minimum viable products*) [20]. Although there might be several specific practices and artifacts in different agile methods, we concentrate on the basic

practices that underly all these specific methods to broadly capture agile practice intensity independent of the specific method used. The resulting construct is a composite formative rather than a reflective construct because it fulfills the definitional criteria by Jarvis et al. [80]: A change in one item of agile practices has an influence on the overall construct but does not necessarily indicate a change in the other items (i.e., the items do not necessarily need to correlate). Further, the items can have different antecedents and consequences. And lastly, excluding an item of the construct would change its overall meaning. Since these criteria apply and prior literature also differentiates between these three dimensions [9], [12], we build agile practice intensity as a formative construct.

Moderator Variables. Business Case existence was measured using the three-item scale of Kopmann et al. [22] ($\alpha = 0.858$). The construct verifies if the business case is mandatory for the project portfolio selection process, even for mandatory projects, and if the business case is checked intensively within portfolio structuring. *Strategic clarity* ($\alpha = 0.877$) is the three-item scale from Kock and Gemünden [60], examining whether the strategic goals, the competitive strategy, and the mission are clearly communicated and understood. We used the construct *operational control* from Kock and Gemünden [60], which provides information about controlling mechanisms on the portfolio level ($\alpha = 0.823$). *Strategic control* is a four-item construct ($\alpha = 0.913$) from Kopmann et al. [59]. Portfolio coordinators assessed the portfolio management variables.

Control variables. We controlled for several variables on the project level and the portfolio level that might affect TWQ and project success. We identified two general project control variables (team size and project manager experience) and five project control variables that directly concern agile characteristics (project innovativeness, team diversity, dedication, colocation, and autonomy). As our argumentation is based on agile routines and not on overall agile characteristics of teams, we control for these to isolate the effect of agile practices on TWQ and project success. The project manager was the informant for the project-level

variables. For the general project control variables, *team size* indicates the number of team members (natural logarithm). It could be related to TWQ because collaboration is likely easier in smaller teams [81]. Further, we controlled for the *experience of the project manager* (natural logarithm of years). Less experienced project managers might cause lower TWQ and, as Savelsbergh et al. [82] investigated, lower project success.

Additionally, we added five variables that are connected to agile project management and could present alternative explanations for observed effects. First, we controlled for projects' *technological innovativeness* ($\alpha = 0.869$) from Nguyen et al. [29], as team members in innovative projects might be more open to new management methods and be in general more motivated. Second, *team diversity* reveals information about the team composition (functional background, expertise in different areas, variety of experiences; $\alpha = 0.781$) and is also a characteristic connected with agile teams [1], [10]. Third, *team dedication* describes the share of team members' time allocated to the project on a scale from 0 to 1. Agile team members are often full-time dedicated to a project [83] and probably build good relationships with their team colleagues [19]. Fourth, *team colocation* assesses whether team members were collocated within the same room, same building, same site, same country, or internationally. Agile teams are often collocated, which is why team members can spontaneously communicate with each other more easily than geographically distributed team members [84]. Last, we used *autonomy* to exclude this effect for the interpretation of the final findings. Autonomy is a three-item scale that captures if the project team is free in their decisions regarding project scope or human resources ($\alpha = 0.641$). While autonomy is likely positively related to TWQ and project success [10], the effect of diversity on TWQ is unclear because higher heterogeneity can also lead to social categorization and conflict [85].

Furthermore, we controlled for four portfolio-level context factors that were assessed by the portfolio coordinator and the decision-maker. *Portfolio size* was measured as the natural logarithm of the annual portfolio budget in millions of euros. The *formalization* of project

portfolio management was taken from Teller et al. [68] and was slightly adapted into a four-item scale ($\alpha = 0.928$). This construct indicates the overall maturity of the portfolio management process, which likely correlates with the moderating variables [22], [59], [60]. *Innovation culture* from Kock and Gemünden [60] consists of four items ($\alpha = 0.862$). *External turbulences* ($\alpha = 0.767$), with the objective of capturing the pace of change in the company's environment, consists of items taken from Sethi and Iqbal [86]. Senior managers assessed this construct because they have a better overview of the firm's environment. We present the correlations and descriptives in Table 2.

Insert Table 2 about here

We took several measures to avoid common method variance *ex-ante* and test for common method bias *ex-post*. First, the multi-informant approach combines different hierarchical levels and perspectives and, thus, reduced common method variance [76]. Further, we protected project managers' anonymity and assured them that their assessment was not reported back to the company's senior managers and that there were no right or wrong answers. Ex post, we applied Harman's single-factor technique. PCFAs revealed that the largest factor on the project and portfolio level only explained 23% and 29% of the variance, respectively. Additionally, two CFAs with single-factor models for all project- and portfolio-level variables showed a very poor fit. Overall, we conclude that common method bias is unlikely to have affected the results reported in the next section.

V. RESULTS

A two-level model is required for our analysis because the data contains projects nested in portfolios. We use random-effects regression with the portfolio as the grouping variable in order to separately account for portfolio- and project-level effects. Model 1 in Table 3 shows the

results for the control variables only, model 2 includes the direct effect of agile practices, and the subsequent models include the interaction effects. Regarding the control variables from the portfolio level, we find that formalization and innovation culture are positively related to TWQ. At the project level, project manager experience, all four agile characteristics we controlled for (team autonomy, diversity, collocation, and dedication) all positively predict TWQ.

Insert Table 3 about here

Hypothesis H1 argued that agile practices are beneficial for teamwork quality. The empirical results in model 2 support H1 because the unstandardized regression coefficient is positive ($b = 0.19; p = .000$).

In contrast to H3a, b, and H4a, the results show that portfolio-level contingencies actually weaken the positive effect of agile practice intensity on TWQ. We argued that the existence of business cases positively affects the relationship between agile practice intensity and TWQ (3a). However, the interaction term is negative ($b = -0.046; p = .016$). Thus, we reject Hypothesis 3a. Regarding the moderation effect of strategic clarity (H3b), the positive relationship between agile practice intensity and TWQ also decreases with increasing strategic clarity ($b = -0.043; p = .065$). Hence, strategic clarity also weakens the main relationship, and H3b has to be rejected, too. Similarly, model 5 (H4a) shows that operational control negatively moderates the relationship between agile practice intensity and TWQ ($b = -0.049; p = .024$). Therefore, we have to reject hypothesis 4a. For Hypothesis 4b, we find that the interaction with strategic control is not significant ($b = -0.013; p = .603$). Thus, we can neither accept nor reject H4b. We visualize the marginal effects of agile practice intensity on TWQ for different levels of business case existence, strategic clarity, and operational control with 90%-confidence bands in Figure 2. The influence of agile practices on TWQ decreases with increasing levels of all

three contingency factors. For a sufficiently high degree of business case existence, strategic clarity, or operational control, the effect is zero.

Finally, model 8 shows the direct relationship between teamwork quality and project success, which is positive ($b = 0.245; p = .001$). However, agile practices also show a positive residual coefficient ($b = 0.104; p = .034$), which suggests a partial mediation. To identify the indirect effect of agile practice intensity on project success through its influence on TWQ moderated by the three significant interaction terms, we followed the approach suggested by Hayes and Preacher [87] and bootstrapped the results with 5,000 repetitions. The marginal indirect effects of agile practice intensity through TWQ on project success are shown in Figure 2 for each significant moderation. The results reveal a significant indirect effect that decreases with increasing portfolio contingencies, which supports hypothesis 2. The indirect effects remain significant up to a value of business case existence = 6.3, strategic clarity = 6.7, and operational control = 5.8.

Insert Figure 2 about here

We ran supplementary analyses to rule out that our results are only valid for companies in dynamic environments or in highly innovative project portfolios. In addition to including external turbulences as a control variable, we tested the interaction term between external turbulences and agile practices on TWQ, which is insignificant ($b = 0.037; p = .234$). Additionally, we tested the innovativeness of the portfolio as moderator, which also stayed insignificant ($b = -0.026; p = .384$). A summary of the results can be found in table 4.

Insert Table 4 about here

VI. DISCUSSION

A. Theoretical Implications

This study aimed to empirically investigate how the relationship between agile practice intensity and project success is mediated by TWQ while considering portfolio-level contingencies. With our study, we make three primary contributions to research.

First, we extend the research on team processes in agile project management by using the well-established six dimensions of TWQ as our main measurement for collaboration [17], [18], [32]. So far, only qualitative studies, with the exception of Lindsjørn et al. [16], have examined collaborative team processes in agile teams [11], [13], [14], [15], [83]. With our study, we quantitatively demonstrate TWQ's mediating role in the relationship between agile practices and project success [83] [6], [14]. We found a partial mediation, suggesting that agile practices can also benefit project outcomes beyond their effect through TWQ. For example, agile teams regularly present prototypes to users, who then provide feedback. This early involvement and regular consultation of customers might improve the product also beyond benefitting a team's collaboration [9]. Overall, our study provides valuable quantitative insights to research on agile project management [11], [13], [14], [15], [83], especially agile teams' behavior [15], [83], [88].

Second, this study shows the performance relevance of agile practices' key elements in a context beyond software development. Prior research conducted agile project team studies only for software development teams [8], [16]. We extend this research with a broad cross-industry sample of different portfolio and project types. The results demonstrate that agile practices' core principles are transferable to non-software project management and show similar benefits for performance in that setting. A recent study by Baham and Hirschheim [12] emphasizes four facets of agile methods that are in line with our conceptualization. Their fourth dimension incorporates close communication and cooperation. However, in their argumentation, they also elaborate that the iterative working structures and the close collaboration with customers lead

to collaboration. Bianchi et al. [9] identified sprints, feedback, and specifications as key factors for agile software development projects. We contribute to their research on finding the key elements that agile methods have in common and transfer these elements to the non-software project management literature.

Third, we embed agile practices in the PPM context and shed light on portfolio contingency factors that constrain the beneficial influences of agile practice intensity on TWQ in projects. By applying contingency theory [50], we identified management characteristics along the PPM process that determine the context for the project level. We found out that agile practices do not fit in every portfolio management context or that the contingent environment needs to change when organizations decide on agile management approaches in their projects. Therefore, we expand contingency theory in project management that, so far, only considered single projects' characteristics as contingencies on the project level [53] or portfolio characteristics as contingencies on the portfolio level [68]. We contribute to this research by applying project portfolio characteristics as contingencies for the project level, specifically agile project management. This answers the call for more context-specific PPM research [26] and adds empirical evidence to the sparse multi-level research between portfolios and projects [29], [55], [68].

We initially proposed that business case existence, strategic clarity, strategic control, and operational control strengthen the relationship between agile practices and TWQ. However, we found negative moderation effects of business case existence, strategic clarity, and operational control. One explanation could be that these portfolio-level practices, despite their positive effects on the overall portfolio, limit the freedom and creativity of agile teams [22]. Since creativity is necessary for problem-solving in agile practices, standardization through portfolio management practices, for example, strategic control or business case existence, may hinder agile project teams from using their routines and practices to fulfill their goals. This can lead to conflicts within the team. Measuring agile projects' goals and their impact on the entire

portfolio is often difficult using conventional indicators [8]. Sweetman and Conboy [1] argue that project portfolio complexity increases when significant parts of the portfolio consist of agile projects. Since agile projects strive to achieve high customer satisfaction [2], [8], it is difficult for agile projects to prioritize between customer requirements and the company's strategy [1]. Deciding which stakeholder's objective to prioritize can lead to stress for team members, who may have diverging opinions concerning this choice. For these reasons, agile teams may ignore the portfolio's common purpose [89].

Additionally, our results imply that traditional, prevalent PPM methods and, eventually, the PPM process need adjustment when organizations integrate agile projects into the portfolio. Many companies already try to apply agile practices at the portfolio level. One widely used approach is the Scaled Agile Framework (SAFe) by Leffingwell [90] or frameworks that have been developed by Krebs [91] or Vähäniitty [92]. Agile PPM can help to adapt portfolio processes to the iterative nature of agile practices. However, as Stettina and Hörz [3] found out, firms still struggle to scale agile methods at the portfolio level after initiating agile methods in individual projects and most firms still simultaneously use agile and traditional project management methods in one traditionally managed project portfolio. Therefore, our findings are important and support former research that when implementing agile practices, the organization needs to be committed to agile practices and might scale agile practices beyond the project level.

By investigating these interaction effects of portfolio-level practices, we contribute to the literature on PPM and on agile project teams who operate in non-agile or hybrid environments by demonstrating possible barriers in the form of contingency factors. Thus, we answer the call for research on the interaction between project and portfolio management practices in general [29], [55], and, specifically, agile practices [1], [15], [20].

B. Managerial Implications

This study's findings suggest for practitioners that teams enhance their cooperation, communication, and cohesion when they use agile methods. Managers can profit from this study by evaluating agile practices in their respective contexts. The use of agile practices in terms of iterative planning and execution cycles, continuous customer feedback, and minimum viable products enhances team-internal collaboration and success, also for non-software projects. Even if managers choose not to use agile methods explicitly, they can learn from their routines and implement parts of them in traditionally managed projects.

Furthermore, organizational contingencies on the portfolio level, such as operational control, business case existence, and strategic clarity, weaken this relationship. Decision-makers should be careful when introducing agile practices to an otherwise traditionally managed project portfolio. In strongly controlled portfolios, agile practices might be less valuable. Managers should be aware requirements of agile and traditionally managed projects differ not only at the project level but also in relation to the overall portfolio. However, well-established routines, for example business cases, should be adopted where appropriate by using other approaches that are designed for agile projects (e.g., planning poker).

C. Limitations and Future Research

The results should be interpreted in light of the study's limitations. First, the data were collected using a cross-sectional survey and therefore provide only correlational evidence. Although we tried to rule out alternative explanations through portfolio- and project-level controls and address common method bias through multiple informants, the results do not imply causality. For example, it might be that teams with higher TWQ more likely adapt to new working methods, such as agile practices.

Second, we investigated contingency factors that influence the relationship between agile practices and agile projects' teamwork. However, future research should address which

part of the portfolio management process firms need to adapt most when including agile projects in an otherwise traditionally managed portfolio. We think it is important to adapt phases of the process or routines for agile projects to be successful [1], [27]. In this regard, a longitudinal research approach of project portfolios and their project teams introducing agile practices could deliver interesting insights.

Third, while we identified important contingency factors along the portfolio process, additional contingencies could influence the relationship between agile practices, teamwork, and project success. For example, the entrepreneurial orientation or a company's innovation climate can affect the relationship between agile practices and teamwork because these factors can enhance agile teams' freedom and autonomy. Also, investigating different portfolio types could shed more light on the importance of agile practices and contingency factors in different portfolios (e.g., R&D or construction portfolios).

Lastly, we focused on project business success to demonstrate the relevance of the relationship between TWQ and agile practice intensity. However, there are further dimensions of project success, such as learning success or customer satisfaction [93]. It remains unclear whether agile practices pay off across all dimensions [9], [44]. Especially the performance comparison of a mixed project portfolio of traditional, hybrid, and agile projects calls for a multidimensional approach of project success. Future research could investigate this issue with a qualitative research approach to investigate how companies compare project success between traditionally managed and agile projects.

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VIII. FIGURES AND TABLES

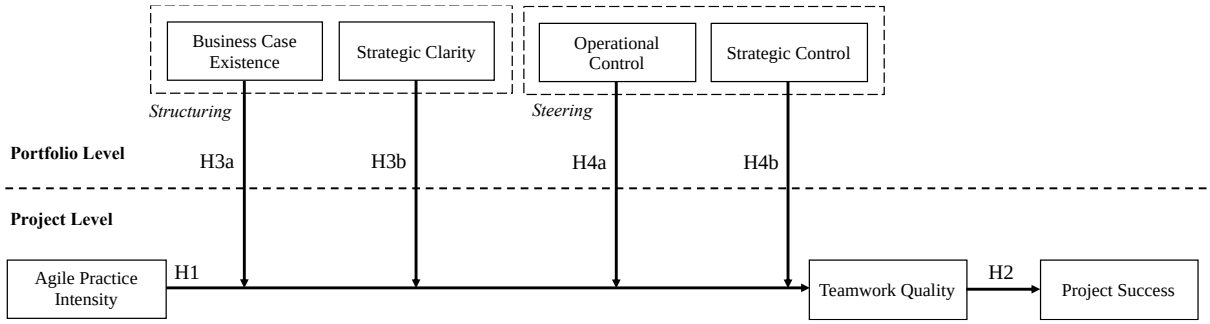
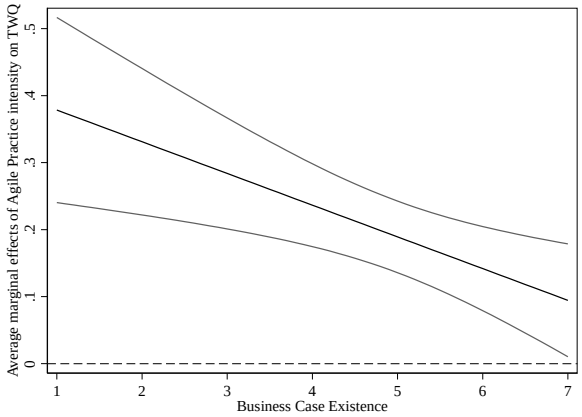
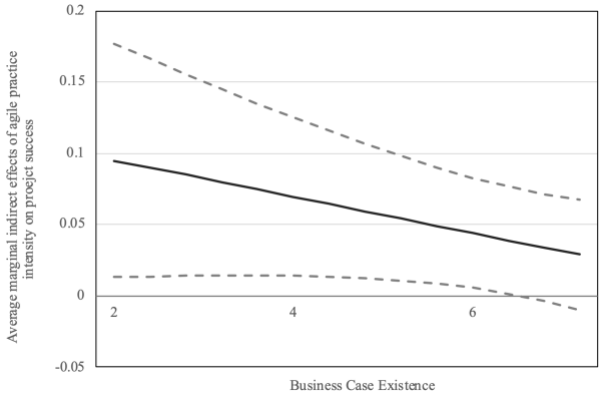
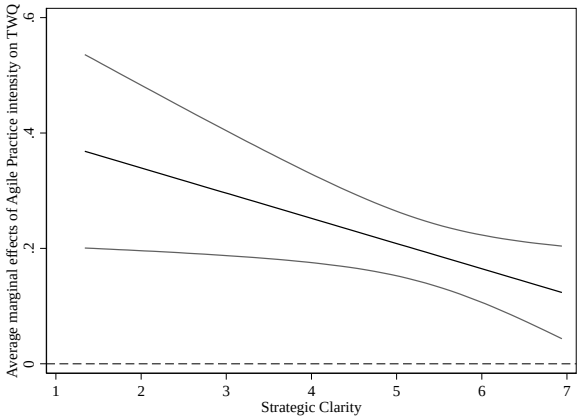
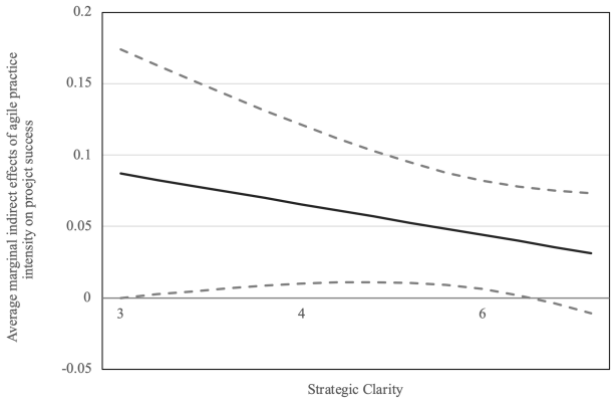


Figure 1: Conceptual model









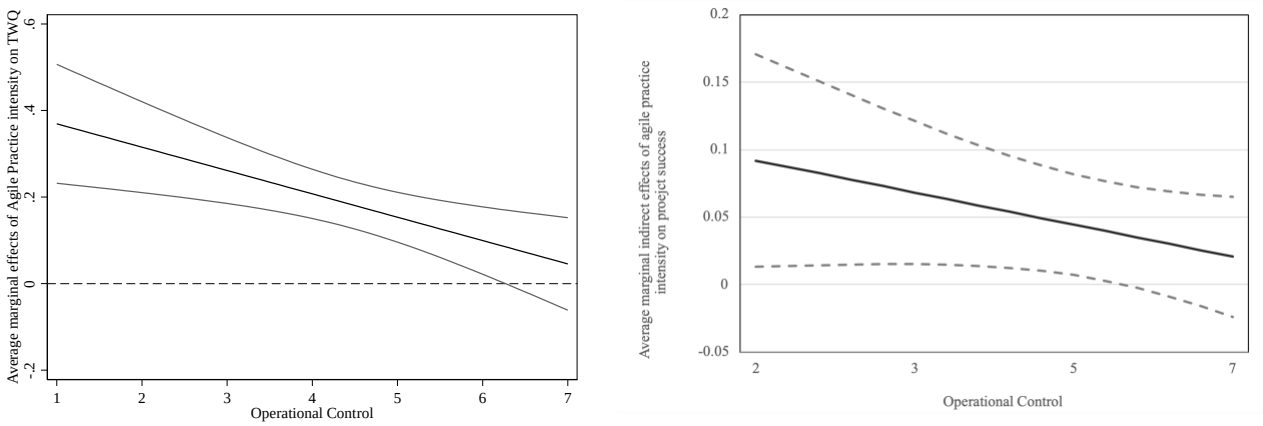


Figure 2: (Left) Marginal effects of Agile Practice Intensity on TWQ in respect of different levels of business case existence, strategic clarity, and operational control (thin lines represent a 90% confidence band); (Right) Marginal effects of Agile Practice Intensity on Project Success (dashed lines represent a 90% confidence band)

TABLE 1: SAMPLE CHARACTERISTICS

Portfolio Level (N=100 portfolios)						Project Level (n=378 projects)			
Revenue		Employees		Portfolio Budget		Project Budget		Project Duration	
<100 Mill. EUR	17%	<500	29%	<10 Mill. EUR	22%	<200k EUR	14%	< 1 year	20%
100-500 Mill. EUR	20%	500-2000	30%	10-30 Mill. EUR	24%	200-500k EUR	19%	1-2 years	48%
501-2000 Mill. EUR	26%	>2000	41%	30-100 Mill. EUR	26%	501-2000k EUR	23%	2-3 years	16%
>2000 Mill. EUR	37%			>100 Mill. EUR	28%	>2000k EUR	44%	> 3 years	16%

TABLE 2: CORRELATIONS AND DESCRIPTIVES

	Variables	M	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Project Level																				
(1)	PL Experience (ln)	2.10	0.74	1.00																
(2)	Team size (ln)	2.64	0.88	.20	1.00															
(3)	Team Diversity	5.80	1.22	.11	.28	1.00														
(4)	Project Dedication	0.44	0.28	.15	.20	.05	1.00													
(5)	Colocation	2.90	1.22	-.06	-.17	-.24	.05	1.00												
(6)	Team Autonomy	4.02	1.37	.06	.00	.05	-.02	-.07	1.00											
(7)	Project Innovativeness	4.04	1.73	.04	-.02	.09	.13	.01	-.02	1.00										
(8)	Project success	4.62	1.23	.14	.21	.19	.04	-.03	.19	-.06	1.00									
(9)	Teamwork Quality	5.47	0.93	.20	.04	.10	.19	.08	.30	-.05	.27	1.00								
(10)	Agile Practice Intensity	4.99	1.39	.14	.13	.13	.20	-.09	.25	.19	.23	.35	1.00							
Portfolio Level																				
(11)	Portfolio Size (ln)	3.58	1.84	.14	.18	.06	.29	-.10	.01	-.07	.14	.05	.11	1.00						
(12)	Formalization	5.01	1.57	-.13	.11	-.05	.14	.16	-.05	.08	-.04	.10	-.03	.02	1.00					
(13)	Innovation Culture	4.77	0.75	.02	.00	-.03	.17	.03	.13	-.06	.06	.19	.12	.19	.10	1.00				
(14)	External Turbulences	4.47	1.08	-.00	-.07	-.12	.02	.06	.01	.02	-.04	-.01	-.00	-.09	.20	-.11	1.00			
(15)	Strategic Control	4.05	1.3	-.09	.12	-.03	.21	.05	.04	.08	-.01	.07	.05	.11	.48	.31	.09	1.00		
(16)	Operational Control	4.39	1.37	-.03	.11	.04	.29	.08	.03	.09	-.00	.14	.04	.20	.47	.34	.02	.68	1.00	
(17)	Strategic Clarity	5.38	1.33	.06	.07	.01	.12	.06	-.01	.05	.01	.17	.05	.20	.29	.26	.17	.32	.34	1.00
(18)	BC Existence	4.76	1.58	-.00	.06	.01	.08	.04	-.03	-.09	.02	.04	-.07	.16	.16	.15	-.09	.26	.33	.09

N (project portfolios) = 100; n (projects) = 378; M = mean; SD = standard deviation; PL = Project leader; BC = Business case; all correlations above .1 are significant at the 5%-level.

TABLE 3: REGRESSION RESULTS

	Teamwork Quality (TWQ)												Project Success			
	(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)	
Portfolio-Level Controls																
Formalization	0.06+	[.07]	0.07*	[.04]	0.07*	[.03]	0.06+	[.05]	0.07*	[.03]	0.07*	[.03]	-0.01	[.76]	-0.03	[.59]
External Turbulence	-0.03	[.46]	-0.04	[.37]	-0.04	[.28]	-0.03	[.42]	-0.04	[.36]	-0.04	[.36]	0.00	[.97]	0.01	[.91]
Innovation Culture	0.12+	[.07]	0.09	[.15]	0.09	[.13]	0.09	[.15]	0.09	[.14]	0.09	[.16]	0.06	[.52]	0.01	[.88]
Portfolio size (ln)	-0.03	[.27]	-0.04	[.14]	-0.04	[.11]	-0.04	[.14]	-0.04	[.15]	-0.04	[.14]	0.07*	[.05]	0.07*	[.04]
Project Innovativeness	-0.05+	[.07]	-0.07**	[.00]	-0.07**	[.00]	-0.07**	[.00]	-0.07**	[.01]	-0.07**	[.00]	-0.04	[.33]	-0.04	[.29]
Project-Level Controls																
Project Leader Experience (ln)	0.22**	[.00]	0.20**	[.00]	0.19**	[.00]	0.19**	[.00]	0.20**	[.00]	0.20**	[.00]	0.12	[.17]	0.05	[.54]
Team Size (ln)	-0.06	[.28]	-0.08	[.13]	-0.07	[.15]	-0.08	[.12]	-0.08	[.14]	-0.08	[.13]	0.22**	[.00]	0.22**	[.00]
Team Diversity	0.08*	[.03]	0.07+	[.05]	0.07+	[.06]	0.07+	[.05]	0.06+	[.10]	0.07+	[.05]	0.15**	[.00]	0.13*	[.02]
Team Dedication	0.53**	[.00]	0.39*	[.02]	0.40*	[.01]	0.41*	[.01]	0.39*	[.02]	0.39*	[.02]	-0.09	[.71]	-0.29	[.22]
Team Colocation	0.07+	[.06]	0.08*	[.03]	0.08*	[.03]	0.08*	[.03]	0.08*	[.04]	0.08*	[.03]	0.06	[.23]	0.05	[.32]
Team Autonomy	0.19**	[.00]	0.15**	[.00]	0.15**	[.00]	0.15**	[.00]	0.15**	[.00]	0.15**	[.00]	0.16**	[.00]	0.09+	[.06]
Moderators																
BC Existence	0.00	[.92]	0.01	[.79]	0.25*	[.02]	0.01	[.67]	0.01	[.64]	0.01	[.72]	0.00	[.94]	0.01	[.82]
Strategic Clarity	0.08*	[.02]	0.08*	[.02]	0.09*	[.01]	0.30*	[.02]	0.09*	[.01]	0.08*	[.02]	-0.01	[.82]	-0.03	[.52]
Operational Control	0.03	[.56]	0.03	[.44]	0.03	[.44]	0.04	[.36]	0.28*	[.02]	0.04	[.43]	-0.04	[.52]	-0.05	[.48]
Strategic Control	-0.06	[.24]	-0.06	[.19]	-0.06	[.17]	-0.06	[.18]	-0.06	[.16]	0.00	[1.0]	0.01	[.94]	0.02	[.80]
Hypothesized Effects																
Agile Practice Intensity			0.19**	[.00]	0.20**	[.00]	0.19**	[.00]	0.19**	[.00]	0.19**	[.00]			0.10*	[.03]
Agile x BC Existence					-0.05*	[.02]										
Agile x Strategic Clarity							-0.04+	[.07]								
Agile x Operational Control									-0.05*	[.03]						
Agile x Strategic control											-0.01	[.61]				
TWQ															0.25**	[.00]
Constant	3.01**	[.00]	2.73**	[.00]	3.71**	[.00]	2.72**	[.00]	2.71**	[.00]	2.73**	[.00]	1.77**	[.00]	0.87	[.27]
R^2 (within)	0.14		0.23		0.24		0.24		0.24		0.23		0.04		0.11	
R^2 (overall)	0.22		0.29		0.30		0.29		0.30		0.29		0.12		0.17	
R^2 (between)	0.48		0.48		0.49		0.48		0.50		0.48		0.35		0.33	

Random effects GLS regression; N (project portfolios) = 100; n (projects) = 378; unstandardized regression coefficients are reported; interaction variables were mean-centered; + > 0.1; ∗p < 0.05; ∗ ∗p < 0.01; p-value in brackets; Agile = Agile Practice Intensity

TABLE 4: SUMMARY OF RESULTS

Hypothesis	Effect	Result
H1: Agile practice intensity is positively related to TWQ.	positive	supported
H2: Teamwork Quality mediates the relationship between agile practices and project success.	positive	supported
H3a: BC existence on portfolio level positively moderates the relationship between agile practice intensity and TWQ.	negative	not supported
H3b: Strategic clarity on the portfolio level positively moderates the influence of agile practice intensity on TWQ.	negative	not supported
H4a: Operational control on portfolio level positively moderates the relationship between agile practice intensity and TWQ.	negative	not supported
H4b: Strategic control on portfolio level positively moderates the relationship between agile practice intensity and TWQ.	no sig. effect	not supported

APPENDIX - MEASUREMENT

Construct	Items	lambda	alpha	AVE	CR
Project-Level					
Teamwork Quality	Project team members communicated frequently and openly with each other.	.68	.85	.50	.85
Informant: Project Manager	Within the project team, work packages and tasks were well coordinated.	.66			
Source: [17]	Strengths and weaknesses of individuals were respected in the project team.	.70			
	Within the project team, members were willing to support each other.	.80			
	Project team members did their best to fulfil their task.	.68			
	Project team members were proud to work on this project.	.70			
Project Success	The product/project result achieved…		.91	.78	.92
Informant: Project Manager	...the planned market goals (e.g., market share).	.79			
Source: [48]	...the planned profitability goals (e.g., ROI).	.97			
	...the planned payback period.	.89			
Team Autonomy	The project team …		.64	.43	.68
Informant: Project Manager	...had control over what they were supposed to accomplish.	.48			
Source: [48]	...was granted autonomy on how to handle scope changes.	.90			
	...was free to assign personnel to the project.	.50			
Project Team Diversity	The members of the project team varied in their functional backgrounds.	.80	.78	.55	.78
Informant: Project Manager	The members of the project team had expertise in different areas.	.58			
Source: [10]	The members of the project team had a variety of different experiences.	.82			
Technological Project Innovativeness	At the beginning of the project we did not have the necessary technical knowledge.	.81	.87	.69	.87
Informant: Project Manager	At the beginning of the project we had little practical experience in the application of the required technology.	.92			
Source: [29]	In our project, we could only partially rely on the existing technological competence of the company.	.76			

Construct	Items	lambda	alpha	AVE	CR
Portfolio-Level					
BC Existence	All projects must have a business case in order to enter the selection process.	.89	.86	.65	.85
Informant: Coordinator	"Must-Projects" (mandatory projects) also require a business case.	.83			
Source: [22]	We intensively examine the business case when structuring our portfolio.	.70			
Strategic Clarity	We have a written mission, long-term goals and strategies to achieve them.	.80	.88	.72	.88
Informant: Coordinator	Goals and strategies are communicated in our company.	.90			
Source: [60]	Our long-term competitive strategy is clear and understandable.	.83			
Operational control	We frequently examine the targets (e.g., strategic alignment, net return, risk) for our portfolio.	.80	.82	.62	.83
Informant: Coordinator	In our portfolio, we analytically examine plan/ actual performance deviations between planned and actual performance.	.80			
Source: [60]	We systematically analyze single projects when monitoring our portfolio.	.77			
Strategic control	We frequently review …		.91	.71	.91
Informant: Coordinator	... the feasibility of the portfolio strategy based on information acquired in projects.	.87			
Source: [59]	... the validity of the premises defined within strategic planning.	.87			
	... whether the strategy of the project portfolio remains justified in light of changed conditions.	.90			
	Based on the information gained in our projects we deliberately challenge the portfolio strategy.	.73			
External Turbulences	In our industry, it is difficult to predict how customers' needs and requirements will evolve.	.35	.77	.46	.77
Informant: Decision Maker	In our kind of business, customers' product preferences change quite a bit over time.	.52			
Source: [86]	The technology in our industry is changing rapidly.	.82			
	There are frequent technological breakthroughs in our industry.	.94			
	Technological changes provide big opportunities in our industry.	.61			
Formalization	Essential project decisions are made within clearly defined portfolio meetings.	.79	.93	.77	.93
Informant: Coordinator	Our project portfolio management process is divided in clearly defined phases.	.81			
Source: [68]	Our process for project portfolio management is clearly specified.	.93			
	Overall, we execute our project portfolio management process in a well-structured manner.	.97			
Innovation Culture	In our organization, …		.83	.57	.84
Informant: Coordinator and Project Manager	... employees are given sufficient responsibility, resources, and freedom to work independently.	.70			
Source: [60]	... communication is open, meaning that we share information and appreciate debates and diverse opinions.	.70			
	... we emphasize creativity and innovativeness.	.83			
	... unconventional ideas are encouraged by management.	.78			