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The Role of Transaction Cost Economics in Information Technology Outsourcing Research: A Meta-Analysis of the Choice of Contract Type

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The Role of Transaction Cost Economics in Information Technology Outsourcing Research: A Meta-Analysis of the Choice of Contract Type

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ABSTRACT

Two recent reviews report that the empirical findings in information technology outsourcing (ITO) research are frequently inconsistent with the prevailing dominant analytical framework of transaction cost economics (TCE). While employing similar methodologies, the two reviews propose different strategies to resolve the inconsistencies. One is to improve the methodological rigor, specifically, the operationalization of TCE constructs. The other is to abandon TCE in favor of a new analytical framework. This paper presents a meta-analysis of the empirical findings on the choice of contract type as a function of task uncertainty. The results support both strategies. Refining the operationalization of TCE constructs, specifically of task uncertainty, would have improved the reliability of findings on TCE-based relationships between task uncertainty and the choice of contract type. However, independent of such methodological improvements, TCE is of limited relevance in recent ITO research for predicting the choice of contract type. Generalizing these findings, we conclude that ITO research requires a new analytical framework to further develop the theory of ITO and to provide sound guidance to the ITO industry.

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HIGHLIGHTS

- We use meta-analysis to review empirical findings on the relationship between task uncertainty and choice of contract type in the ITO literature.
- The dataset for the meta-analysis contains 22 independent empirical samples that include data on 6,479 ITO engagements.
- We find that the relationship between task uncertainty and choice of contract type is contingent on the operationalization of task uncertainty and on the period to which the data refers.
- We argue that a core assumption of transaction cost economics on how uncertainty affects contractual governance is no longer applicable to ITO research.
- We conclude that ITO research needs a new analytical framework to further develop the theory of ITO.

Keywords: IT outsourcing; Transaction Cost Economics; Task uncertainty; Choice of contract type; Time-and-material contract; Fixed-price contract

INTRODUCTION

Information technology outsourcing (ITO) theory has contributed significantly to the development of best practice in the ITO industry. For example, ITO research examines the decision to outsource (e.g., Watjatrakul, 2005) and how to establish effective formal and relational governance for ITO engagements (e.g., Poppo and Zenger, 2002). In this literature, transaction cost economics (TCE) is the dominant analytical framework from which many of the predictions in ITO research are derived (See Aubert et al., 2012; Dibbern et al., 2004; Karimi-Alaghehband et al., 2011; Klein, 2002; Lacity et al., 2011).

Two recent reviews report significant inconsistencies among the empirical findings for TCE-based predictions in the ITO literature (See Karimi-Alaghehband et al., 2011; Lacity et al., 2011). The reviews employ similar methodologies and report similar levels of inconsistency. However, they present different explanations for the inconsistencies. Karimi-Alaghehband et al. (2011) argue that measurement errors and construct validity threats explain the inconsistencies. They call for more rigorous methodology, including the operationalization of TCE constructs. In contrast, Lacity et al. (2011) argue that TCE is an increasingly obsolete analytical framework for ITO research. They call for the development of an "endogenous" ITO theory.

We adopt meta-analysis to investigate the two explanations in the specific context of the relationship between task uncertainty (TU) and the choice of contract type (CT) in the ITO literature. We choose this relationship because TCE makes specific and unambiguous predictions about the choice of CT as a function of TU. To examine the two explanations, the meta-analysis investigates whether the cumulative findings for the relationship between TU and choice of CT in the ITO literature support the conclusions by Karimi-Alaghehband et al. (2011) and/or by Lacity et al. (2011) for the inconsistencies between empirical findings and TCE-based predictions.

The paper is structured as follows. First, we derive two hypotheses that model the assumptions that underpin the different conclusions drawn by Karimi-Alaghehband et al. (2011) and by Lacity et al. (2011). Next, we explain how meta-analysis enables us to test each of the hypotheses, which would not be possible using the vote-counting methodology adopted by Karimi-Alaghehband et al. (2011) and Lacity et al. (2011). The results support both hypotheses. We discuss the results, potential limitations, and implications for theory and practice. In conclusion, we agree with Lacity et al. (2011) that the core challenge for future ITO research is to develop a new rigorous and powerful analytical framework.

THEORETICAL BACKGROUND

In IT outsourcing research, researchers frequently adopt the analytical framework of Transaction Cost Economics (TCE) to model two critical decisions in ITO engagements. One is the decision to outsource IT, which is predominantly modeled as a function of asset specificity (Crook et al., 2013). This is commonly referred to as the 'make-or-buy' decision (Riordan and Williamson, 1985). The other decision and the focus of this paper is on the choice of "governance features" (Williamson, 1991, p. 269). This choice is modeled as a function of uncertainty. Governance features are "special adaptive mechanisms to effect realignment and restore efficiency when beset by unanticipated disturbances" (Williamson, 1991, p. 272).

Here, we examine the empirical findings on the choice of contract type (CT), which is an important example of the application of TCE-based governance features in the ITO literature. Realigning transactions in response to disturbances incurs costs (Williamson, 2008). The choice between different contract types, specifically time-and-material (TM) contracts and fixed-price (FP) contracts, allocates those additional costs to the parties to the contract (Hoermann et al., 2015). In the ITO context, monitoring costs and renegotiation costs are allocated to the vendor or the client (Osei-Bryson and Ngwenyama, 2006; Susarla et al., 2009).

Under TM contracts, vendors are remunerated on the basis of reported working hours or working days. The client carries the risk of budget overruns. The client incurs monitoring costs to limit the risk of vendors charging for more resources than the project goals require. In FP contracts, budget overruns affect the project profitability for the vendor (Ethiraj et al., 2005; Gopal and Koka, 2012; Gopal and Sivaramakrishnan, 2008; Gopal et al., 2003).

Therefore, FP contracts provide strong incentives for vendors to manage projects efficiently (Bajari and Tadelis, 2001; Corts and Singh, 2004; Kalnins and Mayer, 2004). For example, vendors assign more trained personnel to FP projects compared with TM projects (Arora and Asundi, 1999; Gopal and Sivaramakrishnan, 2008). In general, FP contracts incur lower monitoring costs compared with TM contracts because of the different incentive structures.

In contrast, renegotiation costs are higher under FP contracts compared with TM contracts (Bajari and Tadelis, 2001; Corts and Singh, 2004; Kalnins and Mayer, 2004). FP contracts typically include detailed project plans, specify the functional requirements, service levels, and costs (Fink et al., 2013). When unforeseen contingencies occur, project specifications must be renegotiated, which generates additional costs (Bajari and Tadelis, 2001). This is not the case under TM contracts, which, compared with FP contracts, include more coarse-grained plans that allow for adjustments to specifications during the course of the project (Fink et al., 2013). So, under TM contracts, vendors are more willing to accept adjustments without the need for costly renegotiations (Kalnins and Mayer, 2004; Susarla et al., 2009).

TCE models this choice between FP contracts and TM contracts as a problem of minimizing transaction costs, which are a function of task uncertainty (TU). Indeed, ITO engagements "could well become nonviable when the frequency of disturbances reaches a high level" (Williamson, 1991, p. 291). In high TU contexts, the lower renegotiation costs under TM contracts compared with FM contracts outweigh the lower monitoring costs under FP contracts compared with TM contracts. In low TU contexts, the lower monitoring costs under FP contracts compared with TM contracts outweigh the lower renegotiation costs under TM contracts compared with FM contracts (See, for example, Bajari and Tadelis, 2001; Crocker and Reynolds, 1993; Dey et al., 2010; Kalnins and Mayer, 2004; Susarla et al., 2009). Formally, TCE predicts that *the frequency with which TM contracts are chosen instead of FP contracts is a positive function of TU*.

Restricting our meta-analysis to the relationship between TU and choice of CT allows us to investigate whether the inconsistent empirical findings in the ITO literature are a function of the methodologies employed and/or the relevance of the TCE analytical framework. To test the former explanation, we examine whether the correlation between TU and CT is contingent on how TU is operationalized (See Karimi-Alaghehband et al., 2011).

To do this, we compare the effect of the five measures of, or proxies for, TU on the magnitude of the relationship between TU and CT. The five constructs are technological uncertainty (e.g., Banerjee and Duflo, 2000; Kalnins and Mayer, 2004; Maruping and Ahuja, 2012), requirements uncertainty (e.g., Gopal and Koka, 2012; Huckman and Staats, 2011; Rai et al., 2009; Susarla, 2012; Susarla et al., 2009; Tiwana, 2010), technological complexity (e.g., Bapna et al., 2012; Chen and Bharadwaj, 2009a; Ethiraj et al., 2005; Gefen et al., 2008; Langer et al., 2008; Rai et al., 2009; Susarla, 2012), organizational complexity (e.g., Chen and Heng, 2012; Maruping and Ahuja, 2012; Pee et al., 2010; Staats et al., 2012; Weber et al., 2011) and project size (e.g., Argyres et al., 2007; Ethiraj et al., 2005; Mani et al., 2012; Ramachandran and Gopal, 2010; Staats et al., 2011; Staats et al., 2012). Formally, we use meta-analysis to test:

Hypothesis 1: *The magnitude of the relationship between TU and CT reported in the ITO literature is a function of the operationalization of TU.*

In contrast, the explanation according to Lacity et al. (2011) is that the frequent inconsistencies among the empirical findings for TCE-based predictions are the result of changes in ITO management practices in response to the increasingly competitive and consolidated ITO market (Manning, 2013). For example, vendors have become subject to powerful market pressure to control costs, reducing the importance of monitoring costs. Management practices, including standardization, centralization and modularization, have enabled ITO vendors to develop contractual governance mechanisms, which include effective risk buffers, to manage both FP and TM contracts efficiently and effectively.

At the same time, ITO clients are becoming better informed due to increasing market transparency (Reimann et al., 2010), which decreases renegotiation costs. Together, these effects on vendors and clients have reduced the relative transaction cost differentials between FM and TM contracts, and, therefore, reduced the relationship between TU and choice of CT. So, the benefits predicted by TCE from the appropriate choice of CT as a function of TU have declined over time. Formally, we use meta-analysis to test:

Hypothesis 2: *The magnitude of the relationship between TU and CT reported in the ITO literature is a function of the period of investigation.*

METHODOLOGY

Meta-analysis is a suite of quantitative techniques to synthesize empirical research findings across multiple studies (Glass, 1976; Hedges and Olkin, 1985; Hunter and Schmidt, 2004). The input data are effect sizes, frequently correlation coefficients, from individual studies addressing the relationship of interest (Lipsey and Wilson, 2001). Meta-analysis utilizes the total sample size by aggregating across the individual studies to estimate more reliable effect sizes compared with traditional review procedures, including narrative reviews or vote-counting approaches (Glass et al., 1981; Hunter and Schmidt, 2004; Rosenthal and DiMatteo, 2001). In this way, our meta-analysis complements the studies of Karimi-Alaghehband et al. (2011) and of Lacity et al. (2011), which are based on the vote-counting methodology.

Meta-analysis is a widely accepted methodology in the reference disciplines of information systems (IS) research. It is also increasingly being used in IS research (See, for example, He and King, 2008; Joseph et al., 2007; Sabherwal et al., 2006; Sharma and Yetton, 2003, 2007; Sharma et al., 2009; Wu and Lederer, 2009). In the following sections, we describe the literature search, coding, and analysis.

Literature Search

The relationship between TU and choice of CT is the subject of a major research stream in the ITO literature (See Fink et al., 2013; Gefen et al., 2008; Gopal and Sivaramakrishnan, 2008; Gopal et al., 2003; Kalnins and Mayer, 2004; Susarla et al., 2009). This body of research is sufficiently large to support a meta-analysis to examine Hypotheses 1 and 2. The sample of individual studies in the meta-analysis consists of empirical studies reported in journals, forthcoming journal papers, conference proceedings, dissertations, and working papers. Conference proceedings, dissertations, and working papers are included to address the "file-drawer problem". This refers to the issue that published studies, compared with unpublished studies, may systematically overestimate effect sizes (Rosenthal, 1979).

Following the recommendations by Cooper (2010) and meta-analyses in IS (See Sharma and Yetton, 2003, 2007; Wu and Lederer, 2009), we conducted four complementary literature searches to minimize the probability of failing to identify relevant studies. First, we conducted a systematic keyword search in the following databases[1]: Business Source Premier, JSTOR, ScienceDirect, ABI/INFORM, ACM Digital Library, IEEE Xplore, The Association for Information Systems Electronic Library (AISeL), ProQuest Dissertations and Theses, and WorldCat Dissertations and Theses[2]. Second, we conducted backward and forward searches (Webster and Watson, 2002). Third, we searched for working papers and forthcoming journal papers by screening the websites of key authors identified in the previous steps, conducting keyword searches in Google, and searching the Social Science Research Network (SSRN). Fourth, we sent requests for unpublished working papers using the AISworld and AOM OCIS mailing lists.

We included a study in the final meta-analytical dataset if the study satisfied three criteria. First, the study investigates ITO engagements as its unit of analysis. Second, the study measures the choice of CT and one or more operationalizations of TU. Multiple studies based on the same sample were included only when each of the studies reports at least one operationalization of TU that is not reported in the others. Third, the study reports the sample size, the years for which the data was collected, and the correlation coefficients between TU and choice of CT. For the studies in which any of these statistics were missing, we contacted the corresponding author of the study and requested the missing statistics. This process identified three additional studies.

1 Following Sabherwal et al. (2006) we used several keywords related to IS outsourcing projects (including "software", "information system", "information technology", "outsourcing") and several keywords related to contract type (including, "contract", "fixed price", "time and materials", "cost plus") and their variants (e.g., "fixed-price").

2 The databases included the major journals and conference proceedings in the IS and management disciplines such as Management Information Systems Quarterly (MISQ), Information Systems Research (ISR), Journal of Management Information Systems (JMIS), Management Science (MS), Academy of Management Journal (AMJ), Strategic Management Journal (SMJ), International Conference on Information Systems (ICIS), Americas Conference on Information Systems (AMCIS), European Conference on Information Systems (ECIS), and Hawaii International Conference on System Sciences (HICSS).

The final meta-analytical dataset includes 28 studies based on 22 independent samples[3]. The dataset includes data on 6,479 ITO engagements. Of the 28 studies, 59% do not support the logic of TCE for the effect of TU on choice of CT. This is similar in magnitude to the findings in the two reviews: Karimi-Alaghehband et al. (2011) report that 44% of TCE-based hypotheses are not supported and Lacity et al. (2011) report that 51% of TCE-based hypotheses are not supported.

Coding

We extracted the following information from each study in the final meta-analytical dataset: sample size, start year and end year of the sample[4], and the name and description of all variables that were used by the authors to measure properties of TU. For each measure of TU, we extracted the correlation coefficient between CT and TU, and the reliability coefficient to estimate the measurement error. In total, we extracted 92 correlation coefficients for the relationship between TU and choice of CT as input for coding the dependent variable (choice of CT) and the independent variable (TU) for each study.

The dependent variable

The individual studies included in the final meta-analytical dataset operationalize the choice of CT as a binary variable. Where necessary, we converted the reported correlation coefficients, so that higher values correspond to stronger preferences for a TM contract compared with an FP contract and lower values correspond to a stronger preference for an FP contract compared with a TM contract.

The independent variable

TCE-based research operationalizes TU with variables that relate to particular properties of TU, including technological uncertainty and requirements uncertainty, or proxies that are highly interrelated with TU, including technological complexity, organizational complexity and project size (See Bajari and Tadelis, 2001; Crocker and Reynolds, 1993; Fink et al., 2013; Kalnins and Mayer, 2004)[5].

We coded each variable of the 92 correlation coefficients according to how the authors of each study operationalized TU. For instance, we coded the level of familiarity with particular programming

[3] Appendix 1 provides an overview of the final meta-analytical sample. Furthermore, a '*' in the references denotes a study as part of the final meta-analytical sample.

[4] The start year and end year define the period of investigation. In studies using secondary data, this is the period of time for which the data was extracted from public or private archives. In other studies, this is the period of time during which the authors collected the data.

[5] Definitions and coding examples for the different operationalizations of TU are presented in Appendix 2. A complete mapping of the study variables to the different operationalizations of technological uncertainty is presented in Appendix 3.

languages as technological uncertainty (See Banerjee and Duflo (2000). This process identified 10 effect sizes for technological uncertainty, 10 effect sizes for requirements uncertainty, 19 effect sizes for technological complexity, 22 effect sizes for organizational complexity, and 31 effect sizes for project size.

This process involved judgment by the coders (Heugens and Lander, 2009). To minimize coding errors, we adopted the protocol recommended by Lipsey and Wilson (2001). Two coders independently coded each study. The initial Cohen (1960) kappa was 0.94, which demonstrates a high inter-coder reliability. Disagreements between the coders were resolved very quickly through discussion.

Analysis

The unit of analysis is the zero-order, Pearson correlation coefficient between CT and TU. This is a well understood, scale-free measure of the relationship between two variables (Rosenthal and DiMatteo, 2001). The Fisher z transformation, a potential alternative unit of analysis, was not adopted because it introduces an expected positive bias that is larger than the expected negative bias when using untransformed correlation coefficients (See Hall and Brannik, 2002; Hunter and Schmidt, 2004).

We corrected the correlation coefficients for measurement error by dividing each correlation coefficient by the product of the square root of the reliability coefficient for the TU and CT variables (Hunter and Schmidt, 2004). If a measurement was based on a single-item or a proxy variable, we adopted a conservative standard of 0.8 for the reliability coefficient (Bommer et al., 1995; Dalton et al., 2003; Dalton et al., 1998; Dalton et al., 1999; Jiang et al., 2012; Sleesman et al., 2010).

We prepared the final meta-analytical dataset in three steps. The first step estimates independent effect sizes for each of the 22 independent samples included in the meta-analytical dataset. This avoids biased estimates that would result from the inclusion of interdependent effect sizes in the meta-analysis (See He and King, 2008; Palmatier et al., 2006). When a sample was used to measure more than one variable related to TU, for example, both project size and requirements uncertainty, we averaged the effect sizes of all variables (Hunter and Schmidt, 2004; Palmatier et al., 2006). The initial 92 correlation coefficients were combined to estimate 22 independent effect sizes at the sample-level.

The second step estimates independent effect sizes for each of the operationalizations of TU. When a study reports more than one variable related to a particular operationalization of TU, for example, the length of the ITO engagement and the contract value, which both refer to project size as an operationalization of TU, we averaged the corresponding effect sizes (Hunter and Schmidt, 2004;

Palmatier et al., 2006). The initial 92 correlation coefficients were combined to estimate 64 independent effect sizes for the different operationalization of TU. This avoids biased estimates that would result from including interdependent effect sizes for the different operationalizations of TU (See He and King, 2008; Palmatier et al., 2006).

The third step ensures an unbiased analysis of potential temporal effects as the final meta-analytical dataset includes samples that cover more than 20 years (e.g. Chen and Heng, 2012). We partition the final meta-analytical dataset into two subsets using a median-split based on the start year of the period of investigation ($SYS_{median} = 1999$). The subset 'SYS $\leq$ 1999' includes 11 independent samples that have a start year prior to or including 1999.

The other subset 'SYS $>$ 1999' includes 11 independent samples with a start year of 2000 or later. While the subset 'SYS $\leq$ 1999' contain data beyond 1999[6], the subset 'SYS $>$ 1999' does not include data prior to 2000. Using the same logic for partitioning at the level of operationalizations of TU results in 32 independent effect sizes for different operationalizations of TU prior to and including 1999 and 32 independent effect sizes for different operationalizations of TU post 1999.

Following recent meta-analyses in IS (See Joseph et al., 2007; Sabherwal et al., 2006), we adopted the Hunter and Schmidt (2004) random effects model. Weighting the correlation coefficients by sample size and reliability, the following meta-analytic outcomes were estimated: the number of effect sizes (k), the total sample size (N), the average corrected correlation (expected rho; $\bar{\rho}$), the standard deviation of rho (SD_{ρ}), and the 95-percent confidence interval around the expected rho ($CI_{\bar{\rho};.95}$)[7].

Positive values of $\bar{\rho}$ indicate that the frequency with which TM contracts are chosen instead of FP contracts is a positive function of TU. Negative values of $\bar{\rho}$ indicate that the frequency with which TM contracts are chosen instead of FP contracts is a negative function of TU. The relationship of TU and choice of CT is statistically significant when $CI_{\bar{\rho};.95}$ does not include zero.

In addition, we calculated three meta-analytic outcomes to assess the generalizability of the results: the 80-percent credibility interval around the expected rho ($CR_{\bar{\rho};.80}$); the percentage of variance that is accounted for by statistical artifacts ($\%V$); and the Cochran (1954) chi-square statistic for heterogeneity (Q). In contrast to $CI_{\bar{\rho};.95}$, which refers to the accuracy of $\bar{\rho}$, the $CR_{\bar{\rho};.80}$ refers to the distribution of ρ and is used to assess the generalizability of the $\bar{\rho}$ (Hunter and Schmidt, 2004). When

6 This source of bias is discussed below under the heading of test procedure.

7 We used Hunter and Schmidt's (2004) formula for individually corrected correlation coefficients to calculate the standard error of the estimated average correlations: $SE_{\bar{\rho}} = SD_r/\sqrt{k}$.

$CR_{\bar{\rho};.80}$ is large or includes zero, $\bar{\rho}$ does not generalize (Whitener, 1990). Instead, the distribution of ρ is assumed to be heterogeneous. Similarly, if $\%V$ is less than 75 percent, Hunter and Schmidt (2004) suggest that the relationship is heterogeneous. When Q is significant, $\bar{\rho}$ does not generalize. Instead, it should be interpreted as the expected value of a number of effects rather than a common true effect (Hedges and Olkin, 1985).

Test procedure

We test Hypotheses 1 and 2 as follows. First, we examine the hypotheses using the 22 independent effect sizes partitioned into two subsets (SYS $\leq$ 1999 and SYS $>$ 1999). We use the ANOVA-based analysis procedure proposed by Borenstein et al. (2009). This is based on a decomposition of Q, Cochran's (1954) chi-square statistic for heterogeneity (See Park and Shaw, 2013). A significant Q_{within}-statistic is interpreted as showing that the remaining heterogeneity within the subsets includes a number of effects rather than a common true effect. This would support Hypothesis 1. In that case, a significant Q_{within}-statistic would justify a meta-analytic examination of the different operationalizations of TU.

A significant $Q_{between}$-statistic is interpreted as showing that a significant proportion of the heterogeneity in the total dataset is explained by the moderator variable. So, a significant $Q_{between}$-statistic would support Hypothesis 2. In that case, the effect size is a function of the period of investigation.

The estimated effect sizes of TU and CT for the subset 'SYS $\leq$ 1999' would be biased when Hypothesis 2 is true because this subset includes data on ITO engagements during 2000 and later (See Appendix 1). For example, the sample used by Chen and Bharadwaj (2009a) starts in 1993 and ends in 2003. So when Hypothesis 2 is true, the estimated effect sizes for the subset 'SYS $\leq$ 1999' would include a negative bias. The estimated effect size for the subset 'SYS $\leq$ 1999' would be less than the true unbiased value. For the subset 'SYS $>$ 1999', the estimated effect size would be unbiased as this subset does not contain data on ITO engagements before 2000.

The test for Hypothesis 2 examines whether the expected effect size for the subset 'SYS $\leq$ 1999' is significantly greater than the expected effect size for the subset 'SYS $>$ 1999'. So, the negative bias in the estimates of the effect size for subset 'SYS $\leq$ 1999' increases the probability of a false negative result and not for a false positive one. Therefore, a significant finding for the $Q_{between}$-statistic is not subject to a potential internal validity threat. In addition, we conducted sensitivity analyses for different start years of the period of investigation because the choice of a median split to partition the final meta-analytical sample is somewhat arbitrary (See Appendix 4). The results reported below are robust for different partitions.

A significant Q_{within}-statistic would justify a meta-analytic examination of the different operationalizations of TU to test Hypothesis 1. Again, we use the ANOVA-based analysis procedure based on the decomposition of Q (Borenstein et al., 2009). Here, a significant $Q_{betweenTU}$-statistic is interpreted as support for Hypothesis 1, showing that a significant proportion of the heterogeneity in each subset can be explained by the different operationalizations of TU. The median split partition by SYS does not bias this test because the analysis is within each subset, not between them, which is the case for the test of Hypothesis 2.

RESULTS

The results in Table 1 support Hypothesis 1: *The magnitude of the relationship between TU and CT reported in the ITO literature is a function of the operationalization of TU.* The Q_{within}-statistics are significant ($Q_{within}^{SYS\leq1999}$= 22.92, p < 0.05; $Q_{within}^{SYS>1999}$= 24.18, p < 0.05).

	$\boldsymbol{k}$	$\boldsymbol{N}$	$\boldsymbol{\bar{\rho}}$	$\boldsymbol{SD_\rho}$	$\boldsymbol{CI_{\bar{\rho};.95}}$	$\boldsymbol{CR_{\bar{\rho};.80}}$	**%*V***	$\boldsymbol{Q_{within}}$	$\boldsymbol{Q_{between}}$
SYS ≤ 1999	11	3,096	.15	.08	.08 : .21	.05 : .25	.47	22.92*	9.09*
SYS > 1999	11	3,152	.05	.08	-.01 : .11	-.05 : .15	.45	24.18*	

$\boldsymbol{k}$**:** Number of effect sizes; $\boldsymbol{N}$: Total sample size; $\boldsymbol{\bar{\rho}}$**:** Expected rho; SD_ρ: Standard deviation of ρ; $\boldsymbol{CI_{\bar{\rho};.95}}$: 95% confidence interval around $\bar{\rho}$; $\boldsymbol{CR_{\bar{\rho};.80}}$**: 80%** credibility interval around $\bar{\rho}$; **%V:** Percentage of variance that is accounted for by statistical artifacts; $\boldsymbol{Q_{within}}$**:** Cochran's chi-square statistic for heterogeneity that remains within the subset; $\mathbf{Q_{between}}$: Cochran's chi-square statistic for heterogeneity that is explained by the SYS; * $\boldsymbol{p}$-value of Q < 0.05. A sensitivity analysis for different values of SYS is reported in Appendix 4.

Table 1. The relationship between TU and choice of CT controlling for SYS

The results in Table 1 also support Hypothesis 2: *The magnitude of the relationship between TU and CT reported in the ITO literature is a function of the period of investigation.* The $Q_{between}$-statistic is significant ($Q_{between}$ = 9.09, p < 0.05). In the subset SYS $\leq$ 1999, the effect of TU on CT ($\bar{\rho}$ = .15) is significantly larger than in the subset SYS $>$ 1999 ($\bar{\rho}$ = .05). In addition, in the subset SYS $\leq$ 1999, consistent with TCE, the effect of TU on CT is significant ($CI_{\bar{\rho};.95}$ does not include zero). In contrast, in the subset SYS $>$ 1999, inconsistent with TCE, the effect of TU on CT is not significant ($CI_{\bar{\rho};.95}$ includes zero).[8]

The significant Q_{within}-statistics in Table 1 motivated a meta-analytic examination of the different operationalizations of TU. Table 2 shows that, consistent with the significant values for Q_{within} reported in Table 1, the different operationalizations of TU have different effect sizes. The $Q_{betweenTU}$ statistic is significant for both the subset SYS≤1999 ($Q_{betweenTU}$ = 34.53, p < 0.05) and the subset SYS>1999 ($Q_{betweenTU}$ = 23.74, p < 0.05). This supports Hypothesis 1: The operationalizations of TU explain a significant proportion of the variance in the expected correlation coefficients in each subset.

[8] The sensitivity analysis presented in Appendix 4 shows that the test for Hypothesis 2 is robust and not contingent on the choice of 1999/2000 to partition the data.

Operationalization of TU	k	N	$\bar{\rho}$	SD_{ρ}	$CI_{\bar{\rho};.95}$	$Q_{betweenTU}$
SYS ≤ 1999						
Technological uncertainty	2	559	.17	.15	-.06 : .40	34.53*
Requirements uncertainty	3	640	.29	.13	.12 : .46	
Technological complexity	10	2,986	.05	.06	-.01 : .11	
Organizational complexity	6	1,826	.12	.08	.03 : .21	
Project size	11	3,090	.21	.10	.14 : .28	
SYS > 1999						
Technological uncertainty	3	753	.05	.04	-.05 : .15	23.74*
Requirements uncertainty	7	1,661	.07	.12	-.03 : .18	
Technological complexity	5	1,434	.02	.11	-.09 : .13	
Organizational complexity	8	2,803	-.06	.17	-.18 : .07	
Project size	9	2,615	.10	.21	-.04 : .24	

k: Number of effect sizes; N: Total sample size; $\bar{\rho}$: Expected rho; SD_{ρ}: Standard deviation of ρ; $CI_{\bar{\rho};.95}$: 95% confidence interval around $\bar{\rho}$, $Q_{betweenTU}$: Cochran's chi-square statistic for heterogeneity that is explained by the operationalization of TU; *: p-value of Q < 0.05.

Table 2. The relationship between TU and choice of CT controlling for SYS and the operationalization of TU

The results in Table 2 are also consistent with Hypothesis 2. Three operationalizations of TU (requirements uncertainty, organizational complexity, and project size) in subset SYS≤1999 have significant effects on the choice of CT. In contrast, no operationalization of TU in the subset SYS>1999 has a significant effect on the choice of CT ($CI_{\bar{\rho};.95}$ includes zero for all operationalizations of TU).

Secondary analysis

Table 3 reports the statistics for the studies for which the datasets included data only for years post 1999. Inspecting Table 3, the estimates of the correlation coefficient between CT and TU ($\bar{\rho}$) appear to trend towards zero, from 0.05, for data collected after 1999, to 0.01, for data collected after 2005. The latter include data on 791 ITO engagements. The estimated correlation coefficients for the most recent samples, post 2004 and post 2005, are trivially different from zero.

Consistent with the interpretation that $\bar{\rho}$ is declining for samples collected post 1999, the Q_{within} statistic, which tests whether the estimates of $\bar{\rho}$ are stable, also decreases over this range of years (SYS). The numbers of studies in the subsets are not large enough to test the above interpretations. However, the patterns in Table 3 are consistent with Hypothesis 2 and with the effect of TU on CT tending to zero over time.

SYS after	k	N	$\bar{\rho}$	SD_{ρ}	$CI_{\bar{\rho};.95}$	$CR_{\bar{\rho};.80}$	$\%V$	Q_{within}
1999	11	3,152	.05	.08	-.01 : .11	-.05 : .15	.45	24.18*
2000	10	2,914	.04	.07	-.03 : .10	-.05 : .13	.51	19.44*
2001	8	2,606	.04	.08	-.03 : .11	-.06 : .14	.42	18.73*
2003	6	1,867	.08	.06	.00 : .15	.00 : .16	.56	10.57
2004	5	872	.03	.08	-.08 : .14	-.07 : .14	.57	8.75
2005	4	791	.01	.03	-.08 : .10	-.03 : .04	.92	4.31

k: Number of effect sizes; N: Total sample size; $\bar{\rho}$: Expected rho; SD_{ρ}: Standard deviation of ρ; $CI_{\bar{\rho};.95}$: 95% confidence interval around $\bar{\rho}$; $CR_{\bar{\rho};.80}$: 80% credibility interval around $\bar{\rho}$; %V: Percentage of variance that is accounted for by statistical artifacts; Q_{within}: Cochran's chi-square statistic for heterogeneity that remains within the subset; $Q_{between}$: Cochran's chi-square statistic for heterogeneity that is explained by the SYS

Table 3. The relationship between TU and choice of CT for various SYS > 1999

DISCUSSION

Here, we begin by summarizing the findings for Hypotheses 1 and 2. Then, we consider five limitations with respect to these findings. Finally, we generalize the findings to TCE-based predictions in the ITO literature, and explore the implications for the theory and practice of ITO.

Findings

The results support both the explanation by Karimi-Alaghehband et al. (2011) and the explanation by Lacity et al. (2011) for the frequent inconsistencies between the empirical findings for predictions based on TCE that are reported in the ITO literature. Karimi-Alaghehband et al. (2011) explain the inconsistent empirical findings as a function of measurement errors and construct validity threats. Consistent with this explanation, the significant Q_{within}-statistics in Table 1, and the diverse range of effect sizes combined with the significant $Q_{betweenTU}$-statistics for each of the two subsets in Table 2, show that the magnitude of the relationship between TU and choice of CT is contingent on the operationalization of TU, independent of the period of investigation. Generalizing these findings, and consistent with the explanation by Karimi-Alaghehband et al. (2011) , there is a major potential construct validity threat to the findings in the ITO literature as a function of how variables are operationalized.

Lacity et al. (2011) explain the inconsistent empirical findings in terms of TCE becoming an increasingly obsolete analytical framework for ITO research. Consistent with this explanation, the relationship between TU and choice of CT is a function of the period of investigation. In the early research, the relationship between TU and CT is significantly positive as predicted by TCE. However, in more recent research, the findings in Tables 1 and 3 show that the relationship between TU and CT is non-significant and trending to zero.

In combination, our results show that the two strategies proposed by Karimi-Alaghehband et al. (2011) and by Lacity et al. (2011) are complementary rather than competing strategies. Karimi-Alaghehband et al. (2011) call for a more refined and more rigorous operationalizations of TCE constructs. Consistent with this, we show and agree that the operationalization of TU constructs was and still potentially is an important issue in ITO research.

Lacity et al. (2011) call for the development of an "endogenous" ITO theory to replace the analytical framework of TCE. We show that the TCE-based prediction of the choice of CT as a function of TU is not supported in datasets containing data collected post 1999, independent of the operationalization of TU. Generalizing this result to the ITO literature, our results support the call by Lacity et al. (2011) that ITO research requires a new analytical framework to further develop the theory of ITO and to provide sound guidance to the ITO industry.

Limitations

The meta-analysis presented above is subject to a number of limitations. Five are reviewed here. First, it is not possible to know that all empirical research studies on the relationship between TU and choice of CT in ITO research were identified and included in the final meta-analytical dataset. Although we conducted an extensive literature search, the possibility remains that we did not identify all relevant studies. In addition, some studies did not report the necessary statistics and, thus, were not included in the meta-analysis dataset. However, considering the extensive nature of our literature search process, we are confident that any excluded studies would not substantially affect the results presented above.

Second, to address the file-drawer problem (Rosenthal, 1979), we searched extensively for conference papers, dissertations, and working papers. Twenty-eight percent of the studies included in the meta-analysis fall into these three categories. We are confident that the file-drawer problem is not a potential major validity threat to the findings.

Third, although the coding of TU resulted in high inter-coder reliability, the process of designing the coding scheme itself involved some subjectivity. To mitigate this risk, the variables were assigned to the operationalizations of TU based on their explicit use in primary studies. When this was in any doubt, the assignment was discussed and resolved between two of the authors.

Fourth, we corrected the variables for only three statistical artifacts that are present in each study: sampling error, measurement error of TU, and measurement error of choice of CT. Hunter and Schmidt (2004) describe procedures to correct for other statistical artifacts including range restriction and dichotomization of continuous variables. However, information that must be extracted from the individual studies to correct for these artifacts is rarely available and is, thus, beyond the scope of this meta-analysis.

Fifth, estimates of the expected rhos ($\bar{\rho}$), particularly in the analysis of the different operationalizations of TU, are based on a small number of effect sizes. While a small number of effect sizes does not bias the estimates of the $\bar{\rho}$, it may affect the estimates of the standard deviation of ρ that are used to calculate the credibility intervals (Hunter and Schmidt, 2004). However, we calculated two additional meta-analytic measures to assess the generalizability of the results. All three measures, the 80-percent credibility interval around $\bar{\rho}$ ($CR_{\bar{\rho};.80}$), the percentage of variance that is accounted for by statistical artifacts ($\%V$), and Cochran's (1954) chi-square statistic for heterogeneity (Q), produce consistent results. There is no evidence of bias in the findings.

In addition, our sampling frame, the relationship of TU and choice of CT, may limit the generalizability of the findings. The results reported above may not generalize to TCE-based relationships in the rest of the ITO literature. Against this threat, the meta-analytical dataset examined here can be treated as a stratified random sample from the ITO literature in terms of the proportion of the TCE-based relationships that are not supported.

Karimi-Alaghehband et al. (2011) report that 44% of TCE-based hypotheses are not supported and Lacity et al. (2011) report that 51% of TCE-based hypotheses are not supported. Partitioning the correlations in our meta-analytical dataset between those that significantly support and those that do not significantly support the logic of TCE, 41% support the logic of TCE and 59% do not support the logic of TCE. These proportions are not significantly different from those reported by Karimi-Alaghehband et al. (2011) and by Lacity et al. (2011). So, the results reported here are unlikely to be specific to the relationship of TU and choice of CT, and are expected to generalize to other TCE-based relationships in ITO. However, future research should investigate this assumption.

Implications for Theory and Practice

The results above have implications for the two strategies proposed to resolve the inconsistencies in TCE-based relationships in the ITO literature. Karimi-Alaghehband et al. (2011) call for more rigorous application of TCE in ITO research. Perhaps not surprisingly, the results presented here, the effect of the operationalization of TU in the research stream on the choice of CT, support their conclusions that the variance in findings is, at least partially, a function of construct validity threats. This conclusion may also generalize to the findings in other IS research domains.

The findings also show that TCE has become an inappropriate analytical framework for ITO research. This supports the call by Lacity et al. (2011) for the development of an endogenous theory of ITO. We agree that the search for, or development of, a new analytical framework is critical for future research on ITO.

The core assumption underpinning the argument by Lacity et al. (2011) is that the ITO industry has become an industry with characteristics that go beyond the boundary conditions of TCE. For example, ITO vendors have developed management practices that allow them to "deliver positive results to clients while still generating positive margins" (Lacity et al., 2011, p. 151) in the increasingly competitive and consolidated ITO markets (Manning, 2013). In addition, ITO clients are becoming better informed due to increasing market transparency and increasing experience with ITO engagements (Reimann et al., 2010). These characteristics affect the trade-offs between monitoring costs and renegotiation costs, which reduce the benefits from making the choice of CT contingent on the level of TU.

Specifically, ITO vendors increasingly offer standardized and modularized services that include detailed project plans, including functional requirements, service levels, and costs (Fink et al., 2013). These developments reduce the extent to which clients need to implement additional monitoring of vendor behavior. In addition, management practices, including technology enablement and IT factory facilities, provide extensive built-in monitoring capabilities for the client (Grönroos, 2011; Lacity et al., 2011).

Renegotiation costs are incurred from adjusting the specification of an ITO engagement when facing unforeseen contingencies (Hoermann et al., 2015). Standardized and modularized services decouple the production of ITO services from particular ITO engagements and clients (Manning, 2013). This enables ITO vendors to customize and adapt ITO service offerings more efficiently. Furthermore, standardized and modularized services have enabled ITO vendors to develop contractual governance mechanisms, including reliable risk buffers, and to price the costs for unforeseen contingencies into the contracts, independent of contract type. These developments have reduced the differential renegotiation costs under TM contracts compared with FP contracts.

Historically, ITO clients entered into ITO contracts to improve the cost-efficiency of their IT operations. Recently, increased market transparency combined with the potential punitive loss of reputation from opportunistic vendor behavior have reduced the historical monitoring costs of TM contracts, reducing the need for clients to control vendor behavior (Dibbern et al., 2004). In addition, ITO clients now engage in co-creation partnerships with ITO vendors to deliver high ITO performance (Sarker et al., 2012; Vargo and Lusch, 2007). In combination, these developments have shifted the intent for both vendors and clients from improving the efficiency of ITO transactions to developing value-creating relationships.

The diminishing relevance of TCE, as argued by Lacity et al. (2011) and confirmed by our research, is in part a function of the increasing maturity of the ITO industry. Other IS researchers have commented on this increased maturity (See Manning et al., 2011; Stadtmann and Kreutter, 2009; Suarez et al., 2013). Our findings are also consistent with research on the relevance of TCE to IS reference disciplines (See, for example, Agarwal et al., 2002; Argyres and Bigelow, 2007; Karniouchina et al., 2013; Misangyi et al., 2006; Suarez et al., 2013). For example, in the automotive industry, Argyres and Bigelow (2007) show that the effect of transaction misalignment on firm survival varies across different phases of maturity. They conclude that the explanatory power of TCE is contingent on the maturity of an industry. Our results generalize this conclusion to the ITO industry.

It is interesting to speculate about why the inconsistent findings reported by Karimi-Alaghehband et al. (2011) and Lacity et al. (2011) had not been investigated earlier. To explore one potential explanation, consider the following evidence. Of the 28 studies in our final meta-analytical dataset, 17 studies use CT as a control variable and do not test the relationship explicitly. The studies use CT to control for differential governance modes.

We assume that, prior to the reviews by Karimi-Alaghehband et al. (2011) and Lacity et al. (2011), the null findings for the correlation between TU and CT post 1999 were not salient to researchers because CT was included in the analysis only as a control variable. So, ITO researchers did not recognize the potential importance of the cumulative null findings for the effect of TU on choice of CT. A similar explanation could also apply to the cumulative null findings in other ITO-based research domains as reported in the two reviews that had not been recognized previously.

Accepting the challenge proposed by Lacity et al. (2011), the critical question for future research on ITO is: What would be the components and the form of an "endogenous" ITO theory? By its name, TCE is fundamentally about costs. Within the TCE framework, the choice of CT is not about improving the quality of the service but about reducing transaction costs to improve market efficiency. We speculate that within the new "endogenous" ITO framework, the challenge would be to explain how to create value in ITO engagements.

For example, Gopal and Koka (2012) and Hoberg et al. (2013) report that relational flexibility is a major driver of ITO performance. This suggests that an alternative analytical framework would focus on collaborative behavior between clients and vendors as opposed to a market-based and potentially adversarial relationship. Consistent with this framing, (Dibbern et al., 2004) argue that, in a transparent and competitive market, ITO vendors are motivated to propose a contract that enables the client to leverage the vendor's specific expertise to create value. So, vendors should offer and clients should choose contracts that help to build flexible, effective relational governance to leverage the vendor capabilities to create value for the client. This would transform models of vendor/client relationships from cost-based market relationships to value-based collaborative relationships.

The domain of ITO, similar to other domains in IT research, is subject to the rapid changes and the constant adaptation of organizations to new economic, social, and technological realities (Gable, 2010; Merali et al., 2012; Ward, 2012). In these domains, IS researchers must always examine the, often implicit, boundaries of applied theoretical frameworks. Such frameworks that have been useful lenses in the past may offer inconclusive or even misleading insights in the future. We argue that the search for 'expiration dates' of theoretical frameworks is a critical avenue of research to advance both the rigor and the relevance of IS research to strategic decision-making. Reviewing the core assumptions and boundaries of theoretical frameworks potentially improves the validity and relevance for IS executives to prepare "strategic decisions and control their effects" (Buhl et al., 2012, p. 176).

CONCLUSION

This study presents support for the two explanations by Karimi-Alaghehband et al. (2011) and by Lacity et al. (2011) for the inconsistent findings in ITO research when TCE is adopted as the analytical framework. Karimi-Alaghehband et al. (2011) explain the inconsistent findings in terms of measurement errors and construct validity threats. They call for more rigorous research methodology to reduce inconsistent findings in the future. Supporting their conclusion and call, we show that the inconsistent findings on the relationship between TU and the choice of CT are contingent on how TU is operationalized.

Lacity et al. (2011) explain the inconsistent findings by arguing that TCE is no longer an appropriate analytical framework for ITO research. They call for the development of a new analytical framework. Consistent with their explanation and call, we show that the effect of TU on the choice of CT is contingent on the period of investigation. In recent studies compared with early research, TU has a significantly weaker and potentially null effect on the choice of CT, independent of how TU is operationalized.

This paper is not a test of TCE but rather of its relevance to investigating critical issues in ITO research. We conclude that it was relevant in the early period of ITO but is not relevant today. Generalizing our findings to the ITO literature, we agree with Lacity et al. (2011) that TCE is no longer a relevant and appropriate analytical framework for ITO research. Identifying and integrating the core constructs and core relationships of ITO into an effective analytical framework is necessary to further develop the theory of ITO and to provide guidance for both vendors and clients.

Consequently, a critical challenge for ITO research is to develop a new rigorous and powerful analytical framework.

APPENDICES

Appendix 1. Overview of Independent Samples

Period of Investigation	Studies using the same Sample	N_{study}	ES	$\bar{\rho}$
1986-1998	Kalnins and Mayer (2004)	394	5	.19
	Argyres et al. (2007)	386	3	
	Weber et al. (2011)	385	3	
1989-2009	Bapna et al. (2012)	753	4	.11
1989-2011	Chen and Heng (2012)	945	3	.10
1993-2003	Chen and Bharadwaj (2009a)	112	1	.44
1994-2006	Chen and Bharadwaj (2009b)	153	3	.09
1994-2006	Subramanyam and Susarla (2011)	100	3	.18
1995-1997	Ramachandran and Gopal (2010)	85	3	-.04
	Gopal and Koka (2012)	105	5	
1996-2001	Ethiraj et al. (2005)	138	3	.09
1996-2005	Mani et al. (2013)	100	3	.02
1997-1998	Banerjee and Duflo (2000)	167	5	-.04
1998-2004	Susarla (2012)	141	4	.22
2000-2003	Gefen et al. (2008)	238	3	.18
2001-2001	Susarla et al. (2009)	153	2	.05
2001-2004	Rai et al. (2009)	155	6	.04
2002-2003	Tiwana (2008a)	209	3	-.14
2002-2006	Langer (2007)	530	4	.00
2004-2006	Huckman and Staats (2011)	562	1	.09
	Staats et al. (2011)*	727	1	
		1,203	1	
	Staats et al. (2012)	1,118	4	
2005-2010	Hoermann et al. (2012)	81	1	.23
2006-2006	Tiwana (2008b)	120	3	.08
	Tiwana (2010)	120	2	
2007-2008	Srivastava and Teo (2012)	160	2	-.12
2008-2008	Maruping and Ahuja (2012)	87	6	-.07
2008-2011	Ramasubbu et al. (2011)	424	5	.04
$\mathbf{N_{SA} = 22}$	$\mathbf{N_{IS} = 28}$		$\mathbf{N_{ES} = 92}$	

Period of Investigation: ITO engagements for this sample fall into this timeframe; **Studies using the same Sample**: Multiple studies based on the same sample were included only when each of the studies reports at least one operationalization of TU that is not reported in the other studies. For instance, Kalnins and Mayer (2004), Argyres et al. (2007), and Weber et al. (2011) use the same sample but examine different aspects of ITO engagements. All three studies have a shared set of variables but each study provides a unique set of variables related to one ore more operationalization of TU; N_{study}: Subset of ITO engagements used in study; ES: Effect sizes extracted from study (i.e., correlation coefficients of a variable related to task uncertainty and CT); $\bar{\rho}$: Average corrected correlation (expected rho) of TU and CT; $\mathbf{N_{SA}}$: Number of independent samples included in the final meta-analytical dataset; $\mathbf{N_{IS}}$: Number of studies included in the final meta-analytical dataset; $\mathbf{N_{ES}}$: Number of (potentially interdependent) effect sizes included in the final meta-analytical dataset; *: Staats et al. (2011) use different sample sizes for different variables in their analysis. See Dongus (2016) for the full meta-analytical sample.

Appendix 2. Definitions and Coding Examples for the Operationalizations of Task Uncertainty

Operationalization of TU	Definition	Coding examples
Technological uncertainty	Uncertainty that stems from low experience with the technologies employed in the project (Nidumolu, 1995)	Technology knowledge of vendor (e.g., Banerjee and Duflo, 2000; Kalnins and Mayer, 2004); perceived technological uncertainty (e.g., Maruping and Ahuja, 2012)
Requirements uncertainty	Uncertainty regarding the client's requirements (Nidumolu, 1995)	Goal codifiability (e.g., Susarla et al., 2009; Tiwana, 2010); incomplete specification (e.g., Gopal and Koka, 2012; Susarla, 2012); extent of change requests (e.g., Huckman and Staats, 2011; Rai et al., 2009); outcome measurability (e.g., Kalnins and Mayer, 2004)
Technological complexity	Multiplicity and interdependence between different elements of the solution (Xia and Lee, 2005)	Breadth of tasks (e.g., Chen and Bharadwaj, 2009a; Susarla, 2012); type of task (e.g., Bapna et al., 2012; Langer et al., 2008); functions points (e.g., Ethiraj et al., 2005; Rai et al., 2009); perceived technological complexity (e.g., Gefen et al., 2008)
Organizational complexity	Multiplicity and interdependence between different elements of the organizational environment (Xia and Lee, 2005)	Team size (e.g., Staats et al., 2012); multiplicity of vendors and clients involved (e.g., Maruping and Ahuja, 2012); temporal and geographical dispersion (e.g., Maruping and Ahuja, 2012; Weber et al., 2011); offshore percentage (e.g., Chen and Heng, 2012; Staats et al., 2012)
Project size	Size of the project (Argyres et al., 2007)	Effort (e.g., Ethiraj et al., 2005; Staats et al., 2011); duration (e.g., Mani et al., 2012; Staats et al., 2012); monetary value (e.g., Argyres et al., 2007; Ramachandran and Gopal, 2010)

Appendix 3. Mapping of Study Variables to the Different Operationalizations of Task Uncertainty

$N_{weighted}$	Variable	Description	Study
Technological Uncertainty ($\mathbf{k = 5, N = 1,312}$)			
392	Programming	Whether project involves programming	Kalnins and Mayer (2004)
	Vendor hardware	Whether project involves vendor hardware	Kalnins and Mayer (2004)
	Vendor proprietary technology	Whether project involves vendor proprietary technology	Kalnins and Mayer (2004)
	Innovation	Degree to which the project required innovation	Argyres et al. (2007)
167	Application area familiar to the firm	Whether the firm has experience with the application	Banerjee and Duflo (2000)
	Programming tools familiar to the firm	Whether the firm has experience with the programming tools	Banerjee and Duflo (2000)
	Platform familiar to the firm	Whether the firm has experience with the platform	Banerjee and Duflo (2000)
209	Outsourcee ignorance	Reverse score of the outsourcee firm's knowledge	Tiwana (2008a)
120	Vendor domain knowledge	Items for measuring domain knowledge	Tiwana (2010)
424	Newness	Experience with technology	Ramasubbu et al. (2011)
Requirements Uncertainty ($\mathbf{k = 10, N = 2,301}$)			
394	Difficulty to measure quality	Whether the technology used in the project made it difficult to determine the quality	Kalnins and Mayer (2004)
105	Requirements instability	Four adapted questionnaire items	Gopal and Koka (2012)
141	Complexity	Incomplete specification or transformational project	Susarla (2012)
153	Service uncertainty	Difficulty to estimate project specification	Susarla et al. (2009)
155	Requirements uncertainty	Number of formal written changes	Rai et al. (2009)

$N_{weighted}$	Variable	Description	Study
562	Task change	Percentage of requirements that have changed in the project	Huckman and Staats (2011)
120	Project goal codifiability	Extent of written documentation	Tiwana (2010)
160	Knowledge stickiness	Availability of documentation and manuals	Srivastava and Teo (2012)
87	Requirement clarity	Simplicity of requirements, easy project guidelines, and clarity of specifications	Maruping and Ahuja (2012)
424	Requirement volatility	Effort spent on rework due to changes	Ramasubbu et al. (2011)
Technological Complexity ($k = 15, N = 4,420$)			
394	Customer mainframe	Whether project involves client mainframe technology	Kalnins and Mayer (2004)
95	Technological complexity	Whether the technological environment would be a source of problems during the project	Ramachandran and Gopal (2010)
	Project type	New development or reengineering	Gopal and Koka (2012)
167	Y2K, CAD, Web Pages	Classes of project technology complexity	Banerjee and Duflo (2000)
138	Project size and complexity	Number of function points	Ethiraj et al. (2005)
753	Number of subsegments	Number of distinct IT tasks/activities	Bapna et al. (2012)
	Engagement type complexity	Complexity categories	Bapna et al. (2012)
153	Task complexity	Items for complexity of software development	Chen and Bharadwaj (2009b)
945	Number of functions	Number of IT functions outsourced	Chen and Heng (2012)
100	Problem solving complexity	Items to measure task-specific variables	Subramanyam and Susarla (2011)
100	Type of outsourcing	Complexity categories	Mani et al. (2013)

$N_{weighted}$	Variable	Description	Study
	initiative		
141	Breadth of service	Sum of services performed by the vendor	Susarla (2012)
238	Perceived software complexity	Items to measure interconnectivity between modules	Gefen et al. (2008)
	Perceived software complexity	Items to measure module complexity	Gefen et al. (2008)
155	Project complexity	Number of adjusted function points	Rai et al. (2009)
530	Log of FP	Function points associated with the project	Langer (2007)
	Project technology	Low level or high level programming language	Langer (2007)
87	Technological complexity	Measured on a five-item scale	Maruping and Ahuja (2012)
424	Project size	Forward counted function points	Ramasubbu et al. (2011)
Organizational Complexity ($k = 14, N = 4,269$)			
385.3	Interdependence	Customer personnel are listed as being responsible for some deliverables	Argyres et al. (2007)
	Any-office-50	Vendor office within 50 miles	Weber et al. (2011)
	Minimum distance	Geographic distance between client and closest vendor office	Weber et al. (2011)
105	Team size	Number of team members	Gopal and Koka (2012)
138	Team size	Number of team members	Ethiraj et al. (2005)
153	Offshore (dummy variable)	Software developed in the US versus outside the US	Chen and Bharadwaj (2009b)
945	Offshore	Service by offshoring/onshore vendor or domestic vendor	Chen and Heng (2012)
100	Anticipated coordination	Anticipated interdependence based on the strategic rationale for outsourcing	Mani et al. (2013)

$N_{weighted}$	Variable	Description	Study
	requirements		
155	Client representative	Whether a project team had a client representative present or not	Rai et al. (2009)
	Client-meet	Number of visits by the client	Rai et al. (2009)
	Team-meet	Number of visits to the client site	Rai et al. (2009)
209	Outsourcer liaison team size	Number of team members	Tiwana (2008a)
530	Team size	Number of people who have been allocated to the project	Langer (2007)
1,118	Team size	Number of team members	Staats et al. (2012)
	SoftCo percentage	Coordination complexity due to employees working at different locations	Staats et al. (2012)
120	Project team size	Number of team members	Tiwana (2008b)
160	Team size	Number of vendor employees	Srivastava and Teo (2012)
87	Temporal dispersion	Number of time zones spanned	Maruping and Ahuja (2012)
	Client participation	Proportion of offshore IS project team members	Maruping and Ahuja (2012)
	Organizational complexity	Multiplicity of contractors and vendors and multiplicity of client units involved	Maruping and Ahuja (2012)
424	Team size	Full time headcount	Ramasubbu et al. (2011)
	Client involvement	Effort spent on engaging with end users	Ramasubbu et al. (2011)
Project Size ($\mathbf{k = 20, N = 5,704}$)			
385.5	Dollar value	Total monetary value of the project	Argyres et al. (2007)
	Duration	Number of weeks to complete the project	Weber et al. (2011)
95	Duration	Number of calendar days	Gopal and Koka (2012)

$N_{weighted}$	Variable	Description	Study
	Effort	Measured in function points	Gopal and Koka (2012)
	Cost	Total development cost	Ramachandran and Gopal (2010)
	Financial risk	Risk in comparison to other projects of the vendor	Ramachandran and Gopal (2010)
167	Project size	Duration in person-months	Banerjee and Duflo (2000)
112	Contract duration	Number of months in contract	Chen and Bharadwaj (2009a)
138	Person-months	Number of person-months	Ethiraj et al. (2005)
753	Length	Total length of the contract in months	Bapna et al. (2012)
	Contract value	Dollar value of the contract	Bapna et al. (2012)
153	Contract duration	Duration is greater than 12 months or not	Chen and Bharadwaj (2009b)
945	Log of contract length	Duration in months	Chen and Heng (2012)
100	Duration	Length of the contract	Subramanyam and Susarla (2011)
	Contract value	Monetary value of the project	Subramanyam and Susarla (2011)
100	Expectation of continuity of the relationship	Length of the contract in months	Mani et al. (2013)
141	Contract length	Length is greater than 3 years or not	Susarla (2012)
	Contract value	Log of the monetary value	Susarla (2012)
153	Length	Duration in years	Susarla et al. (2009)

$N_{weighted}$	Variable	Description	Study
238	Project duration	Time invested	Gefen et al. (2008)
155	Project size	Size in lines of code	Rai et al. (2009)
209	Project duration	Duration in months	Tiwana (2008a)
530	Duration	Duration in months	Langer (2007)
1,041.5	KLOC	Size in kilolines of code	Staats et al. (2011)
	Effort	Duration in hours	Staats et al. (2011)
	Log of estimated effort	Duration in person minutes	Staats et al. (2012)
	Log of estimated duration	Time to complete the project	Staats et al. (2012)
120	Project alliance scope	Project size in comparison to other projects	Tiwana (2008b)
	Project duration	Duration in months	Tiwana (2008b)
81	Project size	Estimated volume of the project	Hoermann et al. (2012)
87	Project size	Total cost of the project in US dollars	Maruping and Ahuja (2012)

$N_{weighted}$: We combined variables from studies analyzing the same sample by averaging the N_{study} across all included variables.

Appendix 4. Sensitivity Analysis Controlling for Start Year of Sample (SYS)

	k	N	$\bar{\rho}$	SD_{ρ}	$CI_{\bar{\rho};.95}$	$CR_{\bar{\rho};.80}$	$\%V$	Q_{within}	$Q_{between}$
SYS ≤ 1996	9	2,788	.15	.07	.09 : .22	.06 : .24	.50	17.49*	9.15*
SYS > 1996	13	3,460	.05	.09	-.01 : .12	-.06 : .17	.44	29.55*	
SYS ≤ 1997	10	2,955	.14	.08	.07 : .21	.04 : .25	.46	21.42*	6.37*
SYS > 1997	12	3,293	.06	.09	-.01 : .13	-.05 : .17	.42	28.40*	
SYS ≤ 1999	11	3,096	.15	.08	.08 : .21	.05 : .25	.47	22.92*	9.09*
SYS > 1999	11	3,152	.05	.08	-.01 : .11	-.05 : .15	.45	24.18*	
SYS ≤ 2000	12	3,334	.15	.07	.09 : .21	.05 : .25	.50	23.71*	13.56*
SYS > 2000	10	2,914	.04	.07	-.03 : .10	-.05 : .13	.51	19.44*	
SYS ≤ 2001	14	3,642	.14	.08	.08 : .20	.04 : .24	.49	27.97*	9.68*
SYS > 2001	8	2,606	.04	.08	-.03 : .11	-.06 : .14	.42	18.73*	

$\boldsymbol{k}$: Number of effect sizes; $\boldsymbol{N}$: Total sample size; $\bar{\boldsymbol{\rho}}$: Expected rho; $\boldsymbol{SD_{\rho}}$: Standard deviation of ρ; $\boldsymbol{CI_{\bar{\rho};.95}}$: 95% confidence interval around $\bar{\rho}$; $\boldsymbol{CR_{\bar{\rho};.80}}$: 80% credibility interval around $\bar{\rho}$; $\%\boldsymbol{V}$: Percentage of variance that is accounted for by statistical artifacts; $\boldsymbol{Q_{within}}$: Cochran's chi-square statistic for heterogeneity that remains within the subset; $\boldsymbol{Q_{between}}$: Cochran's chi-square statistic for heterogeneity that is explained by the SYS; *: p-value of $Q < 0.05$.

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[9] * = Study included in the final meta-analytical dataset.

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