A Knowledge-Based Perspective on Contract Choice in Application Outsourcing

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Abstract. A key governance decision in application outsourcing projects is the choice between fixed-price and time-and-materials contracts. While existing research draws on economic theories to explain contract choice, knowledge-based perspectives on contract choice remain underdeveloped. In this paper, we formulate and empirically test such a knowledge-based perspective. We argue that different contract types (fixed-price versus time-and-materials) assign the primary responsibility for coordination to different parties (vendor versus client) and that the ability of each party to coordinate the work depends on task characteristics. Specifically, vendors are most able to coordinate work when knowledge specificity is low and when task scope is high. Data on 1035 contract choices at 223 clients support these ideas. Fixed-price contracts are more frequent under low knowledge specificity and under high task scope. Our key contribution lies in formulating and empirically substantiating a knowledge-based perspective on contract choice.

Keywords: contract type, contract choice, knowledge-based perspective, knowledge-based view, knowledge specificity, coordination

1 Introduction

Application outsourcing—the delegation of the development or maintenance of application software to vendors—has long become a modus operandi in many organizations [1]. The success of application outsourcing projects critically depends on governance decisions [2, 3]. Among the most important governance decisions is contract choice, i.e., the choice between a fixed-price (FP) and a time-and-materials (T&M) contract [4, 5]. In a FP contract, the client pays a fixed fee for software that meets the requirements specified in the contract. Conversely, in a T&M contract, the client pays the vendor based on the vendor's effort and expenses. Existing research explains contract choice primarily by drawing on economic theories, focusing on risk allocation, relative bargaining power, environmental uncertainty, and opportunistic threats [4, 6-8]. Although economic perspectives on contract choice have met considerable empirical support [4, 7, 9, 10], the information systems (IS) and strategic management literatures increasingly recognize that economic perspectives alone are unable to account for the complex nature of application outsourcing [11, 12]. A growing stream of research argues that economic perspectives on application outsourcing should

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be complemented by knowledge-based perspectives [13-15]. Knowledge-based perspectives explain governance decisions not with economic motives but with irreducible knowledge differences between client and vendor. Such knowledge-based perspectives are, however, rare in research on contract choice. We therefore ask: *Can knowledge-based reasoning explain contract choice in application outsourcing?*

To address this question, we develop a knowledge-based perspective on contract choice. We argue that different contract types assign the primary responsibility for coordination to different parties and that contract choices reflect differences in the ability of each party to coordinate the work. It is widely acknowledged that FP contract assign the primary responsibility for coordination to vendors, whereas T&M contracts assign it to clients [16]. To this often articulated idea, we add that clients and vendors differ, often in irreducible ways, in their coordination knowledge (i.e., in their ability to coordinate the work performed in a particular application outsourcing project) and that differences in coordination knowledge are influenced by two important task characteristics: knowledge specificity and task scope. Vendors have superior coordination knowledge when projects require little specific knowledge (i.e., low knowledge specificity) and when a complex bundle of tasks needs to be coordinated (i.e., high task scope). In these conditions, decision makers will prefer FP contracts in order to allocate the responsibility for coordination to vendors. Conversely, they will decide for T&M contracts when knowledge specificity is high and task scope is low.

We empirically test these ideas using a comprehensive dataset of 1035 contract choices made by 223 Swiss public organizations. The results strongly support the hypotheses. Our study is among the first to formulate and empirically test a knowledge-based perspective on contract choice. More broadly, our findings reinforce calls for greater attention to knowledge-based issues in outsourcing research.

2 Background Literature and Theoretical Model

2.1 Existing Research on Contract Choice

A substantial body of research has examined contract choice in application outsourcing projects. Qualitative work has shown that contract choice affects the behavior of people involved in application outsourcing [5]. Quantitative research has primarily drawn on economic theories to explain contract choice and its effects [4, 6-8]. The arguments in these studies center on risk, power, environmental uncertainty, and opportunistic threats. A key argument is that different contract types assign the major portion of *risk* to different parties. Under a FP contract, the vendor bears the risk for cost escalation given that the vendor commits to deliver a particular software at a given price. Conversely, under a T&M contract, this risk is borne by the client [8]. Since self-interested, risk-averse parties prefer to transfer risks to the other party, the relative *power* of each party influences which party is able to impose its preference. Relatively powerful clients will manage to impose FP contracts, while relatively powerful vendors will manage to impose T&M contracts [4]. Moreover, *environmental uncertainty* (i.e., the extent of unpredictable exogenous change, such as change in technology and in business environments) affects to what extent vendors are willing to

take over the risk that a FP contract allocates to them. The higher environmental uncertainty, the higher is the portion of the risk that vendors cannot control and, hence, the less willing are vendors to accept a FP contract [17, 18]. Threats of *opportunistic behavior* (i.e., self-interest seeking with guile) are also argued to affect contract choice. Drawing on agency theory [17] and transaction cost economics (TCE) [19], studies have argued that different contract types are differentially effective in combating opportunistic threats [7, 9]. Specifically, FP contracts, with their clear specification of goals, are considered high-powered incentives, which are preferred when opportunistic threats are high, such as when the parties lack trustful working relationships [7, 9].

Although these economic perspectives have met considerable empirical support and although they have contributed to a much improved understanding of contract choice [4, 7, 9, 10], three problems remain. First, by emphasizing economic theories, the literature on contract choice may overlook important explanations for contract choice [11], in particular knowledge-based perspectives. Second, most empirical studies focus on one sole client [7, 9, 10] or one sole vendor [4, 20]. It is unclear to what extent the results in these studies mirror idiosyncratic contracting practices of these particular firms. Third, there is some uncertainty surrounding the empirical operationalization in these studies, in particular with regard to knowledge specificity. Knowledge specificity is a key construct of TCE [21]. Although several studies of contract choice have invoked TCE [4, 10, 18], only one [9] included a measure of knowledge specificity. However, this measure focused on business knowledge, while empirical studies of application services highlight the critical nature of application knowledge (i.e., knowledge of the inner workings of a particular software application) [22, 23].

2.2 A Knowledge-based Perspective on Contract Choice

In this paper, we advance a knowledge-based perspective on contract choice. A knowledge-based view (KBV) explains governance decisions with irreducible knowledge differences between parties [24-26]. Knowledge is the capacity to act and includes both individual-level skills and team-level or organizational-level capabilities [27]. The knowledge that enables the performance of complex tasks, such as application services, is largely tacit [28] and is acquired through years of practice in the particular domains of a task [22, 24, 29]. Because the acquisition of knowledge takes long time, knowledge differences between client and vendor are often irreducible within a single project [13]. While knowledge is essential for the performance of complex tasks, it is also essential for their coordination [24-26]. Application services require engineers to develop one coherent software [30], which requires that many technical and business-related decisions be coordinated [31]. A key assertion of the KBV is that knowledge required to achieve such coordination in a particular setting differs between firms because firms, and the teams and individuals within them, acquire such knowledge only through long situated practice [24].

Although application outsourcing research has shown that knowledge-based perspectives can explain important issues such as cost overruns [13], coordination [32], contract extensiveness [9], transition activities [29], and knowledge-sharing [14], knowledge-based perspectives on the choice of contract types remain rare. In this paper,

we formulate such a perspective. Specifically, we argue that different contract types assign the primary responsibility for coordination to different parties and that each party's coordination knowledge depends on task characteristics. It is widely acknowledged that under a FP contract the vendor bears the bulk of responsibility for coordination because the vendor is ultimately responsible for achieving the specified outcomes. Conversely, under a T&M contract, the client retains the right to coordinate the activities of vendor personnel [16]. Based on these ideas, we argue that decision makers will align responsibilities with the distribution of knowledge. When the vendor has stronger coordination knowledge than the client, FP contracts will be preferred because they place the responsibility for coordination on the vendor. Instead, when the client has stronger coordination knowledge than the vendor, T&M contracts will be preferred. We next formulate hypotheses about how two important task characteristics influence the distribution of knowledge and, hence, contract choice.

2.3 Hypotheses

Figure 1 presents our theoretical model. It predicts that knowledge specificity and task scope correlate with contract choice.

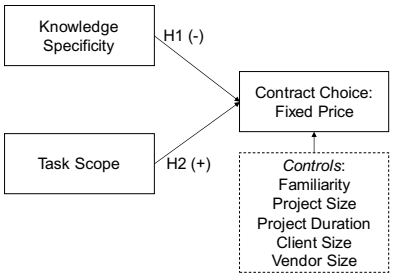

Figure 1. Theoretical Model

Knowledge specificity is likely to influence the distribution of knowledge and, hence, contract choice. Knowledge specificity (or human asset specificity) is the degree to which the task requires knowledge that is idiosyncratic to the client [13, 21, 33]. Whether knowledge is specific depends on the knowledge domains relevant for a particular task. A key knowledge domain in application services is application knowledge [31, 34]. Application knowledge enables engineers to comprehend existing code and data structures, to identify where and how changes the existing code should be made, and to anticipate side-effects from code changes [22, 35]. A study of application outsourcing transitions showed that application knowledge is often the most critical knowledge [23]. Given the key role of application knowledge, we argue that the specificity of knowledge depends on the application that shall be developed or maintained. If a project refers to a custom-developed application, the application exists only at this client. Key knowledge domains (e.g. knowledge about the modules, the control flow and data flow in and between these modules, the data model, the meaning of the data, configuration settings) are then specific to the client. Vendors will often

lack knowledge in these domains at the outset of projects. Under such circumstances, clients are likely to have stronger coordination knowledge than vendors. Hence, decision makers are likely to prefer T&M contracts. Conversely, if a project refers to a software package (or commercial-off-the-shelf software), installations of the software exist at many clients. Vendors can then leverage the knowledge that they bring from prior implementations of the same application at other clients. Such vendors will be able to avoid mistakes made in prior projects and to quickly map the details of the client's business to the inner workings of the familiar application. Even if clients choose to strongly customize a software package, the vendor will benefit from knowledge about the software package that helps organize and comprehend existing and planned customizations. Hence, under the conditions of low knowledge specificity, decision makers will choose FP contracts in order to leverage the coordination knowledge brought in by the vendor. We anticipate:

H1: Projects of high knowledge specificity (as empirically indicated by the use of custom-developed software) are less likely to choose FP contracts than projects of low knowledge specificity (as empirically indicated by the use of packaged software).

Task scope is also likely to influence the distribution of knowledge and, hence, contract choice. Task scope refers to the degree to which the project includes a variety of services (e.g. application design, development, maintenance, hardware management, hardware procurement, telecommunication) [36, 37]. When task scope is high, the coordination of the technical elements of a project is complex [36]. Such projects require knowledge about how these technical elements can be combined. Vendors are more likely than clients to possess such knowledge. They may have greater experience in coordinating the application with other, typically not client-specific, technical elements, such as machines and telecommunication infrastructure. Clients prefer to leverage this knowledge by delegating the responsibility for coordination to the vendor:

H2: The higher task scope, the more likely is the choice of a FP contract.

It is interesting to note that H1 and H2 are opposed to predictions that can be derived from economic theories. Knowledge specificity is a construct not only of the KBV [13, 24] but also of TCE [21, 33]. According to TCE, knowledge specificity augments opportunistic threats because opportunistic vendors may underinvest into specific knowledge, given that they cannot redeploy this knowledge to other clients. TCE suggests that clients respond to higher opportunistic threats by choosing the high-powered governance mechanism of FP contracts [4, 16]. This yields the (opposed) prediction that projects of high knowledge specificity choose FP contracts.

Economic theories also yield a prediction opposed to H2. As task scope increases, so increase task complexity and, hence, uncertainty. Drawing on agency theory [17], contract choice research has often argued and empirically demonstrated that high uncertainty is associated with preference for T&M, rather than FP, contracts [4, 10, 16].

2.4 Control Variables

We include five variables to account for alternative explanations derived from economic perspectives. We control for familiarity (i.e., joint experience of client and vendor). Familiarity is a source of trust and, hence, of reduced opportunistic threats.

Under high familiarity, clients have been found to be more willing to accept the low-powered mechanism of T&M contracts [7, 16]. Moreover, we control for project size (i.e., the amount of effort in a project) and project duration. The literature suggests that the larger and the longer projects are, the higher is project risk and, hence, the more likely should be T&M contracts [10]. Moreover, we control for client and vendor size. The larger clients and the smaller vendors, the higher is the relative bargaining power of clients and, hence, the more likely are FP contracts [4].

3 Method

3.1 Dataset

We tested our theoretical model using a comprehensive dataset of 1035 contract choices that 223 public Swiss clients made between 2013 and February 2017. We extracted the data from the simap database (http://www.simap.ch), a public procurement platform for Swiss public administrations and publicly held companies. All federal organizations and most cantonal and local administrations are legally required to publish bid invitations and contract awards of projects exceeding a value of 250,000 Swiss Francs (CHF) on simap. The platform has been in operation since 2008.

We crawled the data from the simap website and performed a series of steps to select, cleanse, and code the data. The crawler produced a list of 3235 IS projects. We used the 3235 project to estimate familiarity, but focused our analysis on the projects awarded in or after 2013. From all 2103 projects awarded in or after 2013, we randomly selected 1687. In each of these projects, we coded whether it referred to application services (i.e., systems planning, systems integration, application analysis, design, coding, or maintenance), whether sufficient information was available for coding, and whether the project was not a duplicate. This resulted in a list of 1103 projects. Out of these 1103 projects, 88 chose a variety of hybrid contractual arrangements while 1035 projects were clearly FP or T&M contracts. Because we were interested in the decision between pure T&M and FP contracts, because hybrid contracts were only a minor fraction, and because the hybrid contracts were of many different kinds, we excluded hybrid projects, resulting in a final sample of 1035 projects. Out of these projects, 188 (18.2%) were FP and 847 were T&M contracts.

3.2 Coding Process

Each project was coded by two coders. The coders coded both the categories that were used to select projects into the final sample (see previous section) and the categories used to test our theoretical model (see next section). The coders were blind to the hypotheses of the study and performed the coding based on a detailed coding scheme (available on request from the authors). After being trained on sample data, they started independent coding only once the agreement between a coder and the first author in the sample data exceeded 85%.

3.3 Variables

Table 1 shows the variables used for testing our theoretical model. The variables contract choice, familiarity, project size, client size, and vendor size were automatically extracted from the database. We used the total volume of sales in the simap database as proxies for client and vendor size. The variables knowledge specificity, task scope, and project duration were coded according to the coding procedure described above. Information about project duration was published only in a subsample of 422 projects.

Table 1. Variables

Variable	*Description*
Contract Choice	1 if fixed price, 0 if time-and-materials (automatically extracted)
Knowledge Specificity	1 if the project involved custom-developed software; else 0 (coded)
Task Scope	The number of services types included in the project [37]; the following service types were coded: application analysis and design, application development, application maintenance, systems planning, systems integration, data center operations, telecommunication, licensing, hardware products (coded)
Familiarity	1 if the client had previously awarded a contract to the vendor; else 0 (automatically extracted)
Project Size	Project volume in CHF (logarithmized) (automatically extracted)
Project Duration	Number of months between planned end date and start date (logarithmized) (coded)
Client Size	Total volume in CHF of IS projects awarded by the client on the simap platform (logarithmized) (automatically extracted)
Vendor Size	Total volume in CHF of IS projects awarded to vendor on the simap platform (logarithmized) (automatically extracted)

3.4 Estimation Approach

Our estimation approach considered two peculiarities of our dataset. First, projects were nested within 223 clients and within 538 vendors. Nested data violate the assumption of independent observations in ordinary least squares or logistic regression. For instance, the intraclass correlation of contract choices made by the same client was 54%, showing that observations were not independent. Second, our dependent variable was dichotomous. Because of these two peculiarities, we used generalized linear mixed models (GLMM) [38]. Mixed models can cope with nested data. Generalized models are able to include a logistic link function that allows estimating a dichotomous dependent variable. GLMM unite the qualities of mixed models and of generalized models. Our GLMM included a logistic link function, fixed effects for all predictors and the intercept, and two normally distributed random intercepts for client and vendor. We used the *glmer* method of the R lme4 package. We separately estimated models without project duration using the full dataset and with project duration using the subsample of 422 projects. Because our data structure included crossed random effects (for clients and vendors), we used LaPlace approximation [38]. To check robustness,

we also ran alternative models without the random intercept for the vendor, permitting the use of Gauss-Hermite quadrature [38]. The findings were highly consistent. We also examined further alternative random effect structures, such as random slopes for knowledge specificity or for task scope and a random intercept for regional clusters. However, model fit did not improve with these additional parameters. Hence, we retained the more parsimonious specification.

4 Results

Table 2 provides descriptive statistics and bi-variate correlations. Table 3 shows the regression results. Positive (negative) coefficient in Table 3 imply that the higher the independent variable, the more likely are FP (T&M) contracts.

Table 2. Descriptive Statistics and Bi-variate Correlations

	Mean	*SD*	*CT*	*Fa.*	*PS*	*PD*	*CS*	*VS*	*KS*	*TS*
Contr. Type	0.18	0.39	1							
Familiarity	0.32	0.46	-.09	1						
Project Size	3.3m	15m	-.03	.10	1					
Proj. Duration	49.14	37.03	-.14	.05	.38	1				
Client Size	292m	612m	-.08	.37	.28	.17	1			
Vendor Size	171m	1.2bn	-.13	.39	.47	.23	.22	1		
Knowl. Spec.	0.35	0.48	-.21	.16	.07	.13	.16	.09	1	
Task Scope	2.49	1.59	.25	-.23	.16	.01	-.15	-.06	-.22	1

Table 3. Regression Results

	Model 1	*Model 2*
Intercept	-1.38 (1.59)	-1.12 (2.07)
Familiarity	.17 (.31)	.65 (.44)
Project Size	.05 (.11)	.23 (.17)
Project Duration	-	-.29 (.18)
Client Size	-.02 (.08)	.10 (.09)
Vendor Size	**-.12* (.06)**	**-.36*** (.10)**
Knowledge Specificity	**-1.20*** (.29)**	**-1.22** (.42)**
Task Scope	**.45*** (.08)**	**.40*** (.11)**
n_1 (# projects)	1035	422
n_2 (# clients)	223	126
n_3 (# vendors)	538	274
Random intercept variance for clients	1.23	.51
Random intercept variance for vendors	.99	.36
AIC	851.1	361.7
% correct predictions	91.3%	87.2%

Dependent variable: contract type (1 = fixed price), ***p <.001, **p <.01, *p <.05, significances are from Wald tests, significant number in bold, standard errors in parentheses

Model 1 shows the results obtained when using the full dataset and when not controlling for project duration. H1 predicted a negative relationship between knowledge specificity and the choice of FP contracts. The model shows a strong negative relationship (β = -1.20, p <.001), supporting H1. The beta coefficient implies that the odds of a FP contract decreased by 70% when knowledge specificity was high. H2 predicted a positive relationship between task scope and the choice of FP contracts. The model shows a strong positive relationship (β =.45, p <.001), supporting H2. Hence, the odds of a FP contract increased by 57% for each service type included in the contract. Among the control variables, only vendor size was significant (β = -.12, p <.05). The negative coefficient was in line with prior research [4]. The model correctly predicted 91.3% of contract choices, supporting the validity of the model specification.

Model 2 shows the results obtained when controlling for project duration and using the subsample of 422 projects for which project duration was given. The findings were highly consistent with model 1. Knowledge specificity (β = -1.22, p <.01) and task scope (β =.40, p <.001) were significantly related to contract choice in the hypothesized directions. Overall, the findings provide strong support for H1 and H2.

5 Discussion

This research was motivated by the observation that although contract choice has important implications for knowledge coordination, knowledge-based perspectives are rare in research on contract choice. We advance the idea that contract choice serves to align coordination responsibilities with the distribution of knowledge between client and vendor and that the distribution of knowledge depends knowledge specificity and task scope. Results from a comprehensive dataset of 1035 contract choices made by 223 clients provide strong support for these ideas.

Our paper makes three important contributions. First and foremost, our paper is among the first to formulate and empirically test a knowledge-based perspective on contract choice. We thus contribute to the growing body of IS outsourcing research that acknowledges the need to combine economic with knowledge-based perspectives [11, 13]. It is interesting to compare economic and knowledge-based predictions on contract choice because economic and knowledge-based perspective produce, at least in part, conflicting predictions and recommendations for contract choice. While TCE would suggest the choice of high-powered FP contracts under the high opportunistic threats associated with high knowledge specificity, the KBV recommends the choice of T&M contracts. Moreover, while agency theory would advocate the reliance on T&M contracts under the uncertainty associated with broad task scope, the KBV advocates the choice of FP contracts. The results from our large-scale empirical analysis support the predictions derived from the KBV, whereas the predictions derived from economic theory obtained limited support (see our findings on control variables). This may indicate that although decision makers combine economic and knowledge-based reasoning when making decisions about contract types, they appear give priority to knowledge-based reasoning. This is somewhat surprising given the prevalence of economic reasoning in research on contract choice [4, 6-8]. Yet, our study is only a first

step towards a knowledge-based perspective on contract choice. More research is needed that develops a more comprehensive knowledge-based perspective on contract choice and/or that systematically compares the predictions from economic and from knowledge-based theories.

While our formulation and test of a knowledge-based perspective on contract choice is the primary contribution of this paper, we also offer two further implications for research on contract choice. One, prior research has rarely acknowledged the multi-level nature of contract choice, where contract choices are nested within clients and within vendors. Our empirical examination revealed an intraclass correlation coefficient of 54% for contract choices made the same client. This shows that the same clients often make similar contract choices. In other words, the assumption of independent observations that underlies the regression approaches typically used in contract choice research may not be met. Our paper shows how GLMM are an effective way to overcome this problem.

Two, outsourcing research, including research on contract type, has often struggled to demonstrate significant associations of governance choices or outcomes with knowledge specificity (or human asset specificity) [11, 39]. For instance, in contrast to our study, Benaroch et al. [9] found no significant association between knowledge specificity and contract choice. Interestingly, the operationalization used by Benaroch et al. focused on business knowledge whereas ours focused on application knowledge. We believe that this discrepancy may echo findings from research on knowledge processes in application outsourcing, according to which application knowledge is often the most critical knowledge [23]. Hence, greater attention to application knowledge and its characteristics may help resolve some of the inconclusive findings in outsourcing research [11, 39].

We acknowledge a number of limitations of our study. First, although we argue that knowledge-based reasoning explains the correlations between task characteristics and contract choice, our research design does not permit any insights into mediating processes or causal mechanisms. Qualitative or survey studies may zoom into these processes and ascertain whether and how different contract choices actually help leverage distinct distributions of knowledge in distinct settings. Second, our study focuses on a limited amount of factors that reflect knowledge-based reasoning. Future research could incorporate, for instance, the role of joint project-specific experience (rather than any type of familiarity) to acknowledge that in some situations, vendors may possess valuable client-specific knowledge from the outset of projects. Third, our sample is from the public sector. Although the organizations in our sample were not legally constrained in their decisions for a particular contract type, it is possible that our findings mirror some peculiarities of the public sector. Fourth, our study focused on contract choice but not on the performance associated with contract choice. Future research could examine whether contract choices in line with our theoretical reasoning do indeed result in higher performance. Fifth, we did not distinguish between agile and waterfall software development methods. Yet, the choice for a development method may affect contract choice given that the rigid requirements specified in FP contracts may not align well with agile methods. This issue remains open to future research.

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