

B2B Projects, Task Configuration, and Innovation

ABSTRACT

Many new products and processes originate from projects. In two studies we consider how a project's design, as captured by its particular task configuration, impacts its ability to promote product and process innovation. Study 1 involves an analysis of panel data spanning 2001 through 2015 and involving 429 business-to-business (B2B) projects in the construction industry. We test hypotheses regarding the role of project size, subcontractor diversity, and task configuration on product and process innovation. Our empirical tests show a pattern of nuanced effects on the two innovation types. A project's task configuration, as reflected in the general contractor's participation in project tasks, plays a coordination role that helps unlock a positive effect of project size on product innovation. At the same time, such participation impedes process innovation due to subcontractor concerns about information leakage. Study 2 bolsters the first study through a survey of 230 subcontractors in the U.S. construction industry to show how leakage concerns arise, their outcomes, and how they are mitigated. We also bolster our central study through 1) interviews with professional construction managers and 2) survey evidence across five industries. We draw on our findings to develop implications for innovation management, B2B marketing, and marketing organization.

Keywords: B2B projects, task configuration, coordination, innovation

Innovation is inherently important to firms, as reflected in Tellis' (2013, p. 2) observation that "perennial success belongs to those firms that innovate unrelentingly". Consequently, understanding how innovation comes about is important both for academics and managers (Hauser, Tellis, and Griffin 2006). While some innovations are the result of a "flash of genius" or even accidents, as in the well-known cases of the Post-it-Note, most innovations have systematic and identifiable drivers.

A sizeable body of research in marketing, strategy, organization theory, and economics has documented these drivers. Historically, as noted by Baldwin and von Hippel (2011), the focus of this research has been on a single firm and the particular characteristics that promote or impede innovation. For instance, researchers have studied the effect of organizational culture (Moorman, 1995; Tellis, Prabhu, and Chandy, 2009), structure (Azoulay and Lerner 2013), resources (Chandy and Tellis 1998), and demographics (Damanpour 1991). Over time, this line of research has been augmented by an inter-organizational focus, including the roles of long-term relationships (Noordhoff et al. 2011), strategic alliances (Cui and O'Connor 2012; Rindfleisch and Moorman 2001), and joint ventures (Gulati 1998; Sampson 2007).

Interestingly, however, much innovation takes place outside of permanent firms and long-term relationships, in the context of projects or, in organization-theoretic parlance, temporary organizations where a set of diversely skilled firms come together to perform a set of interrelated tasks over a limited time period (Hadida, Heide, and Bell 2019; Goodman and Goodman, 1976).

A project represents a fundamental but poorly documented paradox: On the one hand, projects promote innovation by bringing together a set of specialists (Goes and Park 1997). The larger a given project's *size*, as reflected in its number of subcontractors (Damanpour

1991), and the greater their *diversity* in their tasks (Phelps 2010; Lahiri and Narayanan 2013), the greater the amount of information that is brought to bear on the project (Rindfleisch and Moorman 2001), and the greater the potential for innovation. As a specific example, Tesla, as the general contractor, relied on a dedicated project to create the model S for its customers. In this project, dozens of subcontractors like Panasonic and ZF developed components like batteries and power steering, while Tesla itself participated in software design and integration activities. Similarly, Apple as the general contractor developed the first iPod through the so-called “P-68” project with input from key subcontractors like Pixa and PortalPlayer, while performing key integration tasks internally.

At the same time, converting the different specialists’ inputs into innovation (Chandy et al. 2006) represents significant challenges. Kirsner (2017) notes that innovation is not limited by a lack of ideas – a greater challenge is capitalizing on them through organizational coordination. Interestingly, the very characteristics that create the potential for innovation in the first place give rise to coordination problems. Large projects, while providing resource access, pose coordination problems due to the number of task interdependencies (Puranam and Raveendran 2013; Thompson 1967). Subcontractor diversity creates its own coordination problems, due to the need to overcome differences in project members’ goals and communication codes (Phelps 2010; Gulati, Wohlgezogen, and Zhelyazkov 2012).

Bechky (2006) notes how past research on projects has focused on their general impetus and desired outcomes but has ignored the mechanisms by which the outcomes come about. We argue that projects, like any organization, must be purposely organized or governed. At the same time, because of their distinct characteristics, projects require unique governance solutions. We draw on classic (e.g., March and Simon 1958; Thompson 1967) and emerging (Greenwood and Miller 2010; Joseph and Gaba 2020) work on organizational design which suggests that innovation depends crucially on a project’s particular *task*

configuration (Mintzberg 1979). Specifically, we argue that a general contractor's own participation in project tasks facilitates coordination and ultimately promotes innovation.

Our conceptual framework focuses on 1) product and 2) process innovation (Chandy and Prabhu 2010), which involve significantly improved 1) product outcomes and 2) means of task performance, respectively (Mooi, Wathne, and Kayande 2016; Rindfleisch and Moorman 2001). While the two may co-occur, they represent distinct forms of innovation, and they pose different challenges (Sorescu 2017). We identify two main innovation drivers, namely 1) project size and 2) subcontractor diversity and examine how their ability to drive product and process innovation is contingent on the project's task configuration.

We seek to make the following three contributions: First, we generate new insights into the long-standing question of how firms should organize for innovation (Hauser, Tellis, and Griffin 2006; Lilien 2016; Tellis, Chandy, and Prabhu 2012). More specifically, we add to a nascent literature in marketing (e.g., Hadida, Heide, and Bell 2019) on organizations with defined durations. Theoretically, a project represents a unique organizational form, a so-called temporary organization, that is distinct from both permanent firms and ongoing relationships. While research has documented the ubiquity of this organizational form, using terms like "project society" (Lundin et al. 2015), it has received limited attention in marketing.

Second, while innovation is commonly viewed as a "collective activity" (Powell, White, Koput, and Owen-Smith 2005, p. 1133), past research has tended to focus on questions like project composition *per se* (Vakili and Kaplan 2020), rather than on how the interactions between its members are managed. However, projects have been argued to represent "daunting challenges" (Greenwood and Miller 2010, p. 78) from an organizational standpoint. Theoretically, projects resemble a one-shot "Prisoner's Dilemma" game, whose fixed duration undermines coordinated action (Axelrod 1984). This challenge, we argue, requires a unique

approach to coordination, including mechanisms that can be implemented under time compression. Our specific focus is on *task configuration*, which addresses the tension between 1) accessing the diverse skills of a set of specialist subcontractors, and 2) coordinating their inputs in a manner that produces innovation. In general, our focus on coordination advances the literature on inter-firm governance, which, as noted by Oliveira and Lumineau (2017), has paid limited attention to these types of problems.

Third, we show that a project's task configuration, as reflected in the general contractor's degree of task participation, impacts product and process innovation differently. Indeed, we propose that participation creates a potential trade-off between the two: On the one hand, task participation produces coordination benefits that promote *product* innovation. At the same time, participation creates concerns about information leakage for the project's subcontractors, since a general contractor can misappropriate key practices and deploy them on future projects. In examining this question, we enhance our understanding of the role that so-called "integrators" (Oliveira and Lumineau 2017) play in projects. Specifically, we argue that misappropriation concerns discourage subcontractor engagement and ultimately impede *process* innovation. As such, when left unchecked, task participation possesses a "dark side" (Noordhoff et al. 2011). This perspective adds nuance to prior research (e.g., Damanpour 2010), which has assumed that product and process innovation have common causes. Theoretically, it points to a fundamental organizational tension (Katila, Rosenberger, and Eisenhardt 2008), namely between 1) acquiring key resources, as per resource dependence theory (Pfeffer and Salancik 1978) and 2) protecting one's own, as per extant governance theory (Williamson 1985).

From an empirical standpoint we respond to calls from innovation researchers for "fine-grained data at the project level" (Azoulay and Lerner 2013, p. 576). Our empirical approach is as follows: Study 1 tests four different hypotheses (H1-H4) based on a unique

longitudinal data set of 429 construction projects from 2001 through 2015. To address potential concerns about unobserved heterogeneity while fully using the information available, we adopt a hybrid effects model (Allison 2009) that combines the beneficial properties of fixed- and random-effects estimators. We also conducted a supplementary survey to Study 1 across five industries to assess the generalizability of our constructs. Study 2 involves a cross-sectional survey of 230 construction subcontractors designed to test two hypotheses (H5-H6) regarding the key processes underlying our model, namely how 1) task participation creates information leakage concerns, 2) its consequences, and 3) how these consequences can be mitigated. We complement our formal hypotheses tests with a set of in-depth interviews designed to validate our key constructs.

This paper is organized as follows: First, we discuss the project as an organizational form and how its unique characteristics both promote and impede innovation. Next, we present our conceptual framework, including our research hypotheses. Then, we describe the research method, the research setting, and our empirical studies. We conclude by summarizing our contributions, the study's limitations, and possible extensions.

THE PROJECT AS AN ORGANIZATIONAL FORM

A project is a particular form of temporary organization, where a set of specialist firms (e.g., electricians, plumbers) collaborate to complete a task (e.g., a new building) within a predetermined time frame (Puranam and Raveendran 2013). Theoretically, a project represents a particular organizational form which doesn't fit into standard typologies like 'market, hierarchy, and hybrid' (Williamson 1991). To understand why, it's useful to compare a project's unique features to those of other organizational forms like permanent firms and strategic alliances on the basis of the so-called "three Ts" (Lundin and Söderholm 1995),

namely *task*, *time*, and *team*. We discuss each of these below and provide concrete examples in Web Appendix A of how they manifest themselves in different settings.

First, with regard to *task*, a project is typically a one-off undertaking. The Project Management Institute (PMI) notes how “every project is undertaken for the first time” (Gallagher 2015). While novel tasks may also happen within a firm or alliance, the latter two’s tasks frequently involve repetition or adjustments to existing strategies. In contrast, task novelty is a defining characteristic of a project.

Second, projects are undertaken within a discrete *time* frame, with the beginning represented by the commitment to the focal task, and the endpoint by its completion. A project is subject to “institutionalized termination” (Lundin and Söderholm 1995, p. 499). This contrasts with 1) on-going firms whose members possess a common history and an expected future, and 2) partnerships that are frequently “built to last” (Bakker and Knoben 2015) and whose termination may be unrelated to task completion (Das 2006).

Finally, a project’s *team* typically comprises a large number of specialist suppliers that are selected – frequently from scratch and in an open market – based on the characteristics of the task at hand. In contrast, a permanent organization tends to assign members from an internal labor pool (Kaufman 2013). A strategic alliance, like a project, involves purposeful partner selection, but it typically comprises only two parties, in contrast with a project which has numerous members (Parmigiani and Rivera-Santos 2011).

A project’s capacity for innovation follows from its “Task” and “Team” dimensions; from the ability to bring a set of specialist suppliers’ knowledge and resources to bear on a particular task, while its “Time” dimension represents constraints due to time compression. As stated by The Project Management Institute: “... a project team may not be the first to build an aircraft carrier, but they are the first to build that aircraft carrier – which must be built

using this team, in that location, with those suppliers, this design, and these constraints.

Project ... is all about breaking new ground ... this places innovation right at the heart of projects” (Gallagher 2015).

In the context of construction projects, our 9 interviews (details of which we discuss in the Method section) suggest that innovation is very much a sought outcome, in part because of the ability of innovation to generate savings, both for contractors and customers. Laursen and Salter (2006) note how innovation-related goals, for instance in the form of health, safety, and environmental standards, are often stated explicitly at a project’s outset. Indeed, innovation and task completion often coincide with each other in construction, and this represents a key source of competitive advantage for construction firms. Ultimately, the importance of innovation is often reflected in how such firms communicate with their stakeholders.¹

CONCEPTUAL FRAMEWORK

As shown in Web Appendix B, a project comprises 1) a *buyer*, who initiates the project, 2) a series of *subcontractors* who apply their knowledge and resources to the focal tasks, and 3) a *general contractor* who represents the buyer and coordinates the tasks of the various subcontractors. Often, the general contractor participates in project tasks herself (Knoben and Gössling 2009). A project’s pattern of task allocation is described as its task configuration (Mintzberg 1979).

Baseline Predictions: Innovation Drivers and Outcomes

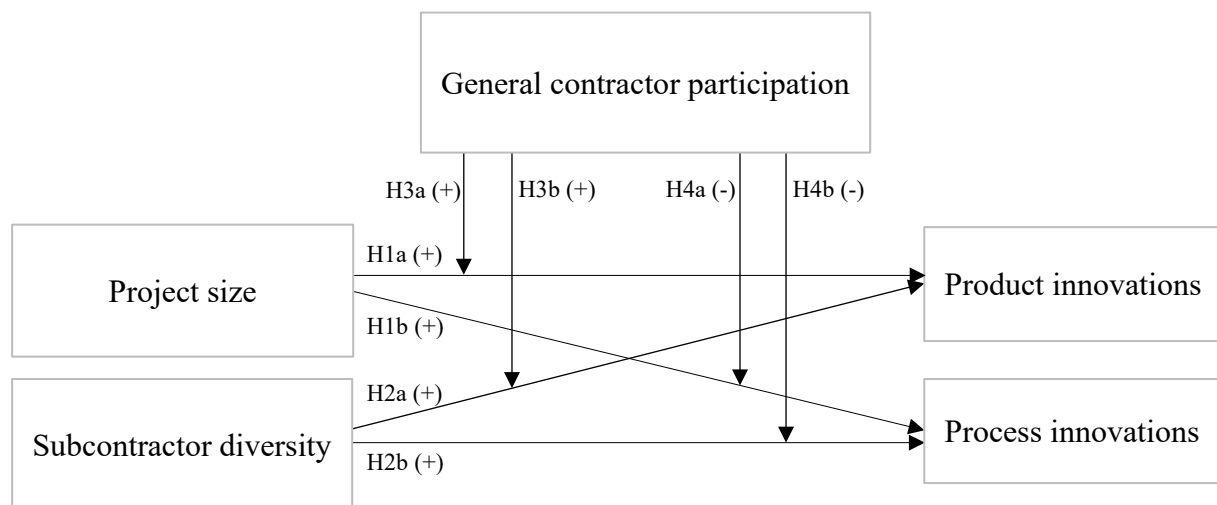
Our conceptual framework is shown in Figure 1. Its dependent variables are two different types of innovation, namely *product* and *process* innovation (Chandy and Prabhu

¹ As an example, Skanska, one of the largest global construction firms, wrote in their 2019 annual report that “Skanska set a target of achieving net-zero carbon emissions by 2045, including our value chain. This is essential for supporting the Paris Agreement and for innovating climate-smart solutions”.

2010). Product innovation is defined as new or significantly improved product features or attributes (Rindfleisch and Moorman 2001). In the context of construction, an example would be a building with a significantly lower ecological footprint than the industry norm. Process innovation refers to a significantly improved operational process or working method (Damanpour 1991), such as a fast-track design/build scheduling methodology.

To further illustrate the difference between the two forms of innovation, the construction of the Cedar Water Treatment Facility (CWTF), one of the projects in our sample, delivered 1) product innovation through its pioneering use of UV technology which improved filtration efforts, and 2) process innovation in the form of an automated Supervisor Control and Data Acquisition (SCADA) system which significantly improved the facility's monitoring capability. We provide additional details in Web Appendix A, Panel A.

Figure 1. Study 1 Conceptual Framework



As shown in prior research (e.g., Cui and O'Connor 2012), innovation of any kind hinges on the availability of resources and knowledge. Our framework captures this through two particular project characteristics, namely 1) *project size* (the number of subcontractors involved), and 2) *subcontractor diversity* (the variation in the tasks performed by the different subcontractors). We discuss each of these drivers below.

Project Size. As shown in Figure 1, one of our baseline predictions is that the greater the project size, as reflected in the number of subcontractors, the greater the number of product innovations. There are two reasons for this expectation: First, as past research and our interviews revealed, project size determines the amount of knowledge that is available (Rindfleisch and Moorman 2001). The larger the project, the greater the quantity of available information, and the greater the potential for innovative outcomes. Second, larger projects make slack resources available; resources that exceed a given project's minimum requirements. This allows for risk-taking and the ability to absorb failure (Sydow, Lindkvist, and DeFillippi 2004), which promotes innovation. We propose the following:

H1. Project size is positively related to the number of (a) product innovations and (b) process innovations.

Subcontractor diversity. Project size, as discussed above, impacts product and process innovation due to the quantity of knowledge and resources that is generated by a large pool of members. We expect diversity to have a parallel effect, but based on a different explanatory mechanism, namely the breadth of information and resources that are made available. The greater the diversity among a project's subcontractors, the greater the range of available skills, knowledge, and resources that are brought to bear (Edquist and Hommen 1999), and the greater the resulting number of product and process innovations (Cui and O'Connor 2012). In essence, diversity makes unique information available to a project (Rindfleisch and Moorman 2001), which allows for novel input configurations and an increased likelihood of innovative outcomes (Sampson 2007). Our second baseline hypothesis is as follows:

H2. Subcontractor diversity is positively related to the number of (a) product innovations and (b) process innovations.

We characterize H1 and H2 as baseline predictions, based on the innovation literature's perspective on size and diversity. That said, these predictions are not entirely obvious. In fact, as will be discussed, size and diversity can give rise to various governance-

related problems which undermine their innovation potential. For instance, the greater the number of suppliers, the greater the difficulty of monitoring individual performance, and the greater the potential for shirking that undermines coordination (Alchian and Demsetz 1972).

The Project Coordination Problem: Converting Innovation Drivers into Outcomes

H1 and H2 express the potential for product and process innovation that follows from project size and diversity. We now add precision to these arguments by considering 1) whether this potential may be *impeded* due to coordination problems that follow from size and diversity, and 2) how such problems may be *solved* in a way that promotes innovation.

Theoretically, a project involves a specific division of labor, namely 1) a mapping of organization-level goals into tasks, and 2) an allocation of tasks to individual agents (March and Simon 1958; Puranam and Raveendran 2013). The resulting partitioning creates efficiencies (Malone et al. 1999), but it also introduces biases. One of them is a “component focus” (Heath and Staudenmayer 2000), namely a tendency by project members to focus on individual tasks to the detriment of the boundaries between them (von Hippel 1988). In practice, this creates a coordination problem which will compromise performance unless “the collective set of interdependent tasks ... is integrated” (Okhuysen and Bechky 2009, p. 463).²

The magnitude of a given project’s coordination problem depends on its particular characteristics. Consider first project size. While a large number of subcontractors increases information availability, it also increases the number of task interdependencies that must be

² Past research recognizes two different kinds of integration problems that are information- and motivation-related, respectively (Puranam and Raveendram 2013). The former pertains to coordination, whereas the latter involves cooperation. While both types of problems may manifest themselves on a project, our current focus is on those that follow from size and diversity, and that have to do with coordination. Compared to traditional (dyadic) buyer-seller interactions, coordination problems are amplified in projects due to the exponentially greater number of possible interdependencies that must be managed (Eccles 1981).

managed (Thompson 1967; Knoblen and Gössling 2009). A failure to manage them means unsynchronized tasks, likely compromises, and ultimately a failure to achieve innovation.

Subcontractor diversity creates a coordination problem for a different reason. The greater the subcontractor diversity, the higher the likelihood that the focal parties will have different goals, decision-making processes, and communication protocols (Phelps 2010). Such differences represent impediments to coordinated action, above and beyond those that follow from size and task interdependencies per se. As such, high diversity represents a potential innovation barrier in its own right. Next, we consider how the coordination problems that follow from size and diversity may be addressed.

Task Participation as a Project Coordination Mechanism

To identify a solution to the project coordination problem, we turn to the literature on organizational design, whose core subject matter is “the pursuit of integration” (Puranam, Raveendran, and Knudsen 2012). Historically, this literature focused on coordination through permanent organizational structures (e.g., Thompson 1967), but emerging design research focuses specifically on coordination in new organizational forms like projects that span organizational boundaries (Gulati Wohlgezogen, and Zhelyazkov 2012; Joseph and Gaba 2020). This literature notes that while projects lack the support of a formal hierarchy (Greenwood and Miller 2010), hierarchical influence can be brought to bear on a project through the use of “integrators” (Oliveira and Lumineau 2017) who are uniquely qualified to assess and manage a project’s interdependencies (Puranam, Raveendran, and Knudsen 2012).

Due to its particular role which intersects with both the buyer and the subcontractors, a project’s general contractor is in a unique position to serve as an integrator. We posit, however, that the general contractor role is in itself insufficient to ensure coordinated action. This capability ultimately resides in the general contractor’s own *participation* in a range of

different project tasks. The participation construct is central in different branches of the design literature (e.g., Milgrom and Roberts 1988; Mintzberg 1979) and it has also been examined in different marketing settings, including wholesaler-retailer interactions (John and Reve 1982), new product development (e.g., Slot, Wuyts, and Geyskens 2020), buyer-supplier alliances (Heide and John 1990), and manufacturer-distributor relationships (Sa Vinhas and Heide 2015).³ As a design mechanism participation has unique coordination properties, because of its ability to generate and share knowledge between parties (Fang, lee, and Yang 2015) without the rigidity of mechanisms like plans, rules, and contracts (Thompson 1967).⁴

Consider how a general contractor's task participation mitigates the specific coordination problems that follow from project size and diversity, and thus helps realize their innovation potential. By performing key tasks internally, a general contractor acquires a first-hand understanding of 1) the skills needed for task execution, 2) the relevant standards for task performance, and 3) the inter-relationships between individual tasks. Essentially, participation provides a general contractor with architectural knowledge (Sanchez and Mahoney 2013) which facilitates directing subcontractors, holding them accountable, and taking corrective action to ensure that the different individual actions support the larger innovation goal.⁵

In principle, the general contractor's own involvement in the focal tasks generates informal authority based on expertise (Gulati, Wohlgezogen, and Zhelyazkov 2012). As such, its communications and directions will be accepted as legitimate by the relevant

³ Theoretically, participation pertains to the manner in which particular functions are executed across organizational boundaries (Heide and John 1990; von Hippel 1990). As such, the participation construct has a long history in marketing, going back to the early functional and institutional schools of thought (e.g., Bucklin 1967). In those literatures, however, the emphasis was on the *allocation* of functions rather than on sharing or participation per se.

⁴ Indeed, researchers (e.g., Goodman and Goodman 1976) have noted how formal organizational structures, including fixed role specifications, possess inherent limitations as coordination devices.

⁵ We thank one of the interviewees for offering this insight.

subcontractors (DeFillippi and Sydow 2016; Stinchcombe 1990). Thus, if a given project due to its size and diversity poses coordination challenges, the general contractor's own task participation ensures that the relevant project inputs are converted into product innovation with a minimum of friction.

The preceding discussion suggests that the expected positive effect of project size (as per H1a) and subcontractor diversity (as per H2a) on product innovation will be enhanced for higher levels of general contractor task participation. In hypothesis form:

H3. General contractor task participation strengthens the effect of (a) project size and (b) subcontractor diversity on the number of product innovations.

In technical terms, H3 expresses two positive moderation scenarios, where the effects of the two project characteristics on product innovation are enhanced by the general contractor's task participation. Importantly, however, we expect the positive moderation effect of general contractor participation to be limited to product innovation. Process innovation, we argue, involves a different scenario, where general contractor participation actually has a negative moderation effect. Specifically, we posit that participation will weaken the effect of the two project characteristics on process innovation (as per H1b and H2b).

Our logic is as follows: Past research (e.g., Slot, Wuyts, and Geyskens 2020) suggests that while task participation has efficiency implications, it may also cause transactional problems (von Hippel 1990). Specifically, because a process innovation possesses a generalizable quality, the subcontractor's efforts and project-specific investments can be misappropriated by the general contractor and deployed in other projects. Indeed, a misappropriation scenario is predictable based on both general contractor ability and motivation; participation facilitates process learning (ability) which can be leveraged through subsequent redeployment (motivation). Our interviews specifically suggested that since

process innovations typically result in cost and time savings, they create significant incentives for information leakage by a general contractor.

Once the general contractor adopts process innovations in one project, the innovating subcontractors may subsequently be expendable, and may not benefit fully from their investments and innovation efforts more generally. Importantly, research (e.g., Cohen, Nelson, and Walsh 2000) suggests that R&D executives have limited faith in formal safeguards like patents, and often consider secrecy the most effective source of protection. Our interviews also suggested patents were "of little or no use" and that subcontractors tend to keep valuable knowledge "close to themselves" and avoid sharing it.

Thus, for process innovations, where the general contractor's task participation poses leakage concern, the predictable outcome is a reluctance on the part of the subcontractors to share information and engage in purposeful coordination (Susarla and Mukhopadhyay 2019). Interestingly, concerns about leakage and secrecy are less salient for product innovations. Since such innovations are tailored to a buyer's demands and become its property, they don't possess the generalizable quality that causes leakage concerns for process innovations. We summarize the above discussion in the following prediction:

H4. General contractor participation weakens the effect of (a) project size and (b) subcontractor diversity on the number of process innovations.⁶

The prediction in H4 differs from the positive moderation scenario in H3. Theoretically, this means that participation by a general contractor has two different effects, depending on the type of innovation. In H3, the unique nature of product innovation mitigates leakage concerns, and participation is expected to play a positive coordination role. In

⁶ We note that our empirical test of H4, which, as will be discussed, relies on secondary data, is inherently constrained in its ability to generate fine-grained insights into the underlying constructs and processes, including a subcontractor's specific investments in the project and its specific concerns about misappropriation. Our empirical test of H4 can only establish whether general contractor participation weakens the hypothesized effects in the context of process innovations. However, we augment this test with a test involving primary (survey-based) data which allows us to document the underlying processes. We return to this question in the next section.

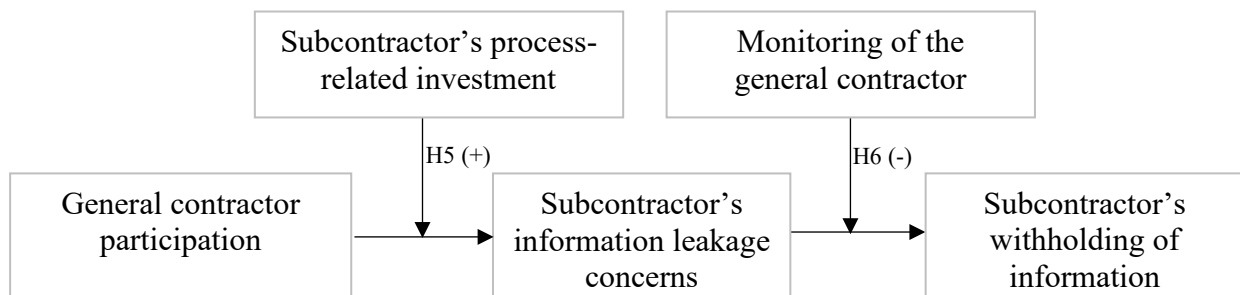
contrast, H4 suggests that the very actions that enhance coordination for product innovation actually have a “dark side” (Noordhoff et al. 2011) that undermine process innovation.

The Dark Side of Task Configuration

While the misappropriation construct has received limited attention in marketing, it is a significant concern on projects, in part because the built-in restraints on opportunism that characterize other organizational forms like partnerships and alliances are not available. Baccara (2007) specifically notes how misappropriation problems manifest themselves in many different project contexts, including IT, engineering, consulting, and finance.

We now add precision to our earlier arguments by proposing a conceptual framework, shown in Figure 2, which explicates 1) how task participation creates leakage concerns, 2) the specific outcomes of such concerns, and 3) how these concerns can be mitigated.

Figure 2. Study 2 Conceptual Framework



By definition, task participation allows a general contractor to observe subcontractor practices, and thus to acquire key information. Such learning, in turn, can be applied by the general contractor to future projects, without compensating the subcontractor(s) in question. Thus, our baseline expectation is that the greater the level of general contractor participation on a given project, the greater the subcontractor's leakage concern.

Our previous discussion of H4, however, suggests that this effect is contingent on the nature of a given subcontractor's contributions to the project. Specifically, if the subcontractor

has made process-related specific investments (Wathne et al. 2018) in the project, it increases the value of the practices that are brought to bear on it, and thus the general contractor's incentive for misappropriation. From the subcontractor's standpoint, such investments represent vulnerability, and ultimately create concern about leakage. This scenario is aptly described by Shapiro and Varian (1999, p. 3) in their description of information which is "costly to produce but cheap to reproduce". We propose the following hypothesis:

H5: The positive effect of general contractor participation on a subcontractor's leakage concerns is amplified by the subcontractor's process-related specific investments.

The right part of Figure 2 describes the effects of the subcontractor's leakage concern. In the absence of protection for misappropriation, a subcontractor's predictable response to leakage concern is to curtail the commitment to the focal project (Li et al. 2012); specifically, by withholding key information (Frazier et al. 2009). While this causes efficiency losses for the project as a whole, withholding protects the subcontractor's investments. Thus, we expect that leakage concerns will cause a subcontractor to withhold information.

This begs the question, however, of whether safeguards exist that mitigate the subcontractor's concerns, and, if so, promote efficient information transfer. Contracts and patents are intuitively appealing safeguards but have been shown to be constrained in their ability to protect against misappropriation (Katila, Rosenberger, and Eisenhardt 2008; Mayer and Solomon 2006). We posit that the risk must be addressed in a more direct fashion – in a way that addresses the basic information problem that exists. This can be accomplished through direct monitoring which can detect general contractor opportunism. As a governance strategy, monitoring represents a formal communication channel which 1) signals permissible actions, and 2) deters non-acceptable ones like misappropriation (Murry and Heide 1998). Thus, as shown in Figure 2, we predict that the effect of leakage concern on information

withholding will be mitigated in the presence of monitoring of the general contractor. In hypothesis form:

H6: The positive effect of a subcontractor's leakage concern on information withholding is weakened by monitoring of the general contractor.

STUDY 1: METHOD AND RESULTS

Empirical Context

Study 1 tested hypotheses H1-H4 using data on construction projects from the Design-Build Institute of America (DBIA), an organization which promotes design-build project delivery in the U.S to its members. The DBIA asks its members to submit structured information on completed projects; information which is subsequently verified by an electronic signature certifying that "I confirm that all information provided about this project is true and accurate to the best of my knowledge". Our data span all 429 projects that the DBIA reported on from 2001 to 2015. Typically, these projects feature a different composition of buyers, general contractors, and subcontractors. However, some of them feature the same general contractor, enabling us to observe both between- and within-project variation.⁷ We augmented the rich DBIA data with data from Hoovers (Company Profiles), the U.S. Census Bureau, and metrics from Google. The unit of analysis is a particular construction project and is reported on by the general contractor, who is in an excellent position to describe the phenomena in question. Below, we first describe our measurement procedures in detail, followed by a discussion of our hypothesis testing approach.

Measurement and Descriptive Statistics

Product innovation is defined as new or significantly improved product features or attributes (e.g., Damanpour 1991; Rindfleisch and Moorman 2001). We multiplied the count

⁷ We observe five "role reversals" in our dataset where buyers become general contractors or vice-versa. Further testing does not show that such reversals themselves are predictive of product or process innovation.

of the number of product innovations by the weight, in terms of their newness of the innovation to the market, for each innovation. The count of product innovations was taken from the text describing the project's key achievements, from which we coded each distinct product innovation manually. We verified, using a second independent coder, that the coding was accurate, and we resolved a small number of differences through discussion. To measure product innovation newness, we used Latent Dirichlet Allocation (LDA) to arrive at the latent topic structure, consisting of "clusters" of words (Berger et al. 2020), which were ordered by their degree of novelty. Empirically, this involved retrieving innovation topics using Latent Dirichlet Analysis (LDA). Similar to Jedidi et al. (2021) and Berger et al. (2020), we relied on topic interpretability and the multinomial probability of the words for each topic. This resulted in three product innovation topics; new or significantly improved 1) materials, 2) design and configuration, and 3) energy systems and infrastructure. Next, we asked our 9 interviewees to rank these topics in terms of their newness, and a clear ranking pattern emerged. We assigned the least novel topic a value of 1, and the most novel one a value of 3. By multiplying the count of product innovations by their weight (1, 2, 3), we obtained a rich measure of product innovation by simultaneously accounting for impact and breadth.

Process innovation is defined conceptually as new or significantly improved operational processes or methods (Damanour 1991). We multiplied the count of the number of process innovations by the weight, in terms of the newness of the innovation to the market, for each process innovation. We relied on the same LDA analysis and process as for product innovation to arrive at a newness measure of process innovation. We arrived at three topics of process innovation, including new or significantly improved 1) process and planning software, 2) cost and time-efficient methods, and 3) sustainable construction methods.

Project size is the count of the total number of subcontractors involved in the project. The number of subcontractors ranged from 1 to 58.

General contractor participation indicates the number of tasks the general contractor performs. There are seven generic task categories defined by the DBIA based on industry parlance, namely 1) general contractor, 2) team leader, 3) architecture, 4) engineering, 5) specialty consultant, 6) specialty contractor, and 7) a final category labeled “other”.

Subcontractor diversity reflects the heterogeneity of the subcontractors’ tasks. We operationalized diversity following Wuyts, Stremersch, and Dutta (2004).⁸ We denoted the number of subcontractors performing task j in project i as n_{ij} . We then calculated the proportion of subcontractors performing task j relative to the total number of subcontractors in project i as $p_{ij} = n_{ij} / \sum_{j=1}^j n_{ij}$. We squared each p_{ij} and summed across all tasks j . To facilitate interpretation, we subtracted this from 1, thus defining subcontractor diversity as $1 - \sum_{j=1}^j p_{ij}^2$. The maximum level of diversity exists when each subcontractor performs a unique task. We note that the subcontractor tasks are a subset of the general contractor’s, and exclude the possibility of the subcontractor performing general contractor tasks.

We conducted a supplementary survey across five industries as part of Study 1 where we asked respondents to rate the importance of our core constructs for product and process innovation. The five industries represent project-intensive contexts, including media, advertising, engineering/construction, event management, and consulting. Most of the respondents indicated that project size and subcontractor diversity were very important to both product and process innovation. To test if the means of our core, hypothesized, constructs differ across these industries, we conducted an ANOVA test including a pairwise Tukey comparison test. The results suggest no statistically significant differences between the importance of project size and subcontractor diversity across the five industries ($p > .1$).

⁸ We note that this measure parallels the Hirschman-Herfindahl index, a measure of diversity commonly used in law, finance, and economics (Gans 2007).

We included an extensive set of control variables to account for potentially alternative explanations of our results. We discuss these in turn:

Environmental uncertainty indicates the unpredictability of sales in the construction industry, which may impact both product and process innovation. Heeding prior work (e.g., Raassens, Wuyts, and Geyskens 2012), we use fluctuations of industry spending as a measure of uncertainty by 1) regressing total construction spending on the related years, and 2) using the standard error of the regression slope coefficient as the resulting measure.

Contracted duration is the time span (in days) between the project's contractually stipulated start and end dates. Longer-lasting projects may promote cooperation between its different members, which in turn may impact product and process innovation (Phelps 2010).

Buyer-project distance is the geographical distance between the buyer and the project and is measured as the number of miles between the buyer's main location and the project location (e.g., Handley and Benton 2013). Using Google Maps, we extracted the driving distance between a buyer and a project location using their respective addresses, as made available by the DBIA. We control for distance given the likelihood that geographical distance may increase coordination problems between the parties (Knoben and Gössling 2009) and ultimately reduce innovation (Tracey, Heide, and Bell 2014).

Projects involve multiple parties, some of whom may have interacted on previous projects and thus possess *prior ties* with each other (Eccles 1981). Prior ties can generate learning (Lane and Lubatkin 1998), which may promote product and process innovation. Prior ties may manifest themselves in different ways, and to account for this we controlled for 1) *buyer-general contractor prior ties*, a count variable indicating the number of times a buyer has done business previously with the same general contractor, 2) *general contractor-subcontractor prior ties*, a count variable indicating the number of times a specific pair of

general contractor-subcontractor share a prior tie, and 3) *buyer-general contractor-subcontractor prior ties*, also a count variable indicating the number of times a specific set of buyer-general contractor-subcontractors share a prior tie.

We included *project category* to absorb unobserved heterogeneity across different types of projects (including civil infrastructure, commercial/institutional, industrial process facility, and others). We also controlled for the general contractor's size, both in terms of the *number of employees* and *annual sales*. Both serve as proxies for the firm's human and financial resources, which can influence product and process innovation.

We also accounted for selection and the nature of the pricing contract. *Selection* captures the key selection criteria used by the buyer in identifying a general contractor. Our specific measure indicates whether buyers in their selection emphasize 1) general contractors' capabilities and past performance (ability-based selection), or 2) project price offered (price-based selection). *Pricing contract* indicates whether the project was managed through a fixed or variable pricing format. A buyer's attempts to minimize costs, which may be accomplished through price-based selection and fixed pricing, will likely impact innovation.

Lastly, we controlled for *government* and *defense* projects. These two are subject to (different) sets of federal and state rules plus, potentially, local rules that can impact the project and thereby innovation.

Web Appendix D summarizes the measures and data sources used. Table 1 shows the correlations and descriptive statistics for the variable set. We note that product and process innovation, not unexpectedly, are positively correlated. However, the size of the correlation ($r = .42, p < .01$) is in line with past work (e.g., Mooi, Wathne, and Kayande, 2018) and suggests that the two forms of innovation are distinct.

Table 1. Study 1 Correlations and Descriptive Statistics

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Product innovation	-																	
2. Process innovation	.344	-																
3. Project size	.167	.051	-															
4. Subcontractor diversity	.106	-.030	.107	-														
5. General contractor participation	-.063	-.023	-.170	-.219	-													
6. Environmental uncertainty	.071	-.046	-.038	-.028	.024	-												
7. Contracted duration	-.063	.064	-.011	.077	-.057	-.195	-											
8. Buyer-project distance	-.045	-.007	-.071	-.072	.014	.056	.178	-										
9. General contractor-buyer prior ties	-.054	-.014	-.015	-.002	-.014	.118	.053	.077	-									
10. General contractor-subcontractor prior ties	-.012	.026	.271	.100	-.169	.007	.025	.006	.087	-								
11. Buyer-general contractor-subcontractor prior ties	.009	-.029	.025	.060	-.039	-.026	.043	.048	.477	.247	-							
12. Project category	-.110	.054	-.137	-.078	.087	-.130	.212	-.030	.004	-.008	-.043	-						
13. General contractor total number of employees	-.007	.035	.047	-.193	.067	-.020	.017	-.015	-.021	.015	-.063	.101	-					
14. General contractor's annual sales	.099	.191	.053	-.095	-.011	-.022	.075	-.009	.080	-.030	-.026	.202	.416	-				
15. Selection	-.019	.015	.043	-.075	.177	.039	-.165	-.022	-.006	-.037	-.087	.008	.124	-.017	-			
16. Pricing	-.004	-.068	.067	-.056	.145	.090	-.212	-.064	.079	-.081	-.020	-.095	.047	-.108	.281	-		
17. Government	.127	.106	.101	.102	-.100	-.053	.306	-.009	-.032	.022	.021	.324	.005	.171	-.113	-.089	-	
18. Defense	-.089	-.096	-.074	-.097	-.048	.001	-.011	.047	.056	-.018	.019	-.116	-.029	-.063	-.146	-.195	-.488	-
M	1.841	3.088	9.385	.508	2.491	48138.470	664.784	184.172	.070	1.622	.308	1.469	165.628	448.378	.305	.463	.457	.210
SD	4.758	5.590	8.470	.212	.915	2402.904	386.584	857.592	.279	3.787	1.457	.915	308.520	981.883	.461	.499	.499	.408
Minimum	.000	.000	.000	.000	1.000	44,570.560	92.000	.000	.000	.000	.000	.000	1.000	.010	.000	.000	.000	.000
Maximum	48.000	51.000	58.000	.800	6.000	51,865.810	4,856.000	7,039.000	2.000	24.000	13.000	3.000	3,000.000	5,522.310	1.000	1.000	1.000	1.000

Note: n = 328. Correlations with an absolute value greater than .108 are significant at $p < .05$ (two-tailed).

Hypotheses Test

Our data and hypotheses impose certain requirements on our analyses, namely (1) that the dependent variables (product and process innovation) can take on only count values, (2) the need to account for repeated *and* single observations of the same general contractor, (3) time invariant regressors, (4) the possibility of unobserved heterogeneity, and (5) potential endogeneity.

We rely on the *hybrid effects* estimator to satisfy these requirements. The hybrid estimator parses a variable into a time-invariant mean of each regressor ($\bar{x}_i$) and a time-variant deviation from this mean ($x_{it} - \bar{x}_i$) and relies on the random effects estimator to produce consistent estimates of both time-varying and time-invariant coefficients (cf. Allison 2009). To test our hypotheses, we specify our hybrid effects model as follows:

$$(1) \quad y_{it1,2} = \beta_0 + \beta_1 (x_{it} - \bar{x}_i) + \beta_2 c_i + \beta_3 \bar{x}_i + \mu_i + \epsilon_{it}$$

i denotes time-invariant variables, and t denotes time-varying variables. $y_{it1,2}$ refers to product and process innovation, respectively. x_{it} refers to the vector of theoretical and control variables. To implement the hybrid estimator, for each time-varying variable, we require that $\bar{x}_i$, the cluster mean of each variable and their deviations to the mean ($x_{it} - \bar{x}_i$), be added as predictors. Time-invariant variables are denoted by c_i . Finally, μ_i denotes the combined effect of all unobserved characteristics of general contractors that are constant over time (Allison 2009), while ϵ_{it} is an individual disturbance term with a mean of zero. The parameters of interest are the deviations, with the means absorbing individual and time-invariant unobserved heterogeneity. We note that the ability of the hybrid estimator to account for time-invariant omitted variables also partially addresses concerns about endogeneity. We note, however, that this only constitutes a part of our approach to addressing endogeneity, and we return to this below.

Results

Table 2 contains the results of the hybrid effect models for product and process innovation. The models estimating the number of product and process innovations are significant ($p < .01$). Overall, the results are largely supportive of our hypotheses, with some interesting exceptions that we discuss in turn.

The results provide full support for H1. Specifically, we obtain support for H1a ($p < .01$) and H1b ($p < .05$) which posit that project size is positively related to product and process innovations, respectively. We also obtain full support for H2, which posited that subcontractor diversity is positively related to both the number of product (H2a, $p < .01$) and process innovations (H2b, $p < .05$). For H3, which suggests that general contractor participation strengthens the effect of a) project size and b) subcontractor diversity on product innovation, we find support for H3a ($p < .01$). For H3b we obtain an effect opposite to our expectation ($p < .01$). In Figure 3, we illustrate these contingency effects using partial derivatives. As illustrated in Panel A of Figure 3, general contractor participation strengthens the positive effect of project size on product innovation, while it weakens the relation between subcontractor diversity and product innovation (see Figure 3 Panel B).

For H4, which states that general contractor participation weakens the effect of project size and subcontractor diversity on process innovation, we don't find support for H4a ($p > .10$), while H4b is supported ($p < .01$). We plot the contingency effect of H4b in Figure 3 panel C, which shows that general contractor participation weakens the positive effect of subcontractor diversity on process innovation.

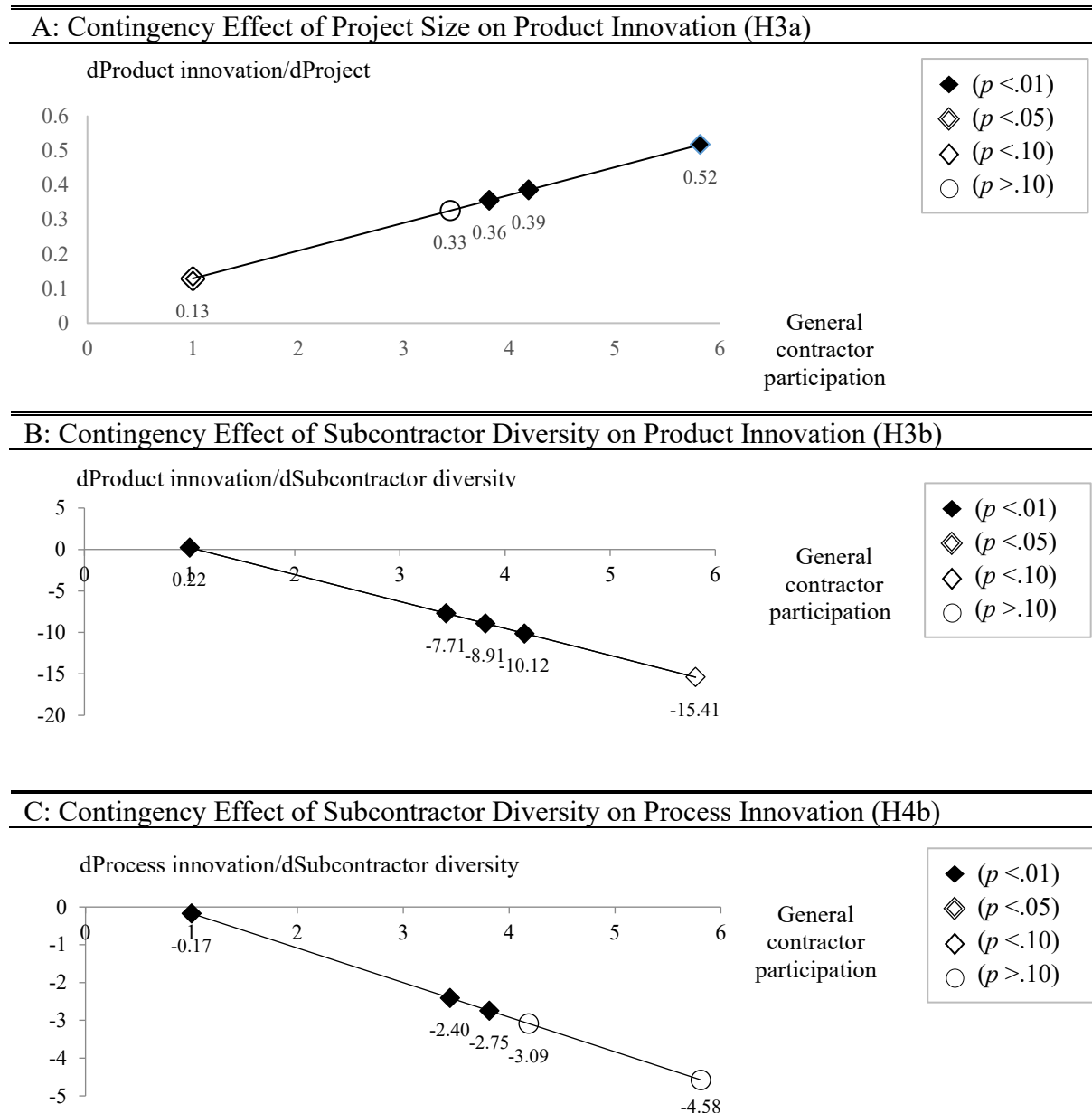
Table 2. Hybrid Effects Poisson Model Estimates

Variables	Product Innovation		Process Innovation	
		B (SE)		B (SE)
<i>Intercept</i>		-1.352 (.746) *		1.074 (.461) **
Project size	(H1a)	.049 (.016) ***	(H1b)	.022 (.009) **
Subcontractor diversity	(H2a)	3.468 (.764) ***	(H2b)	.747 (.374) **
General contractor participation		-.029 (.237)		.193 (.105) **
Project size * General contractor participation	(H3a)	.081 (.026) ***	(H4a)	-.013 (.013)
Subcontractor diversity * General contractor participation	(H3b)	-3.247 (.737) ***	(H4b)	-.9156 (.303) ***
<i>Control variables</i>				
Environmental uncertainty		.000 (.000)		-.000 (.000)
Contracted duration		.001 (.000)		.000 (.000)
Project contracted cost		.000 (.000) ***		.000 (.000) ***
Buyer-project distance		.001 (.000) ***		.000 (.000) ***
General contractor-buyer prior ties		-.807 (.339) **		.048 (.255)
General contractor-subcontractors prior ties		-.199 (.031) ***		.028 (.030)
Buyer-General contractor-subcontractor prior ties		.247 (.060) ***		.034 (.056)
Project category:				
Commercial/Institution building		-2.039 (.388) ***		.419 (.322)
Industrial process facility		-2.728 (.551) ***		.248 (.378)
Civil infrastructure project		-3.251 (.542) ***		.029 (.364)
General contractor total number of employees		.000 (.001)		.000 (.000)
General contractor's annual sales		.000 (.000) *		.000 (.000) ***
Selection		-1.157 (.261) ***		-.118 (.140)
Pricing		.379 (.268)		-.540 (.211) ***
Government		.540 (.271) **		-.409 (.154) ***
Defense		-1.477 (.404) ***		-1.05 (.217) ***
Wald chi2 (42)		250.910 ***		188.750 ***
Log-likelihood		-524.4623		-737.807
Observations per group				
Min		1		1
Average		1.8		1.8
Max		14		14

Note: In hybrid effects models, means and deviations are estimated separately. We only show the substantively interpretable deviations for parsimony.

*p < .10; **p < .05; ***p < .01. Two-tailed. Standard errors are reported in parentheses adjacent to coefficients.

Figure 3. Illustrations of the Contingency Effects of Project Size and Subcontractor Diversity



Turning to the control variables, longer projects appear unrelated to product innovations, but are positively related to process innovations ($p < .05$). Greater buyer-project distance relates positively to both product ($p < .01$) and process ($p < .05$) innovation. Two different manifestations of prior ties, between the general contractor and subcontractors ($p < .05$) and between the triad of the buyer-general contractor-subcontractor ($p < .01$), have negative and positive associations, respectively, with product innovation. Neither form of prior ties appears related to process innovation.

We also observe significant heterogeneity across project categories. General contractor annual sales, a proxy for firm size, relates positively to both product ($p < .10$) and process ($p < .01$) innovations. Selection has a negative relationship with product innovation ($p > .01$). Variable pricing correlates with process innovation ($p < .01$) but is unrelated to product innovation ($p > .10$). Lastly, we note significant heterogeneity across buyer type (government or defense).

Endogeneity

The choices with regard to project size, subcontractor diversity, and general contractor participation may be purposefully made to promote product or process innovation, raising the potential for endogeneity and thereby potentially biased parameter estimates (Wooldridge 2002). We rely on (1) the Gaussian Copula estimator of Park and Gupta (2012) and (2) the heteroscedasticity-based identification estimator of Lewbel (2012) to assess potential endogeneity threats. The Gaussian Copula approach proposed by Park and Gupta (2012) is a semi-parametric method that models the joint distribution of the error term and the endogenous regressors using a copula method and makes inferences on model parameters by maximizing the resulting likelihood function. We re-estimated our aforementioned model using Park and Gupta's approach (2012) and the results of this method (untabulated) show consistent estimates of the coefficients of interest, both in direction and level of significance, with those found in the original hybrid effects model. We also estimated our model using the heteroscedasticity-based identification proposed by Lewbel (2012), which uses higher moments, in the form of heteroscedasticity to construct synthetic instruments. Lewbel's estimator provides results (untabulated) that are consistent with those found in the original hybrid effects models (again both in direction and level of significance). Both estimation approaches a) suggest that endogeneity is not a likely threat to making correct inferences in our models and b) demonstrate a good degree of robustness.

STUDY 2: METHOD AND RESULTS

In Study 2, we test hypotheses H5-H6 regarding the ‘dark side’ of task participation, specifically (1) the effect of general contractor participation on subcontractor leakage concern, and (2) the effect of leakage concern on subcontractor information withholding.

Empirical Context

We conducted a cross-sectional survey of 230 subcontractors in the U.S. construction industry via the Qualtrics platform. To avoid self-selection, Qualtrics randomly prescreened respondents on certain criteria, specifically whether they had been involved in a construction project (1) that was fully completed in the last two years and (2) where their company acted as a subcontractor (not a general contractor). Our initial sampling frame consisted of 230 subcontractors. We eliminated 17 informants who reported limited project involvement.

Measures

All our focal constructs are measured using five-point multi-item scales. We adapted our measures from past research when possible and developed new scales for the others. We conducted a pilot test with 30 US construction subcontractors to examine the face validity of our measures and to assess the relevance and wording of our items. No problems were revealed. A complete list of the final scales used can be seen in Web Appendix F. We discuss each of the variables next.

General contractor participation indicates the extent to which the general contractor was involved in certain tasks during project execution. The specific items were adapted from the ones used by Harmancioglu, Wuyts, and Ozturan (2021). *Subcontractor information leakage concern* reflects the subcontractor’s initial expectation about the usefulness of its proprietary knowledge and skills to the general contractor. Again, we adapted the items from Harmancioglu, Wuyts, and Ozturan (2021). *Subcontractor withholding of information*

captures the extent to which the subcontractor purposely curtailed the sharing of new information with the general contractor during project execution. The items were adapted from Heide and John (1992). *Subcontractor's specific investments* capture the process-related investments made by the subcontractor in the project (Anderson and Weitz, 1992, Wathne, Heide, Mooi, Kumar, 2018). *Subcontractor monitoring of the general contractor* indicates the extent of monitoring undertaken by the subcontractor of the general contractor during project execution (Heide, Wathne, and Rokkan 2007; Kashyap, Antia, and Frazier 2012).

We included a set of control variables in our analysis. *Environmental uncertainty* is defined as unanticipated changes in circumstances surrounding an exchange (Noordewier, John, and Nevin 1990, p. 82) and we measured this construct based on the extent to which the market's competitive and technological conditions were difficult to predict (Noordewier, John, and Nevin 1990). *Project duration*, a single-item variable, reflects the number of months/years that the project had taken to complete. Shorter projects involve greater time compression, *ceteris paribus*, which has coordination implications (Ghazimatin, Mooi, and Heide 2021). We also account for *project type* to absorb unobserved heterogeneity across different types of projects (including, civil infrastructure, commercial/institutional building, industrial process facility, and others). Additionally, we control for *general contractor-subcontractor prior ties* which is a count variable indicating the number of times a subcontractor has collaborated previously with the same general contractor. Finally, we controlled for the possibility that the general contractor may monitor the subcontractor. The *General contractor monitoring of the subcontractor* scale uses similar items to the earlier monitoring scale.

Construct Validity

We evaluated all of our reflective multi-item scales through a series of confirmatory factor analysis (CFA) models. A measurement model containing all the multi-item scales was estimated and demonstrated acceptable model fit ($\chi^2 = 103.161(50 \text{ df})$, $p < .001$, RMSEA = .071, SRMR = .048, CFI = .960, TLI = .948). Consistent with Bagozzi and Yi's (1988) recommendations, all the alpha coefficients exceeded the threshold of .60. Using the procedure suggested by Fornell and Larcker (1981), we calculated the composite reliabilities (CR) and average variance extracted (AVE) for all reflective multi-item constructs, and all of them met or exceeded the thresholds recommended by Fornell and Larcker (1981).

Hypotheses Test

To test our hypotheses, we must account for (1) the simultaneous estimation of multiple equations and (2) potential heteroskedasticity, and 3) the potential for endogeneity. Regarding the former two requirements, we rely on a seemingly unrelated estimation procedure (SUEST), which combines heteroskedasticity-robust estimates from multiple regression equations (cf. Wathne, Heide, Mooi, and Kumar 2018). Our final SUEST model consists of the following two regression equations:

- (2) Subcontractor information leakage concerns_i = $\alpha_{10} + \beta_{11}$ General contractor participation + β_{12} Subcontractor process-related investment + β_{13} (General contractor participation * Subcontractor process-related investment) + β_{14} Uncertainty + β_{15} Project duration + β_{16} Subcontractor-general contractor prior ties + β_{17} Project category + ε_1
- (3) Subcontractor information withholding_i = $\alpha_{20} + \beta_{21}$ Subcontractor information leakage concerns + β_{22} Subcontractor monitoring of the general contractor + β_{23} (Subcontractor information leakage concerns * Subcontractor monitoring of the general contractor) + β_{24} General contractor monitoring of the subcontractor + β_{25} (Subcontractor information leakage concerns * General contractor monitoring of the subcontractor) + β_{26} Uncertainty + β_{27} Project duration + β_{28} Subcontractor-general contractor prior ties + β_{29} Project category + ε_2

where α is the intercept, β is a parameter estimate, and ε represents the error term.

Results

Table 3 contains the results and robust standard errors of our SUEST estimates. In support of H5, we find that the interaction between general contractor participation and subcontractor process-related specific investment is positive and significant ($p < .01$). As hypothesized, we also obtained a negative and significant ($p < .05$) interaction between subcontractor leakage concerns and subcontractor monitoring of the general contractor (H6).⁹

To understand the nature of these interaction effects (H5 and H6), we conducted a simple slope analysis (Aiken and West 1991). Panel A and B in Figure 4 represent the main effects across the full range of the moderator variables. For this purpose, we tested the simple slopes at their minimum, low (-1SD), mean, high (+1SD), and maximum values of the moderators.

Figure 4, Panel A, presents the moderating effect of Subcontractor's process-related investment on the relationship between general contractor participation and subcontractor information leakage concerns. As the plot indicates, the effect of general contractor participation on subcontractor information leakage concerns is positive and significant at the mean ($p < .01$), +1SD ($p < .01$), and at the maximum ($p < .01$) observed value of Subcontractor's process-related investment. However, this effect disappears where Subcontractor's process-related investment is absent ($p > .10$) and at -1SD ($p > .10$).

Figure 4, Panel B, presents the moderating effect of subcontractor monitoring of the general contractor on the relationship between subcontractor information leakage concerns and subcontractor withholding of information. As the plot indicates, subcontractor monitoring

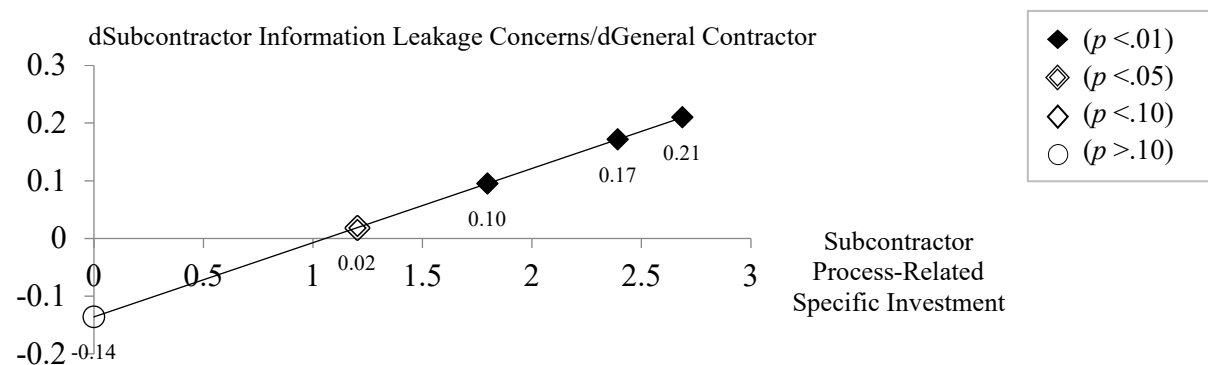
⁹ While our focus was on monitoring, we also explored the possible roles of other safeguards that are mentioned in the temporary organization literature, most notably reputations (Jones, Hesterly, and Borgatti 1997). Conceivably, a favorable general contractor industry reputation may serve as a safeguard which weakens the effect of leakage concern on information withholding. However, the moderating effect of reputation was not significant, suggesting that in the context at hand (direct) monitoring plays a key safeguarding role.

has a positive but weakening effect at the minimum level ($p < .1$). However, from +1SD ($p < .05$) to the highest ($p < .05$) observed values of subcontractor monitoring, this effect becomes negative and stronger.

To address the potential for endogeneity, we used two instrument-free methods, namely (1) the Gaussian Copula estimator of Park and Gupta (2012) and (2) the heteroscedasticity-based identification estimator of Lewbel (2012), to assess the robustness of our results to endogeneity concerns. Both methods provided consistent results, both in direction and level of significance, with those found in the original OLS models, showing that endogeneity is not a likely threat.

Figure 4. Illustrations of Simple Slope Analyses

Panel A. The Contingency Effect of General Contractor Participation on Subcontractor Information leakage Concerns (H5)



Panel B. The Contingency Effect of Subcontractor Information Leakage Concern on Subcontractor Withholding of Information (H6)

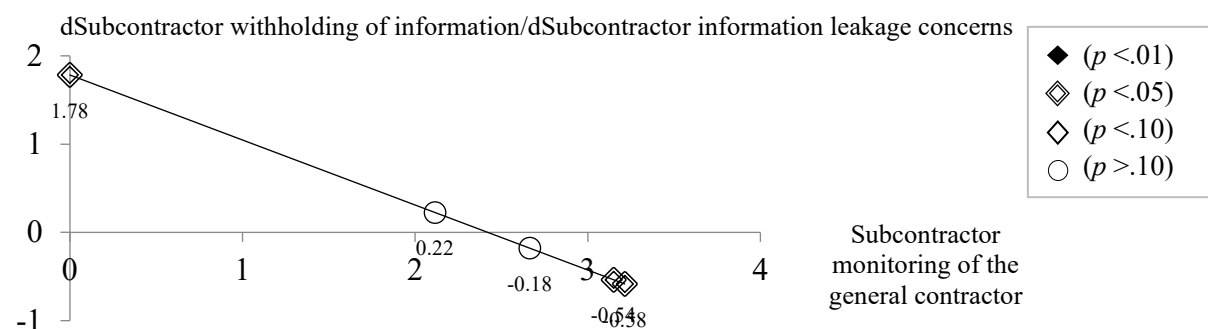


Table 3. SUEST Estimates of Subcontractor Withholding Information Model

Variables	Subcontractor information leakage concerns		Subcontractor withholding of information	
	β (Robust SE)		β (Robust SE)	
General contractor participation	.262 (.070)	***		
Subcontractor process-related specific investment	.089 (.046)	*		
General contractor participation * Subcontractor process-related specific investment	(H5) .129 (.043)	***		
Subcontractor information leakage concerns			-.148 (.123)	
Subcontractor monitoring of the general contractor			-.155 (.145)	
Subcontractor information leakage concerns * Subcontractor monitoring of the general contractor			(H6) -.736 (.311)	**
General contractor monitoring of the subcontractor			.092 (.152)	
Subcontractor information leakage concerns * General contractor monitoring of the subcontractor			.324 (.287)	
Control Variables				
Uncertainty	-.017 (.054)		.709 (.077)	***
Project duration	-.030 (.021)		.025 (.045)	
Subcontractor-general contractor prior ties	.024 (.021)		.135 (.040)	***
Project type:				
Civil infrastructure project	-.105 (.066)		.175 (.151)	
Commercial/institution building	-.058 (.067)		-.079 (.136)	
Industrial process facility	-.298 (.207)	*	.120 (.130)	
Intercept	-1.798 (.138)	***	-.455 (.089)	***

No. observations = 213, * $p < .10$; ** $p < .05$; *** $p < .01$. Two-tailed if hypothesized.

Robust standard errors are reported in parentheses.

DISCUSSION

Most innovations are the result of “collective activity” (Powell, White, Koput, and Owen-Smith 2005, p. 1133). Important questions exist, however, about the specific *context* for such activity, and the roles that different organizational forms play. Past research in marketing has generated important insights into the innovation roles of permanent firms (Chandy and Tellis 1998) and long-term relationships (Rindfleisch and Moorman 2001), but we know relatively little about how innovation takes place within temporary organizations or projects. This gap is significant; in particular when considered against the backdrop of our interviews which identified innovation as a crucial project outcome (Web Appendix G).

We proposed a conceptual framework with project size and subcontractor diversity as the drivers. Our results showed that size and diversity promote both product and process innovation, consistent with H1 and H2. These findings converged with the insights from our interviews (Web Appendix G). We also showed that the ability of project size to bring about product innovation was facilitated by the general contractor’s task participation, consistent with H3a. We attribute this finding to the general contractor’s ability to gain architectural knowledge through participation; knowledge which facilitates coordination which ultimately promotes innovation. One of our interviews revealed that general contractor participation both 1) promotes learning about client needs and 2) helps “correct the way” subcontractors perform project tasks.

We note, however, that general contractor participation did not play such a role vis-à-vis subcontractor diversity, in contrast with our a priori expectation (H3b). In fact, task participation significantly weakened the effect of subcontractor diversity on product innovation. Conceivably, this is due to the inherent complexity of coordinating the activities of diverse project participants. As a consequence, rather than providing net coordination benefits, participation by a general

contractor may add friction to an already complex project organization. Considered in combination, these findings suggest that the coordination effect of participation on product innovation is limited to the particular problem caused by project size.

Further, we found that task participation did not weaken the effect of size on process innovation. However, in support of H4b we showed that general contractor participation weakened the positive effect of subcontractor diversity on process innovation. These findings suggest that in the context of process innovation, subcontractors are reluctant to share information and engage in purposeful coordination. Our interviews suggested that such reluctance is due to a lack of formal protection for process innovations.

Finally, as predicted, our survey results showed that general contractor participation gave rise to leakage concerns when a subcontractor had made project-specific investments. Thus, participation has a “dark side”, as per H5. We also showed, consistent with H6, that such concerns had negative efficiency implications by virtue of causing subcontractors to withhold information. This tendency, however, was mitigated through monitoring.

Theoretical Implications

We identify four different theoretical contributions of our findings. First, we advanced the literature on projects and temporary organizations. Somewhat surprisingly, despite the prevalence of projects in different marketing contexts, including new product development, advertising, and service delivery, they have, with some recent exceptions (Hadida, Heide, and Bell 2019), received limited attention in the marketing literature. Indeed, reviews (Lundin et al. 2015) show that our current knowledge about projects is based almost exclusively on research in

management and engineering – marketing’s voice has been silent. Our study represents an attempt to rectify this, and to engage marketing in the academic dialogue about projects.

Second, we generated insight into the mechanisms through which projects produce performance outcomes. Past research in marketing (e.g., Tellis 2013) has pointed to the general role that organizational variables play in driving innovation. Much of the extant work (e.g., Chandy and Tellis 1998) has focused on organizational culture and its ability to promote (as well as constrain) innovation. It’s noteworthy, however, that culture is unlikely to play a major role in projects given that 1) the relevant “team” (Lundin and Söderholm 1995) is often assembled from scratch, and 2) its members interact for a short time. Indeed, these characteristics have led some organization theorists (e.g., Meyerson Weick, and Kramer 1996) to hypothesize that projects as organizational forms are inherently unstable. Others (e.g., Bechky 2006) have challenged this view, and argued that projects don’t lack structure, and are able to draw on unique sources of support. These different viewpoints suggest the need for a more fine-grained theory of coordination in a project context. Our current study represents a first step towards that goal.¹⁰

Third, we provided new insights into different types of innovation. Although prior research in marketing has made a distinction between product and process innovation (Hauser, Tellis, Griffin 2006; Chandy and Prabhu 2010), empirical evidence, with some notable exceptions (Mooi, Wathne, and Kayande 2016; Rindfleisch and Moorman 2001), is scarce. Our findings suggest that product and process innovation are different phenomena. Perhaps most importantly, task participation, which was shown to provide coordination benefits in the context

¹⁰ It’s noteworthy that the general project management literature is relatively silent on the specific processes by which outcomes come about. Much of this literature treats a “project” as general background or context, without considering its specific organizational challenges and solutions.

of product innovation, actually served as an impediment to process innovation. This discrepancy points to an important “dark side” of coordination in a project context.

Fourth, from a governance standpoint we showed the importance of direct or project-specific efforts in the form of monitoring. Indeed, such efforts were capable of mitigating the negative efficiency implications that leakage concerns create.

Managerial Implications

Innovation is often the result of “purposeful activity” (Drucker, 1985, p. 34). However, the relevant activities often involve practical challenges. To wit, Boeing’s launch of the new 737 Max airplane involved hundreds of suppliers who produced 367,000 parts, from engines to exit signs. Indeed, managing such a large and diverse supplier pool and ensuring that the end product met its innovation goals posed significant coordination problems (Washington Post 2019).

Our findings speak to these challenges, but they also suggest possible solutions, tied to the role of the general contractor. Specifically, our finding that general contractor participation plays a selective coordination role (in the context of product, but not process, innovation) suggests that buyers of complex services can make deliberate selection decisions on the basis of the general contractor’s project role. To a buyer, such differences in task configuration matter, because they influence a project’s organizational properties and ultimately its innovation outcomes. As a consequence, for a buyer the manner in which a project’s tasks are allocated, either through negotiation, contracting, or tendering, represents a key decision criterion.

Our findings suggest that decisions on task configuration must be made with specific reference to 1) project characteristics (size, diversity) and 2) desired outcomes (product or process innovation). On this note, our empirical tests uncovered a potential “dark side” to task

participation by the general contractor. Specifically, for process innovations such participation may cause information leakage concerns, since a subcontractor's learning can be exploited by the general contractor through subsequent redeployment on other projects. Interestingly, the World Intellectual Property Organization (2019) points out that the "use of confidentiality" is a critical protection mechanism, but one which is largely unavailable in the context of process innovations where information sharing with other parties is inherent. Indeed, based on a recent survey, Kroll (2019), a global provider of risk solutions, concludes that information leakage and IP theft were key concerns for 41 and 43%, respectively, of the firms in their sample.

Unexpectedly, we also observed a "dark side" of coordination in the domain of product innovation. Specifically, our results showed that managing subcontractor diversity through general contractor participation was ineffective, presumably because of the incremental organizational complexity that participation introduces.

To illustrate the practical importance of our analyses, we rely on counterfactuals to calculate "what if" scenarios. Consider the U.S. Marine Corp's project to renovate Camp Pendleton. A team of 12 subcontractors was led by a general contractor who did not participate in any of the key tasks. The reported outcomes reveal one process innovation but no product innovations. Had the task been configured differently, as evidenced by inserting different values (the counterfactual) into equation (1), our model suggests that full participation by the general contractor would have resulted in one product innovation (but no process innovations). Essentially, accounting for participation flips the pattern of product and process innovation between the observed pattern and the counterfactual. This has practical implications, since process innovation (as per the logic of H4), unlike product innovation, possesses a generalizable and redeployable quality. As such, the shift that we observe is material, in that a product

innovation falls to the buyer, whereas a process innovation can fall to any party that can observe and learn. This single counterfactual demonstrates the practical importance of task configuration.

Limitations and Future Research

Our findings must be viewed in light of certain limitations. While we attempted to assess industry differences with regard to our drivers, other types of projects may pose different organizational challenges and require different solutions. For example, Kaggle.com, a community that hosts data science projects, relies on 1) a clear-cut *ex ante* specification of desired innovative outcomes, 2) a compensation structure that is based almost solely on achievement, and 3) very detailed timelines. Relatedly, our database is U.S.-centric, and the relatively homogeneous research context can limit the generalizability of the findings to other countries. We also note that the fact that nearly all information on (construction) projects is proprietary; independent third-party verification of data is not possible.

We close by suggesting some avenues for future research. One intriguing candidate is the participation construct, which has numerous manifestations in marketing contexts (e.g., Heide and John 1990; Sa Vinhas and Heide 2015). Future research can be directed to further unpacking the participation construct, and to showing its positive and negative effects. Future research may also consider whether the attributes of a project's members and their relationships are "portable" across projects. Finally, what role do the parties' R&D efforts play when a large number of parties collaborate? Must parties have similar levels of R&D to allow them to absorb information better, or is some degree of diversity beneficial?

In general, these types of questions point to the need for more fine-grained accounts of projects governance. Our current focus was on coordination problems, and we showed that a

design-based mechanism like task configuration was capable of promoting product innovation. Our findings for process innovation, however, which show the possibility of self-interested leakage, suggest a need to consider a broader range of motivations and governance mechanisms. Specifically, promoting process innovation may require a broader governance lens and a safeguarding (Heide and John 1992) type of perspective.

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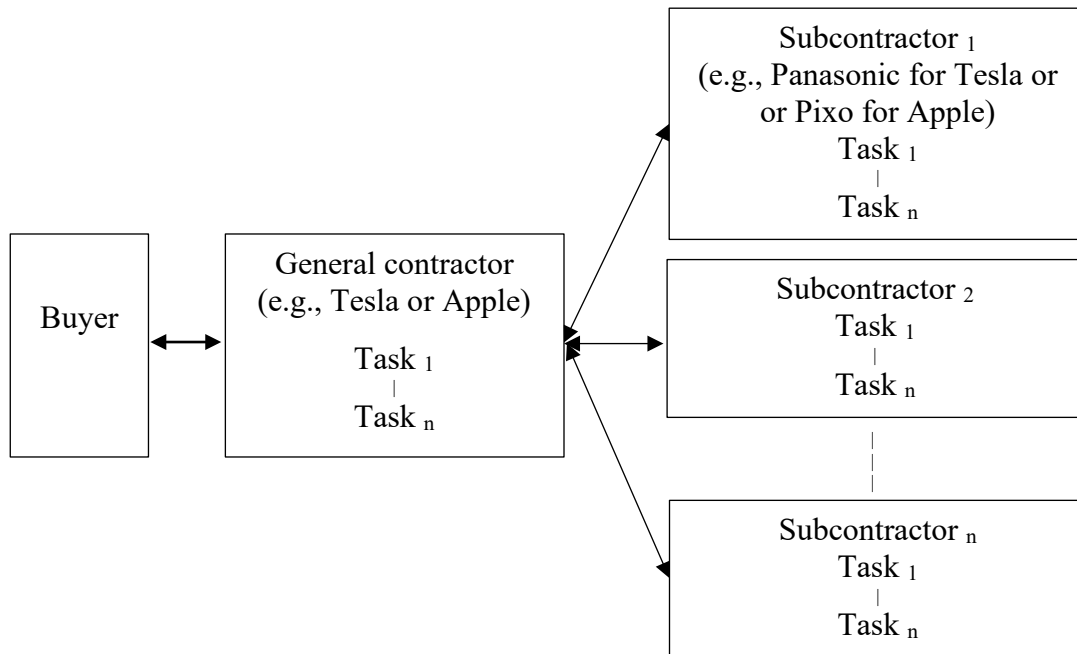
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WEB APPENDIX A: SALIENT POINTS OF DIFFERENCE BETWEEN PROJECTS AND STRATEGIC ALLIANCES

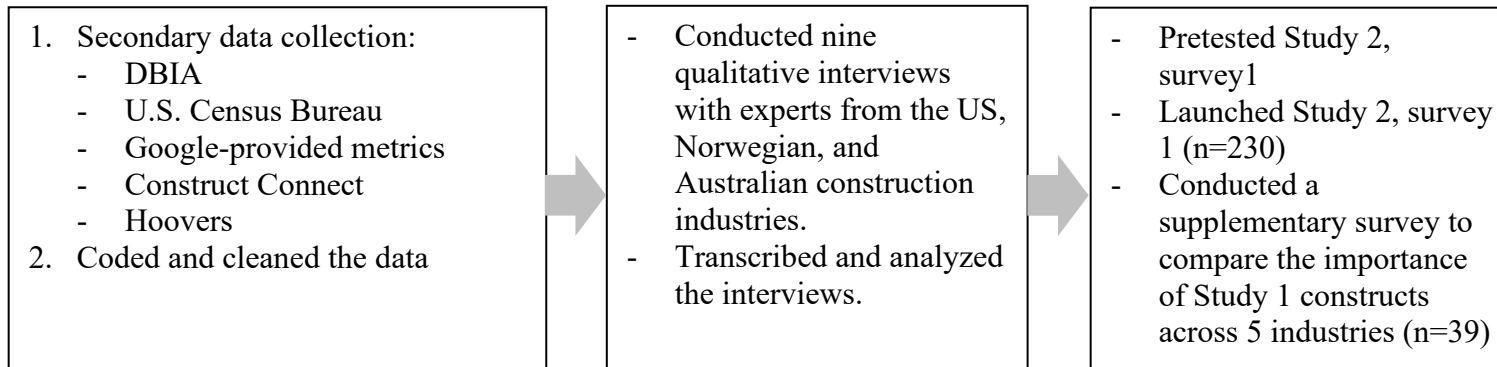
	Key Definition	Example 1: Movie Industry	Example 2: Construction	Example 3: Advertising	Example 4: Event Management	Points of Difference
Project	“A set of diversely skilled people working together on a complex task over a limited period of time” (Goodman and Goodman 1976).	20 th Century Studios, Lightstorm Entertainment, and Paramount Pictures formed a project to produce the movie Titanic.	The construction of the Sydney Opera House involved about 244 companies contracted specifically for this project.	In 2004, Dove collaborated with Ogilvy & Mather, Edelman Public Relations, and others to launch the “Dove campaign for Real Beauty”.	Hundreds of companies collaborated to supply the Olympic Games site in London.	Task. In projects, the task is typically unique and not repeated. Alliances, in contrast, are enduring interfirm cooperative arrangements (Parkhe 1993) and typically involve task repetition. Time. Projects are temporary and exist for a limited period of time (Hadida, Heide, Bell, 2019). Alliances, in contrast, are typically “built to last” (Bakker and Knoblen 2015) and are established with an expectation of on-going interactions (Barringer and Harrison 2000). Team. Projects typically involve a large number of firms while alliances are typically a “formal agreement between <i>two</i> partners” (emphasis added, Parmigiani and Rivera-Santos 2011, p. 1117). An implication of this difference is that projects can benefit from a highly diverse set of resources.
Strategic Alliance	Any voluntarily initiated cooperative agreement between firms that involves sharing or co-development, and it can include contributions by partners of capital, technology, or firm-specific assets (Gulati and Singh 1998).	Disney and Pixar started an alliance in 1978 to produce animation movies together.	Skanska engaged in a long-term alliance with Anglian Water to execute an asset management program.	In July 2007, Saatchi & Saatchi and Fallon formed an alliance, called SSF Group. This alliance was formed to help the growth of both firms.	The International Olympic Committee (IOC) formed an alliance with Getty Images, as its official photographic agency.	

WEB APPENDIX B: PROJECT CONFIGURATION



WEB APPENDIX C: DATA COLLECTION PROCESS

The approach followed our data collection efforts was as follows:



WEB APPENDIX D: STUDY 1 VARIABLES AND DATA SOURCES

Variable	Measurement	Data Source
Product innovation	Count of the number of product innovations per project multiplied by their newness.	DBIA
Process innovation	Count of the number of process innovations per project multiplied by their newness.	DBIA
Project size	Count of the number of subcontractors included in the project.	DBIA
General contractor participation	Count of the total number of tasks that the general contractor performs in the project.	DBIA
Subcontractor diversity	An index measuring diversity of subcontractors across the project tasks.	DBIA
Environmental uncertainty	The standard error of the regression slope of U.S. construction spending regressed on the year.	U.S. Census Bureau
Contracted duration	The calculated days between the contracted start and end date of a particular project.	DBIA
Buyer-project distance	The distance (in miles) between the address of the buyer and the focal project.	Google
Buyer-general contractor prior ties	A count variable indicating the number of times a specific pair of buyer-general contractor share a prior tie.	DBIA
General contractor-subcontractors prior ties	A count variable indicating the number of times a specific pair of general contractor-subcontractors share a prior tie	DBIA
Buyer-general contractor-subcontractor prior ties	A count variable indicating the number of times a specific pairing of buyer-general contractor-subcontractors share a prior tie.	DBIA
Project category	A categorical variable classifying construction projects into civil infrastructure projects, commercial/institutional projects,	DBIA

industrial process facility, with other projects being the base category.

General contractor total number of employees	A count variable indicating the total number of people employed by the general contractor's firm.	Hoovers
General contractor's annual sales	The \$ annual sales of the general contractor.	Hoovers
Selection	A dichotomous variable indicating the main selection criteria based on which the buyer selects the supplier(s): 0 = price-based selection, and 1 = ability-based selection.	DBIA
Pricing	A dichotomous variable indicating the pricing terms guiding the project: 0 = fixed pricing, and 1 = variable pricing.	DBIA
Government	A binary variable indicating whether a buyer is government (=1), or not.	DBIA
Defense	A binary variable indicating whether a buyer is a defense organization (=1), or not.	DBIA

WEB APPENDIX E: STUDY 2 CORRELATIONS AND DESCRIPTIVE STATISTICS

	1	2	3	4	5	6	7	8	9	10
1. Subcontractor withholding of information	-									
2. General contractor participation	.255	-								
3. Subcontractor process-related specific investment	.324	.606	-							
4. Subcontractor information leakage concerns	.063	.447	.332	-						
5. Subcontractor monitoring of the general contractor	.134	.456	.580	.447	-					
6. General contractor monitoring of the subcontractor	.223	.519	.653	.413	.791	-				
7. Uncertainty	.490	.493	.589	.242	.379	.496	-			
8. Project duration	.063	.015	.088	-.100	.148	.075	.046	-		
9. Subcontractor-general contractor prior ties	.011	.101	.105	-.070	.030	-.020	.033	.157	-	
10. Project type	.213	.114	.053	.119	.012	.091	.099	.014	.012	-
M	.0246	.046	.060	.056	.044	.0279	.016	2.667	1.868	3.831
SD	.928	.595	1.06	.467	.549	.536	.653	1.258	.972	1.303
Minimum	-1.870	-1.751	-3.275	-2.270	-2.621	-1.788	-2.461	1	1	1
Maximum	1.459	.936	1.241	.524	.528	.543	.854	5	4	6

Note: n = 213. Correlations with an absolute value greater than .135 are significant at $p < .05$ (two-tailed).

WEB APPENDIX F: STUDY 2 MEASUREMENT SCALES AND ITEMS

Construct	Scale items
General Contractor Participation (Coefficient $\alpha = .783$)	A five-point scale anchored by No Involvement and Extensive Involvement for items 1 and 2 and No Participation and Extensive participation (item 3) plus Very Little and Very much (item 4). 1. Please consider the extent to which the general contractor was involved in the following activities during the execution of this project: ○ Technology sharing. ○ Cost information sharing. 2. How extensive was the general contractor's participation in this project in general? 3. How much direct communication took place between your company and this general contractor during the execution of this project?
Subcontractor's process-related investment (Coefficient $\alpha = .862$)	A five-point scale anchored by No Effort and Extensive Effort. Consider the efforts made by your firm as part of its involvement in this project. For each item, consider how extensively your firm: 1. provided specialized training to your employees. 2. made changes to your operating routines. 3. made internal adjustments to facilitate project collaboration.
Subcontractors' Information Leakage Concerns (Coefficient $\alpha = .635$)	A five-point scale anchored by Highly Unlikely and Highly Likely. Before this project started: 1. we expected that our own knowledge and skills might be useful for this general contractor. 2. we expected that our information might benefit this general contractor. 3. we expected that our proprietary knowledge might benefit this general contractor.
Subcontractor's Monitoring of the General Contractor (Coefficient $\alpha = .896$)	A five-point scale anchored by No Monitoring and Extensive Monitoring. Please indicate the extent of monitoring undertaken by your firm of this general contractor during the execution of this project: 1. timelines and schedules. 2. work practices and standards. 3. quality-control procedures. 4. final project quality. 5. completion timeliness. 6. conformity of final project to standards.

General Contractor's
Monitoring of the
Subcontractor
(Coefficient $\alpha = .866$)

A five-point scale anchored by No Monitoring and Extensive Monitoring.
Please indicate the extent of monitoring undertaken by this general contractor of your firm during the execution of this project:

1. timelines and schedules.
2. work practices and standards.
3. quality-control procedures.
4. final project quality.
5. completion timeliness.
6. conformity of final project to standards.

Environmental
Uncertainty
(Coefficient $\alpha = .802$)

A five-point scale anchored by Completely Disagree and Completely Agree.
During the execution of this project:

1. the actions of competitors in our major markets were changing rapidly.
2. technological changes in our industry were rapid.
3. the competitive conditions in this market were highly unpredictable.

WEB APPENDIX G: TAKE-AWAYS AND ILLUSTRATIVE QUOTES FROM INTERVIEWS

We conducted nine qualitative interviews with experts from the US, Norwegian, and Australian construction industries, including directors, architects, consultants, subcontractors, general contractors, and buyers. These interviews were designed to shed more light on 1) the importance and origins of innovation, 2) our key constructs (project size, subcontractor diversity, and GC participation) as first-order issues in the configuration of projects, and 3) the importance of our findings to practitioners.

Theme	Key take-away	Illustrative quotes
Panel A: The Importance of Innovation in Projects		
(1) The importance of innovation.	There is a need for projects to deliver faster, cheaper, and better.	“There is a high need to innovate. We fall behind if we do things as we did 10 years ago. There is an impetus to learn.” “Even if buyers don’t directly ask for a particular innovation in a project, they typically ask for the project to be delivered within a minimum time and cost. Then it largely depends on the contractors to come up with innovations to decrease the time and cost of the project.”
(2) What are the origins of innovation?	Innovations are a sought outcome, but their origins are somewhat diffuse and opaque and can be the result of interactions between many parties.	“The owners like the use of innovative systems. They ask for better solutions and the applicant with the best solution will win the contract.” “The reasons for product innovations are a) cost reductions b) “feel good” or “the client wants to push it”, c) government regulations (CO2), d) ESG, e) investor expectations, and f) corporate comms.” “For product innovations, architects and designers often push for specific innovations. For process innovations typically the builder takes the initiative.”
Panel B: The Importance of Our Key Constructs		
(3) Project size	The more contractors in a project, the more innovative ideas are available.	“We, as buyers, are driven by providers or contractors to tell us what new things are out there.” "It is critical to assemble a good team."

(4) Subcontractor diversity	Diversity is important to getting the task done innovatively.	“It’s better to get good people for mobility, good people for wind analysis, good people for sustainability, good people for energy use, I don’t think we can find one single company who is the best at all the different tasks.” "There is a trend towards using more specialized subcontractors."
(5) The benefits of GC participation	GC participation provides coordination and promotes an understanding of client needs.	“Overlap provides a degree of coordination. In effect, it makes it very hard for the other party to mislead.” “Having the general contractor and subcontractor work on the same tasks helps innovation because you see the basic needs from a client perspective and that helps you to correct the way that you are working.”
(6) The dark side of GC participation and its implications for innovation	There is a lack of formal protection for process innovation and in most cases, secrecy is the only way to protect innovation.	“Subs develop innovative methods. They deploy them and unfortunately, there is no way to hide them. As soon as they use a novel method, it’s exposed to everyone.” “What we find most valuable we keep close to ourselves and do not share it. We keep the core knowledge close to ourselves and do not share it because that represents an advantage for us.” “We use patents for product innovations. But for process innovations, it’s of little or no use. There is nothing besides hiding that we can do to protect our process innovation.” "Contractors don't want to let out innovations but sometimes there is no choice."
Panel C: The Importance of Our Hypotheses and Findings for Practitioners		
(7) The importance of the results	The results provide useful and actionable insights.	“I think your research is very good because we need them to push the sector in a different direction.” "It’s important not only to general contractors, but also to owners and developers to know about these findings because they have the key to everything, and they can decide what they use their money for. They have a key position and a position with power. So, they could actually change a lot and force companies to think differently.”

		“The building industry still has a lot to learn and a long way to go regarding innovation. And so, we are forced to think critically in a very short time.”
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