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Project Lineage Management and Project Portfolio Success

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Abstract

Project portfolio approaches consider various concurrent project interdependencies but typically neglect longitudinal interdependencies. These are important for exploratory projects which create strategic options. If these options are not exploited in successive projects they become lost opportunities. This study analyzes 138 firms regarding their extent to consciously manage project sequences. We differentiate "proactive lineage" (planning a roadmap of future projects) and "reactive lineage" (using learnings from past projects). Results show that both practices are positively and independently related to portfolio success. We derive suggestions for future research, which theoretical foundations could be used to better understand the impact of lineage management.

Kew words:

exploratory projects, project lineage, project portfolio management, project sequences

Author Biographies

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Project Lineage Management and Project Portfolio Success

Introduction

Organizations need to develop and use both explorative and exploitative practices in order to survive (March, 1991; Tushman & O'Reilly, 1996). Three approaches have been used in the realm of projects to address this challenge of ambidexterity. The first one considers projects as stand-alone items and suggests that they should be managed according to their task demands. In particular, explorative projects should follow different management principles than exploitive ones (Lenfle, 2008; Lenfle, 2016; Maniak, Midler, Lenfle, & Le Pellec-Dairon, 2014). This is an application of the general principle of contingency theory that projects with different task characteristics should be managed differently—one size does not fit all (Shenhar, 2001).

The second approach is based on the premise that projects are embedded in programs or in project portfolios. On the program and the portfolio level managers decide, which projects should be started or terminated and which resources should be invested in them. Project portfolio and program management approaches consider various concurrent project interdependencies but typically neglect longitudinal interdependencies. For program management, the insightful longitudinal case study by Pellegrinelli, Murray-Webster, and Turner (2015) documents how the focused project management approach and the flexible program management approach complement each other to simultaneously reach efficiency and effectiveness goals. The authors show that a succession of incremental execution projects can lead to a strategic breakthrough if properly managed in a cumulative way.

A third approach, *lineage management*, focusses on a sequence of projects that build on each other (Maniak & Midler, 2014; Midler, 2013). Typically, the first project is an exploratory one,

which creates options that are then exploited in follow-up projects. The longitudinal interdependencies are a constituting element of this approach. Our article concentrates on this approach and we are interested, which role sequential relationships of projects play in managing collectives of projects, not only the specific sequence.

Projects are often defined as temporary endeavors to create a unique product, service or result (e.g., PMI, 2013). This definition stresses projects' singularity and temporality. Davies (2017: 7) discusses the *completeness* of projects: "A project can be complete in itself such as the creation of a new consumer product, building, or urban metro system. It can form part of a continuing programme of interrelated projects using shared resources and coordinated to achieve a common objective such as Apple's digital hub of products and online iTunes services." This example illustrates that an organization does not only use *one* project to achieve an objective, but a *set* of projects.

Typically, this phenomenon is discussed in the context of program and portfolio management (Gemünden, Lehner, & Kock, 2018; Kopmann, Kock, Killen, & Gemünden, 2017; Martinsuo, 2013; Martinsuo & Hoverfält, 2018; Müller, Martinsuo, & Blomquist, 2008). Davies (2017: 7) comments: "A portfolio can be established to allocate resources to a set of projects that are planned, mapped, and sequenced to achieve an organization's long-term strategic objectives." Project management therefore not only occurs at a single project's level but also at the level of the program or the portfolio. Major projects (e.g., building an airport) are often planned and executed by a set of different (inter-)organizational actors who may create their own projects or joint projects with shared responsibilities.

Although projects are temporary and unique, they are therefore not as singular as the often-used definitions by professional organizations suggest. Rather, multiple *interdependencies*

between different projects derive from pooled resources, sequential work flows, or reciprocal information flows. An increasing number of projects performed by organizations and an increasing complexity of programs have led to an increased attention to project interdependencies (Killen, 2013; Maniak & Midler, 2014; Maniak et al., 2014; Teller, Unger, Kock, & Gemünden, 2012) and to a change of project management by linking it more strongly with strategic management (Killen, Jugdev, Drouin, & Petit, 2012; Maniak & Midler, 2014; Meskendahl, 2010; Midler, 2013). The central problem with strategies is their implementation. And the management of project portfolios and major programs has been perceived as a means to better understand, plan, and control the strategies' implementation (Kopmann et al., 2017; Meskendahl, 2010).

Most of the literature, however, concentrates on *concurrent* project interdependencies, while the *longitudinal* project interdependencies are typically neglected—an exception is the work of Midler and colleagues (Jullien, Lung, & Midler, 2013; Maniak & Midler, 2014; Midler, 2013). But if resource spending should reflect the fulfilment of strategic goals and their priorities, the long-term impact of projects should be considered. Managers should not only assess projects based on their expected direct outcomes, but also on the projects' contribution to future projects that build on them. Thus, in order to align projects to strategies, it is not sufficient to allocate bottleneck resources by looking only at the ratio of expected short-term outputs and resource inputs of the *current* projects. It is important to consider long-term outcomes and the additional option-value that a project creates for future follow-up projects. This is usually done for platform projects that pave the ground for subsequent derivative projects, but is not yet a standard principle for whole project portfolios (Wheelwright & Clark, 1992).

This paper thus addresses the longitudinal interdependencies between projects. We start with the assumption that the development and implementation of a major innovative venture requires

more than a single project: *Rome was not built in a day.* Wheelwright and Clark (1992) already acknowledged the importance of project sequencing for building development capabilities. Midler (2013) showed the relevance of project sequences and their management in his in-depth investigation of Renault and coined the term "project lineage management". But it is not clear how prevalent the concept is and how it affects the performance of project portfolio environments.

Managing a sequence of projects poses fundamental challenges to the basic assumptions of a project's nature. First, envisioning a sequence of projects does not imply that the corresponding business activity has a determined time horizon, because it is not decided ex ante how many elements the sequence will have. Only the single projects have a determined time horizon. Thus, project lineage is an *ongoing*—not a temporary—business development activity. Second, it is not necessarily determined ex ante *how big* the step should be in each of the sequential projects. For example, development projects in the car industry create a significantly changed new product generation. But more incremental changes—face-lifts—are also organized as projects. Such intermediate projects in a project sequence are also used to adapt the IT infrastructure of a car. In software development project sequences, we encounter different types of releases that may vary in the amount of changes. Product changes of prototypes in agile methods may use sprints of a fixed length, so that the boundaries between pure project management and the management development processes increasingly resemble operational processes. Third, the more projects build on already existing projects or platforms, the less unique might be the result of each single project. It delivers a new product or service that is *customized* to specific wishes. The term mass-customization expresses this trend well, and the boundaries between unique customizations and automated adaptations blur. Fourth, against the dominant view of *one* highly innovative project delivering a quantum leap in performance, empirical evidence shows that a sequence of

comparatively short but highly interactive projects can deliver a performance increase, which is much higher than the existing industry standard and can re-position an underperformer into a top-in-class performer (Berggren, 2019; Rubin & Abramson, 2018). Fifth, a sequence of consecutive projects may not only be beneficial. Repeated positive experiences with external partners in a sequence of successful projects can create path-dependencies leading to lock-in effects—for example, a "trust trap" (Möllering & Sydow, 2018).

In this paper, we want to explore to which extent firms *consciously* manage project sequences instead of isolated projects (i.e., neither considering systematic learning from the past nor the options current projects generate for future projects). The perspective of looking forward is often associated with the term *project roadmaps* (Bengtsson & Lindkvist, 2017), whereas the perspective of building on previous projects is often associated with *learning.* There is some literature on inter-project learning (Brady & Davies, 2004; Ekrot, Kock, & Gemünden, 2016; Prencipe & Tell, 2001; von Zedtwitz, 2002), but is not always specified whether this targets knowledge sharing between concurrent projects, or learning from previous projects (Marsh & Stock, 2006). We are interested here in approaches how to learn from previous projects.

Our conceptualization of project lineage management comprises both approaches: the *proactive* approach to plan a project roadmap that enables the implementation of a complex innovation by a project sequence, and the *reactive* approach to secure learnings from the past and to actively use them in follow-up projects. Thus, we differentiate between proactive and reactive project lineage management. The latter does not only comprise information and communication activities, but also a management of team and strategic partner continuity between two or more sequential projects. We are interested in the following research questions:

(1) To what extent are proactive and reactive practices of project lineage management used

in a project portfolio environment?

(2) How do these practices relate to project portfolio management success?

Although firms may show a variety of sequential patterns, our principle line of reasoning assumes that firms first perform *exploratory* projects in order to find out if new ideas or more elaborated concepts are technologically and economically feasible (Frederiksen & Davies, 2008; Lenfle, 2008; Wheelwright & Clark, 1992). Firms may also explore to which extent the discovered opportunities for new business fit with the resources and competences of the firm. The more such exploratory projects are pursued, the more likely it is that valuable options and opportunities are created and eventually seized. Seizing means engaging in one or several follow-up projects that build on the previous exploratory project. The first follow-up project may already lead to a higher profitability and may also pave the way for further projects that potentially transform the whole permanent organization. Therefore, practices of lineage management might be especially valuable, the more exploratory projects a firm has in their project portfolio. This raises our third research question:

(3) Is the performance impact of these practices increasing with an increasing share of exploratory projects in the project portfolio?

Conceptual Background

Project Lineage Management

John F. Kennedy stated in his famous speech before congress on May 25 of 1961: “First, I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the earth.” This goal was a vision that required several sequential missions to finally realize it. Neither Kennedy’s vision nor the missions

that he initiated started from scratch. Rather, they built on previous visions and missions, and the high investments in space exploration that Kennedy wanted to get approved by congress were also driven by the fear that Russia could win the race to the moon. The USA were shocked that the Russians had been the first to send a satellite in space in 1957. Kennedy stated a clear vision and clearly described the scope and kind of projects that were needed, what budget would be required, and which uncertainties had to be mastered. It was also clear that a *roadmap* of consecutive projects was necessary, and that further investments in future years should get approval by future congresses as well.

Many years later, Midler (2013) published his article on how to create a completely new business, based on managing a *project sequence*. He called this systematic management of a project sequence *"project lineage management".* Using the Logan Case from Renault's Daccia division, his case study frames project lineage management as a way to expand the initial move into a diversified range of products and a multi-continent deployment, while keeping the key specificities of the pilot project. It is typical that different generations of a product innovation are developed, and profitability may rise during such a sequel. For example, for the Renault Logan and following product family they were 8%, 23%, and finally over 100% (Midler, 2013; Midler & Silberzahn, 2008). This case study describes a very successful example, but there are others: the Toyota Prius, the sequels to Star Wars movies, or the iPod, iPhone, and iPad products from Apple, which generated sequences of product generations and associated service platforms making Apple the first trillion-dollar company. Thus, the management of project sequences is not a new concept, but it has been neglected in project management research—compared to the number of publications on the management of programs, project portfolio, and project networks, which all enlarge the concept of managing a single project.

Project Lineage in Project Portfolio Management

The project lineage management approach has so far only been analyzed in the form of qualitative studies of successful cases without using control cases or control variables. Furthermore, we are interested in project lineage management as a typically applied practice for an entire set of projects that are bundled under the same project portfolio management regime. We do not ask whether project lineage management is applied for *some* of the projects in a portfolio and then look at the antecedents of these specific cases and the performance effects of lineage practices on specific sequences. Rather, we are interested in the management of project sequences as a practice that plays a significant role in decision-making at the level of the *whole* project portfolio (i.e., it is in principle applied to the management of *all* portfolio projects).

Questions portfolio managers must ask are: is the expected impact of a project on follow-up projects an important element of resource allocation decisions? How fuzzy is the front end, when new projects are set up? Are results from previous projects systematically considered? Have rules, processes, and infrastructures been developed and used that facilitate and direct the usage of learnings from previous projects? Is there a systematic management of team member or strategic partner continuity between previous, current and future projects, in order to build on shared tacit knowledge and shared social capital?

Our current knowledge to which extent proactive and reactive practices of project lineage is used is still limited. Thus, we concentrate in this study on the question of how intensively such practices are used—without analyzing what this specifically means in each single case. It is a conceptualization of project lineage management that can be used for an exploratory analysis. We develop in the following, why we expect a positive relationship with project portfolio success and

why the share of exploratory projects in a project portfolio should positively moderate this impact. Empirical evidence for this relationship might encourage to make a deeper dive into the specific practices that are used for proactive and reactive project lineage management. And it will also justify research to analyze the drivers and inhibitors of project lineage practices.

Project Lineage and Project Portfolio Success

Project portfolio success has been extensively discussed in the literature and the construct is considered to be multi-dimensional (Cooper, Edgett, & Kleinschmidt, 2001; Meskendahl, 2010; Müller et al., 2008). Cooper et al. (2001) defined a portfolio as successful, if the portfolio achieves the maximal value, if its composition reflects the firm's strategic business priorities, and if it is harmoniously balanced with regards to certain characteristics such as risk/reward, short-term vs long-term profitability, or project type. In this study, we follow empirical research that distinguishes between four dimensions of project portfolio success: strategic implementation, portfolio balance, average product success, and exploitation of synergies (Jonas, Kock, & Gemünden, 2013; Kock, Heising, & Gemünden, 2016; Teller & Kock, 2013; Teller et al., 2012; Voss & Kock, 2013).

Strategic implementation is defined as the degree to which the company strategy is reflected and successfully implemented by the project portfolio (Kopmann et al., 2017; Meskendahl, 2010). *Portfolio balance* reflects whether the portfolio is well balanced according to risk, innovativeness, and long- and short-term opportunities (Teller et al., 2012). *Average product success* is defined as the average commercial success across all projects (Voss & Kock, 2013). Finally, *synergy exploitation* considers the degree to which the portfolio is more valuable than the sum of its projects by measuring whether synergies across projects are leveraged and redundancies avoided (Jonas et al., 2013).

We generally assume that project lineage management will positively influence project portfolio success. However, we do not know to which extent proactive project lineage management and reactive project lineage management influence project portfolio success, and how both types of lineage interact. In addition, we do not know if both constructs affect all dimensions of project portfolio success equally. In the following, we offer some reasons why project management lineage is expected to be positively related to project portfolio success.

We consider project portfolio management as a *dynamic capability* that helps to plan and control new capabilities in order to adapt to changing needs, changing competition and changing capability landscapes (Killen & Hunt, 2010; Killen et al., 2012; Petit, 2012; Sicotte, Drouin, & Delerue, 2014). Teece (2007) conceptualizes dynamic capabilities based on sensing, seizing, and transforming capabilities, and such capabilities are created or exploited by the projects that are staffed with resources in project portfolio decisions. For example, in order to find and assess new needs and/or new technologies exploratory projects are set up and resourced in order to generate strategic options that can be further explored or exploited in one or more follow-up projects. Thus, follow-up projects are important to seize new opportunities. If these seizing projects show positive results, they may be expanded in scale and scope to create a new platform for a new business ecology and this is done in projects that help to transform the product and service landscape of an organization. Positive examples for this are the Apple iPod, iPhone and iPad success stories and the Logan epic described by Jullien et al. (2013), Midler (2013), and (Maniak & Midler, 2014). Recently, another low-cost car was developed by Renault-Nissan in India: The Kwid. The expectations are high that this may become a success story in emerging markets (Midler, Jullien, & Lung, 2017). Jissink, Schweitzer, and Rohrbeck (2018) posit that project teams must engage in forward-looking search during project development to increase their project's innovativeness.

They argue that this is only relevant if there is room in project planning to facilitate forward-looking search, if slack resources available to implement such changes, and if the external environment is dynamic. Their empirical results from the Danish manufacturing industry show that forward-looking search is significantly related to innovativeness.

The previous examples of project sequences have been spectacular successes. However, in ordinary project portfolios, which are the unit of analysis of the current study, we may have a wide range of different projects that are purely exploratory and sense possible opportunities, others may test more intensively if such opportunities could and should be seized, up to purely exploitative projects that increase the scale and scope of already established offers and make them more efficient and more profitable. Thus, there will also be a mixture of project lineage management applications ranging from project sequences that are still in an infant stage to project lineage management applications that are in a very mature stage and prepare a carve-out or shutting down of an operation. The need for and the impact of proactive and reactive project lineage management activities will probably be highest in project sequences that are near or already in a commercialization stage and have reached some economic impact and expect further growth. We currently do not have information in which stage the project portfolios that we analyze are, but we assume that all portfolios have a considerable share of projects that are at a medium maturity level so that project lineage management will be a value creating activity. Therefore, we postulate the following two hypotheses:

H1: Proactive lineage is positively related to portfolio success.

H2: Reactive lineage is positively related to portfolio success.

We assume a complementary effect of both types of project lineage management, a super-additive

effect such that an increase in either aspect amplifies the benefits of the other aspect (Kopmann et al., 2017).

H3: Proactive and reactive lineage are complementary in their relationship to portfolio success, i.e., they show a positive interaction effect.

We also assume that the share of exploratory projects in a project portfolio will strengthen the positive effects of proactive and reactive lineage, mainly for two reasons. Exploratory projects will provide higher opportunities for learning than non-exploratory projects because they face a higher uncertainty, and team members are often allowed to think out of the box, to try out new ways of doing things, to develop completely new architectures, new knowledge and design spaces, new materials, new component technologies, new ways of marketing products and services (Frederiksen & Davies, 2008; Lenfle, 2016; Salomo, Weise, & Gemünden, 2007). Exploratory projects also often bring together new teams with diverse knowledge bases. For these reasons, more and newer knowledge can be generated. Although not all new knowledge is useful for the organization, it is likely that some information is crucial for the creation of new products, services, and business-models. This knowledge needs to be captured and reused. This is done by applying a bundle of measures, for example by making tacit knowledge explicit and store it for future projects as "lessons learned", or by using the same people and the implicit knowledge that they possess and already share in a follow-up project (Ekrot et al. 2016). We may therefore postulate:

H4: The positive relationship between reactive lineage and portfolio success will become stronger with increasing share of exploratory projects in the portfolio.

Exploratory projects create freedom for learning but they are also a costly endeavor if done

properly. When a larger share of such exploratory projects is realized in a project portfolio, potential project candidates will compete against each other. In order to decide which exploratory project should be prioritized, some assumption about the potential impacts or the necessity of these projects is needed. This means that for such exploratory projects some roadmapping ideas have to be derived, probably based on corporate foresight activities (Jissink et al., 2018; Rohrbeck & Kum, 2018). Pro-active roadmapping activities have therefore a stronger positive effect on project portfolio performance when there are many exploratory projects in the portfolio. In addition, these activities may help to more quickly and better seize options that have been created by exploratory projects. We therefore postulate:

H5: The positive relationship between proactive lineage and portfolio success will become stronger with increasing share of exploratory projects in the portfolio.

Method

Sample

A cross-industry sample of medium to large firms is used to test the proposed hypotheses. In each firm we contacted two informants: a decision maker and a portfolio coordinator. Decision makers were senior managers with authority over the portfolio in deciding on initiation, termination, or reprioritization of projects. Typical positions were CEO, head of business unit, or head of R&D. Coordinator informants were middle managers with a good overview of the project landscape who were in charge of actively managing the project portfolio. Typical titles for coordinator informants were portfolio manager, department manager, or head of project management office. This two-informant approach allowed the integration of information from different perspectives and hierarchies within each firm and addressed problems associated with

common method variance.

We contacted firms in mid 2017 to explain the study in general and we sent a call for registration to potential coordinator informants or their superiors. We followed up by phone to encourage registration and participation in the study. All registered informants received a personal letter explaining the multi-informant design and the questionnaires with an introduction describing the terms and definitions. To increase the response rate, we used phone calls and reminder e-mails. We received 147 decision maker questionnaires and 150 coordinator questionnaires from 158 firms, resulting in 138 matched pairs with complete data from both types of informants. In order to test for non-response-bias we compared the 25 percent early and late respondents using a t-test on all study variables and found no significant differences. After the study, each firm received an individual report on findings from their organization, and the overall study results were presented, discussed, and validated during a conference with about 60 participants.

Measurement

We used multi-item scales for the constructs, which are anchored from 1, "strongly disagree", to 7, "strongly agree" and were taken from existing literature as far as possible. Item wordings are listed in table 2, along with the results of the confirmatory factor analysis (see below).

The dependent variable *portfolio success* was measured as a four-dimensional second-order construct using dimensions and their items from existing literature (Beringer, Jonas, & Kock, 2013; Cooper et al., 2001; Jonas et al., 2013; Kock et al., 2016; Voss & Kock, 2013): strategic implementation (4 items), portfolio balance (3 items), average product success (3 items), and synergy exploitation (3). Both types of informants assessed all dimensions of project portfolio success, in order to provide a balanced perspective on performance.

We developed items for proactive and reactive lineage, as these constructs have not been

previously used. For *proactive lineage*, we used four items referring to the usage of project roadmaps, the planning of future project generations, the deliberate planning of project sequences and the systematic identification of opportunities for future projects. For reactive lineage, we relied on project learning literature (Marsh & Stock, 2006; Prencipe & Tell, 2001) to specify four items that referred to the usage and transfer of knowledge and contents from previous projects.

We also included several control variables. First, we controlled for *firm size*, which was captured as the natural logarithm of the number of employees working in the respective company or business unit. Second, we controlled for characteristics of the project portfolio that might have an effect on portfolio success. The budget of the portfolio, measured as the natural logarithm of the budget in millions of Euro, served as a proxy for *portfolio size.* We further included the *percentage of exploratory projects*—that is, projects with which the company enters uncharted territory (from 0 to 1=100%). This variable also serves as a moderating variable to test hypotheses 4 and 5. The *percentage of mandatory projects* (e.g., legal requirements) was also included to account for the discretion of portfolio decisions. For the same reason, we controlled for the *percentage of external projects*, that means projects based on specifications set by (or contracts with) external customers. The last portfolio characteristic is the *percentage of R&D projects* (in contrast to, e.g., IT or organizational change projects) within the portfolio. Finally, to account for the overall maturity of project portfolio management, we included *portfolio management formalization*, which was measured with four items taken from Teller et al. (2012).

We validated the scales using principal components factor analysis (PCFA) and confirmatory factor analysis (CFA). PCFA tests for unidimensionality of each scale by checking whether all items load onto a single factor. We followed the guidelines of Hu and Bentler (1998) to evaluate structural equation models. They suggest a Comparative Fit Index (CFI) of .95 for good

and of .90 for acceptable fit, and a Root Mean Squared Error of Approximation (RMSEA) and a Standardized Root Mean Squared Residual (SRMSR) below .08 for acceptable fit. PCFA showed that all items loaded onto their respective constructs with high loadings and little cross-loading to other constructs. We next performed a confirmatory factor analysis (CFA) with all latent variables.

Results

Descriptive Results

Descriptive statistics for the four items for proactive lineage and the four items of reactive lineage are depicted in table 1. Figure 1 shows boxplots of the respective items. As can be seen, some lineage practices were more often adapted by firms as others. Among the proactive lineage practices, long-term project roadmaps were used by the majority of our firms. The other pro-active practices (i.e., "we plan our projects over several project generations in advance", "we consciously plan sequences of consecutive projects", and "we systematically identify in current projects the opportunities and consequences for follow-up projects") were only used by about half of our sample firms. This may be an indication that roadmapping of projects is a more familiar practice (Bengtsson & Lindkvist, 2017).

Among the reactive lineage practices most firms agree to the item "Our projects often build on the content of previous projects." But only about half of the firms agree to the statements "We are good in transferring knowledge from previous projects to current projects", "We often miss the opportunity to apply what we have learned in previous projects to current projects (Reversed item)" and "We regularly transfer lessons learned after project closure to improve our standards and routines." The mean values of our eight items range between 3.82 and 4.77, which supports the notion that all lineage practices actually occur in our sample to a certain extent. However, there

is a rather large variance in the practices, meaning that some firms practice project lineage to a great extent and others not at all.

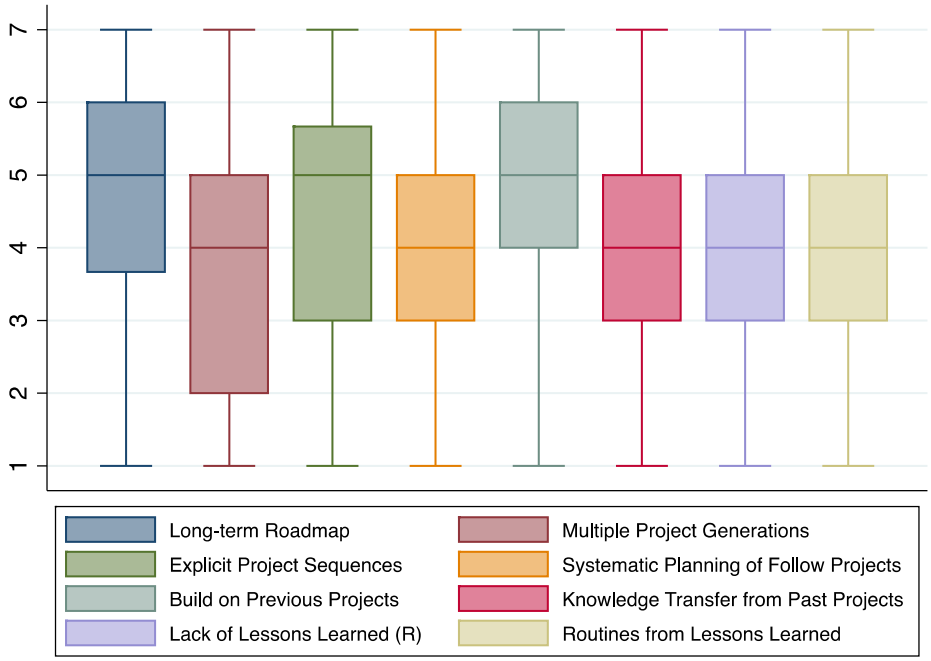

Figure 1: Boxplots of Items for Project Lineage

Table 1. Correlations and Descriptives of Project Lineage Items

	Item	M	SD	Portfolio success			1	2	3	4	5	6	7
				CO	DM	Both							
	Proactive lineage												
1	Long-term roadmap	4.77	1.82	.37	.23	.36							
2	Multiple project generations	3.82	1.89	.27	.13	.25	.52						
3	Explicit project sequences	4.21	1.67	.37	.13	.30	.49	.57					
4	Systematic planning of follow projects	3.82	1.51	.39	.23	.38	.32	.4	.45				
	Reactive lineage												
5	Build on previous projects	4.62	1.31	.21	.02	.14	.15	.31	.30	.28			
6	Knowledge transfer from past projects	4.14	1.31	.50	.10	.37	.34	.28	.28	.31	.38		
7	Lack of lessons learned (R)	4.06	1.32	.44	.16	.37	.28	.15	.15	.23	.16	.65	
8	Routines from lessons learned	3.84	1.51	.34	.17	.31	.28	.19	.27	.35	.16	.31	.23

n = 138, M Mean, SD Standard deviation, CO Coordinator informant, DM Decision maker informant.

The correlations of the eight practice items with portfolio success are significant and positive, but the strength depends on the type of informant. Correlations with the assessment by decision-makers are lower than those with the assessment by coordinators. In order to reach a balanced and more robust assessment of success, we use the combined assessment calculated as the mean value between the two informants for subsequent analysis.

The results of the confirmatory factory analysis are shown in table 2. The measurement model had an acceptable fit ($\chi^2[254] = 374.61$; CFI = .93; RMSEA = .061; SRMR = .067). In particular, these results support the notion that proactive and reactive lineage are separate constructs. Table 3 shows the correlations between the used variables. It can be seen that although proactive and reactive lineage are separate constructs, their correlation is rather substantial (r = .47). This means that firms practicing one type of project lineage are more likely to also practice the other type. As the CFA supports a two-factor solution for project lineage, we include both variables in the regression analyses below. Overall, the results show that the measurement model can be deemed satisfactory.

Table 2. Results of the Confirmatory Factory Analysis

Construct Item	loading
Proactive lineage (Cronbach's *α = .77)*	
We use a project roadmap for the long- term planning of our projects.	.66
We plan our projects over several project generations in advance.	.76
We consciously plan sequences of consecutive projects.	.73
We systematically identify in current projects the opportunities and consequences for follow-up projects.	.56
Reactive lineage (*α = .67*)	
Our projects often build on the content of previous projects.	.44
We are good in transferring knowledge from previous projects to current projects.	.90
We often miss the opportunity to apply what we have learned in previous projects to current projects (reversed item).	.70
We regularly transfer lessons learned after project closure to improve our standards and routines.	.43
Portfolio formalization (*α = .93*)	
Essential project decisions are made within clearly defined portfolio meetings.	.79
Our project portfolio management process is divided in clearly defined phases.	.80
Our process for project portfolio management is clearly specified.	.94
Overall we execute our project portfolio management process in a well-structured way.	.95
Portfolio success	
Strategic implementation (*α = .88*)	
The project portfolio is consistently aligned with the future of the company.	.84
The corporate strategy is implemented ideally through our project portfolio.	.88
Resource allocation to projects reflects our strategic objectives.	.78
The implementation of the strategy is considered a great success in the organization.	.78
Portfolio balance (*α = .83*)	
There is a good balance in our project portfolio ...	
... between new and old areas of application.	.89
... between new and existing technologies.	.91
... between projects that develop new competences and projects that utilize existing competences.	.76
Average product success (*α = .82*)	
Please assess the average success of completed projects:	
Our products/project results achieve the planned market goals (e.g., market share).	.70
Our products/project results achieve the planned profitability goals (e.g., ROI).	.92
Our products/project results achieve the planned amortization period.	.94
Synergy exploitation (*α = .72*)	
During the project execution, development synergies (e.g. shared use of modules, platforms, technologies etc.) between projects are rigorously exploited.	.87
After project completion, exploitation synergies (e.g. shared marketing/sales channels, infrastructure, etc.) between projects are rigorously exploited.	.74
We hardly ever have double work or redundant development.	.48

χ^2 = 374.61 (df = 254; p < .00); RMSEA = .061; SRMR = .067; CFI = .94.

Insert Table 3 here

Regression Results

Table 4 shows the results of ordinary least squares regression with portfolio success as dependent variable. The first model only includes the control variables. As expected portfolio management formalization is strongly related to portfolio success (standardized regression coefficient β = .44, *p* = .000). The other control variables do not have significant effects. Overall, control variables explain 20% of the variance in portfolio success. The next model includes the independent variables reactive and proactive lineage, which both are independently and positively related to portfolio success (β = .29, *p* = .001, and β = .19, *p* = .035, respectively). This means that we can retain hypotheses 1 and 2, which state that both lineage practices contribute to portfolio performance. Together, the independent variables explain an additional 15 % of variance in portfolio success.

Insert Table 4 here

In order to test the postulated complementary effect of reactive and proactive lineage, we included their product term to see whether the constructs interacted. A positive interaction effect would suggest complementary effects between both types of project lineage and a negative effect would suggest substitutional effects. However, we did not find any significant interaction (β = -.05, *p* = .528) and must therefore reject hypothesis 3. In the fourth model, we tested whether lineage

practices become more important in portfolios with a higher percentage of exploratory projects. We must reject hypotheses 4 and 5, because the interaction between the percentage of exploratory projects and reactive lineage (β = .02, p = .79) and proactive lineage (β = -.11, p = .23) are not significant.

In addition, we ran separate models for the different dimensions of portfolio success, to identify whether lineage is more important for certain aspects of portfolio success than for others. The analyses in the subsequent four models of table 4 show that reactive lineage is significantly related to all success dimensions, except portfolio balance. Proactive lineage is only positively related to strategic fit and portfolio balance and not related to average product success and exploitation of synergies. It seems that forward-looking project lineage is more important for the strategic and rather long-term dimensions of portfolio success (i.e., strategic fit and portfolio balance), while reactive lineage is more relevant for the rather operative and short-term dimensions of portfolio success (i.e., average product success and exploitation of synergies).

Discussion

The objective of this study was to show to which extent project lineage management practices exist in project portfolio management and to which extent they are related to the performance of the project portfolio. In addition, we wanted to know if the share of exploratory projects in a project portfolio positively moderates the performance effects of proactive and reactive project lineage management practices. The current study contributes to the project management literature—in particular the literatures on exploratory projects and multi-project management—in several ways. First, while successful examples of project lineage have been demonstrated in previous qualitative case studies (Jullien et al., 2013; Maniak & Midler, 2014; Midler, 2013), the current study is the first quantitative analysis of project lineage and thus

contributes to this emerging field of studying project sequences. Using a sample of 138 project portfolios with two informants per portfolio, we identify two related yet distinct components of project lineage practices: proactive and reactive lineage. We thus operationalize lineage management in a portfolio management context and empirically demonstrate its existence over a larger sample of firms.

Second, we show that both proactive and reactive lineage are related to project portfolio success. This study is therefore the first study to provide quantitative evidence for the performance relevance of project lineage management. Previous studies have centered on the importance and coordination of *concurrent* project interdependencies in portfolios (Killen, 2013; Killen & Kjaer, 2012; Kopmann, Kock, Killen, & Gemunden, 2015; Teller et al., 2012) or programs (Dietrich, 2006; Hoegl & Weinkauf, 2005; Hoegl, Weinkauf, & Gemünden, 2004). We contribute to this research by also showing the relevance of coordinating *temporal* interdependencies.

Theoretical Implications

We find that both components of project lineage have a significant positive effect on project portfolio success. Importantly, these effects exist in addition to the maturity level of project portfolio management as indicated by portfolio management formalization. Thus, both components represent value-creating practices beyond reaching a high maturity of the project portfolio management process. Firms should therefore use both kinds of practices. However, it is interesting to see that proactive lineage is only positively related to strategic fit and portfolio balance and not related to average product success and the exploitation of synergies, whereas reactive lineage is significantly related to all success dimensions, except portfolio balance. These findings indicate that both practices fulfil different purposes in managing project sequences. We also assume that both effects are based on different theoretical foundations.

Regarding both practices' usage we find considerable variance across the project portfolios in our sample. This means that many firms could profit by further increasing project lineage practices. In contrast to the formalization of project portfolio management processes, for which firms have on average a relatively high maturity level, we find a comparatively low maturity level for project lineage practices. Future research should explore the reasons for this and measures to diffuse such practices and attain a higher maturity level.

The *proactive component* is helpful in assessing the strategic contributions of projects by not only assessing their direct expected outcome but also the option value of future projects that they may enable. The proactive component is a driver of the sensing capability and it supports projects that detect possible opportunities, and that validate the feasibility of seizing such opportunities and assessing the fit between the firm and the opportunity. Proactive lineage is also helpful to balance explorative and exploitative projects in the right way, and thus helps firms to become more ambidextrous—meaning that they increase their competence to cope with future opportunities and risks, while at the same time build on past experiences and exploit positions that have been built up by past investments (Tushman & O'Reilly, 1996).

The value-creating function of the proactive component can be found in two streams of research: (1) The work on radical innovations or breakthrough innovations, and (2) the work on real option-based decision-making.

The work on *radical innovation* has shown that many empirical generalizations and theoretical assumptions about managing innovations do not hold in the case of radical innovations (Gemünden et al., 2018; Pich, Loch, & De Meyer, 2002). For example, goal clarity and process clarity can become goal rigidity and process rigidity in case of radical innovation, because people have to *learn* what they can want, and they have to *learn* which unknown risks may occur (Salomo

et al., 2007; Sethi & Iqbal, 2008). If the means to reach a goal are not clear, or if it is not yet clear which positive functions a new technology, product or service will deliver, a feigned goal clarity is not helpful and may hinder exploratory learning. Goal setting theory from Locke and Latham (1990, 2002) states that more specific goals lead to higher performance, but it is based on the premise that actors have the ability to attain their goals. The less the ways to reach a goal are clear, the weaker is the relationship between goal clarity and performance. If it is very difficult and unlikely to find a way to reach the goal in given time and budgets, clear goals may even have a negative effect. The Berlin airport project and its difficulties to fix the smoke extraction function, is a prominent example of massive time and budget overruns. In a similar vein, a process control based on unknown intermediate goals may also induce more harm than benefit. Highly innovative ventures should therefore be managed differently, and specific strategic buckets in which such projects compete for scarce resources should be established (Gemünden et al., 2018). This implication is useful and necessary, but is not sufficient. Radical innovations do not emerge from one project alone. Rather it is very likely that they require a sequence of projects and this should be considered from the beginning. But it is less likely that this is happening. For well-established products and services, it is very clear that its customers expect an even better follow-up product. A project that fulfils this purpose will have not only a promising business plan, but also a lot of senior management support. In case of very new solutions, resistance against change is to be expected, in particular if the new solution cannibalizes existing products and technologies. In this case, expert and power promotion matter most to overcome these barriers. The promotors of such innovations should not only mobilize their power, they should also know that they may require a sequence of consecutive projects to finally reach a successful solution.

The work on real options applies for decision situations with high uncertainty (Tong &

Reuer, 2007). Although radical innovations need a long-term perspective and a sequence of projects, not each and every idea or concept that has been articulated and elaborated should be transferred into a project and not all projects that have been started for such ventures should be completed or get a follow-up project. Rather, choices have to be made that select the right candidates. Real options theory may help to make the right choices and to correctly assess the value of the options created by exploratory projects for follow-up projects.

Market entry, joint ventures, natural resource exploration, new product development projects, and many other strategic initiatives have been studied through a real options lens (Tong & Reuer, 2007). Klingebiel and Adner (2015) delineate three dimensions of resource allocation behavior that allow them to distinguish between real options logic and alternative resource allocation regimes. These elements are: sequencing, low initial commitment, and reallocation. Sequencing is associated with significantly higher new product sales. Low initial commitment and reallocation do not show individual direct effects on new product sales. However, when assessed as a match, the authors find that the fit between low initial commitment and reallocation increases performance significantly. When analyzing the number of assessments in a sequence, the authors find an inverted u-shaped relationship with success: the optimal sequence length is three. Thus, for the management of project sequences, real options reasoning can create value. However, the question remains, to which extent managers are aware of this method and its requirements. The explorative article from Tiwana, Wang, Keil, and Ahluwalia (2007) documents that for IT projects there is only a bounded rationality in using different kinds of real options. And Jahanshahi and Brem (2017) find that higher uncertainty does not always lead to a greater use of real options reasoning.

Based on the article from Klingebiel and Adner (2015), we have developed a scale to

measure if firms apply real options reasoning in making decisions at the project portfolio level about starting or terminating projects, and about resource allocations. We find a moderate positive correlation between project lineage management and real options reasoning ($r = 0.25$ for reactive lineage and $r = 0.31$ for proactive lineage). This means that real options reasoning and project lineage are two different concepts. We may assume that real options reasoning may favor pro-active project lineage, but we do not yet have empirical evidence for this. It is also likely that generating options by proactive lineage management is fostering an options-oriented behavior. The positive correlation between real options reasoning and reactive project lineage surprised us, but makes sense, because seizing options is supported by a systematic learning from the past, and re-using already gained competences in follow-up is equally important. *Our findings suggest that real options reasoning should be combined with both facets of project lineage management.*

The *reactive component* is helpful in exploiting experiences made in past projects, in building on positional advantages that have been created, and in seizing options that have been enabled by previous projects. In contrast to the proactive component, the reactive one realizes values that are on the paths built by previous projects. Therefore, we now observe a positive correlation with the average business success of the projects in the portfolio. Follow-up projects face a lower uncertainty, project managers and project portfolio managers have a clearer understanding of possible synergies between two or more projects, and they can plan and control this better. They may also recognize possible risk accumulations better and take measures to prevent this. This could explain why building on past projects may also help to better manage interdependencies between projects, and why we observe a positive significant influence of the reactive lineage on the success dimension synergies.

The value-creating function of the re-active component can be found in two streams of

research: (1) capturing and disseminating knowledge from previous projects, and (2) retaining project leaders and key team members for subsequent projects.

The first stream of research is about *"lessons learned"* systems and it targets the translation of implicit knowledge into explicit knowledge that can be stored, improved, diffused and made accessible to a wider audience so that it can be leveraged. Ekrot et al. (2016) define a lessons learned systems as the systematic practice of capturing and disseminating knowledge gained during projects. Among the structures and processes established for knowledge management in project contexts, lessons learned systems are the most widely spread (Keegan & Turner, 2001; Mueller, 2015). Capturing and sharing lessons learned from projects has been discussed as appropriate practice to enable the continuous creation of organizational capabilities (Davies & Brady, 2000; von Zedtwitz, 2002) and to realize increased average project performance in the future (Newell & Edelman, 2008; Wheelwright & Clark, 1992). Based on two case studies, Davies and Brady (2000) proposed an organizational learning cycle, which models the building of organizational capabilities based on lessons learned from initial projects and which leads to improved project management procedures and higher project performance of similar follow-up projects.

The second stream of research is about *knowledge sharing* between people. It includes the sharing of tacit knowledge, and of trust and the creation of social capital among actors. If the same people work together in subsequent projects, the actors already know each other and they can rely their coordination on shared knowledge from previous projects. Additionally, their work is facilitated by trust that has been established during their joint previous work (Bartsch, Ebers, & Maurer, 2013; Buvik & Rolfsen, 2015; Mueller, 2015; Situmeang, Buengeler, & Eerde, 2016). Some firms reinforce such knowledge-sharing by establishing departments in which project

managers and key team members are bundled in their permanent organizations so that they develop a common identity, or by establishing communities of practice that exchange their expert knowledge in specific virtual workspaces and in joint conferences where they meet-face-to-face. Research from Ekrot et al. (2016) documents that competence retention is also strongly fostered by career systems for project managers, which link learning on the project job with trainings and seminars that are tailored to the needs of their career level.

It would be very promising for future research to use the research streams outlined above for a more in-depth analysis of project lineage management. In a more elaborated framework, other research streams such as dynamic capabilities, ambidextrous organizing, and path theory could also be included.

Contrary to our expectations we did not find a positive interaction effect of the two project lineage practices with the percentage of exploratory projects on project portfolio performance. Since the percentage of projects in a portfolio is a single-item measure, we also tested other operationalizations of the innovativeness of the project portfolio. The results for the tests with these other multi-item measures of portfolio innovativeness were comparable: there is no significant interaction effect. We may also be cautious about the power of the tests to detect interaction effects. Apart from statistical reasons, this finding can also mean that we can generalize the positive impact of the pro-active and re-active project lineage practices for all degrees of innovativeness. Exploiting experience from previous projects and roadmapping future projects might equally pay off in innovative and non-innovative project portfolios.

In a recent paper, Berggren (2019) illustrated very well the cumulative power of incremental innovation projects, which were focused on improving a specific parameter in the company's established products, done shorter than usually, and applied in a purposefully constructed

consecutive project sequence—see also the concept of 'radical incrementalism' by Myers and Rosenbloom (1996). In his case study of a Swedish car manufacturer, the results of the incremental innovation projects were much higher than expected, and by running a sequence of them in a comparatively short time, this innovation program created a quantum leap in reducing emissions. The study from Pellegrinelli et al. (2015) shows that a succession of incremental execution project can lead to strategic breakthrough if properly managed in a cumulative way. These studies document that projects may have a higher impact and a more efficient resource supply if they are coordinated by a higher management level. This does not only apply to concurrent interdependencies (e.g., resource conflicts, risk accumulations and cost synergies) but also to inter-temporal interdependencies.

Our findings in table 3 show that project portfolio management formalization—an indicator of project portfolio management's maturity level—shows significant positive correlations with reactive and proactive project lineage (correlation coefficient of .19 and .40, respectively). This indicates that a well-managed portfolio process may support future-oriented thinking and stimulate the motivation for exploratory projects.

Managerial Implications

Our findings have some implications for portfolio managers. The results suggest that portfolio managers should practice both proactive and reactive lineage management. Measures to support proactive lineage could be an improvement of roadmapping practices (Bengtsson & Lindkvist, 2017) and corporate foresight activities (Rohrbeck, Battistella, & Huizingh, 2015). Measures to support reactive lineage are lessons-learned systems (Ekrot et al., 2016) and practices that support team continuity.

Furthermore, the finding of project lineage's performance relevance over and beyond

portfolio management maturity shows that only using a static perspective on portfolio decision-making is not sufficient for success. Managers should complement their underlying logic of short-term, inter-project competition for resources with a long-term, temporal cross-project learning perspective.

Finally, project lineage does not only apply to project sequences that aim at completely new functionalities and apply new technological solutions to reach such goals. It can also be used for innovation programs that are more focused on improving existing functions, but want to reach quantum leaps in performance or efficiency.

Limitations and Future Research

This study has some limitations that—apart from its theoretical implications—give rise to future research opportunities. While this study showed the relevance of lineage activities in the context of project portfolio management, the analysis can only be considered exploratory. Although we considered temporal interdependencies by including reactive and proactive linage activities, the analysis itself is cross-sectional. A future theory for managing project sequences is dynamic and thus demands longitudinal designs. This will not only provide a better understanding of how strategic initiatives can be implemented, it will also revise some of the assumptions about projects that we currently have. For example, the literature on the front end of innovation (see Eling & Herstatt, 2017 for a review) has developed specific practices for this highly uncertain stage, but neglects previous projects have generated knowledge, skills and abilities, which should be exploited. And such a sequencing can and should be managed more systematically. Similarly, radical innovations have often been analyzed as stand-alone projects, although even radical projects stand on the shoulders of giants. A longitudinal analysis of project sequences will therefore also lead to a better understanding of the front end and the innovativeness of projects. It

will also generate more knowledge how breakthrough innovations and radical organizational transformations have been successfully implemented in organizations and markets or how they failed. Another example is the theory of dynamic capabilities, which has gained increasing popularity in the realm of project management research (Davies, Dodson, & Gann, 2016; Killen & Hunt, 2010; Killen et al., 2012; Petit & Hobbs, 2010; Sicotte et al., 2014). It has been applied for major complex projects and for project portfolios but not yet for project sequences. In longitudinal studies of project sequences, management researchers could answer the question how dynamic capabilities develop and how such capabilities can also be lost or how previously dynamic capabilities change into ordinary capabilities.

Furthermore, we concentrated on showing the direct effects of lineage on project portfolio success. Future research could investigate contingency variables that affect the strength and maybe direction of these relationships. For example, it could be interesting to analyze the mechanisms and boundary conditions of self-reinforcing spirals in a sequence of projects that create positive and negative effects (Möllering & Sydow, 2018). Lineage management could also be more relevant in certain types of portfolios or environments. Relevant moderators could be, for example, project interdependency and innovativeness, and market and technology turbulence, respectively. Future studies could also analyze potential antecedents to lineage management such the entrepreneurial orientation of the organization (Anderson, Kreiser, Kuratko, Hornsby, & Eshima, 2015).

Our analysis was not intended as a comprehensive test of lineage models that have been developed by Midler and colleagues. Rather, we focused on two elements that we believe are critical in lineage management, learning from the past and exploring future opportunities, as well as the integration of both elements. Our main idea was that a current project should always exploit

previous projects that delivered relevant knowledge, and that it should not only deliver results for its current stakeholders, but also for future projects and their stakeholders.

Finally, we did not develop a theory how to cope with barriers and negative side-effects of lineage management. Our research documents that lineage management is only applied at a medium level and by a minority of firms. Future research should analyze which barriers affect project lineage practices' implementation and which factors motivate and drive their implementation. It should also consider the conditions for fast and slow learning, which have been researched.

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Tables

Table 3: Correlations and Descriptive Statistics

	Variable	M	SD	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Portfolio success	4.49	.66	2.00	6.20	1.00												
2	Strategic fit	4.82	.94	1.13	6.75	0.83	1.00											
3	Portfolio balance	4.59	.79	2.13	6.88	0.79	0.60	1.00										
4	Average product success	4.40	.75	2.38	6.25	0.73	0.47	0.49	1.00									
5	Synergy exploitation	4.21	.85	2.00	6.17	0.77	0.54	0.47	0.43	1.00								
6	Reactive lineage	4.17	.96	1.25	6.25	0.43	0.33	0.24	0.33	0.46	1.00							
7	Proactive lineage	4.16	1.34	1.00	7.00	0.41	0.40	0.34	0.19	0.33	0.47	1.00						
8	Firm size (log)	7.31	1.97	2.77	13.30	-0.09	-0.03	-0.14	-0.13	0.00	0.06	0.13	1.00					
9	Portfolio budget (log)	3.45	1.60	-.80	7.74	0.04	0.04	0.02	0.11	-0.03	0.07	0.19	0.43	1.00				
10	Percentage of exploratory projects	21.0	21.0	0	90	-0.06	0.06	-0.05	-0.11	-0.08	0.02	0.07	-0.05	-0.28	1.00			
11	Percentage of mandatory projects	47.1	29.7	0	100	-0.09	-0.16	-0.16	0.07	-0.02	0.04	0.06	0.05	0.03	-0.02	1.00		
12	Percentage of external projects	26.1	32.7	0	100	-0.05	-0.17	-0.05	0.11	-0.04	0.04	-0.07	-0.16	0.13	-0.11	0.12	1.00	
13	Percentage of R&D projects	28.3	37.1	0	100	0.07	0.01	-0.01	-0.05	0.24	0.25	0.06	-0.10	-0.08	0.08	-0.07	-0.03	1.00
14	Portfolio management formalization	4.97	1.68	1.0	7.0	0.39	0.42	0.33	0.21	0.25	0.19	0.40	0.13	0.13	-0.04	0.04	-0.26	-0.18

n=138, M = mean, SD = standard deviation, Min = Minimum, Max = Maximum. All correlations larger than .17 are significant at $\alpha = .05$.
Diagonal elements in parentheses are square roots of average variance extracted for constructs measured reflectively with multiple items.

Table 4: Results of Ordinary Least Squares Regression Analysis

	Portfolio Success				Dimensions of Portfolio Success			
	Controls	H1/H2	H3	H4/H5	Strategic fit	Portfolio balance	Avg. product success	Synergy exploitation
Controls								
Firm size (log)	-.13	-.16†	-.16†	-.16†	-.12	-.20*	-.23*	.01
Portfolio size (log)	.03	-.01	-.00	-.01	.02	.00	.13	-.13
Percentage of exploratory projects	-.04	-.07	-.07	-.08	.05	-.07	-.07	-.14†
Percentage of mandatory projects	-.09	-.11	-.11	-.09	-.18*	-.18*	.04	-.03
Percentage of external projects	.06	.02	.02	.01	-.08	.01	.07	.01
Percentage of R&D projects	.14	.02	.02	.05	-.03	-.03	-.10	.19*
Portfolio management formalization	.44**	.29**	.29**	.29**	.30**	.25**	.16†	.19*
Independent variables								
Reactive lineage		.29**	.29**	.30**	.20*	.11	.33**	.33**
Proactive lineage		.19*	.19*	.19*	.21*	.23*	-.01	.12
Reactive lineage x proactive lineage			-.05					
Reactive lineage x percentage of exploratory projects				.02				
Proactive lineage x percentage of exploratory projects				-.11				
R^2	.20	.35	.35	.35	.33	.25	.21	.30
Adjusted R^2	.15	.30	.29	.30	.28	.19	.15	.25
Delta R^2		.15	.00	.00	.10	.07	.10	.13
F	4.74**	7.45**	6.72**	6.25**	6.88**	4.65**	3.62**	6.06**

n=138, standardized beta coefficients are reported, † p < .10, * p < .05, ** p < .01.