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Why Project Size Matters for Contract Choice in Software Development Outsourcing

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Abstract:	The contractual mechanism of software development outsourcing, typically either fixed-price (FP) or time-and-materials (T&M), determines the nature of incentives, risk sharing, and coordination between client and vendor. While software engineering considers project size as crucial for project planning and success, neither economic nor organizational theory considers size per se among the determinants of contract choice. In this paper, we address the gap between the centrality of project size in the software engineering literature and the attention it receives in software contracting research by modeling and testing the association between project size and contract choice. Existing empirical evidence indicates that FP contracts are appropriate for small development efforts whereas T&M contracts are suitable for larger projects, based on the reasoning that cost and schedule are difficult to estimate in larger projects. This prediction that size is directly associated with contract choice is the basis upon which two models are developed. The first model draws on the contracting efficiency approach to hypothesize that the effect of project size on contract choice is mediated by project detail. The second model draws on the contingency approach to software development risk management to hypothesize that the effect of project size on contract choice is moderated by project detail and vendor familiarity. We test these models using a large portfolio of software development contracts entered into by a leading European bank, and the results confirm that both mediation and moderation are at play.

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Abstract

The contractual mechanism of software development outsourcing, typically either fixed-price (FP) or time-and-materials (T&M), determines the nature of incentives, risk sharing, and coordination between client and vendor. While software engineering considers project size as crucial for project planning and success, neither economic nor organizational theory considers size per se among the determinants of contract choice. In this paper, we address the gap between the centrality of project size in the software engineering literature and the attention it receives in software contracting research by modeling and testing the association between project size and contract choice. Existing empirical evidence indicates that FP contracts are appropriate for small development efforts whereas T&M contracts are suitable for larger projects, based on the reasoning that cost and schedule are difficult to estimate in larger projects. This prediction that size is directly associated with contract choice is the basis upon which two models are developed. The first model draws on the contracting efficiency approach to hypothesize that the effect of project size on contract choice is mediated by project detail. The second model draws on the contingency approach to software development risk management to hypothesize that the effect of project size on contract choice is moderated by project detail and vendor familiarity. We test these models using a large portfolio of software development contracts entered into by a leading European bank, and the results confirm that both mediation and moderation are at play.

Keywords: Outsourcing, software development, contract choice, project size, mediation, moderation

Introduction

The choice of contractual mechanism, typically between fixed-price (FP) and time-and-materials (T&M) contracts, encapsulates important economic and organizational aspects of software development outsourcing (Kautz, 2009; Lichtenstein, 2004). From an economic standpoint, these two contract types allocate risk very differently. Whereas vendors bear the full risk of cost escalation in FP contracts, clients accept this risk in T&M contracts in exchange for a lower risk of costly contractual amendments (Aubert et al., 2005) and lower uncertainty related to the long-term outcomes of the developed system (Laffont & Tirole, 1993). From an organizational standpoint, FP contracts require formal planning and relatively complete requirement documents, whereas T&M contracts allow for loose requirements and focus on the interaction between client and vendor during software development (Kautz, 2009).

Given the importance of contract choice, research has prescribed the optimal choice under various circumstances. Specifically, FP contracts are appropriate for simple software projects that require *short development time* (Dey et al., 2010), whereas T&M contracts are appropriate for *larger projects*, and those with uncertain requirements (Gopal et al., 2003).

In this paper, we focus on this advice for larger projects and those with short development time by analyzing the role of project size in contract choice. We argue that there is a gap between the centrality of project size in the software engineering literature and the attention it receives in software contracting research. While software engineering considers project size as crucial for project planning and success (Banker & Kemerer, 1989; Barki et al., 1993; Boehm, 1981), neither economic nor organizational theory considers size per se among the determinants of governance structure. Economic theory views contract choice as a way to balance the costs of drafting detailed contracts with the benefits of reducing vendor opportunism (Crocker &

Reynolds, 1993; Williamson, 1985). These costs and benefits are related to asset specificity, uncertainty, and transaction frequency (Macher & Richman, 2008) but not to transaction size. Similarly, when the focus is on risk, contract choice is primarily related to risk sharing (Jensen & Meckling, 1976) and not to the size of the venture (Eisenhardt, 1985). Organizational theories of governance structure similarly pay little attention to project size. Control theory balances social or clan control with performance control (Ouchi, 1979). The latter can take the shape of outcome or behavior control depending on the programmability of the task and the measurability of outcome and behavior (Eisenhardt, 1989). Finally, the application of contingency theory (Galbraith, 1973; Lawrence & Lorsch, 1967) to software project risk management (Barki et al., 2001) highlights the fit between risk exposure and risk management profile. Project size, however, is not directly addressed in these organizational theories.

We aim at bridging this gap between software engineering, which generally has a technical focus, and software contracting, which pays more attention to economic and commercial aspects, by explaining *why* project size matters for contract choice in software development outsourcing. Existing empirical evidence shows that larger software projects are associated with a higher probability of T&M contracts, based on the software engineering reasoning that cost and schedule are more difficult to estimate *ex ante* in larger projects (Gopal et al., 2003). We regard this observation that project size is associated with contract choice as a baseline for theorizing how these two variables are related. We then develop two models, rooted in economic and organizational theory and incorporating additional mechanisms and project attributes, in order to account for the relationship between project size and contract choice.

The first model is theoretically rooted in the contracting efficiency approach (Crocker & Reynolds, 1993), which considers contracts to be efficient when the costs of additional resources

expended in *ex ante* design are balanced against the benefits of mitigating *ex post* opportunism. We rely on this contracting efficiency reasoning to introduce *project detail* and *vendor familiarity* as two key determinants of contract choice, given that project detail is related to the costs of *ex ante* design and that vendor familiarity is related to the benefits of a lower likelihood of *ex post* vendor opportunism. This approach suggests that the effect of project size on contract choice is not direct but rather mediated by the project attributes that reflect contracting costs and benefits. We find theoretical support for such mediation by project detail but not by vendor familiarity. The first model, which is accordingly called the contracting-cost mediation model, hypothesizes that larger projects are more costly to define in detail and thus associated with less detail per unit of size, making it more efficient to use T&M contracts for larger projects.

Whereas the first model highlights the mechanism through which project size and contract choice are related, the second model highlights the conditions under which they are related. The second model is theoretically rooted in the contingency approach to software project risk management (Barki et al., 2001), which considers project performance to be contingent on the fit between risk exposure and risk management. This approach implies that attributes of risk management moderate the implications of project size on contract choice. We rely on this risk management reasoning to consider *project detail* and *vendor familiarity* as two key attributes of the risk management profile in software projects. This contingency approach suggests that different conditions may result in FP and T&M contracts being used for projects of comparable size. The second model, which is accordingly called the project-risk moderation model, hypothesizes that T&M contracts are less likely to be used for larger projects under conditions of high project detail (because there is enough detail to agree on a fixed price) or low vendor familiarity (because it increases the likelihood of opportunism in the relatively open T&M

contracts). These two models therefore provide alternative, theoretically-derived explanations of how project size is associated with contract choice. We test these models with a large portfolio of software development contracts of a leading European bank and find varying levels of support for each of the models.

This paper contributes to the literature by extending the conceptualization and evidence about the relationship between software project size and contract choice beyond a direct association between larger projects and T&M contracts. While both models incorporate additional project attributes, they differ in how these project attributes are determined. Specifically, the contracting-cost mediation model presumes that project attributes may be endogenous to project size, whereas the project-risk moderation model considers them to be exogenous. This study therefore identifies the theoretical mechanisms that account for the importance of project size to contract choice.

Contract Choice in Software Development Outsourcing

The economics literature shows that the domain of procurement contracts is dominated by two contract types, FP and cost-plus (Bajari & Tadelis, 2001; Laffont & Tirole, 1993; McAfee & McMillan, 1986). Research on software development outsourcing similarly distinguishes between FP contracts, in which the price for delivery is prespecified, and T&M contracts, in which the vendor is reimbursed for its costs plus a predetermined profit (Banerjee & Duflo, 2000; Gopal et al., 2003; Lichtenstein, 2004; Whang, 1992).

To make explicit the context and theoretical assumptions, we briefly delineate Holmstrom's (1989) influential formulation of a moral hazard problem. The model assumes an uncertain venture, commissioned by a risk-neutral client and executed by a risk-averse vendor whose actions are not fully observable. The venture yields an uncertain payoff that depends on the

vendor's effort. The client designs a contract that the vendor is ready to take. The contract is also designed to encourage adequate effort, without overly burdening the vendor with risk. The solutions of this model include the two commonplace FP and T&M contracts. Specific to our context, an FP contract optimizes the vendor's effort to reduce the development cost because the vendor pays cost overruns and keeps cost savings. However, risk sharing is not optimal because the risk-averse vendor, rather than the risk-neutral client, accepts the risk of cost overruns. Because of this inefficiency, the model shows that an FP contract is likely when uncertainty is low. The opposite solution of a T&M contract is optimal for risk sharing, but it does not induce optimal effort. The risk-averse vendor has no incentive to exert effort to reduce costs because all its costs are paid by the client. This type of contract is likely when uncertainty is high.

Based on this formulation, numerous considerations affecting contract choice have been studied. A consideration relevant to software development is its multidimensional nature. For example, an FP contract may induce the vendor to decrease quality, which is less measureable, in order to reduce costs (Dey et al., 2010). This risk drives the client to accept a T&M contract when uncertainty is high. Uncertainty about *ex post* adaptations is also particularly relevant to software development. The client may accept the lower incentive to reduce costs associated with a T&M contract in exchange for a lower risk of costly renegotiation and adaptation, in particular when *ex post* adaptations are more probable (Bajari & Tadelis, 2001).

Studies on software development outsourcing frequently draw their predictive power from the identification of project attributes that explain why firms prefer one contract type over the other. For example, Gopal et al. (2003) found that certain attributes, such as uncertainty as to requirements, project size, and number of prior projects, are associated with higher probabilities of either FP or T&M contracts. Other researchers have made similar observations about different

attributes, such as business familiarity (Gefen et al., 2008) and project duration (Dey et al., 2010).

Table 1 presents a summary of the literature on software development outsourcing that looks at contract choice. The table does not take account of more general studies on IT transactions that analyze contracts for services that include, but are not limited to, software development (e.g., Chen & Bharadwaj, 2009; Kalnins & Mayer, 2004). Table 1 demonstrates that project size (reflected in such attributes as effort, team size, function points, price, and duration) is included as an exogenous variable in studies that examine contract choice. The table further shows that research has investigated the extent to which contract choice is associated with various attributes, including those that are project-related (e.g., quality requirements, specification uncertainty, and project detail) and vendor-related (e.g., vendor size, location, and capabilities, previous experience with the vendor). Finally, the table demonstrates the importance of contract choice and its linkages with system quality and vendor profitability.

Theoretical Analysis

We begin our theoretical analysis by briefly summarizing the finding that contract choice is determined by project size (Gopal et al., 2003). We then develop two models that offer integrative explanations for the relationship between project size and contract choice. These models are summarized in Table 2.

Table 1. Contract Choice in Software Development Outsourcing Studies

Study	No. of projects	Contract choice	Variables	Key findings
Banerjee and Duflo (2000)	230	FP-58% T&M-15% Mixed-27%	Project size (man-months), vendor and client size, experience, and location, familiarity with area and platform, project estimate and actual cost, attribution of cost overruns	Low-reputation firms are more likely to get FP contracts
Gopal et al. (2003); Gopal and Sivaramakrishnan (2008)	93	FP-59% T&M-41%	Project size (person days), project duration, team size, project profit, client size, experience, and reputation, previous projects and expectation for future business, specification uncertainty, level of competition, project importance, employee turnover	T&M contracts have higher requirement uncertainty, higher risk in recruiting and retaining personnel, larger project size, and higher profitability; Vendors prefer FP contracts for larger and longer projects; T&M contracts are more profitable when employee attrition risk is high
Lichtenstein (2004)	17	FP-100%	Contract price, project duration, number of milestones, specification detail, project uncertainty and specificity	Use of FP contracts alone is inefficient, particularly because major maintenance work is executed as T&M
Ethiraj et al. (2005)	138	FP-61% T&M-39%	Project size (function points), effort (person months), duration, team size, project contribution (profit), effort overrun, schedule slippage, number of in-process defects	Higher profits in T&M contracts
Gefen et al. (2008)	270	FP-67% T&M-21% Mixed-12%	Contract price, project duration, vendor size and location, software complexity, contract detail (number of pages, external documentation), previous contracts with the vendor	Familiar vendors are more likely to get T&M contracts, thus mitigating the client risk of these relatively open contracts
Dey et al. (2010)	15	FP-40% T&M-27% Mixed-7% Other-26%	Contract duration, quality requirements, client project knowledge, outcome measurability	In addition to FP and T&M contracts, two types of complex pricing mechanisms have been identified in actual agreements: performance-based and profit-sharing contracts
Tiwana (2010)	120	FP-74% T&M-26%	Project scope (size, complexity, person-months), duration, prior client-vendor relationship, client knowledge, vendor size, experience, and location, platform and industry indications, vendor system development capabilities, outcome, behavior, and clan controls	Informal clan control substitutes outcome control, but complements behavior control; contract type has no influence on these effects
Ramachandran and Gopal (2010)	85	FP-61% T&M-39%	Effort (person days), duration, team size, financial risk, requirement instability, technological complexity, inadequacy of trained personnel, previous projects completed for the client, subjective performance	Managers' subjective judgment of project cost and duration performance is biased by their risk anticipation; contract type moderates this effect
Gopal and Koka (2010, 2012) (subsets of a single dataset)	105	FP-~60% T&M-~40%	Effort (person days), duration, team size, requirement and technology uncertainty, client experience, availability of trained personnel and related asset specificity, previous projects completed for the client, quality, profit	Differences between FP and T&M contracts: system quality is higher in FP contracts, vendor profitability is related to quality only in FP contracts, flexibility in project management increases vendor profitability in FP contracts and system quality in T&M contracts

"Mixed" contracts include both FP and T&M components.

Table 2. Summary of the Two Models of Contract Choice

	Contracting-Cost Mediation Model	Project-Risk Moderation Model
Literature	Transaction cost economics	Organization theory, information systems
Theoretical perspective	Contracting efficiency (Crocker & Reynolds, 1993)	Contingency approach applied to software project risk management (Barki et al., 2001)
Objective in deciding on contract type	Use a contract that balances the costs of drafting detailed contracts with the benefits of reducing vendor opportunism	Use a contract that reflects the risk management attributes of formal planning or user participation
Nature of project attributes (project detail, vendor familiarity) decisions	Project detail is endogenous – decisions are made to maximize the efficiency of contracting	Project detail and vendor familiarity are exogenous – decisions are derived from the overall risk management approach to the project
Implications of project detail	Higher project detail increases contracting costs	Higher project detail reflects formal planning as the risk management approach
Implications of vendor familiarity	Higher vendor familiarity reduces the likelihood of vendor opportunism	Higher vendor familiarity reflects user participation as the risk management approach
Relation between project size and project detail	Larger projects are less detailed per unit of size	Stronger positive effect of project size on the likelihood of T&M contracts under conditions of low project detail
Relation between project size and vendor familiarity		Stronger positive effect of project size on the likelihood of T&M contracts under conditions of high vendor familiarity
Results	Project detail fully mediates the effect of price on contract choice, which is also affected by vendor familiarity	The effect of price on the likelihood of T&M contracts decreases as project detail increases

Project Size and Contract Choice

The size of the project is a key decision when planning the development of new software systems (Boehm, 1981). Project size is commonly reflected in two different project attributes, cost and schedule (Boehm, 1981; Sommerville, 2000). Given the intangible nature of software, the major part of the cost in software projects is allocated to manpower effort, measured usually in man-months (Sommerville, 2000). In the context of contracting, effort is reflected in the price of the project, defined as the estimated monetary value of the project at the time the contract is signed. The pricing of custom software differs from that of packaged software (Ethiraj et al., 2004). In the case of packaged software, costs are not a significant driver of price, because of the zero marginal cost of mass producing packaged software (Shapiro & Varian, 1999). Conversely, in the case of custom software, the costs of each project need to be covered by the price paid by a single client, and thus resource costs are a significant determinant of prices (Ethiraj et al., 2004). In the literature on procurement contracts, project size is typically expressed by contract price and not by manpower effort (Kalnins & Mayer, 2004). However, price reflects manpower effort – either literally in T&M contracts or as vendor estimates of effort, which constitute the basis for pricing FP projects (Roditti, 1998).

In the context of contracting, the schedule (development cycle time) is reflected in the duration of the project, defined as the estimated length of time for the completion of the project and delivery of the system that has been commissioned (Kalnins & Mayer, 2004). It should be noted in the context of new system development that project duration is *not* related to relational duration and contract extendibility (Susarla et al., 2010). While project duration pertains to the delivery of the developed system, other contractual aspects may be related to relational contracting (Joskow, 1987) and to the timeframe for future similar projects (Susarla et al., 2010).

Project size has been found to be associated with contract choice. Gopal et al. (2003), through the analysis of data collected on 93 offshore projects from a leading Indian software vendor, showed that larger projects were associated with a higher probability of T&M contracts. Taking the vendor's perspective, the assumption underlying their analysis was that a risk-averse vendor would prefer a T&M contract, all else being equal, in contrast to the preference of a risk-averse client for an FP contract. This assumption led to the hypothesis that the preference for a T&M contract would increase with task uncertainty because the risk-averse vendor would seek more protection from risk *ex post*.

While Gopal et al. (2003) suggested that task uncertainty was responsible for the association between larger projects and T&M contracts, their empirical analysis showed that this association was statistically significant even when requirements uncertainty was controlled for. Software engineering therefore remained the primary conceptual foundation of this association, based on the premise that cost and schedule are more difficult to estimate *ex ante* in larger projects. As the probability and magnitude of estimation errors increase, T&M contracts become more efficient than FP contracts because of their ability to facilitate *ex post* adaptation (Bajari & Tadelis, 2001).

Contracting-Cost Mediation Model

Transaction cost economics (TCE) is the theory most frequently invoked to explain why organizations decide to outsource (Dibbern et al., 2004). TCE reasons that more complete contracts mitigate *ex post* opportunism, but at the cost of additional *ex ante* contracting cost (Bajari & Tadelis, 2001; Corts & Singh, 2004; Williamson, 1985). Crocker and Reynolds (1993) apply this reasoning to develop the contracting efficiency approach. They argue that were

contracting costless, it would be possible to write *ex ante* sufficiently complete contracts to circumscribe all *ex post* vendor opportunism. However, the costs of identifying contingencies, devising responses, and reaching agreements are considerable. The parties therefore balance the costs of additional resources expended in *ex ante* design against the benefits of mitigating *ex post* opportunism. Crocker and Reynolds (1993) argue that the optimal contract "involves a tradeoff between these opposing forces, the magnitudes of which may be predicted based on observable characteristics of the transactors and of the exchange environment" (p. 126). Based on an empirical investigation of U.S. Air Force engine procurement, Crocker and Reynolds (1993) show that contract choice is determined by the variables affecting the marginal cost of contracting and the expectations of opportunistic vendor behavior. Following this reasoning, we identify project detail and vendor familiarity as two key attributes that respectively reflect the costs and benefits of contracting, thus determining contract choice. As explained below, project detail is related to the marginal cost of *ex ante* design and vendor familiarity is related to the expectations of *ex post* opportunistic vendor behavior. The latter relation is based on the notion that "although a contractor's likelihood of engaging in future opportunistic behavior…cannot be observed directly, past experience may serve as a useful guide" (Crocker & Reynolds, 1993, p. 135). As shown in Table 1, previous studies have found these project- and vendor-related attributes to be associated with contract choice.

Project detail. In the context of software development outsourcing, the level of detail in project planning documents reflects the cost of contracting. This level of detail, which we call "project detail", is related to both system specification (its functionality and interfaces) and project plan (the sequence and schedule of outcomes or deliverables). These two aspects of project detail are reflected in what the software industry calls milestones. Sommerville (2000)

defines a milestone as an endpoint of a software process activity. He notes, however, that it is not necessary for all activities to end at a milestone. If milestones are excessively frequent, the project team spends too much time preparing milestones that may not be essential for the progress of the project. If milestones are infrequent, progress problems may lie undetected for long periods of time. Milestones are often a way to monitor progress against a carefully defined specification (Choudhury & Sabherwal, 2003). They can therefore be regarded as a mechanism of control, primarily of outcomes but also of behavior (Eisenhardt, 1985; Kirsch, 1997; Ouchi, 1979). Milestones, as controls, are generally intended to check the quality of the software provided by the vendor and to monitor that the vendor's personnel perform their work (Dibbern et al., 2008). The reasoning of Crocker and Reynolds (1993) suggests that high project detail, reflected in many milestones, is negatively associated with the probability of T&M contracts. As an illustration, consider a project in which the system specification and project plan are defined in minute detail through a large number of milestones. In such a project, the vendor can accurately estimate its costs and agree on a fixed price, and the client can expect to get the minutely-defined system and therefore has no incentive to prefer the more risky T&M contract. The same reasoning applies to a project with limited detail and a small number of milestones. In such a project, the vendor finds it difficult to estimate its costs and set a fixed price, and the client finds it difficult to control the progress of the project and therefore has to be involved in project management as is common in T&M contracts (Banerjee & Duflo, 2000). This reasoning suggests that the probability of FP contracts increases with the detail of the project plan.

Hypothesis 1a. *Project detail is negatively associated with the likelihood of T&M contracts.*

Vendor familiarity. This attribute represents the extent of previous experience with a specific vendor. The contract theory literature views vendor familiarity, or repeated transactions,

as a central mechanism to reduce opportunism (Radner, 1985). Consistent with this view, the literature on familiarity and trust in inter-firm arrangements shows that vendor familiarity, especially when the client can choose among many vendors, is an indicator of past trusting behavior (Gulati, 1995). Vendor familiarity is thus a central antecedent of trust, implying that the client and vendor can depend on each other to do the right thing and not take undue advantage of the situation (Gefen et al., 2008). As a result, T&M contracts are more probable with familiar vendors because of the lower likelihood of vendor opportunism. Stated in terms of trust, honesty and openness are crucial for ongoing cost accounting and functionality changes, typical of T&M contracts, and they evolve gradually between client and vendor (Kern & Willcocks, 2002). Vendor familiarity reduces the need to rely on intensive controls and detailed contracts to ensure expected outcomes (Kumar et al., 1995). A second aspect of vendor familiarity is the scale economies in accounting costs. When a specific vendor is frequently contracted, it is more efficient to contract on a T&M basis, because the costs involved in setting up coordination and accounting procedures are more easily recovered. Accordingly, the extent of prior interactions with a specific vendor has been shown to be positively associated with the probability of T&M contracts (Gefen et al., 2008; Gopal et al., 2003).

Hypothesis 1b. *Vendor familiarity is positively associated with the likelihood of T&M contracts.*

While economic theory provides a rationale for the implications of project detail and vendor familiarity for contract choice, it does not account for the implications of project size. The contracting efficiency approach (Crocker & Reynolds, 1993) does not include project size as an explanatory variable. TCE, the theory upon which this approach is founded, does not take transaction size into consideration. In a recent comprehensive review of TCE research, that of Macher and Richman (2008), scant attention is paid to the attributes of size, volume, duration,

and price. We suggest that this gap in the economic literature is the result of a mediated effect of project size on contract choice, according to which project size affects other project attributes that bear on contract choice. In particular, we hypothesize that project size affects the attribute of project detail.

We expect project size to have a negative effect on project detail. Diseconomies of scale in software development result from the increased complexity of larger projects related to the interfaces among system components, communication between project personnel, and project management activities (Banker & Kemerer, 1989). Diseconomies relevant to *ex ante* project detail are related to both system specification and system design. In particular, the specification of larger software projects involves more functionalities and use cases. The interactions among functionalities, which are often an important part of the specification, grow exponentially with the number of functionalities. Similarly, design documents of larger systems include more modules and more interfaces, requiring the consideration of a larger number of interactions. As a result, we expect larger projects to be characterized by lower project detail per unit of size.

Hypothesis 1c. *Project size (price and duration) is negatively associated with project detail.*

It should be noted that our mediation model is incomplete in the sense that we found no theoretical explanation for an effect of project size on vendor familiarity. However, as both project detail and vendor familiarity are hypothesized to influence contract choice, the model is a complete reflection of contracting efficiency reasoning (Crocker & Reynolds, 1993).

In conclusion, we suggest that the economic literature, in particular the contracting efficiency approach, can be brought forward to support a model in which contract choice is determined by project detail, which mediates the effect of project size, and by vendor familiarity (Figure 1).

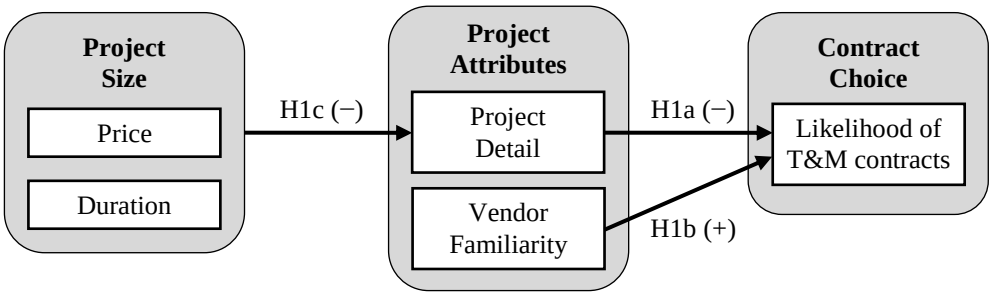

Figure 1. Contracting-Cost Mediation Model (Hypotheses 1a, 1b, and 1c)

Project-Risk Moderation Model

Organizational theory offers another explanation of how project size is associated with contract choice. In particular, the contingency approach to software project risk management (Barki et al., 2001) is brought forward in support of a moderation model, in which the relationship between project size and contract choice is moderated by the profile of risk management. Organizational contingency studies typically explore research models in which the dependent variables are aspects of organizational performance (e.g., Delery & Doty, 1996; Govindarajan, 1988; Venkatraman & Prescott, 1990). Consistent with this approach, Barki et al. (2001) use project performance as their dependent variable. The model developed here diverges from this approach because it uses contract choice as the dependent variable. Nevertheless, we consider the contingency approach to be valuable in understanding how contract choice is affected by the interactions between project size and other project attributes. The contingency approach allows us to highlight the ability of managers to decide on project detail and vendor familiarity in the context of larger projects.

Contingency theory, one of the most influential theories in the study of organizational design and performance, assumes that there is no single best way to organize and that any specific way of organizing is not equally effective under all conditions (Galbraith, 1973; Ginsberg & Venkatraman, 1985). Central to this theory is the proposition that the structure and process of an organization must fit its environment for it to be effective (Drazin & Van de Ven, 1985). Barki et al. (2001) applied this theory to propose that the performance of a software development project is contingent on the fit between the uncertainty and risk involved in the project (risk exposure) and the attributes of risk management, which include formal planning, internal integration, and user participation. This approach implies that risk management attributes should be exogenously determined in light of the level of uncertainty and risk inherent in the project to yield superior project performance.

We apply this approach to describe the relationship between project size and the attributes of project detail and vendor familiarity. Barki et al. (2001) note that project size is often described using the terms uncertainty and risk, suggesting that larger projects have higher risk exposure. Furthermore, project detail and vendor familiarity are attributes of the risk management profile. First, project detail, and specifically the intensity of milestones, is conceptually close to formal planning, defined as "the reliance on plans, schedules, and budgets to ensure the efficient and timely execution of a project" (Barki et al., 2001, p. 44). Second, vendor familiarity in outsourced projects provides many of the benefits of user participation in in-house projects, the setting on which Barki et al. (2001) focus. Specifically, vendor familiarity facilitates mutual interaction, information exchange, and the transfer of knowledge about the client's business processes and systems (Gefen et al., 2008). Third, project detail and vendor familiarity have been identified in the literature (Table 1) as key project- and vendor-related

attributes that influence project risk. This reasoning suggests that project detail and vendor familiarity are attributes of the risk management profile and thus they should be decided upon in the context of project size.

Generally, the moderation perspective defines fit as a set of bivariate interactions between environmental and structural variables that affect performance (Drazin & Van de Ven, 1985; Venkatraman & Prescott, 1990). Our moderation model defines fit as a set of bivariate interactions of project size (price and duration) with attributes of the risk management profile (project detail and vendor familiarity) that affect contract choice. Specifically, we reason that the client may *actively* act upon the characteristics of the project to moderate the effect of project size on the type of contract being used. As noted earlier, while the client prefers FP contracts because the risk of cost overruns is borne by the vendor (Gopal et al., 2003), the client also wishes to control the risk of low quality (Dey et al., 2010). Project size is negatively associated with the probability of FP contracts because larger projects involve more risks of cost escalation and low quality. A risk management alternative available to the client is an approach of formal planning (Barki et al., 2001). In terms of contracting, formal planning means an increase in project detail, namely, a higher intensity of milestones that reflect the project planning agreed upon between client and vendor (including delivery milestones to allow the client to test, accept, and pay for intermediate project outcomes). The higher project detail increases the probability of FP contracts because the client has better control over the risk of low quality and, consequently, cost considerations become more salient. Therefore, high project detail *weakens* the association between larger projects and the use of T&M contracts.

Hypothesis 2a. *Project detail reduces the positive association between project size (price and duration) and the likelihood of T&M contracts.*

Another risk management alternative available to the client is an approach of user participation, which refers to all activities that increase communication and information exchange with users (Barki et al., 2001). In the context of contracting, user participation is more feasible (less costly) with vendors that are more familiar with the client's IT architecture, business processes, and personnel (Bakos & Brynjolfsson, 1993; Gefen et al., 2008). In contrast to project detail, which addresses the risk of low quality *ex ante*, vendor familiarity address the risk of low quality *ex post*, through continuous user feedback on system functionality and subsequent adaptation. This risk management approach, however, is effective only if the type of contract used accommodates *ex post* adaptation, namely, a T&M contract. Consistent with Barki et al.'s (2001) conceptualization of fit, high vendor familiarity *strengthens* the association between larger projects and the use of T&M contracts because of the complementarity between the risk exposure of large projects and the risk management approach of user participation through vendor familiarity.

Hypothesis 2b. *Vendor familiarity increases the positive association between project size (price and duration) and the likelihood of T&M contracts.*

In conclusion, contingency theory and its application to software project risk management are brought forward in support of a model in which contract choice is determined by the interaction of project size with project detail and vendor familiarity (Figure 2).

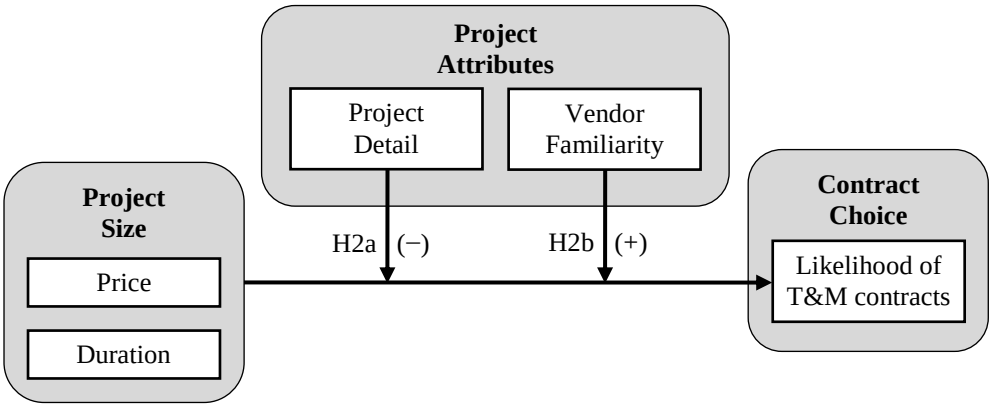

Figure 2. Project-Risk Moderation Model (Hypotheses 2a and 2b)

Research Method

We tested the hypotheses stated above with one of the largest contract portfolios of software development outsourcing projects reported to date in the literature. The research setting is the highly competitive financial services industry, which is the largest user of IT in the industrial sector (Zhu et al., 2004) and which tends to have the highest IT investment risk (Dewan et al., 2007). The contract portfolio that we analyzed includes 237 contracts for software development performed between January 2000 and April 2003 for a leading European bank. The bank, which is among the largest in the world, provides retail and commercial banking, wealth management, and investment banking in dozens of countries and has tens of thousands of employees. The bank's IT department employs about 3,000 permanent employees and 2,000 contractors. The bank's systems are either developed in-house, by internal staff complemented by external consultants and programmers, or they are developed through outsourced projects. The bank contracts out software development through about 100 local and international vendors, and its methods of managing outsourced projects are typical of other large institutions.

Our study continues the recent trend toward the analysis of contractual provisions in actual outsourcing contracts (e.g., Argyres et al., 2007; Chen & Bharadwaj, 2009). Consistent with previous research, the unit of analysis in this study is a contract. Data were collected from the bank's contract repository (an archive of the actual contracts). Each record in the repository represented a single contract and included the contract number, start and end dates, contract price, vendor name, and an electronic scan of the contract. The distinction between FP and T&M contracts was explicitly stated in the contracts. Among the 237 contracts in our dataset, there were 180 FP contracts and 57 T&M contracts.

Project size attributes were evaluated as follows. *Price* was defined as the total price of the contract in U.S. dollars. The price of each contract was copied as explicitly stated in the contract. This value represented the binding price for FP contracts or the estimated price for T&M contracts. The contracts included no information about the extent of manpower effort, but only information about its price. *Duration* was defined as the number of days between the contract's start date and its expected completion date, as recorded in the contract repository. This value represented the duration of the project as contracted between the bank and the vendor.

Project detail was operationally defined as the intensity of milestones specified in the contract, and it was calculated as the sum of payment, delivery, and project milestones, divided (normalized) by the contract price in thousands of dollars. Payment milestones were taken as those milestones at which a portion of the price was due. Delivery milestones were taken as delivery dates at which a work package had to be delivered to the client without a payment. Project milestones were neither payment nor delivery milestones; rather, they represented defined end-points in the progress of the project (e.g., compulsory meetings, client sign-off of specification documents, or the end of internal testing).

Vendor familiarity was operationally defined as the *ex ante* accumulated experience with the specific vendor, and it was calculated as the accumulated price of previous contracts signed with the same vendor after January 2000 and up to the specific contract. This operationalization of vendor familiarity was based on the reasoning presented by Gefen et al. (2008), consistent with research that examined previous client-vendor experience (Gopal & Koka, 2010, 2012; Tiwana, 2010).

All the measures described above were objective and involved no subjective judgment. Descriptive statistics for these measures are presented in Table 3.

Table 3. Descriptive Statistics

Attribute	Description	Unit	Minimum	Maximum	Mean	Std. dev.
Price	Total price of the contract	$K	2.083	2,791.667	272.332	407.032
Duration	Duration of the project	Days	3	880	184.058	143.294
Project detail	Intensity of milestones specified in the contract	Milestones per $K	0	2.280	0.105	0.224
Vendor familiarity	Ex ante accumulated experience with the specific vendor	$K	0	21,037.460	4,192.848	5,799.975

Data Analysis

A common approach in previous studies has been to use the log of variables that measure monetary value because of their skewed distribution (e.g., Chen & Bharadwaj, 2009; Ethiraj et al., 2005). We therefore used the log of price and vendor familiarity in testing the hypotheses. Another common approach in using regression analysis to test for moderation is to center the continuous variables with respect to their means (Aiken & West, 1991; Espinosa et al., 2007; Jaccard & Turrisi, 2003). This approach addresses problems of multicollinearity that may arise

from estimating regression models that include both main and interaction effects of the same continuous variables. This approach also produces more interpretable results because the coefficient of a variable represents its effect when the moderating variable is at its mean, and the coefficient of the interaction term represents how this effect changes as the moderating variable departs from the mean. We consequently mean-centered all four attributes of price, duration, project detail, and vendor familiarity. This approach had no influence on the results for the contracting-cost mediation model other than producing different intercept values, which represented the values of the dependent variable when the variables included in the regression analyses were at their respective means. The resulting correlation matrix for the examined attributes is presented in Table 4.

Table 4. Correlation Matrix

Attribute	Price (log)	Duration	Project detail	Vendor familiarity (log)
Price (log)	1			
Duration	0.496***	1		
Project detail	-0.530***	-0.176**	1	
Vendor familiarity (log)	0.307***	0.119	-0.271***	1

* $p<0.05$; ** $p<0.01$; *** $p<0.001$; two-tailed p values are reported.

We started the analysis by establishing the association between project size and contract choice in the current dataset. Because contract choice was a binary variable (FP = 0, T&M = 1), we used logistic regression to estimate the effects of the project size attributes of price and duration on contract choice. The results of this logistic regression analysis, presented in Table 5, show that price alone had a significant positive effect on contract choice (higher price was

associated with a higher likelihood of T&M contracts), while the effect of duration on contract choice was not statistically significant.

Table 5. Results of Logistic Regression Testing the Effect of Price and Duration on Contract Choice

Attribute	Coefficient	Std. err.	Wald	*p*-value
Intercept	-1.282	0.174	54.517	0.000
Price (log)	0.914	0.343	7.081	0.008
Duration	0.001	0.001	0.578	0.447

$\chi^2(2) = 14.737$, $p<0.001$
Log likelihood = -113.208
Pseudo R^2 (Nagelkerke) = 0.097
Contract choice: FP = 0, T&M = 1

Testing the Contracting-Cost Mediation Model

Our approach to testing the contracting-cost mediation model was first to test whether Hypotheses 1a, 1b, and 1c were supported and then to test whether the effect of project size (price and duration) on contract choice was fully mediated by project detail. Hypotheses 1a and 1b were tested by regressing contract choice on project detail and vendor familiarity. The results of this logistic regression analysis, presented in Table 6, showed that the likelihood of T&M contracts was negatively affected by project detail and positively affected by vendor familiarity, providing support for Hypotheses 1a and 1b.

Table 6. Results of Logistic Regression Testing Hypotheses 1a and 1b (Effect of Project Detail and Vendor Familiarity on Contract Choice)

Attribute	Coefficient	Std. err.	Wald	*p*-value
Intercept	-2.074	0.417	24.732	0.000
Project detail	-12.252	4.804	6.504	0.011
Vendor familiarity (log)	0.870	0.287	9.214	0.002

$\chi^2(2) = 29.745$, $p<0.001$
Log likelihood = -84.902
Pseudo R^2 (Nagelkerke) = 0.226
Contract choice: FP = 0, T&M = 1

Hypothesis 1c was tested by regressing project detail on price and duration. Given that project detail was measured on a ratio scale, an ordinary least squares (OLS) regression analysis was performed to estimate the effects of price and duration on project detail. The results of this regression analysis, presented in Table 7, showed that price negatively affected project detail, while duration had no significant effect on project detail. Therefore, Hypothesis 1c was supported for price, but not for duration.

Table 7. Results of OLS Regression Testing Hypothesis 1c (Effect of Price and Duration on Project Detail)

Attribute	Coefficient	Std. err.	Standardized coefficient	*p*-value
Intercept	-0.004	0.013	---	0.749
Price (log)	-0.193	0.023	-0.558	0.000
Duration	0.157×10^{-3}	0.104×10^{-3}	0.101	0.133

$F = 39.518$, $p<0.001$
$R^2 = 0.266$
Adjusted $R^2 = 0.259$

Next, we tested whether project detail fully mediated the effect of project size on contract choice. The classic procedure for testing mediation was outlined by Baron and Kenny (1986). This procedure was designed to assess the relationships among three variables – independent

variable, mediating variable, and outcome variable – to determine the extent to which the effect of the independent variable on the outcome variable is mediated by the mediating variable. The procedure is based on the estimation of three regression equations (Baron & Kenny, 1986). The first equation regresses the outcome variable on the independent variable, establishing the existence of a "total effect" that may be mediated. The second equation regresses the mediating variable on the independent variable. The third equation regresses the outcome variable on both the mediating variable and the independent variable. The following conditions must hold to establish mediation: the independent variable must affect the outcome variable in the first equation; the independent variable must affect the mediating variable in the second equation; and the mediating variable must affect the outcome variable in the third equation. If these conditions all hold in the predicted direction, then the effect of the independent variable on the outcome variable must be smaller in the third equation than in the first, thus establishing the existence of mediation. Full mediation holds if the independent variable has no effect on the outcome variable when the mediating variable is controlled.

The procedure outlined above was used to test whether the effect of project size (independent variable) on contract choice (outcome variable) was fully mediated by project detail (mediating variable). The first step involved regressing contract choice on price and duration. The results of this logistic regression analysis were already presented in Table 5 and showed that price had a significant total effect on contract choice. The second step involved regressing project detail on price and duration. The results of this OLS regression analysis were already presented in Table 7 and showed that price significantly affected project detail. The third and final step involved regressing contract choice on all four attributes – project detail, vendor familiarity, price, and duration. Vendor familiarity was included in this analysis to control for its

effect on contract choice and to allow for the estimation of the complete contracting-cost mediation model. The results of the logistic regression analysis, presented in Table 8, showed that the effects of project detail and vendor familiarity on contract choice were consistent with those presented in Table 6. However, when project detail and vendor familiarity were controlled, price and duration had no direct effect on contract choice.

Table 8. Results of Logistic Regression Testing the Effect of All Four Attributes on Contract Choice

Attribute	Coefficient	Std. err.	Wald	*p*-value
Intercept	-1.957	0.415	22.251	0.000
Project detail	-10.000	4.887	4.187	0.041
Vendor familiarity (log)	0.847	0.297	8.152	0.004
Price (log)	0.276	0.417	0.438	0.508
Duration	0.474×10^{-3}	1.482×10^{-3}	0.102	0.749

$\chi^2(4) = 27.559$, $p<0.001$
Log likelihood = -82.933
Pseudo R^2 (Nagelkerke) = 0.217
Contract choice: FP = 0, T&M = 1

Overall, application of the procedure of Baron and Kenny (1986) for testing mediation showed that of the two project size attributes, price alone met the requirements for full mediation: price had a significant total effect on contract choice, it had a significant effect on project detail, and it had no direct effect on contract choice when project detail was controlled. Duration, in contrast, failed to meet the fundamental requirement for a total effect on contract choice, and its effect on project detail was nonsignificant.

Testing the Project-Risk Moderation Model

Contingency research often uses interaction terms in regression analyses to test for moderation (Delery & Doty, 1996; Govindarajan, 1988; Venkatraman, 1989). This approach was employed to test Hypotheses 2a and 2b by including all possible two-way interactions of price and duration with project detail and vendor familiarity in the logistic regression for contract choice. Consequently, contract choice was regressed on the four attributes of project detail, vendor familiarity, price, and duration and on the four interactions of the two latter attributes with the two former attributes. The results of this logistic regression analysis, presented in Table 9, showed that in addition to the negative effect of project detail and the positive effect of vendor familiarity (consistent with the results for the contracting-cost mediation model), the interaction of price with project detail was also statistically significant, supporting Hypothesis 2a for price.[1] As predicted, the coefficient for this interaction was negative, implying that the effect of price on the likelihood of T&M contracts decreased as project detail increased. The logistic regression analysis showed that the coefficients for the other interactions were not statistically significant, providing no support for Hypothesis 2b.[2]

[1] Multiplying the log of price by project detail, calculated as the total number of milestones divided by price (in thousands of dollars), may raise concerns about having different representations of price in both the numerator and denominator of this interaction term. These concerns were addressed by repeating the same logistic regression analysis, but with the mean-centered total number of milestones (not normalized by price) replacing project detail. This change had little impact on the results – the number of milestones had a negative effect (B = -0.189, p<0.001), vendor familiarity had a positive effect (B = 1.367, p<0.001), and the interaction of price with the number of milestones had a negative effect (B = -0.300, p<0.01), while the remaining coefficients were not statistically significant.

[2] Our findings for the project-risk moderation model were confirmed by employing an alternative approach in which the interaction terms for project detail (H2a) and those for vendor familiarity (H2b) were separately entered into the regression equation with the four attributes. The results of these two different logistic regression analyses were entirely consistent with our original findings.

Table 9. Results of Logistic Regression Testing Hypotheses 2a and 2b (Effect of Interactions of Price and Duration with Project Detail and Vendor Familiarity on Contract Choice)

Attribute	Coefficient	Std. err.	Wald	*p*-value
Intercept	-2.489	0.571	19.020	0.000
Project detail	-16.548	6.706	6.088	0.014
Vendor familiarity (log)	0.923	0.308	9.010	0.003
Price (log)	-0.638	0.572	1.245	0.264
Duration	0.002	0.004	0.370	0.543
Price (log) × project detail	-10.851	4.671	5.397	0.020
Price (log) × vendor familiarity (log)	0.225	0.458	0.243	0.622
Duration × project detail	0.036	0.044	0.654	0.419
Duration × vendor familiarity (log)	0.001	0.003	0.313	0.576

$\chi^2(8) = 32.344$, $p<0.001$
Log likelihood = -80.540
Pseudo R^2 (Nagelkerke) = 0.252
Contract choice: FP = 0, T&M = 1

In testing for moderation, Carte and Russell (2003) argued that ΔR^2 should be used instead of the interaction coefficient as an index of moderator effect size. We applied this approach to logistic regression by using $\Delta\chi^2$ to estimate the moderator effect size. Using hierarchical logistic regression, the interaction of price with project detail was entered into the regression equation after the four attributes of project detail, vendor familiarity, price, and duration had been entered. The results showed that the Wald value for the negative coefficient of the interaction term was significant at the 0.05 level (*Wald* = 4.564, $p = 0.033$) and the $\Delta\chi^2$ between the two equations (with and without the interaction term) was significant at the 0.1 level ($\Delta\chi^2_{(1)} = 2.945$, $p = 0.086$).

Discussion

In this study, we sought to uncover the mechanisms that explain the overall effect of project size on contract choice. As a baseline, we validated the existing evidence of a higher likelihood of T&M contracts for larger software projects (Gopal et al., 2003) for our dataset. The results confirmed this relationship when project size was represented by price but not when it was represented by duration. Possibly, duration by itself was not strongly linked to manpower effort, perhaps because of considerable variability in the size of the development team or the efficiency of utilizing the duration of the project.

On the basis of a brief review of several economic and organizational theories, we identified two explanations that incorporate additional attributes, both project-related (project detail) and vendor-related (vendor familiarity). The contracting-cost mediation model, theoretically anchored in the contracting efficiency approach (Crocker & Reynolds, 1993), proposed that contract choice was determined by project detail, which mediated the effect of project size, and by vendor familiarity. The project-risk moderation model, theoretically anchored in the contingency approach to software project risk management (Barki et al., 2001), proposed that the effect of project size on contract choice was moderated by project detail and vendor familiarity. The results confirmed the mediated effect for price and the moderated effect for the interaction of price with project detail.

The two models complement one another in some aspects and substitute one another in other aspects. The models are founded on the notion that project size is a crucial consideration in deciding on contract type, but different explanations are offered for the importance of project size, associating larger projects with higher estimation errors (the baseline reasoning), higher contracting cost of project detail, and higher project risk exposure. Furthermore, the models

assign different roles to project detail and vendor familiarity in the context of project size. These project attributes are unobserved in the baseline reasoning, partially determined by (endogenous to) project size in the contracting-cost mediation model, and interact with (exogenous to) project size in the project-risk moderation model.

Importantly, the two models differ in the objective of decisions about project detail and vendor familiarity. The contracting-cost mediation model assumes that these decisions are driven by the motivation of managers to maximize the efficiency of contracting per se, resulting in project detail and vendor familiarity being adjusted to balance the costs and benefits of contracting for larger projects. The project-risk moderation model assumes that project detail and vendor familiarity decisions are driven by the motivation of managers to maximize the likelihood of project success, resulting in decisions on the risk management profile that provides the best fit to the risk exposure characterizing larger projects.

This difference in objectives is helpful in interpreting the conceptual models and empirical results. The baseline reasoning assumes that the objective of managers is to reduce the negative effect of cost estimation errors, which increase with project size. In larger projects, the vendor is thus unwilling to contract on an FP basis. The client is similarly unwilling to accept the risk of lower quality if cost overruns materialize in an FP contract. Both client and vendor are therefore more likely to agree on a T&M contract for larger projects. No additional variables are included in the baseline reasoning to allow a more elaborate interpretation. The results confirm this reasoning for pricier projects, but not for longer ones. The contracting-cost mediation model adds complexity to this reasoning by adding project attributes that reflect contracting costs (project detail) and contracting benefits (vendor familiarity). Larger projects are associated with more risk and thus with less detail per unit of size, making it more efficient to use T&M

contracts for larger projects. The results show that the use of T&M contracts for pricier projects is explained by the associations of these projects with lower project detail. Finally, the project-risk moderation model adds interaction terms among the attributes to draw an elaborate picture of the relation between project size and contract choice. Although contracting efficiency considerations favor lower detail for larger projects (contracting-cost mediation model), managers can react to larger projects by increasing formal planning or user participation. These reactions are represented by the interactions of project size with project detail (for formal planning) and with vendor familiarity (for user participation). The interaction of larger projects with higher detail should increase the use of FP contracts, whereas the interaction of larger projects with more familiar vendors should increase the use of T&M contracts. The results show that indeed managers at our research site decided to increase project detail for some pricier projects and to contract them out on an FP basis.

Implications and Limitations

Our findings have important practical implications. The findings for the project-risk moderation model describe an interaction of project size, proxied by price, with project detail in choosing between FP and T&M contracts. This interaction confirms that managers can increase the detail of project planning to make FP contracts a more viable option for large projects. Among the 237 contracts in the portfolio analyzed in this study, 30 contracts were relatively large in size (their price was higher than the mean plus one standard deviation). One of these contracts, for instance, was for the enhancement of an existing system, and thus project detail could be relatively high (the cost of increasing project detail was relatively low). This allowed the bank to use an FP contract for this project. Using the baseline reasoning alone could lead managers to unnecessarily

choose the more risky T&M contract given the large size of the project. In terms of the project-risk moderation model, managers at the bank concurrently considered project size and risk management practices to reduce the risk involved in this project and ultimately achieve higher quality at lower cost.

The contracting-cost mediation model should assist managers to carefully consider the reasons for contract choice. Attributes like the cost of project planning detail and the benefit of vendor familiarity are conceptually subtle, difficult to understand, and often difficult to measure and agree upon. In contrast, project size attributes, such as price and duration, are easily observed. Managers thus frequently base their contract choices solely on project size attributes (Lichtenstein, 2004). The reasoning and findings of our contracting-cost mediation model suggest that managers should pay more attention to project detail and vendor familiarity in making contract choices. In particular, managers should understand that moving away from the prescriptions of the contracting-cost mediation model implies that they make compromises in terms of contracting efficiency, possibly incurring higher costs and lower benefits, to implement the risk management approach they consider as most likely to lead to the successful completion of the project.

More generally, this paper shows that the notion of choosing T&M contracts for large projects is a valid first approximation. However, this approximation should be refined to include the consideration and manipulation of additional project attributes. Projects that can be defined in minute detail without significant cost provide an option to use FP contracts and reduce the client's risk. Likewise, using the approximation for small projects is incorrect when project planning is extremely costly, because an FP contract may fail to define and provide the right functionality.

This study has a number of limitations. The first limitation lies in the reliance on a single client organization. Consequently, the analysis emphasizes client incentives and preferences, while paying less attention to the incentives and preferences of vendors. Furthermore, the large size and long experience of this specific client are likely to influence its contracting practices. Although learning from such a client is laudable, our empirical results should be generalized to other organizations with caution. The second limitation of our empirical findings is related to the gap between the technical measures typical of research on software development and the economic measures typical of research on procurement contracting. Specifically, we could not use manpower effort to measure project size, and instead had to use price and duration. Price is a valid proxy for effort because FP pricing is based on the estimated effort and T&M pricing is by definition based on the actual effort. Furthermore, the particular context, in which all projects are performed either by local vendors or by large European or North-American vendors, ensures that labor costs are quite uniform. The third limitation of this study is the reliance on the contracts themselves to measure project size, project detail, and vendor familiarity. While these measures are part of binding legal documents and thus objective and not subject to bias, our analysis is limited by the fact that non-contractual project information was not available to us.

Two additional limitations are associated with the unavailability of non-contractual data. First, the models developed and tested in this study could not be extended to include additional project attributes that have been shown to influence contract choice in previous research. Gopal et al. (2003) provide a broad coverage of such potential antecedents of contract choice as the perceptions of project importance, client and vendor reputation, and their bargaining power. In this sense, our analysis is reductionist in nature and focuses on the primary project attributes that emerged from our review of the relevant economic and organizational literature. Second, the

models do not address aspects of organizational or project performance and therefore they are not fully consistent with organizational contingency research or with Barki et al. (2001). The above notwithstanding, the unique objective data available to us allowed the empirical investigation of *ex ante* contract choice considerations in a manner that is not biased by *ex post* perceptions.

Conclusion

Motivated by the recent interest in contract choice in software development outsourcing, this study revisits the theoretical foundations of this phenomenon and uncovers additional mechanisms of mediation and moderation in the relationship between project size and contract choice. Whereas previous research has shown that contract choice is contingent on project size, this study contributes to the literature by identifying additional theoretical mechanisms underlying these contingencies. These theoretical mechanisms highlight the multiple levels at which managers consider the consequences of project size on contract choice. These levels include technical aspects of software development cost estimation, economic aspects of contracting between client and vendor, and the technical, economic, and organizational aspects of project risk management. In so doing, this study provides a multi-layered theoretical foundation for why project size matters for contract choice. Future research should follow the path outlined in this study to develop richer theoretical models for the relationships between project attributes and contract choice. Such models have the potential to significantly advance our understanding of the effectiveness of software development outsourcing.

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Why Project Size Matters for Contract Choice in Software Development Outsourcing

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