Contract Design Choices and the Balance of Ex-Ante and Ex-Post Transaction Costs in Software Development Outsourcing

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Abstract

This paper examines multiple contract design choices in the context of transaction and relational attributes and consequent ex-ante and ex-post transaction costs. It focuses on two understudied themes in the IT outsourcing literature. First, while the literature is predominantly concerned with opportunism and consequent *ex-post* hazard costs that contracts can safeguard against, parties to a contract also economize on *ex-ante* transaction costs by their choice of contract type and contract extensiveness. Second, the literature studies the aggregate extensiveness of contracts rather than of distinct contract functions – *safeguarding*, *coordination*, and *adaptability*. Against this backdrop, our research model portrays a nuanced picture that is anchored in the following theoretical interpretation: transaction and relational attributes have implications on specific ex-ante and ex-post transaction costs, and these implications can be balanced by respective choices in both contract type and the extensiveness of specific contract functions. These two contract design choices complement and substitute for each other in their ability to economize on specific transaction costs. Our analysis of 210 software development outsourcing contracts finds that explanatory power increases when analyzing the extensiveness of individual contract functions rather than the aggregate contract extensiveness, highlighting subtle competing influences that are otherwise masked by an aggregate measure. Our analysis also shows that a preference for Time-and-Material contracts counteracts the effect of certain transaction attributes on contract extensiveness, and even cancels it out in the case of transaction uncertainty.

Key words: contract functions (safeguarding, coordination, adaptability), contract extensiveness, contract type (T&M vs. FP), ex-ante and ex-post transaction costs, transaction cost economics, software development outsourcing

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INTRODUCTION

The importance of contract design in IT outsourcing (ITO) is widely recognized. Research has linked the structure of ITO contracts to the success of ITO relationships (Fitzgerald and Willcocks 1994; Saunders et al. 1997) and has provided empirical guidance on various contract design choices (Anderson and Dekker 2005; Chen and Bharadwaj 2009; Kalnins and Mayer 2004; Lacity and Willcocks 2000; Lee and Kim 1999; Susarla et al. 2010). Some studies focus on design choices pertaining to discrete contract features such as pricing (Crocker and Reynolds 1993; Kalnins and Mayer 2004), duration (Crocker and Masten 1988), and decision rights delineation (Susarla 2012). Other studies examine design choices pertaining to the extensiveness of contracts, reflected in the number of provisions included in a contract (Anderson and Dekker 2005; Chen and Bharadwaj 2009).

Motivated by two understudied themes in the ITO literature, we focus on factors that affect the extensiveness of software development outsourcing (SDO) contracts. One theme is that the parties to a contract make choices about its type and extensiveness with the aim of balancing *ex-ante transaction costs* against *ex-post transaction costs*. Another theme is that outsourcing contracts serve multiple functions – *safeguarding*, *coordination*, and *adaptability* (Eckhard and Mellewigt 2006). In the ITO literature, only Anderson and Dekker (2005) and Chen and Bharadwaj (2009) address aspects of these themes, but subject to limitations we discuss shortly.

We address the first understudied theme by examining explicitly how the balance between ex-ante and ex-post transaction costs interacts with the choice of contract type and contract extensiveness.[1] Because inter-organizational contracts are inherently incomplete (Williamson 1975), much research has focused on

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[1]Although contract "extensiveness" and "completeness" are related concepts, they are not equally viable as operational measures (Eckhard and Mellewigt 2006). Contract extensiveness is a contract design feature that can be assessed just from reading a contract, for example, by counting the total number of provisions written in it. In contrast, contract completeness is "the extent to which *all* relevant terms and clauses are specified, and the extent to which the contract accounts for unanticipated contingencies" (Ariño and Reuer 2004, p. 7). The operationalization of completeness therefore requires detailed background information on *all* the attributes of a transaction, resulting in a relative measure that is usually not viable.

how contract extensiveness is affected by transaction attributes that give rise to *ex-post* hazard costs of opportunism, inefficiencies, and disputes (Ang and Straub 1998; Chen and Bharadwaj 2009; Eckhard and Mellewigt 2006; Lacity and Willcocks 1995; Ryall and Sampson 2006). However, while extensive contracts can mitigate ex-post hazard costs, their crafting requires *ex-ante* transaction costs of "planning" the exchange and writing the contract (Crocker and Reynolds 1993; Williamson 1981). Research has given much less attention to these ex-ante costs. These costs can be significant in high-technology contexts (Argyres et al. 2007), and particularly in SDO projects due to a need for extensive knowledge transfer, requirements specification, and system design, among other things (Dibbern et al. 2008). Chen and Bharadwaj (2009) devote little attention to ex-ante transaction costs in their analysis, whereas Anderson and Dekker (2005) seek to explain ex-ante contracting costs by the choice of contract extensiveness, rather than the other way around. Ex-ante costs can also influence contract extensiveness through the choice of contract type. High ex-ante contracting costs facilitate the use of Time-and-Material (T&M) contracts rather than Fixed-Price (FP) contracts because the former need not be as detailed or extensive (Gopal et al. 2003; Kalnins and Mayer 2004). Yet, Anderson and Dekker (2005) do not consider contract type, and Chen and Bharadwaj (2009) treat it as a control variable on the premise that "use of other contractual provisions such as monitoring, dispute resolution, property rights, and contingency planning facilitates management of the *residual* risks not fully covered by the pricing structure" (p. 2). We expand on these studies by examining ex-ante cost considerations and by viewing the two contract design choices as *alternative* devices that *complement* and *substitute* for one another in economizing on transaction costs. Both choices of extensiveness and type aim *together* at balancing ex-ante costs against ex-post costs while minimizing overall transaction costs (Crocker and Reynolds 1993).

To address the second understudied theme, we take this thinking further by examining the extensiveness of specific contract functions. According to a comprehensive review of contracting articles in 22 top journals, contracts serve three functions: *safeguarding* partners in line with set expectations, *coordinating* cross-firm activities, and providing for *adaptation* to changes in the transaction environment (Eckhard and Mellewigt 2006). Different research streams focus on a single function at a time. In particular, empirical transaction cost economics (TCE) research emphasizes the risk of opportunism and consequent ex-post hazard costs as the problem to be addressed by contracts, leading to a focus on the safeguard function of contracts. TCE theory also recognizes the importance of coordination and adaptation in contractual relationships (Williamson 1991), but empirical TCE research has seldom studied these functions. Select management researchers study individual contract functions, including: factors affecting contingency planning and the extensiveness of the contractual adaptability function (Argyres et al. 2007; Mayer and Bercovitz 2008), the substitutive and complementary effects of trust on contractual safeguards and coordination (Mellewigt et al. 2007), and determinants of provisions having enforcement and coordination functions (Reuer and Ariño 2007). In the ITO literature, Anderson and Dekker's (2005) contract dimensions (functions), which emerge from an exploratory factor analysis of their ITO contract sample, do not cover the adaptability function, and in Chen and Bharadwaj's (2009) contract dimensions, which emerge from a textual analysis of three ITO contracts in their sample, monitoring provisions are only one of the types of coordination provisions used in SDO. In contrast, the pre-defined typology of contract functions we use also covers the kinds of coordination and adaptability provisions found in SDO, and whose crafting entails higher ex-ante investments in knowledge transfer, specification, and contingency planning (Argyres et al. 2007; Dibbern et al. 2008; Mayer and Bercovitz 2008).[2] In sum, we expand the literature by studying Eckhard and Mellewigt's (2006) theory-based typology of contract functions, while considering ex-ante transaction costs or contract type.

We perceive these two understudied themes to be related to each other in the sense that a more comprehensive understanding of the various roles of different contract functions demands a nuanced conceptualization of the balance between ex-ante and ex-post transaction costs. We expect the design choices of contract type and contract extensiveness to balance tradeoffs between ex-ante and ex-post transaction costs, where the tradeoffs may not equally affect all contract functions. Our research model is anchored in the following theoretical interpretation. Transaction and relational attributes – knowledge specificity, transaction complexity, transaction uncertainty, and vendor familiarity – have implications on

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[2] Our discussion of coordination in the context of contract design differs from the IS literature on control (Choudhury and Sabherwal 2003; Kirsch 1997; Rustagi et al. 2008). This literature studies broad modes of control, formal (e.g., behavioral and outcome) and informal (e.g., clan and self), also in connection with coordination in software development and its evolution during project execution. Our focus on formal contractual controls precludes coverage of informal controls in connection with coordination but allows us to study and link explicitly contractual coordination mechanisms with ex-ante transaction costs.

specific ex-ante and ex-post transaction costs. These transaction cost implications, along with specific characteristics of the software to be developed and the prospective vendor, need to be addressed by respective choices in contract type and in the extensiveness of the safeguarding, coordination, and adaptability functions. Although the contract type choice normally precedes and can influence contract extensiveness, both design choices are mechanisms for controlling transaction costs that complement and substitute for each other at the same time (Kalnins and Mayer 2004; Mayer and Bercovitz 2008). Namely, both choices are needed to economize on transaction costs, but some transaction costs can be addressed by either of the two. Our research model, therefore, portrays a nuanced picture of the interplay between transaction and relational attributes, the contract type, and the extensiveness of specific contract functions. We explain relationships in the model by carefully looking at how transaction and relational attributes influence the balance of ex-ante and ex-post transaction costs, and at how changes in this balance can be controlled by contract type and contract extensiveness choices. We therefore advance research on both understudied themes in an integrative manner by identifying variations in the balance of ex-ante and ex-post transaction costs under different contingencies, and by analyzing how these variations are addressed by contract type and specific contract functions. By showing that different contract functions are differently associated with the balance of ex-ante and ex-post transaction costs, we demonstrate the value of considering the extensiveness of specific contract functions.

We test our research model with a sample of 210 SDO contracts that a large European bank signed with multiple vendors. Unlike studies that use mixed samples of ITO contracts,[3] focusing on SDO contracts sets a suitable context in which economizing on ex-ante and ex-post transaction costs is central. Ex-ante costs are significant in SDO projects compared to IT operations because SDO projects are non-recurrent and require ex-ante work to specify the services afresh.[4] For example, a software development project requires an original specification of the target system, while contracting for network operations builds on specifications previously developed for earlier network operations outsourcing deals.

[3] In particular, in Chen and Bharadwaj's (2009) sample of 112 ITO contracts, 41% were SDO contracts, and in Anderson and Dekker's (2005) survey-based sample of 858 ITO transactions, only 12% involved software development under the labels customized software, branch specific software, and tailor-made software.

[4] Our analysis assumes that different software development contracts are independent of one another in the sense that the specifications performed under previous contracts are not used for new contracts. Sometimes, however, a contract is entered into to develop a new version of an existing system, in which case available specifications of the existing system may be reused.

Table 1 reveals this paper's contribution to the ITO literature. Whereas much extant research focuses on separate elements of the overall contract design problem, our work integrates several of those elements and their nuanced interactions. Our research is novel in that we are the first to address the interplay between transaction and relational attributes, the balance of ex-ante and ex-post transaction costs, the contract type choice, and the choice of extensiveness of specific contract functions in a single study. Two tangible benefits follow. First, our work represents an evolution of ITO contracting research: contract type is unobserved in Anderson and Dekker (2005), it is used to conduct a split-sample analysis in Chen and Bharadwaj (2009), and it is treated in our work as an alternative mechanism to contract extensiveness in dealing with transaction costs. Second, by looking at specific contract functions, our work stresses that different SDO projects imply the inclusion of different kinds of contract provisions, which studies based only on summary measures of contract extensiveness do not make clear. The SDO context, characterized by significant ex-ante transaction costs, is highly suitable for making these contract design considerations explicit.

Table 1: Comparison of Extant Research on Contract Extensiveness

	Transaction Costs		Extensiveness of		
Study	**Ex-ante**	**Ex-post**	**Contract**	**Contract Functions**	**Contract Type**
Ang and Straub (1998); Lacity and Willcocks (1995); etc.		Y	Y		
Crocker and Reynolds (1993)	Y	Y			Y
Dibbern et al. (2008)	Y	Y			
Mellewigt et al. (2007)		Y	Y		
Argyres et al. (2007)		Y	Y	Y (Adaptability)	
Mayer and Bercovitz (2008)		Y	Y	Y (Adaptability)	
Reuer and Ariño (2007)		Y	Y	Y (Enforcement and coordination – these functions emerged from an exploratory factor analysis)	
Anderson and Dekker (2005)	(Treated as a dependent variable)	(Treated as a dependent variable)	Y	Y (Rights assignment, after-sales service, product and price,* legal recourse – this taxonomy emerged from an exploratory factor analysis)	
Chen and Bharadwaj (2009)		Y	Y	Y (Monitoring, property rights, dispute resolution, contingency – this taxonomy emerged from a textual analysis of three contracts)	(Treated as a control variable; independent of contract extensiveness)
Our study	**Y**	**Y**	**Y**	**Y (Safeguarding, coordination, adaptability – this typology is based on a synthesis of contracting literature in 22 top journals)**	**Y Complementary and substitutive with contract extensiveness**

"Product and price, a dimension that is more likely to reflect "boilerplate" contract elements (Anderson and Dekker 2005, p. 1735)

The paper proceeds as follows. The next section conceptualizes the transaction costs typical of SDO, as well as contract types and contract functions that are the subject of contract design choices. The third section develops our research hypotheses, and the fourth section presents the data and analysis. Finally, the fifth section discusses our results, their implications and limitations, and directions for future research.

THEORETICAL BACKGROUND

This section discusses concepts central to this study. It explicates the categories of ex-ante and ex-post transaction costs arising in the SDO context, and then reviews the choices of contract type and dimensions of contract extensiveness as mechanisms for controlling transaction costs. This study's conceptual model, illustrated in Figure 1, uses these concepts to show how transaction and relational attributes are hypothesized in the next section to be linked to contract type and contract extensiveness.

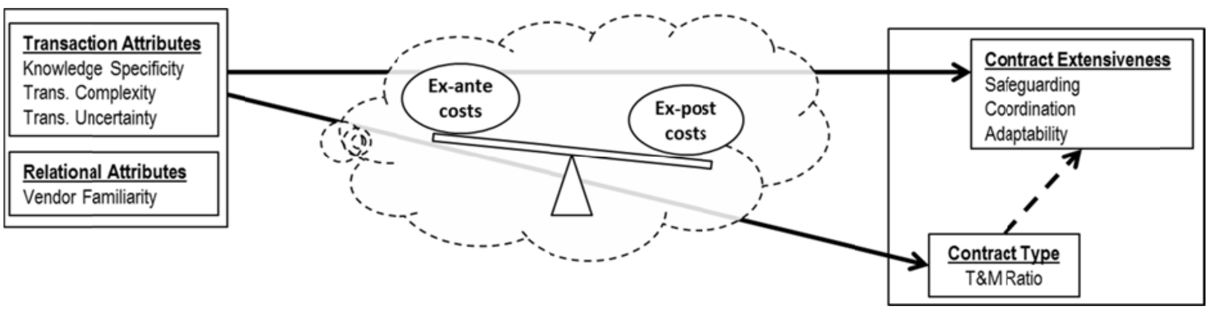

Figure 1: Conceptual model.

Transaction Costs in SDO

Inspired by TCE, our interest is in the transaction costs that arise in the SDO context, that is, the extra costs that a client incurs, as compared with internal software development. Dibbern et al. (2008) recognize several categories of transaction costs arising in the pre-contractual and contract execution (software development) stages. Dhar and Balakrishnan (2006), based on a review of the ITO literature, identify additional categories of transaction costs arising during and after contract execution. Figure 2 displays those cost categories on a timeline, where all costs applicable prior to and after contract signing are hereafter referred to as ex-ante and ex-post transaction costs, respectively.[5]

[5] Our cost categories parallel Milgrom and Roberts' (1990, pp. 60-61) more general account of transaction costs in inter-organizational arrangements: "*Transaction costs* encompass the costs of deciding, planning, arranging, and negotiating the actions to be taken and the terms of exchange …; the costs of changing plans, renegotiating terms, and resolving disputes as changing circumstances may require; and the costs of ensuring that parties perform as agreed. Transaction costs also include any losses resulting from inefficient group decisions, plans, arrangements or agreements; inefficient responses to changing circumstances; and imperfect enforcement of agreements."

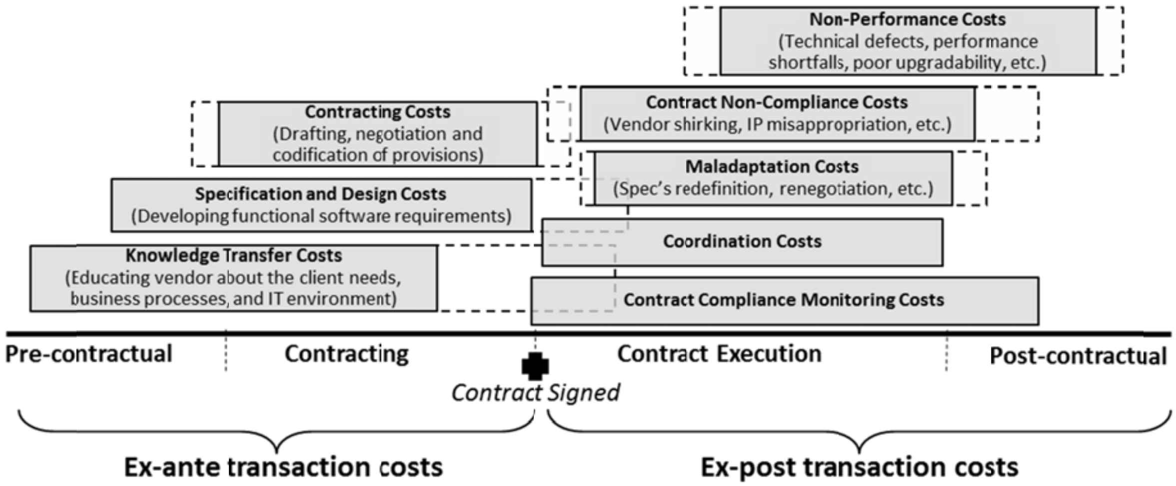

Figure 2: Transaction costs in SDO.

Ex-ante transaction costs arise during the pre-contractual and contracting stages. The pre-contractual stage is about developing an understanding of the transaction (task) requirements, so that a meeting of the minds can be reached and a contract can be negotiated. In SDO, a source of difficulty is knowledge asymmetry: the client possesses "domain" knowledge about its business processes, task characteristics, and existing technical infrastructures (i.e., systems and data sources with which a software solution should interact), and the vendor possesses technical knowledge and expertise based on which a software solution is developed (Dibbern et al. 2008; Tiwana 2003, 2004). Integrating these knowledge types is challenging (Tiwana 2003). It can be done via "knowledge transfer" or "knowledge substitution" (Conner and Prahalad 1996). With knowledge transfer, the client communicates domain knowledge that allows the vendor to lead the requirements specification for the target software. Vendor personnel may have to stay with the client during knowledge transfer (Dibbern et al. 2008), in part because much domain knowledge is business-oriented and tacit in nature. Naturally, this approach is associated with ex-ante *knowledge transfer costs* (Dibbern et al. 2008). With knowledge substitution, the client may take over the majority of the requirements specification, so that the vendor can work from detailed specifications without having to fully understand the application domain (Dibbern et al. 2008; Mirani 2007). Thus, *specification and design costs* are associated with the development of functional software requirements and, more precisely, with "the process of explaining and defining what services are required from the system and identifying the constraints on systems operation and development" (Dibbern et al. 2008, p. 337). Additional ex-ante *contracting costs* are incurred in the contracting stage, in which contract provisions are drafted, negotiated, and codified in a legally-enforceable document. Overall, the ex-ante transaction costs can be significant for SDO (Dibbern et al. 2008), high-technology transactions (Argyres et al. 2007), and complex transactions in general (Crocker and Reynolds 1993).

Ex-post transaction costs arise during the contract execution (software development) and post-contractual stages. Some ex-post costs are associated with controlling vendor behavior and performance (Das and Teng 1998; Tiwana and Keil 2007)[6] through compliance monitoring and coordination activities. *Contract compliance monitoring costs* are needed to ensure conformance with the contract in light of concerns about opportunism of the client or the vendor (Dhar and Balakrishnan 2006). They cover costs of administering warranties, conducting vendor (client) acceptance testing of deliverables, or dispute resolution in case of alleged intellectual property (IP) misappropriation or confidentiality breaches, among other things (Chen and Bharadwaj 2009; Gefen et al. 2008). *Coordination costs* are needed to ensure the accomplishment of joint tasks, independent of any concern for opportunism (Dibbern et al. 2008). They cover costs of linking and integrating client and vendor resources, monitoring vendor progress, measuring outcomes (Barzel 1982), and helping to make decisions about functionality when development work reveals functionalities that were not fully specified.

Additional ex-post transaction costs arise when something "goes wrong." *Contract non-compliance costs* arise when opportunism leads to IP misappropriation, confidentiality breaches, and other costly moral hazards (Williamson 1981). Chen and Bharadwaj (2009) include the switching costs associated with the contractual relationship turning sour in this subcategory. *Non-performance costs* arise when opportunism or incompetence leads to delays in delivery, functional software defects, performance shortfalls, and limited abilities to maintain or upgrade the system (Banker and Kemerer 1992; Dey et al. 2010; Dhar and Balakrishnan 2006; Gopal and Koka 2010). *Maladaptation costs* arise when the contract requires

[6] The broad management literature treats "control as any process in which one party affects the behavior of others" (Das and Teng 1998, p. 493). More specifically, according to Tiwana and Keil (2007, p. 624), "Control in outsourcing alliances refers to the process and rules governing actions by the outsourcee firm in a manner that promotes desirable outsourcee behaviors."

renegotiation in response to changes in the requirements. Some level of requirement volatility is expected in all software projects (Tiwana and Keil 2004), demanding adaptations of the specifications, design, and coding during development. Dealing with these changes in an outsourced project often requires additional knowledge transfer and negotiation.

Transaction Costs and Contract Design Choices

Firms seek to minimize transaction costs by making contract design choices – primarily about contract pricing and contract extensiveness – that balance ex-ante and ex-post transaction costs. In the following subsection, we briefly discuss these choices.

Choice of Contract Pricing

Broadly speaking, firms choose between FP and T&M contracts (Baron and Besanko 1987; Kalnins and Mayer 2004). *FP contracts* consist of a lump-sum payment in exchange for the completion of pre-specified services. They are signed when the parties can agree on a price in advance. This contract type is costly to negotiate and draft. It requires both parties to develop ex-ante detailed and complete client requirements as a basis for an accurate estimate of contract price. Therefore, it entails higher ex-ante costs of knowledge transfer, specification, and contracting. Additional adaptation costs may arise ex-post during development, if changes in requirements are necessary. Moreover, under FP contracts, the vendor bears the risk of cost escalation, the client has less incentive to incur coordination costs, and the vendor has incentives to underprovide quality (Kalnins and Mayer 2004). These adverse consequences give rise to the ex-post costs of non-performance (Dey et al. 2010).

T&M contracts involve the vendor working on a particular task in exchange for a specified payout rate. They are signed when it is difficult to estimate contract price accurately, and the client chooses to pay as work progresses. The typical assumption is that system specifications are not sufficiently clear and will become clearer when partial solutions are presented to users. T&M contracts are less costly to negotiate and involve lower ex-ante costs of specification and knowledge transfer because detailed and complete requirements are not needed ex-ante. In exchange, there may be higher coordination costs during development. Moreover, T&M contracts inherently provide for adaptation. They lower the ex-post costs of maladaptation by reducing the need for re-specification and renegotiation during development (Bajari and Tadelis 2001). However, the client bears the risk of cost escalation because the vendor has "an incentive to oversupply quality in order to increase costs that can be passed along to the buyer" (Kalnins and Mayer 2004, p. 211).

Hybrid contracts allow for a portion of the contract price to be fixed. They may include FP mechanisms such as an FP component with agreed-upon cost estimates or an FP not-to-exceed cap above which any cost is absorbed by the vendor (Kalnins and Mayer 2004). Such FP mechanisms require some specification work and knowledge transfer, possibly carrying additional ex-ante and ex-post costs compared to T&M contracts.

Contract Functions and Extensiveness

Contract extensiveness is another contract design choice involving transaction cost tradeoffs (Crocker and Reynolds 1993). While extensive contracts protect better against ex-post (hazard) transaction costs, they require greater ex-ante investments in transaction planning and in the codification of legally-binding provisions (Bajari and Tadelis 2001; Corts and Singh 2004; Dye 1985; Williamson 1985). Anderson and Dekker (2005) show that the number of contract terms (contract extensiveness) explains the costs of contracting (measured by the number of days spent negotiating and drafting a contract), but only for specific contract functions.

To understand the cost implications of contract extensiveness, it is useful to look at the functions that contracts serve. Eckhard and Mellewigt (2006) conducted a comprehensive review of 22 top journals, to assess and synthesize empirical evidence on the functions of contracts. They found that inter-firm contracts serve the three distinct functions of safeguarding, coordination, and adaptability. Our next discussion explicates these functions, and Table 2 lists provisions they cover.

Safeguarding is a process of bringing about adherence to a desired behavior and outcome, "the purpose being to minimize idiosyncratic and deviant behavior" (Mellewigt et al. 2007, p. 834). This is achieved by using safeguard provisions that pertain to outcome (e.g., checking software quality against agreed specifications) or behavior (e.g., review of coding standards by walking through code with vendor personnel) (Eisenhardt 1985; Kirsch 1997; Ouchi 1980). Safeguard provisions (e.g., protection against IP misappropriation, warranties, insurance, after-sale service, and terms of legal recourse in case of disputes) typically do not detail the exact nature or traits of the end-product. It is therefore less costly to negotiate and draft safeguard provisions than other provision types.

Coordination is a process of enabling the accomplishment of a collective task (Van de Ven et al. 1976). It seeks to minimize inefficiencies and honest mistakes that may occur despite the absence of deviant behavior (Das and Teng 1996). Coordination requires linkages and integration of client and vendor resources, to facilitate better information flow and to avoid mistakes due to miscommunication (Mayer and Argyres 2004). Coordination provisions typically reflect great attention to detail about the nature and traits of the end-product (product description, deliverables, quality standards, detailed tasks and schedules, milestones, etc.). Their development requires extensive knowledge transfer and specification efforts. Therefore, these provisions are more costly to negotiate and codify.

Table 2: Contract Functions and Typical Provisions

Contract Function	Purpose and Typical Contractual Clauses and Provisions
Safeguarding (Bringing about adherence to a desired behavior and outcome)	• **Protection against misappropriation of relationship-specific resources and assets**: IP rights [2, 3, 5, 6]; patents, rights, and ownership of titles [1]. • **Enforcement plan through sanctions**: non-compliance and under-performance penalties [3]; breaches of data security and confidentiality terms [5, 6, 13]; conditions for termination, penalty assumptions [9, 10]. • **Post-transaction obligations**: warranties, insurance, after-sale service, and maintenance clauses [4]. • **Terms of legal recourse**: dispute resolution or conflict arbitration charter (when to involve third parties, timetables for resolving issues, conduct rules for arbitrators) [4, 5, 9].
Coordination (Enabling the accomplishment of a collective task)	• **Product/service description and deliverables**: technical design specifications, output specifications (e.g., service-level targets [9], quality standards [7], and tolerances [3]). • **Transaction tasks and schedules**: enumeration of tasks [7] and their detailed description [8], completion time-frame of tasks/stages [2, 3, 4], milestones, delivery schedule [2, 13]. • **Allocation of resources**: employees/personnel assignment and technologies contributed [3, 9]. • **Framework for monitoring vendor performance**: rights of reports for relevant transactions and of auditing vendor actions [10], measures and procedures, benchmarking standards [5]; reviews and physical audits of vendor development work, timing and content of periodic reviews [3]. • **Communication plan**: reporting procedures between parties, communication flows, schedules, and media [7, 9].
Adaptability (Adjusting to evolving circumstances)	• **Specific, concrete planning clauses**: clauses codifying explicit contingencies that can be clearly identified and a direction to be followed under each contingency [8, 12]. • **Flexibility provisions**: decision rights granted ex-ante as to who could initiate the updating of contract terms or price adjustments [11]. • **A generic framework clause**: a clause outlining a framework for contract renegotiation or a structured process of redetermination of contract terms if unforeseeable contingencies occur [6, 8, 12]; a procedure for proposing and mutually accepting contract amendments [5].

[1] Jensen and Meckling (1992) [2] Whang (1992) [3] Ryall and Sampson (2006) [4] Anderson and Dekker (2005)
[5] Chen and Bharadwaj (2009) [6] Klein et al. (2005) [7] Mellewigt et al. (2007) [8] Argyres et al. (2007)
[9] Goo et al. (2009) [10] Reuer and Ariño (2007) [11] Susarla (2012) [12] Mayer and Bercovitz (2008)
[13] Gefen et al. (2008)

Adaptation is a process of adjusting to evolving circumstances. It facilitates ex-post modifications with minimal renegotiation when problematic contingencies arise during development (Susarla 2012; Williamson 1991). This is achieved through delineation of actions to be taken by the parties in response to the materialization of certain contingencies (Mayer and Bercovitz 2008), or to specific changes in technology, input prices, government regulations, user requirements, and so on. Adaptability provisions can be costly to develop. They may require an extensive planning effort to identify contingencies, devise responses, and reach agreements on both (Argyres et al. 2007; Crocker and Reynolds 1993; Mayer and Bercovitz 2008).

RESEARCH HYPOTHESES

This section develops the conceptual model based on the above discussion and, in turn, formulates several research hypotheses.

Decision Problem and Conceptual Model

To control transaction costs and balance tradeoffs between ex-ante and ex-post costs, the parties have to choose the contract type and the degree of contract extensiveness. These two contract design choices complement and substitute for each other in regard to the ability to control transaction costs. They complement one another because each facilitates economizing on different ex-ante and ex-post costs; for example, T&M contracts cannot neutralize certain ex-post hazard costs that safeguard provisions can mitigate (e.g., IP misappropriation). They substitute for each other because they allow economizing on some of the same transaction costs; for example, both T&M contracts and contracts with extensive adaptability provisions can mitigate ex-post costs of maladaptation. While this means that the two contract design choices may influence each other, detangling the exact influence is not trivial and requires rich data. However, we can assume that the choice of contract type is usually made earlier. Developing a contract could be costly, and so it is less likely that contract type will be chosen after contract extensiveness has been determined; for example, it is wasteful to (ex-ante) transfer knowledge and negotiate coordination clauses that will not be needed under a T&M contract. This view has empirical support in the context of contingency planning (Mayer and Bercovitz 2008):

> The type of contract is determined early on and then the parties negotiate the specifics, including the level of contingency planning. Compustar managers and engineers explained that negotiations with a customer begin with the type of contract (fixed fee, time, and materials, etc.), and then move on to how much contingency planning to include (p. 155).

This reasoning leads us to the conceptual model presented earlier in Figure 1. Based on transaction cost considerations, the model theorizes that the choice of contract type could suppress or enhance the direct influence of transaction and relational attributes on the choice of contract extensiveness.

The research hypotheses we develop next are anchored in TCE's focus on transaction cost considerations and in complementary theories that enrich our reasoning about the SDO context (Tiwana and Bush 2007). ***TCE*** identifies several transaction attributes – primarily, asset specificity, transaction complexity, transaction uncertainty, and transaction frequency – as important determinants of transaction costs (Williamson 1981). Considerable TCE research focuses on how these attributes influence ex-post costs due to vendor opportunism (Macher and Richman 2008), thereby emphasizing the safeguarding function of contracts. While TCE also recognizes the need for contractual coordination and adaptability in support of "planning, adapting, and monitoring task completion" (Williamson 1981, p. 552), it is less explicit about these contractual functions and their associated transaction costs (Milgrom and Roberts 1990). ***Agency theory*** offers a useful complementary perspective. This theory recognizes (like TCE) that the vendor ("agent") might exhibit self-interested shirking behavior, thus, emphasizing two means for mitigating such behavior (Tiwana and Bush 2007). One is to pre-specify in detail how project outcomes will be evaluated and to tie these to vendor performance and rewards. Another is to monitor the vendor during the development process in order to facilitate oversight of vendor activities and outcome quality. The theory offers insight into the costs associated with these two means, especially in the face of uncertainty over outcomes (Bahli and Rivard 2003; Moliné and Abran 1999). The ***knowledge-based view*** (KBV) of the firm complements TCE in another way that is relevant to knowledge-intensive, high-technology contexts. It provides insight into the transaction cost implications of having to exchange and integrate client business knowledge with vendor technical knowledge (Dibbern et al. 2008; Grant 1996; Tiwana and Bush 2007). These challenges depend on two factors not addressed by TCE: (i) the degree to which knowledge about the client's requirements can be communicated to a vendor and (ii) the stability of such knowledge over the project life. Lastly, ***relational exchange theory*** expands on TCE's treatment of transaction frequency. TCE links transaction frequency to scale economies that may incentivize doing a transaction internally (Williamson 1985) and to reputation effects on the prospect of winning future exchanges (Macher and Richman 2008; Williamson 2002). Relational theory considers other effects of repeated exchanges among parties, including trust and relational norms, on contract structure (Heide and Miner 1992; Levinthal and Fichman 1988). It views each contract in terms of the history of the relationship between parties (Gulati 1995), where exchange hazards are mitigated by both economic and sociological mechanisms (Poppo and Zenger 2002).

As recognized in the literature on contracting, contract type and contract extensiveness are choice variables that could be endogenous in our model (Gopal et al. 2003; Hamilton and Nickerson 2003; Shaver 1998). Hence, we examine this possibility in the empirical analysis.

Hypotheses Development

Knowledge Specificity

Asset specificity in SDO is defined as the specificity of knowledge about the client's business requirements, business processes, organizational structure, and IT environment that the vendor needs to master in order to perform the task (Beath and Walker 1998; Chen and Bharadwaj 2009; Dibbern et al. 2005, 2008).

Knowledge specificity creates an asymmetry of knowledge between the client and vendor, thus, influencing both ex-ante and ex-post costs. In the TCE view, knowledge proprietary to the client typically needs to be shared and integrated into the software development process, or else the client will encounter difficulties in formulating objectives and requirements for the vendor (Tiwana and Bush 2007). The client can address the knowledge asymmetry by transferring to the vendor sufficient domain knowledge for the vendor to lead the requirements specification (Choudhury and Sampler 1997; Dibbern et al. 2008), or by "substituting" for the vendor and completing the requirements specification internally and handing them to the vendor for execution (Mirani 2007). Both approaches carry ex-ante costs. However, the KBV suggests that neither of these approaches may be sufficient for ex-ante specification and, therefore, additional ex-post coordination would be necessary. The reason is that client-specific knowledge "can be highly tacit, 'sticky,' and deeply embedded in the idiosyncratic internal practices of the client firm" (Tiwana and Bush 2007, p. 271). Tacit knowledge is difficult to externalize (Conner and Prahalad 1996), suggesting that knowledge substitution is not likely to be efficient. The transfer of tacit knowledge is no less challenging (Dibbern et al. 2008) since it requires active participation of client personnel in educating vendor personnel (Nonaka 1994). The client, however, often lacks personnel to provide this level of participation. In this light, knowledge specificity is expected to make inputs (e.g., requirements) and outputs (e.g., software quality targets) uncertain (Nidumolu 1995), demanding the client to expand more effort on monitoring and coordination activities to ensure adequate product functionality and quality (Choudhury and Sabherwal 2003). The vendor, too, has an incentive to increase coordination to ensure that the client provides necessary knowledge in a timely manner (Kautz 2009). Overall, this implies high ex-post costs for monitoring and coordination.

TCE also suggests that the vendor's propensity to behave opportunistically increases when it has to invest in client-specific knowledge. Client-specific investments prevent the vendor from realizing scale economies by employing the same personnel in engagements with other clients. Therefore, the vendor may underinvest in acquiring client-specific knowledge or relocate personnel familiar with the client to other accounts in mid-project. This could lead to ex-post costs of non-performance due to delays or inferior product quality. Opportunistic behavior could also mean recovering client-specific investments by engaging in rent seeking via exploitation of bilateral lock-in conditions (Susarla 2012), misappropriation of IP, and confidentiality breaches. Such rent-seeking tactics lead to ex-post costs of non-compliance.

The higher ex-ante and ex-post transaction costs associated with knowledge specificity can be controlled by expanding the contract functions of safeguarding and coordination. Provisions that safeguard against misappropriation of relationship-specific resources and define sanctions for non-compliance can mitigate ex-post contract non-compliance costs. Coordination provisions help the client to contain the expectedly higher costs of monitoring and coordination activities, by formally defining how the client will become involved in software development processes (e.g., communication plan and meeting frequency) and how vendor progress is to be tracked (e.g., milestones). Coordination provisions also enable the client to mitigate non-performance costs. Importantly, though, coordination provisions should be less costly to codify under high knowledge specificity. The TCE reasoning about the tradeoff between ex-ante specification and ex-post coordination holds in the SDO context: increased ex-ante knowledge transfer results in more complete specification documents (product description, deliverables, project tasks, etc.) that make coordination provisions richer and easier to formulate. In this light, we hypothesize that:

> ***Hypothesis 1****: Ceteris paribus, knowledge specificity is* **positively** *associated with the extensiveness of the safeguarding and coordination functions.*

Transaction Complexity

Transaction complexity is reflected in the degree to which the software product being developed includes multiple modules, data sources, and interfaces with other systems (Novak and Eppinger 2001).

More complex software generally requires higher ex-ante costs of knowledge transfer and specification. If the system to be built has interactions with other client systems, the parties need to communicate knowledge about the new system and about the business and technical environment of those client systems. The transfer of these two separate knowledge sets demands more effort according to the KBV (Nickerson and Zenger 2004). More importantly, because the number of interactions among modules, data sources, and interfaces to other systems grows exponentially with the number of elements, complexity increases the ex-ante cost of requirements specification.

Transaction complexity also increases the ex-post hazard costs. A greater need to communicate knowledge about existing client systems and the new system makes software design less independent. According to the KBV, this need introduces knowledge exchange hazards and leads to more integrated governance modes (Nickerson and Zenger 2004) that require increased coordination. More complex software also leaves the vendor more room to compromise on quality, leading to higher ex-post costs of non-performance due to technical defects, performance shortfalls, delays in delivery, and lower maintainability and upgradability (Banker and Kemerer 1992; Gefen et al. 2008). The client is, again, required to invest more in monitoring and coordination activities in order to assist and ensure that the vendor accomplishes the collective task satisfactorily (Van de Ven et al. 1976).

Transaction complexity is not likely to increase ex-post adaptation costs, however. Complexity gives rise to a broader spectrum of contingencies. It makes it more difficult and costly to conduct contingency planning and to ex-ante codify respective provisions (Argyres and Mayer 2007; Susarla et al. 2010). Identifying feasible contingencies and negotiating mutually acceptable responses is more difficult when the possibilities are more numerous (Crocker and Reynolds 1993). The parties can compensate for this challenge, in part, by investing more heavily in ex-ante specification and ex-post coordination.

Facing higher transaction complexity, the client is expected to deal with the higher ex-post costs by expanding the safeguarding and coordination contract functions. Safeguard provisions mitigate ex-post costs of non-performance; for example, warranties, customer acceptance testing, and after-sale service specification (Anderson and Dekker 2005; Chen and Bharadwaj 2009). Coordination provisions contain the higher ex-post costs of monitoring and coordination activities. As noted earlier, these costs might escalate in the absence of such provisions. Again, coordination provisions should be less costly to formulate under high transaction complexity since an increased effort of ex-ante knowledge transfer and specification results in more complete specification documents. In contrast, we expect the adaptability contract function to be less extensive since increased software complexity makes adaptability provisions more costly to develop and specify. All of this leads to our next hypothesis:

> ***Hypothesis 2****: Ceteris paribus, transaction complexity is* ***positively*** *associated with the extensiveness of the safeguarding and coordination functions, and* ***negatively*** *associated with the extensiveness of the adaptability function.*

Relatively high ex-ante transaction costs of knowledge transfer and specification and ex-post costs of coordination may motivate the parties to opt for a T&M contract. Presumably, they may decide to control the higher ex-ante and ex-post costs of expanding certain contract functions through contract type as a substitutive mechanism. Indeed, the extant literature suggests that transaction complexity is positively associated with the use of T&M contracts (Bajari and Tadelis 2001). When a software system is complex, the exact development effort and time are difficult to estimate in advance even if requirements are fully specified, making an FP contract a less viable alternative (Banerjee and Duflo 2000; Kalnins and Mayer 2004). Moreover, use of T&M contracts generally lowers ex-ante costs: knowledge transfer is more targeted and occurs where needed during development,[7] much less ex-ante specification is needed, and contracting demands less planning, negotiating, and drafting. At the same time, T&M contracts do not necessarily increase ex-post transaction costs. Maladaptation costs are inherently lower with T&M contracts, as unforeseen contingencies can be accommodated during development (Bajari and Tadelis 2001). Also lower are the ex-post costs of non-performance due to defects, quality shortfalls, and delays. T&M contracts "create an incentive to oversupply quality in order to … increase revenue for the project" (Kalnins and Mayer 2004, p. 211). By contrast, the ex-post costs of coordination are generally higher with such contracts than with FP contracts, as ex-ante interaction between client and vendor is traded for ex-post interaction between them. In sum, T&M contracts lower some ex-post costs and increase others.

While choosing a T&M contract in the face of high transaction complexity increases some ex-post costs while lowering some ex-ante costs, it has little bearing on the association between transaction complexity and the extensiveness of contract functions. The safeguarding function is still necessary (e.g., penalties for IP misappropriation and confidentiality breaches) because T&M contracts do not mitigate all ex-post costs of non-compliance. Coordination provisions are needed to contain the high ex-post costs of coordination that these contracts demand during development (e.g., meeting frequency and communication plans). Finally, the adaptability function would be even less extensive since T&M contracts lower the ex-post costs of maladaptation. In sum, taking into account the use of T&M contracts as a mechanism for controlling transaction costs, we do not expect a change in the associations specified in Hypothesis 2.

Transaction Uncertainty

Transaction uncertainty refers to the degree to which sources of potential disturbances undermine the ability to foresee possible changes (Klein et al. 1990). In SDO and ITO, uncertainty is attributed with a "difficulty of defining ex ante and verifying ex post the products and services for which the parties are contracting" (Anderson and Dekker 2005, p. 1739). Whereas complexity is a product of having too many

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[7] In regard to knowledge transfer, FP contracts need to address a larger variety of circumstances that may or may not happen during actual development; in T&M contracts, conversely, it is natural to acquire less knowledge in the first phases of development and to address specific knowledge needs when they arise.

contingencies whose probabilities are difficult to assign, uncertainty is created by an inherent lack of knowledge of the contingencies and their probabilities (Slater and Spencer 2000).

Transaction uncertainty per se does not increase the ex-ante costs of knowledge transfer and specification or the ex-post costs of non-compliance, but it does increase the ex-post costs of non-performance and maladaptation. According to agency theory, uncertainty due to lack of clarity on task requirements and outcome measurement makes it "difficult to write contracts that adequately govern an outsourcing relationship" (Tiwana and Bush 2007, p. 269). Transaction uncertainty is also associated with the instability of software requirements (Gopal et al. 2003). The KBV suggests that requirements volatility lowers the reliability of knowledge transfer about the project scope and increases the risk that the delivered system might not meet the client's evolved needs (Tiwana and Bush 2007). These two issues lead to ex-post costs of performance shortfalls and schedule slippage. Furthermore, uncertainty significantly increases the need for ex-post adaptation (Bajari and Tadelis 2001). Unlike with transaction complexity, however, high ex-post costs of maladaptation cannot be mitigated by investing more in ex-ante transaction planning and specification.

Higher ex-post costs due to transaction uncertainty can be addressed using appropriate contract provisions. Certain safeguard provisions can mitigate ex-post non-performance costs (e.g., warranties), but not when transaction uncertainty makes requirements unclear and difficult to verify ex-post. Agency theory predicts that uncertainty leads to more intensive coordination (Tiwana and Bush 2007), as evidenced in the software development context (Dey et al. 2010; Lichtenstein 2004). Coordination provisions more effectively lower ex-post cost of non-performance by allowing the client to engage the vendor, be involved in the development process, and keep closer tabs on what is going on (Gefen et al. 2008). Thus, more extensive contractual coordination is expected, at some extra ex-ante cost of specification and ex-post cost of coordination activities. Likewise, more extensive contractual adaptability lowers the maladaptation costs, at some extra ex-ante cost of identifying contingencies and codifying response plans. In sum, while transaction uncertainty is reported to have a limited or even no impact on *aggregate* contract extensiveness (Anderson and Dekker 2005; Dibbern et al. 2004; Rindfleisch and

Heide 1997), we expect it to have a positive effect on the extensiveness of the coordination and adaptability contract functions.

> ***Hypothesis 3a****: Ceteris paribus, transaction uncertainty is* **positively** *associated with the extensiveness of the coordination and adaptability functions.*

Opting for a T&M contract is an alternative way to deal with high transaction uncertainty, as suggested by extant studies (Dey et al. 2010; Gopal et al. 2003). T&M contracts can control the ex-post costs of non-performance and maladaptation, while avoiding the ex-ante costs of developing more extensive contractual coordination and adaptability provisions. As discussed earlier, under T&M contracts, the interaction between client and vendor before the contract is signed (e.g., for ex-ante specification) is traded for significant interaction during development, as described by Gefen et al. (2008):

> It is in the nature of TM projects that the client engages the vendor much more, is more involved with the software development process, and can keep closer tabs on what is going on than in FP projects. In addition, TM projects are often onsite, making it easier to evaluate the software during development, rather than as a black box during testing as in FP projects (p. 9).

T&M contracts also lower the ex-post costs of maladaptation without requiring the high ex-ante costs of contingency planning. Unlike FP contracts, T&M contracts facilitate adaptation during development (Gopal et al. 2003). The client will be able to persuade the vendor to accommodate changes without having to renegotiate the contract (Kalnins and Mayer 2004). In this light, we provide an additional hypothesis about the influence of T&M contracts on the relationship between transaction uncertainty and contract extensiveness:

> ***Hypothesis 3b****: Use of T&M contracts reduces the association between transaction uncertainty and the extensiveness of the coordination and adaptability functions.*

Vendor Familiarity

Vendor familiarity is a product of repeated exchanges with a vendor. While TCE originally linked transaction frequency to the benefits of scale economies, many scholars observed that the governance of repeated inter-firm exchanges is also embedded in social relationships, giving rise to relational exchange theory:

> Economists emphasize the rational, calculative origins of relational governance, emphasizing particularly expectations of future exchanges that prompt cooperation in the present. Sociologists

> emphasize socially derived norms and social ties that have emerged from prior exchange (Poppo and Zenger 2002, p. 710).

According to relational exchange theory, repeated exchanges between a specific client–vendor dyad may have important implications on contract design choices (Gefen et al. 2008; Mayer and Argyres 2004). Familiarity with a vendor has two benefits (Gefen et al. 2008; Gulati 1995). More familiar vendors have already acquired knowledge about the client's business and technological environment through the development of systems previously contracted by the client. This lowers the ex-ante costs of knowledge transfer. Familiar vendors are also more trusted (Dyer and Singh 1998) and, therefore, less prone to opportunistic behavior (Gefen et al. 2008; Mayer 2006; Noorderhaven1996; Ouchi 1980; Poppo and Zenger 2002). This means less ex-post cost of non-compliance. Moreover, the "promise of future business is greater with repeat customers, so the supplier has every incentive to be honest and flexible" (Kalnins and Mayer 2004, p. 212). Thus, the vendor will also accommodate client requests for adaptation without much renegotiation, implying lower ex-post costs of maladaptation. In sum, the client is faced with lower ex-ante *and* ex-post transaction costs as a consequence of vendor familiarity, suggesting that some contract functions will be less extensive. This explains why research "has generally viewed relational governance and formal contracts as substitutes" (Poppo and Zenger 2002, p. 711).

However, it is useful to bring to bear the "learning to contract" perspective (Mayer and Argyres 2004), which suggests that relational governance and formal contracts can also be complementary (Poppo and Zenger 2002). Familiarity of the parties helps them to learn about issues that might arise due to a variety of problems and about effective strategies for handling them (Poppo and Zenger 2002; Ryall and Sampson 2006). Research shows this learning to lead to improved client–vendor communication (Williamson 1979), to utilization of more safeguards for preventing repeated disputes (Mayer and Argyres 2004), to more precisely codified safeguards (Argyres et al. 2007; Mayer and Argyres 2004; Ryall and Sampson 2006), and to reuse of provisions that were agreed upon in the past (Mayer and Bercovitz 2008; Ryall and Sampson 2006). Overall, this learning suggests that some contract functions may be more extensive.

All in all, vendor familiarity has a trust effect and a learning effect with opposing impacts on contract extensiveness, and "the optimal level of contract detail depends upon the relative magnitude of these two effects" (Ryall and Sampson 2006, pp. 209). By this logic, since safeguard provisions display more standardization across SDO situations, the learning effect would make them less costly to specify and, therefore, would dominate the trust effect. Hence, vendor familiarity would not lower the extensiveness of safeguard provisions, as has been observed for penalties (Ryall and Sampson 2006) and dispute resolution provisions (Chen and Bharadwaj 2009). In contrast, since coordination and adaptability provisions in SDO tend to be project-specific, they would be costly to draft in spite of the learning effect and, therefore, the trust effect would dominate. Hence, vendor familiarity would reduce the extensiveness of the coordination and adaptability functions, as also reported by Reuer and Ariño (2007) and by Mayer and Argyres (2004), respectively.

> ***Hypothesis 4****: Ceteris paribus, vendor familiarity is* **negatively** *associated with the extensiveness of the coordination and adaptability functions.*

The literature shows that vendor familiarity is associated with the use of T&M contracts (Gefen et al. 2008; Gopal et al. 2003). Presumably, because of increased trust, the client responds to the low ex-post costs of vendor opportunism and lower risk of cost escalation by opting for a T&M contract. In addition, choosing a T&M contract does not increase the ex-ante costs of specification and contracting nor the ex-post costs of coordination and maladaptation. To the contrary, it lowers the ex-post costs of non-performance and maladaptation because the client is incentivized to be more involved in development (Gefen et al. 2008) and the vendor is incentivized to overinvest in quality and avoid opportunities to renegotiate the initial contract (Kalnins and Mayer 2004). Accordingly, taking into account the influence of T&M contracts on ex-ante and ex-post transaction costs, we did not expect a change in the associations between vendor familiarity and the extensiveness of the coordination and adaptability functions.

DATA AND ANALYSIS

We next discuss the data and methodology used to test our research hypotheses, and then present the analysis results.

Data

Data were collected from the archival contract repository of the IT department in a leading international bank headquartered in Europe. The bank's IT department is part of its headquarters and employs about 3,000 permanent employees and 2,000 contractors. It uses five different contractual arrangements to acquire IT resources: body (personnel) leasing, consulting, system maintenance, software licensing, and software development. This last type is the focus of our study.

The data sample included 210 SDO contracts the bank signed between January 2000 and December 2003. The data specify the fixed price component relative to the estimated total project price, based on which the non-fixed-to-total price ratio can be calculated; we term this as the *T&M-ratio*. Of the 210 contracts, 128 were FP with a T&M-ratio of 0.0, 52 were T&M with a T&M-ratio of 1.0, and 30 were hybrid contracts with a T&M-ratio that ranges between 0.0 and 1.0. The overall average T&M-ratio was 0.272. The contracts in the sample had a total value of $70.1 million. Their values ranged from $5,167 to $3.49 million, with an average of $337,079, and their durations ranged from 15 to 880 days, with an average of 192 days. The contracts were signed with 54 different vendors.

Contract Extensiveness: The data items extracted from the contracts were objective legally-binding provisions. We used the classification of contract functions presented in Table 2 as the conceptual basis for operationally mapping provisions in our contract samples in the functions of safeguarding, coordination, and adaptability. In what follows, we established the validity for our measures by listing the provisions in each category and making references to other studies that used the same or similar provisions. Following Parkhe (1993) and Reuer and Ariño (2007), we measured the extensiveness of contract functions as a simple count of the number of provisions in each function.

The extensiveness of the *safeguarding* function was measured as a count of contractual safeguard provisions, where each was a binary item coded as 1. These provisions mapped to safeguards against vendor opportunism described in Table 2, corresponding to what others call rights assignment (Anderson and Dekker 2005; Chen and Bharadwaj 2009), penalties (Reuer and Ariño 2007; Ryall and Sampson

2009), after-sale service specification (Anderson and Dekker 2005), and enforcement (Reuer and Ariño 2007) (Cronbach's alpha coefficient was 0.75):

- *Source Code Escrow account/IP protection*. If the contract designates an escrow party that holds the source code and transfers it to the client if the vendor closes down
- *Penalty*. If the contract specifies a vendor penalty amount to be paid in the event of a breach of confidentiality, data protection, or employment of bank staff
- *Warranty*. If the contract specifies a warranty period post project completion
- *Customer acceptance test (CAT)*. If the contract specifies that CAT is to be completed by a pre-specified time

The extensiveness of the *coordination* function was measured as a count of contractual coordination clauses, where each was a binary item coded as 1. These clauses corresponded to at least one of the coordination activities described in Table 2, representing monitoring mechanisms (Ryall and Sampson 2009; Susarla 2012), specification of milestones and deliverables (Lichtenstein 2004; Sommerville 2004), payment terms (Anderson and Dekker 2005), and communication-related activities (Mellewigt et al. 2007; Susarla 2012; Willcocks and Feeny 2006) (Cronbach's alpha coefficient was 0.71):

- *Project milestones.* If the project schedule identifies activity endpoints that entail customer sign-off on such things as specification papers and internal testing
- *Intermediate deliverables.* If the project schedule defines points when the vendor submits intermediate deliverables, such as system modules, that should be checked and accepted by the client; these are not tied to payments.
- *Intermediate payments.* If the project schedule defines intermediate payments to the vendor; these are not tied to intermediate deliverables.
- *Intermediate deliverables/payments.* If the project schedule defines points when the vendor submits intermediate deliverables that should be checked and accepted by the client and then followed by intermediate payments

- *Meetings*. If the contract mandates meetings at some frequency (e.g., bi-weekly or monthly); meetings ease the challenges of communication between client and vendor.

The extensiveness of the *adaptability* function is measured as a single binary-item variable, consistent with the operational definition of Argyres et al. (2007):

- *Contingent change provision*. If the contract includes an adaptability clause, which allows the client to initiate requests for changes in requirements, to which the vendor can agree and respond with respective price and schedule adjustments

Finally, *aggregate contract extensiveness* is measured as the sum of provision counts of safeguarding, coordination, and adaptability.

Contract Type: The variable *T&M-ratio* takes a value between 0 and 1, indicating the portion of the overall project cost that is not fixed in the contract (i.e., one minus the fixed-to-total-price ratio).

Transaction Attributes: The conceptual definitions brought forward in hypotheses development are used to operationally define transaction attributes. Consistent with extant definitions of client specificity of knowledge requirements (Dibbern et al. 2005, 2008; Rustagi et al. 2008), *knowledge specificity* is measured as a binary variable, coded as 0 if the contract referenced only the target software product and as 1 if it also referenced explicitly the product's work environment (business processes, specific user types, etc.) and related systems. In accordance with the definition offered earlier in hypotheses development (Anderson and Dekker 2005), *transaction complexity* was measured as a binary variable, coded as 0 if the contract referenced the target software product as a single-module system and as 1 if the product was referenced as a multi-module system with multiple data sources and interfaces to other modules. Consistent with Anderson and Dekker (2005), *transaction uncertainty* was measured as a binary variable on the basis of two binary items: it is coded as 0 if the contract contained *no* explicit statement of (i) business objectives and (ii) technical outcomes, and as 1 otherwise. A contract lacking these items is taken to indicate a difficulty defining ex-ante and verifying ex-post the contracted product.

Relational Attributes: *Vendor familiarity* was measured based on the number and cumulative price of SDO contracts signed with the vendor of a contract (Gefen et al. 2008). This operational definition relies on accepted perceptions of inter-organizational trust as originating from both prior history and expectations of continuity (Poppo et al. 2008). Accordingly, vendor familiarity was measured by the next four items, the first two reflecting past experience and the last two reflecting expectations of future transactions:

- *Past contracts with vendor*. Number of past contracts with a vendor up to the current contract
- *Past cost with vendor*. Total cost of past contracts with a vendor up to the current contract (K US$)
- *Total contracts with vendor*. Number of all contracts signed with a vendor in the sampling period
- *Total cost with vendor*. Total cost of all contracts signed with a vendor in the sampling period (K US$)

Project size, which we later used as an instrumental variable, was measured based on two items: *project price*, measured in US dollars, and *project duration*, measured in days from the start date to the expected delivery date (Ethiraj et al. 2005; Gopal et al. 2003).

The scores for transaction uncertainty, vendor familiarity, and project size were computed on the basis of a principal component analysis (PCA) with a Varimax rotation. The results strongly support our operational definitions of the three factors, with factor loadings above 0.7 and cross-loadings below 0.2, indicating satisfactory convergent and discriminant validity. Cronbach's alpha coefficients were 0.69 for transaction uncertainty, 0.95 for vendor familiarity, and 0.71 for project size, indicating satisfactory reliability. Factor scores were subsequently computed as the means of normalized item values weighted by loadings.

Table 3 displays descriptive statistics for the above items. Although the multi-item factors were measured by objective, legally-binding contractual items, we followed the norm of reporting their reliability in Table 4 (Mithas et al. 2011). Their Cronbach's alphas were close to or exceeded the recommended 0.7 level, indicating their internal consistency reliability. Finally, Table 5 displays inter-correlations for the integrative measures used for hypothesis testing. We used the log values of the integrative measures of vendor familiarity and project size because of their skewed distribution.

Table 3: Descriptive Statistics for Contract Items

Data Item	N	Mean	Std Dev	Min	Max
Source code escrow account/IP protection (present Y/N)	210	0.110	0.313	0	1
Penalty (present Y/N)	210	0.633	0.483	0	1
Warranty (present Y/N)	210	0.762	0.427	0	1
Customer acceptance test (CAT) (present Y/N)	210	0.752	0.433	0	1
Project milestones (present Y/N)	210	0.671	0.471	0	1
Intermediate deliverables (present Y/N)	210	0.571	0.496	0	1
Intermediate payments (present Y/N)	210	0.600	0.491	0	1
Intermediate deliverables/payments (present Y/N)	210	0.481	0.501	0	1
Meetings (present Y/N)	210	0.271	0.446	0	1
Contingency change (present Y/N)	210	0.110	0.313	0	1
T&M-ratio	210	0.272	0.424	0	1
Knowledge specificity	210	0.561	0.249	0	1
Transaction complexity	210	0.857	0.351	0	1
Business objectives	210	0.314	0.465	0	1
Technical outcomes	210	0.867	0.341	0	1
Past contracts with vendor	210	19.35	24.86	0	96
Total contracts with vendor	210	37.94	36.67	1	97
Past cost with vendor ($K)	210	4,680	5,796	0	21,037
Total cost with vendor ($K)	210	8,644	7,994	38.33	21,052
Project price ($K)	210	337	493	5.167	3,489
Project duration (days)	210	192	143	15	880

Table 4: Factor Reliabilities

Factor	Item	Correlation with Total	Deleted Item Alpha	Cronbach's Alpha
(1) Safeguarding Extensiveness	IP protection	0.492	0.725	0.752
	Penalty	0.473	0.735	
	Warranty	0.596	0.667	
	CAT	0.636	0.644	
(2) Coordination Extensiveness	Project milestones	0.537	0.516	0.711
	Intermediate deliverables	0.420	0.576	
	Intermediate payments	0.474	0.545	
	Intermediate deliverables/payments	0.502	0.535	
	Meetings	0.539	0.651	
(3) Adaptability Extensiveness	Contingency change	NA	NA	NA
(4) T&M-ratio	T&M-ratio	NA	NA	NA
(5) Knowledge Specificity	Knowledge specificity	NA	NA	NA
(6) Transaction Complexity	Transaction complexity	NA	NA	NA
(7) Transaction Uncertainty	Business objectives	0.575	NA	0.687
	Technical outcomes	0.575	NA	
(8) Vendor Familiarity	Past contracts with vendor	0.858	0.938	0.949
	Total contracts with vendor	0.882	0.931	
	Past cost with vendor	0.908	0.922	
	Total cost with vendor	0.854	0.939	
(9) Project Size	Project price	0.550	NA	0.709
	Project duration	0.550	NA	

Table 5: Factor Inter-Correlations

	0	1	2	3	4	5	6	7	8	9
(0) Aggregate Extensiveness										
(1) Safeguarding Extensiveness	**0.739**									
(2) Coordination Extensiveness	**0.848**	**0.289**								
(3) Adaptability Extensiveness	**-0.248**	**-0.619**	-0.005							
(4) T&M-ratio	**-0.566**	**-0.230**	**-0.618**	-0.054						
(5) Knowledge Specificity	-0.110	**-0.171**	-0.025	0.108	**-0.144**					
(6) Transaction Complexity	**0.224**	**0.307**	0.098	**-0.249**	0.098	**-0.390**				
(7) Transaction Uncertainty	**0.145**	-0.029	**0.205**	**0.184**	**-0.335**	**0.221**	**-0.302**			
(8) Vendor Familiarity	**-0.133**	-0.004	-0.121	**-0.327**	0.081	-0.127	**0.220**	**-0.165**		
(9) Project Size	**-0.367**	-0.090	**-0.437**	-0.122	**0.815**	**-0.218**	**0.206**	**-0.225**	**0.264**	

Values in boldface indicate Pearson correlations statistically significant at a 5% level or lower.

Method of Analysis

We used regression methods to test our research hypotheses. While our hypotheses did not address the variable of aggregate contract extensiveness, we examined it to demonstrate our contribution of studying specific contract functions. Assuming a linear specification, our analysis involved the following equations:

$$T\&Mratio = \omega_0 + \omega_1 specificity + \omega_2 complexity + \omega_3 uncertainty + \omega_4 familiarity + \varepsilon_1 \quad (1)$$
$$Aggregate\ extensiveness = \alpha_0 + \alpha_1 specificity + \alpha_2 complexity + \alpha_3 uncertainty + \alpha_4 familiarity + [\alpha_5 TMratio] + \varepsilon_2 \quad (2)$$
$$Safeguarding\ extensiveness = \beta_0 + \beta_1 specificity + \beta_2 complexity + [\beta_5 TMratio] + \varepsilon_3 \quad (3)$$
$$Coordination\ extensiveness = \gamma_0 + \gamma_1 specificity + \gamma_2 complexity + \gamma_3 uncertainty + \gamma_4 familiarity + [\gamma_5 TMratio] + \varepsilon_4 \quad (4)$$
$$Adaptability\ extensiveness = \delta_0 + \delta_2 complexity + \delta_3 uncertainty + \delta_4 familiarity + [\delta_5 TMratio] + \varepsilon_5 \quad (5)$$

We started with the effect of transaction and relational attributes on contract type (T&M-ratio) and on aggregate contract extensiveness. We used ordinary least squares (OLS) regressions to estimate equation (1) (Model 0) and equation (2) without T&M-ratio (Model 1). We ran seemingly unrelated regressions (SUR) on the system of equations (3)–(5) without T&M-ratio to estimate the effects of transaction and relational attributes on specific contract functions (Model 1 – functions). SUR was necessary because interdependencies among contract functions could render error terms correlated and viable due to the fact that each function is influenced by a different set of explanatory variables.

Then, to address the effect of the contract type choice, we added the T&M-ratio as an explanatory variable, while recognizing the possibility that endogeneity may cause our estimates to be biased and inconsistent. Specifically, this part of the analysis was complicated by the possibility of endogeneity due to T&M-ratio being both predicted by transaction and relational attributes, and as a predictor of contract extensiveness (Figure 1). It is also possible that the contracting parties anticipated hazards and made self-selection adjustments in contract type. In particular, research has shown that firms self-select contracts into the T&M category on the basis of the expected contracting effort and contract extensiveness (Kalnins and Mayer 2004; Mayer and Bercovitz 2008). We did not consider transaction and relational attributes to be endogenous because they are not likely to be adjusted (self-selected) based on expectations about contract extensiveness. That is, they are not likely to be guided by the need for inclusion of specific provisions at the time of contract negotiation. Knowledge specificity and complexity of the software to be developed follow from business and technological needs of the client, and the levels of environmental uncertainty and vendor familiarity (past experience) are given when a specific contract is negotiated and drafted.

We primarily controlled for endogeneity by using two-stage least squares (2SLS) (Antonakis et al. 2014; Bascle 2008), where T&M-ratio is instrumented by project size. Project size is informative on the basis of previous research that has found it to positively impact the likelihood of using T&M contracts (Fink and Lichtenstein 2014; Gopal et al. 2003). This supposition was confirmed by the high correlation between the two variables in our data (Table 5). At the same time, project size was exogenous. Project scope decisions are driven by business and technological needs of the client rather than the need to include specific contract provisions. We followed the next steps to develop the 2SLS estimator. First, we developed an OLS estimator of contract type (T&M-ratio) using transaction and relational attributes [equation (1)] and saved the residuals. Second, we added the residuals and T&M-ratio as independent variables to equations (2)–(5). Third, we developed non-instrumented estimators by using the OLS method with equation (2) and the SUR method with equations (3)–(5). The coefficients of the residuals came out significant for aggregate contract extensiveness in equation (2) and coordination extensiveness in equation (4). This suggests that the endogenous variable, T&M-ratio, should be instrumented. Therefore, we developed a 2SLS instrumented estimator for aggregate contract extensiveness (Model 2) and three-stage least squares (3SLS) instrumented estimators for the three contract functions (Model 2–

functions). We also ran the Hausman specification test for endogeneity (Davidson and MacKinnon 1993; Hausman 1978). This test compares the coefficients of the instrumented 2SLS estimator and the non-instrumented OLS estimator, where a significant difference indicates that the OLS estimator is inconsistent. The Hausman test was statistically significant for aggregate contract extensiveness in equations (2) (χ^2 = 9.29, p = 0.0023), and for coordination extensiveness in equation (4) (χ^2 = 4.62, p = 0.0316); it was non-significant for equations (3) and (5), as well as for equations (3)–(5) analyzed as a system of equations. The Hausman test supports the use of the instrumented models. In all cases, we also tested for the presence of multicollinearity (Belsley et al. 1980), outliers, and the normality of errors (Shapiro and Wilks 1965) and found no violated assumptions of the OLS model.

We also used Heckman's adjustment to control for selection bias (Chen and Bharadwaj 2009; Gopal et al. 2003; Hamilton and Nickerson 2003; Heckman 1979), knowing that firms self-select contracts into the T&M category on the basis of the expected need for contract extensiveness (Kalnins and Mayer 2004; Mayer and Bercovitz 2008). We specifically used the treatment effect model described in Shaver (1998). In the first step, a probit regression was used to analyze the probability of a "positive" value of a single dependent variable possessing a limited range (e.g., binary or ordered). In our case, contract type was the target dependent variable, and it took on a value of 1 when the contract choice was pure T&M. This step computed a bias correction factor called the inverse Mills ratio. In the second step, the inverse Mills ratio was introduced as an additional explanatory variable into equation (2) for aggregate extensiveness and into equations (3)–(5) for the extensiveness of contract functions. In our case, the inverse Mills ratio was statistically significant, indicating the need to adjust for endogeneity.

Analysis Results

The analysis results, summarized in Tables 6 and 7, generally support our research hypotheses. Model 0 in Table 6 confirms that transaction complexity, transaction uncertainty, and vendor familiarity are positively associated with T&M-ratio. Model 1 shows that the same three attributes are significantly associated with aggregate contract extensiveness, but with a negative coefficient for vendor familiarity. Model 2 shows that these same associations remain statistically significant after the inclusion of T&M-

ratio (instrumented by project size) and that T&M-ratio is negatively associated with aggregate contract extensiveness, consistent with our argument about substitution in contract design decisions. The inclusion of the inverse Mills ratio following Heckman's adjustment yields similar results (not reported here), except for a small difference. The association between vendor familiarity and aggregate extensiveness is even weaker than in the instrumented model and becomes non-significant.

Table 6: Regression Results – Aggregate Contract Extensiveness

	Model 0 (OLS)	Model 1 (OLS) T&M-ratio excluded	Model 2 (2SLS) Instrumented
	Dependent Variable		
	T&M-ratio	Contract Extensiveness	Contract Extensiveness
	Coef. (Std. err.)	Coef. (Std. err.)	Coef. (Std. err.)
Intercept	0.401 *** (0.142)	6.627 (4.245)	9.703 ** (4.178)
Knowledge Specificity	-0.003 (0.028)	0.432 (0.841)	0.683 (0.802)
Transaction Complexity	**0.120** ** (0.058)	**6.281** *** (1.736)	**5.950** *** (1.649)
Transaction Uncertainty	**0.524** *** (0.102)	**8.847** *** (3.035)	**5.715** * (3.097)
Vendor Familiarity	**0.064** *** (0.017)	**-0.892** * (0.491)	**-0.846** * (0.465)
Project Size	**0.234** *** (0.011)		
T&M-ratio			**-3.711** *** (1.363)
Adj. R^2	0.715	0.098	0.190

* *p*<0.10, ** *p*<0.05, *** *p*<0.01

The results in Table 7 address contract extensiveness at the function level. This more granular perspective, like the aggregate perspective, shows knowledge specificity *not* to have a statistically significant association with the expected contract functions, thus, leaving Hypothesis 1 unsupported. Hypothesis 2, in contrast, is strongly supported by the results, showing that transaction complexity is positively associated with safeguarding and coordination extensiveness and negatively associated with adaptability extensiveness. As predicted, these associations remain significant after the inclusion of the instrumented T&M-ratio (Model 2 – Functions). Table 7 shows that transaction uncertainty is positively associated with coordination and adaptability extensiveness, supporting Hypothesis 3a. However, the inclusion of T&M-ratio weakens these two associations to a point where both are no longer statistically significant, supporting Hypothesis 3b. The results also support Hypothesis 4. Vendor familiarity is negatively associated with coordination and adaptability extensiveness. As predicted, these associations were maintained after the inclusion of T&M-ratio. Finally, substitution in contract design decisions is confirmed at the function level only for safeguarding and coordination, as their extensiveness is negatively associated with T&M-ratio. Again, in all these runs, inclusion of the Mills ratio following Heckman's adjustment for endogeneity yielded similar results (not reported here), except for a slight difference. Transaction uncertainty had a marginally significant association with adaptability extensiveness ($p<0.1$), like in the non-instrumented model. We conducted additional robustness testing due to the possibility of estimation bias arising from a single (dominant) vendor being the counter party to a disproportionate share of the contracts in our sample. We repeated the analysis after excluding contracts signed by the bank with this vendor. The results we obtained (not reported here) are qualitatively similar to those reported in Table 7, with only two relationships becoming non-significant for the smaller sample of contracts – the one between transaction uncertainty and adaptability extensiveness and the one between vendor familiarity and coordination extensiveness.[8]

Table 7: Regression Results – Function-Specific Contract Extensiveness

	Model 1-Functions (SUR) T&M-ratio excluded			Model 2-Functions (3SLS) instrumented		
	(a) Safeguarding Extensiveness	(b) Coordination Extensiveness	(c) Adaptability Extensiveness	(a) Safeguarding Extensiveness	(b) Coordination Extensiveness	(c) Adaptability Extensiveness
	Coef. (Std. err.)	Coef. (Std. err.)	Coef. (Std. err.)	Coef. (Std. err.)	Coef. (Std. err.)	Coef. (Std. err.)
Intercept	2.122 *** (0.256)	1.356 * (0.778)	0.711 *** (0.139)	2.300 *** (0.249)	3.298 *** (0.654)	0.831 *** (0.140)
Knowledge Specificity	0.055 (0.117)	-0.065 (0.159)		0.096 (0.109)	0.049 (0.126)	
Transaction Complexity	**1.085** *** (0.281)	**0.810** ** (0.327)	**-0.124** ** (0.059)	**1.042** *** (0.268)	**0.646** ** (0.259)	**-0.135** ** (0.059)
Transaction Uncertainty		**1.858** *** (0.554)	**0.247** ** (0.097)		0.228 (0.484)	0.136 (0.102)
Vendor Familiarity		**-0.146** * (0.087)	**-0.100** *** (0.016)		**-0.180** ** (0.073)	**-0.106** *** (0.015)
T&M-ratio				**-0.518** ** (0.233)	**-1.690** *** (0.217)	-0.006 (0.058)
Adj. R^2	0.093	0.085	0.144	0.152	0.412	0.144

* $p<0.10$, ** $p<0.05$, *** $p<0.01$

[8] We also repeated the analysis with the entire sample, while accounting for a potential bias in the vendor familiarity variable by means of including two additional terms in all models: a dummy variable denoting every contract with the dominant vendor and an interaction of this dummy variable with vendor familiarity. The results we received were similar to those obtained upon exclusion of contracts from the dominant vendor.

A closer examination of the differences between Tables 6 and 7 provides insight into the value of looking beyond aggregate contract extensiveness. First, the results demonstrate that offsetting effects at the function level may not be visible at the aggregate level. Such is the case for the negative association between transaction complexity and the adaptability extensiveness, which is masked by a positive association at the aggregate level. Second, the results for aggregate extensiveness may mask the mitigating effects of T&M-ratio. In the case of transaction uncertainty, the inclusion of T&M-ratio diminishes the associations at the function level, an effect that is less evident at the aggregate level.

DISCUSSION

In this final section, we discuss our main findings in light of the theoretical gaps addressed in our study, in addition to topics for future research.

Main Findings and Theoretical Gaps Addressed

This paper has focused on two related theoretical gaps in the ITO contracting literature. The first gap was that this literature is more salient about considerations of ex-post hazard costs than about those of ex-ante contracting costs. Anderson and Dekker (2005) considered ex-ante contracting costs, but as a dependent variable driven by contract extensiveness rather than the other way around. Additionally, past research has focused on either contract type or contract extensiveness. It has overlooked the impact of contract type on ex-ante contracting costs and, thus, on contract extensiveness. Indeed, Anderson and Dekker (2005) did not observe contract type, and Chen and Bharadwaj (2009) used it to conduct a split-sample analysis. The second gap is that studies have focused on the aggregate extensiveness of a contract rather than on the extensiveness of specific contract functions. Anderson and Dekker (2005) and Chen and Bharadwaj (2009) are exceptions, but their taxonomies of contract functions were derived from their collected data rather than from theory.

Our study has addressed these theoretical gaps by investigating the nuanced interplay between transaction costs and the two choices of contract type and contract extensiveness, while recognizing that these contract choices complement and substitute for each other. To facilitate our analysis, we relied on Eckhard and Mellewigt’s (2006) theory-based typology of contract functions (safeguarding, coordination, and adaptability), and used the ex-ante and ex-post costs implied by different transaction and relational attributes as the theoretical vehicle for examining the interrelationship between the contract type and the extensiveness of these contract functions. The empirical analysis results generally support our research model, showing that contract type and contract extensiveness are alternative mechanisms for economizing on the transaction costs arising under different circumstances. An unexpected result, however, is that knowledge specificity was *not* associated with contract extensiveness or contract type. One plausible explanation is that, compared to other transaction and relational attributes, knowledge specificity has less bearing on contract design choices in the specific contexts of SDO and ITO. This view is well-supported by a comprehensive survey of empirical ITO research based on TCE: of 33 studies, only one-third find support for TCE's prediction about asset specificity (Lacity et al. 2011). A finding similar to ours has also been reported by Aubert et al. (2012):

> Asset specificity has no significant effect on the extent of outsourcing. … Studies finding support for asset specificity were mostly looking at traditional industries. Maybe the effect of asset specificity can only be observed for extreme cases, where the investments are very large and durable. In IT services, such effect could not be found (p. 240).

Other plausible explanations for the knowledge specificity result are rooted in methodology. Our use of contracts from a single client – a large international bank – may have resulted in relatively lower variance in knowledge specificity than in the other transaction attributes we studied. Alternatively, our measure of knowledge specificity may be too focused on business-related aspects. Tiwana and Keil (2004) linked knowledge specificity to the integration of client business knowledge and vendor technical knowledge. In our specific context of a Tier One bank, where core banking and trade systems typically involve internally developed propriety software, technical knowledge specificity is also important but insufficiently reflected in the data and in our measure.

Contributions and Implications

Our study's contribution to the IT literature is three-fold. The first is our explicit account of how ex-ante and ex-post transaction costs come into play in formulating hypotheses about contract design choices. We did so in the software development context, which differs from the broader ITO context in terms of the influence of ex-ante transaction costs on contract design. Ex-ante transaction costs are considerable in

SDO contracting. The intangibility of software and non-recurrent nature of development projects require extensive knowledge transfer and product specification before the contracting parties can agree on a predefined price. The research implication is that overemphasis on ex-post hazard costs cannot tell the whole story of how contract design choices come about.

A second contribution is our fine-grained conceptualization of how the extensiveness of different contract functions varies with transaction and relational attributes, their implied transaction costs, and the contract type choice. Being at the intersection of the two understudied themes on which this paper is focused, this contribution is based on using a nuanced and explicit account of tradeoffs between ex-ante and ex-post transaction costs to explain variations in the extensiveness of different contract functions. In addition, our research model provides the basis for theorizing and demonstrating that studying aggregate contract extensiveness alone might conceal granular variations and even opposing influences on the extensiveness of specific contract functions. For example, although transaction complexity has an overall positive impact on aggregate contract extensiveness, it has a negative influence on adaptability extensiveness and this influence is not suppressed by the use of T&M contracts.

Our third research contribution is the inclusion of contract type as a design choice that complements and substitutes for contract extensiveness, that is, a design choice that influences contract extensiveness while also being influenced by the same transaction and relational attributes influencing contract extensiveness. Our hypotheses suggest, and our findings confirm, that choosing a T&M contract in situations of high ex-ante contracting costs makes it inefficient to develop extensive contracts. This is most apparent from the unique impact that transaction uncertainty has on contract design choices. Specifically, we find that contract extensiveness and contract type *fully substitute* for each other in controlling the extra transaction costs arising due to uncertainty. In other words, to control the higher ex-ante and ex-post transaction costs associated with higher transaction uncertainty, it is sufficient to either use a T&M contract or to expand the coordination and adaptability functions. Theoretically, this finding provides a plausible explanation for reports about the limited, or lack of, impact of transaction uncertainty on contract extensiveness (Anderson and Dekker 2005; Dibbern et al. 2004; Rindfleisch and Heide 1997).

Two broad practical implications emerge from our findings. The first concerns how contract design choices are related to each other, namely, the inclusion of specific clauses and provisions in SDO contracts cannot be independent of contract type. Managers should carefully decide on whether to use an FP contract or a T&M contract given the degree of transaction complexity and uncertainty, and the associated ex-ante contracting costs. Managers should then factor this choice into decisions on whether or not to include specific contractual provisions. In particular, when ex-ante contracting costs are expected to be high, a strategy of economizing on these costs is to postpone product specification and project coordination decisions to the software development stage, implying the practice of T&M contracts and low contract extensiveness.

Another practical implication concerns contract functions. To begin with, advice to extend contract extensiveness must also identify the specific contract functions that need to be extensive. As an example, one of the contracts we studied was for a system that implements a well-established protocol for transferring different currencies between accounts. The project included interfaces to many internal systems. It was necessary to learn each interface and the relevant internal system, implement the protocol, and then test the interface under a variety of conditions. While this complex, multi-interface project required increased contractual coordination with the vendor during software development, less contractual adaptability was needed because the protocol itself and most internal systems were stable. In this sense, our findings highlight factors that guide managers' decisions on the extensiveness of specific contract functions. For complex projects, our results direct practitioners to increase contractual safeguarding and coordination. For familiar vendors, contractual coordination can be less extensive even for complex systems. The obvious flipside is that extensive contractual adaptability is wasteful for complex projects and with familiar vendors. Overall, our results should motivate managers to discuss and assess relatively subtle attributes of the SDO project and the relationship in negotiating and contracting with their vendors, rather than use simple measures such as the cost or duration of a project to guide decisions on contract extensiveness (Lichtenstein 2004).

Limitations and Future Research

All of this said, we recognize several limitations of this study. First, we have not examined the implications of contract design choices on the outcomes of SDO projects. This limitation cuts across most ITO contracting studies (Narayanaswamy et al. 2007). Future research ought to also focus on outcome, considering evidence that contractual controls, among other forms of formal controls, could impact the quality and efficiency of the outcome (Gopal and Gosain 2010). Second, our data on actual SDO contracts come from a single client organization that is large in size and has lengthy experience with SDO. While this methodological feature controls for the potential effects of client-related variables, our empirical results are likely to be influenced by idiosyncratic contracting practices that could limit their generalizability. Third, our analysis does not fully explore the vendor perspective. This perspective is not reflected in the data made available to us. Since vendors are typically involved in making contract design choices, future research could also take into account the contractual preferences of vendors. Fourth, the data coding was done by a research assistant who was granted physical access to SDO contracts on the bank's premises. This person had more than a decade of IT industry experience, including project management experience in both client and vendor firms. Although data coding required no judgment or subjective interpretation, carrying out this effort by independent observers would have enabled testing for inter-rater reliability and eliminated a potential source of bias. Fifth, vendor familiarity is computed as a weighted combination of four measures, two indicating the number and total cost of *past* contracts with a vendor up to the observed contract, and two indicating the number and total cost of *all* contracts signed with a vendor in the sampling period. We use the two latter measures to proxy for expectations of continuity and future transactions with the vendor as the basis for developing inter-organizational trust. Such expectations have typically been measured by questionnaire items (Poppo et al. 2008), whereas we assumed that such expectations were reflected in the archival data available to us by the volume of transactions between client and vendor over the sampling period. Even so, it is possible that the forward-looking expectations of the parties were different from the actual number and cost of contracts and that this biased our vendor familiarity values for vendors with a relatively large number of contracts.

Lastly, using a transaction, or a single contract, as the unit of analysis overlooks the possibility that SDO contracts may be interrelated. A single contract is the typical unit of analysis in TCE research. It also reflects well the practice at the bank of negotiating each contract separately. In particular, the bank has a different contracting procedure and a separate contract database for maintenance work, enabling our empirical analysis to focus on software development. This notwithstanding, development contracts may still relate to one another: specific contracts may build upon knowledge and specifications acquired on previous contracts, as in the case of a contract for a new version of an existing system. Dependencies among contracts could influence ex-ante and ex-post transaction costs, consequently affecting contract design choices. Given that we could not address these dependencies with our data (i.e., the bank's database of development contracts includes no explicit links among contracts), we highlight this issue as an interesting extension for future research.

Our study pinpoints two additional opportunities to build and improve on our analysis. An important venue is to more carefully study the interrelationships between contract design choices as a formal mediation model, using richer (temporally-oriented) data. In our results, a dominant impact of contract type on contract extensiveness appeared for higher transaction uncertainty. However, contract type did not diminish the need to adjust contract extensiveness for higher knowledge specificity, transaction complexity, or vendor familiarity. In this light, using path analysis terminology, we could say that contract type *fully* mediates (suppresses) the association of transaction uncertainty with contract extensiveness, while it *partially* mediates this association for other transaction and relational attributes. Such process models should be confirmed using richer data that track SDO decision making over time.

Another direction for future research is to study complementary and substitution affects among contract functions. Argyres et al. (2007) were first to investigate this question, postulating that: "Contingency planning [adaptability] and task description [a facet of coordination] have reciprocal positive effects on one another, suggesting that they act as complements in complex, high-technology contracts" (p. 7). Their economic logic is that "opportunities for clearer and more detailed task description are often important by-products of the contingency planning activity, while opportunities for additional contingency planning are important by-products of efforts at task description" (p. 7). In a similar vein, some of our theorizing draws on literature suggesting that increased coordination can reduce the need for certain safeguards, as coordination requires the client to engage the vendor more closely, and this can foster trust (Gefen et al. 2008; Ouchi 1980). In sum, one can think of this direction as another column in Table 1 that contracting research could study, the same way one could add to this table the outcome of a contractual outsourcing relationship (measured by product quality or by adherence to schedule and budget) as an important dimension that contracting research could address more thoroughly.

In conclusion, we believe that this paper's conceptualizations and empirical findings will stimulate researchers to expand and build on our line of reasoning. Beyond addressing some of the limitations of our study, future research ought to look to advance the study of how different contract design mechanisms influence one another (high-level perspective) and how different contract functions influence one another (low-level perspective). In so doing, the distinction between ex-ante and ex-post transaction costs provides an important lens through which to understand contract design decisions.

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