EXPLAINING MULTISOURCING DECISIONS IN APPLICATION OUTSOURCING

Research paper

Krancher, Oliver, University of Bern, Bern, Switzerland, oliver.krancher@iwi.unibe.ch

Stürmer, Matthias, University of Bern, Bern, Switzerland, matthias.stuermer@iwi.unibe.ch

Abstract

Multisourcing—the delegation of interdependent tasks to multiple vendors—is receiving increasing attention in practice and in research. Yet, we know little about the circumstances under which organizations choose multisourcing. In this paper, we draw on incomplete contracting theory and the knowledge-based view to explain multisourcing decisions in application projects. We test our model using a comprehensive dataset of 1093 sourcing decisions made by Swiss public organizations. The results provide strong support for the model. We find that clients choose multisourcing more frequently when (1) the project is large, (2) the software is client-specific and the project is large enough, (3) client and vendor lack joint experience, (4) the client seeks knowledge, (5) the technology is not proprietary, and (6) the client is experienced in outsourcing. While these findings support common views that clients choose multisourcing in response to opportunistic threats and to knowledge needs, the findings also shed light on prerequisites for multisourcing.

Keywords: Multisourcing, Multisourcing decision, Incomplete contracting theory, Property rights theory, Transaction cost economics, Knowledge-based view, Sourcing decision, asset specificity.

1 Introduction

When the Swiss Post aimed to replace the software that supported their 30,000 letter carriers in their daily work, they did not contract *one* vendor to develop a new, state-of-the-art software; they contracted *six*. The Swiss Post assigned a number of work packages to each vendor and promised them further work packages if they demonstrated their ability to deliver. The multi-million dollar project was highly successful, being completed 6 months ahead of plans (Hurni et al. 2015; Tomczak 2015).

The Swiss Post project is an example of information systems (IS) *multisourcing*, i.e., the delegation of interdependent IS services to two or more vendors (Bapna et al. 2010; Wiener and Saunders 2014). Multisourcing is not the same as contracting multiple vendors (or multi-vendor outsourcing) (Currie and Willcocks 1998; Koo et al. 2016). Multisourcing denotes the more specific situation where a client assigns *interdependent* tasks to multiple vendors, forcing vendors to collaborate (Bapna et al. 2010; Wiener and Saunders 2014). For instance, the Swiss Post assigned work packages within the same software project to multiple vendors, forcing the vendors to jointly develop a coherent system.

IS multisourcing is attracting increasing interest in practice and in research. According to data collected by IDC, the global IS multisourcing business increased from less than \$1 billion in 2001 to more than \$7 billion in 2007 (Bapna et al. 2010, p. 787). Researchers have called multisourcing "the leading edge of modern organizational forms" (Bapna et al. 2010, p. 785), and begun to explore benefits and challenges associated with multisourcing. One benefit is that multisourcing allows clients to engender post-contractual competition, mitigating the dependence on a single vendor (Levina and Su 2008, p. 561). For instance, as the project progressed, the Swiss Post dynamically assigned work packages to vendors based on their performance, extending competition beyond contract settlement. This contrasts with single-sourcing (i.e., delegating all interdependent tasks to one vendor), where competition often vanishes after contract settlement given that only one vendor acquires the project-specific knowledge and, hence, is able to carry out subsequent work (Williamson 1981). A second benefit from multisourcing is access to the knowledge of best-of-breed vendors (Bapna et al. 2010). These two benefits come at the cost of two important challenges. First, vendors may have lower incentives to make client-specific investments, in particular if a client "slices the pie too thinly" (Levina and Su 2008, p. 545). Second, clients face the difficult mission of managing multiple vendors. They may need strong knowledge to orchestrate the contributions of the individual vendors (Brusoni et al. 2001) and to make individual vendors accountable for their omissions (Bapna et al. 2010).

Although these insights provided by the multisourcing literature are valuable, our understanding of *multisourcing decisions* remains limited. We lack theory-based explanations for multisourcing decisions and empirical evidence that shows under which conditions clients choose multisourcing. Yet, theoretically and empirically substantiated knowledge about multisourcing decisions would be valuable for two reasons. First, in line with assumptions in the institutional economics and the strategy literatures, we believe that by studying decisions for alternative organizing forms (e.g., firm versus market, multisourcing versus single-sourcing), scholars can gain insights into more the more fundamental question of why these organizing forms exist and, hence, what they serve for (Coase 1937; Poppo and Zenger 1998; Williamson 1981). Second, such knowledge would be practically relevant for clients in their mission of balancing the benefits and challenges of multisourcing in particular projects.

In this paper, we address these gaps in the context of application projects. Application projects (i.e., application development or maintenance projects) typically require intensive coordination among involved parties (Kraut and Streeter 1995), which aligns well with the multisourcing characteristic of interdependent tasks. Moreover, application projects vary strongly in the degree to which client-specific knowledge is required (Dibbern et al. 2008), promising insights into issues related to specific knowledge and vendor dependence. Our research question is: *Under which conditions do organizations choose multisourcing, as opposed to single-sourcing, for application projects?*

We address this question by developing hypotheses based on incomplete contracting theory and the knowledge-based view. We test these hypotheses on a large dataset of 1093 sourcing decisions. Our key contribution is to show that both theories explain unique variance in multisourcing decisions.

2 Theory and Hypotheses

In this paper, we aim to explain multisourcing decisions by drawing on incomplete contracting theory, which encompasses both transaction cost economics (TCE) (Williamson 1981) and property rights theory (PRT) (Alchian and Demsetz 1972; Hart and Moore 1990), and on the knowledge-based view (KBV) (Conner and Prahalad 1996; Hodgson 1998).

We choose these theories because they provide explanations that resonate with thinking and with findings in existing multisourcing research. TCE provides the key idea that, in single-sourcing, opportunistic threats arise, under certain conditions, from the client's dependence on a single vendor (Williamson 1981). Since multisourcing helps reduce the dependence on a single vendor (Levina and Su 2008, p. 561), it may help safeguard against the opportunistic threats that arise from such dependence. PRT offers the idea that when a party shares residual rents with other parties, the party's motivation to make relationship-specific investments drops (Alchian and Demsetz 1972; Hart and Moore 1990). This resonates with the finding that, in multisourcing, vendors may hesitate to invest unless the business perspective for vendors is significant (Levina and Su 2008, p. 545; Wiener and Saunders 2014, p. 220). The KBV holds that differences in knowledge between organizations are often irreducible (Conner and Prahalad 1996; Hodgson 1998). Irreducible knowledge differences help explain why clients choose multisourcing to access best-of-breed knowledge (Bapna et al. 2010). Table 1 provides an overview of these theories, including their key assumptions, their explanations for multisourcing decisions, and the ensuing predictions. Figure 1 shows our theoretical model with hypotheses.

Theory	*Key Assumptions*	*Key Explanations for Multisourcing Decisions*	*Predictions: Multisourcing is more frequent when …*
Incomplete contracting theory (Hart and Moore 1990; Williamson 1981)	Bounded rationality, opportunism	Function of multisourcing: Multisourcing helps safeguard against opportunistic threats by engendering post-contractual competition (TCE).	… opportunistic threats are high (H1-H3).
		Prerequisite for multisourcing: Expected residual rents need to be high enough for vendors to make investments into client-specific assets (PRT).	… projects are large enough to warrant investment (H4-H5).
Knowledge-based View (Conner and Prahalad 1996)	Irreducible knowledge differences	Function of multisourcing: Multisourcing enables access to knowledge.	… client seeks knowledge (H6).
		Prerequisite for multisourcing: Multiple vendors possess relevant knowledge.	… technology is not proprietary (H7).
		Prerequisite for multisourcing: Clients possess sufficient knowledge to manage multiple vendors.	… client is experienced in outsourcing (H8).

Table 1. Theory Overview

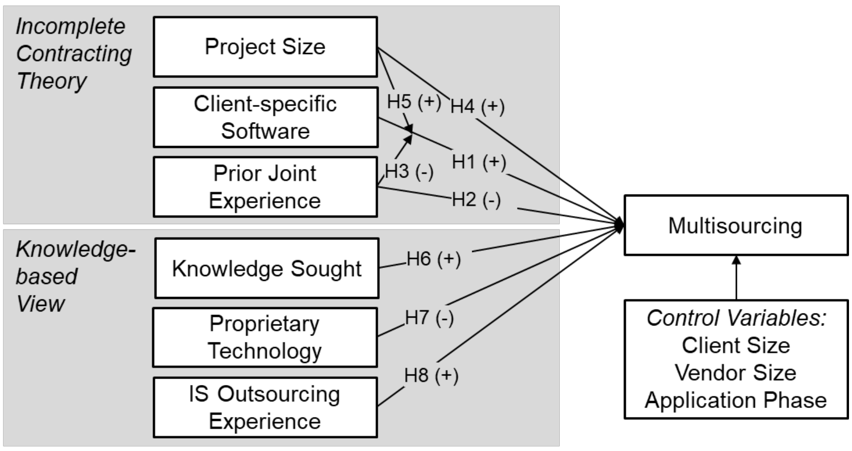

Figure 1. Theoretical Model

2.1 Incomplete Contracting Theory

In line with Kim and Mahoney (2005), we subsume TCE and PRT under the umbrella of incomplete contracting theory. Both theories rely on the key assumptions of bounded rationality and opportunism (Grossman and Hart 1986). *Bounded rationality* means that actors are intendedly rational but only limitedly so because of human cognitive limitations (Simon 1957; Williamson 1981, p. 553). Specifically, clients are unable to fully anticipate all possible future states of the world, which results in incomplete contracts (Hart and Moore 1990, p. 1120; Williamson 1979, p. 238). Incomplete contracts due to bounded rationality are a reality in application projects, where clients are typically unable to fully anticipate requirements at the outset of projects (Wallace et al. 2004; Walz et al. 1993). *Opportunism* is "self-interest seeking with guile" (Williamson 1979, p. 234). Vendors are opportunistic, for instance, when they shirk, lie, of hold up clients to maximize own gains. While both theories share these assumptions, TCE emphasizes the perspective of the client whereas PRT incorporates the perspective of the vendor, in particular the issue of how the distribution of residual rents affects the vendor's motivation to invest (Kim and Mahoney 2005, p. 231). Thus the theories are complementary (Kim and Mahoney 2005). We next develop hypotheses for multisourcing decisions based on TCE before we complement them with ideas from PRT.

2.1.1 Transaction Cost Economics

According to TCE, bounded rationality and opportunism are relatively unproblematic as long as there is competition between vendors. When a client can select from a market with many equivalent vendors, the client can respond to opportunistic vendor behavior by switching to another vendor (Williamson 1979, p. 248). Conversely, bounded rationality and opportunism become problematic when competition vanishes, or markets fail. Competition vanishes when *asset specificity* is high, i.e., when vendors are required to invest into assets (including knowledge) that lose most of their value when they are redeployed to other clients (Williamson 1981). Under high asset specificity, clients become dependent on the vendor that possesses client-specific assets. For instance, when a project requires deep knowledge in a client-specific software system (high asset specificity), a vendor that possesses such knowledge may hold up the client, such as by charging higher fees after contract changes, being aware that client is hardly able to obtain the service from an alternative vendor. Clients anticipate these opportunistic threats and choose organizing forms depending on opportunistic threats. Some organizing forms are held to be more effective for discouraging opportunism than others.

There is some evidence that *multisourcing* is more effective for discouraging opportunism than single-sourcing. Multisourcing helps discourage opportunism by extending the competition between vendors to the period after initial contracts are signed. Empirical evidence describes vendors in multisourcing settings as highly cooperative because of this competition-enhancing effect (Levina and Su 2008, p. 561; Wiener and Saunders 2014). When vendors behave opportunistically, multisourcing clients can credibly threaten to award future work to another vendor because multiple vendors have been engaged in the project, have acquired project-specific knowledge, and, hence, would be able to provide the service. A similar point was made in a case study by Wiener and Saunders (2014), who observed that "the overlap in vendor skills and areas led to intense competition among vendors and reduced [the client's] dependency on a single vendor" (p. 218). In sum, an important function of multisourcing from the perspective of TCE is to help safeguard against opportunistic threats by engendering post-contractual competition. Clients, hence, choose multisourcing in those settings where opportunistic threats are particularly high (see also the second line in Table 1).

The key driver of opportunistic threats according to TCE is asset specificity (Williamson 1981, p. 555). *Asset specificity* refers to the degree to which an asset loses its value when it is redeployed to its second best use. While Williamson introduced several dimensions of asset specificity, in "IT outsourcing, the most likely specific asset is human, more precisely, employee knowledge" (Aubert and Rivard 2016, p. 65). IS outsourcing research has thus focused on knowledge specificity (or human asset specificity), i.e., the degree to which knowledge loses its value when it is redeployed to its second best use (Dibbern et al. 2016). Knowledge specificity causes two types of opportunistic threats: underinvestment and hold-up. High knowledge specificity may lead to underinvestment because projects of high knowledge specificity require vendors to make costly investments into "[s]pecialized training and learning-by-doing" (Williamson 1979, p. 240). Opportunistic vendors may be reluctant to make these investments given that they cannot leverage these investments in their business with other clients. A second opportunistic threat is that client may be held up during contract renegotiations because once the vendor has made investments into client-specific knowledge, the client will not find alternative vendors with similar client-specific knowledge on the market. Vendors may then exploit this dependence and influence contract adjustments or renewal to their advantage, such as by charging higher prices. Multisourcing can help counteract both threats. If clients observe underinvestment by a vendor, multisourcing allows them to threaten to delegate portions of work to other vendors. In a similar vein, with multisourcing, vendors may be in a weaker position to hold up clients because clients can choose among several of their existing vendors, which may all have acquired client-specific knowledge during the collaboration. Foresighted clients anticipate the opportunistic threats that result of high knowledge specificity and choose multisourcing to mitigate them.

An important issue for testing is these ideas is how knowledge specificity manifests in application projects. Software development research (Banker et al. 1993; Banker et al. 2002; Boh et al. 2007) and outsourcing research (Chua and Pan 2008; Krancher and Dibbern 2015) concur that a key type of knowledge in application projects is *application knowledge*, i.e., knowledge about the application software that is developed or maintained. Engineers often require long experience in a *particular* software before their cognitive schemas of the software are sufficiently powerful to allow them to effectively configure or maintain it (Krancher and Dibbern 2012; Von Mayrhauser and Vans 1995). The extent to which application knowledge is client specific depends on the nature of the software. When the software is client specific (i.e., custom-developed), vendor engineers cannot reuse their cognitive schemas (or knowledge) of the software across projects because, per definition, no other instance of the same software exists. Conversely, when the software is not client-specific (i.e., packaged software), vendor engineers can apply the same application knowledge (e.g. knowledge about SAP) for many clients. Thus, opportunistic threats are lower in packaged software, where the market offers alternative vendors with largely equivalent application knowledge (e.g. knowledge about SAP), than in custom-developed software projects, where the market does not offer alternative vendors with application knowledge (i.e., knowledge about the particular custom-developed software). Clients anticipate the opportunistic threats associated with client-specific software and choose multisourcing to extend competition beyond contract settlement and thus to safeguard against opportunism. We hypothesize:

H1: The likelihood of multisourcing is higher when the software is client specific.

A second important driver of opportunistic threats according to TCE is uncertainty. Although TCE researchers distinguish several types of uncertainty (Schermann et al. 2016), Williamson emphasizes behavioral uncertainty, or "[u]ncertainty of a strategic kind [that] is attributable to opportunism" (Williamson 1984, p. 205). Behavioral uncertainty refers thus to the likelihood that transaction partners behave opportunistically. Outsourcing research has often measured behavioral uncertainty based on prior joint experience (Benaroch et al. 2016, p. 69; Corts and Singh 2004, p. 232; Dekker and Van den Abbeele 2010, p. 1234; Gefen et al. 2008, p. 531). The argument is that when clients do business with the same vendor again, this indicates that the client has developed trust in the integrity and ability of the vendor during the prior project, or the client would not have chosen the same vendor again. Prior joint experience thus indicates lower behavioral uncertainty and, hence, lower opportunistic threats. Since clients choose multisourcing when opportunistic threats are high, we expect multisourcing to be more frequent when clients and vendors lack prior joint experience:

H2: The likelihood of multisourcing is higher when clients and vendors lack prior joint experience.

According to TCE, knowledge specificity and behavioral uncertainty should not be considered in isolation; it is their interplay that affects decisions for organizing forms (Williamson 1985, p. 59). If a client fully trusts a vendor (i.e., if behavioral uncertainty is absent), the client has no reason to fear underinvestment or hold-up, even if knowledge specificity is high. In a similar vein, if vendors do not have to make client-specific investments into knowledge (i.e., if knowledge specificity is very low), the client may not fear vendor opportunism because the vendor could easily be replaced by a competitor. We thus expect the following interaction of client-specific software and prior experience:

H3: Joint prior experience weakens the positive relationship between client-specific software and multisourcing.

2.1.2 Property Rights Theory

While PRT shares key assumptions with TCE, it complements TCE by focussing on the conditions that affect the vendor's motivation to make client-specific investments. Like TCE, PRT assumes that bounded rationality prevents opportunistic parties from stipulating complete contracts. The basic argument of PRT is that, under incomplete contracts, vendors have stronger incentives to make client-specific investments when their residual rights and their expected residual rents are substantial. *Residual rights* are those rights to use, earn income from, and exchange a resource that a party does not give away through the contract (Richmond et al. 1992). *Residual rents* are the benefits from the collaboration that are not distributed ex ante through the incomplete contract (Hart and Moore 1990).

To illustrate the applicability of these concepts, consider a vendor that faces the decision of whether to allocate its best engineers to a new single-sourcing project. If the vendor assigned its best engineers to the project, the engineers would spend some months to acquire client-specific knowledge. After that, they would be able to combine their superior pre-existing knowledge with the newly acquired client-specific knowledge to make superior design decisions in the project. The superior design decisions could result in substantial cost savings and in follow-up contracts with the highly satisfied client. The decision to allocate its best engineers to this project is rational for the vendor if the vendor can expect to reap a large portion of these benefits. How does this situation change if the project is a multisourcing project? PRT points to two important changes. First, multisourcing curtails the vendor's residual rights related to the key resource, its engineers' knowledge. Whereas in single-sourcing the vendor can leverage this knowledge to independently make superior design decisions, in multisourcing the vendor would need to make many design decisions jointly with other vendors, given that the vendors' tasks are interdependent. Other vendors that eschewed investments and, hence, lack the superior knowledge of our focal vendor may disagree with the suggested designs and convince the client of an alternative, less effective design. The vendor is thus unable to generate rents from the investments. Second, even if the other vendors recognize the superior knowledge of our focal vendor and let the vendor make key design decisions, it is uncertain whether our focal vendor will the reap the rents caused by the superior design decisions. Given low verifiability of results in application projects (Ravindran 2012) and team production due to multisourcing (i.e., production by a team of interdependent vendors) (Alchian and Demsetz 1972), other vendors may claim to be accountable for the superior performance and attempt to reap the rents. For instance, the other vendors may save costs by allocating junior engineers, given that the overall project is ahead of plans, or they may falsely claim to be responsible for the superior project performance and attempt to win follow-up contracts. Hence, low verifiability paired with interdependence in multisourcing curtail the residual rents that our focal vendor can reap from own investments.

While these arguments suggest that multisourcing generally reduces the vendor's motivation to invest, they also points to conditions under which vendors may be willing to make substantial investments despite multisourcing. If a project is very large, the residual rents that each vendor can gain may still be substantial enough to warrant client-specific investments. In a very large project, it is more likely that there are large chunks of work in which vendors can make decisions relatively autonomously and, hence, more credibly claim to be accountable for the results. Moreover, due to scale effects, it will generally be easier to amortize investments in large projects such that substantial residual rents are possible even in the presence of multiple vendors. This is in line with findings in multisourcing research according to which clients need to promise a substantial business perspective to vendors in order to motivate them to make investments (Levina and Su 2008, p. 545; Wiener and Saunders 2014, p. 220). In light of this positive relationship between residual rents and project size, we expect:

H4: The likelihood of multisourcing increases with project size

PRT suggests that the effect of knowledge specificity on multisourcing decisions may be more complex than suggested in our arguments derived from TCE. Although the enhanced competition generated through multisourcing may help force vendors to make client-specific investments, the uncertain distribution of residual rents with multisourcing may also make vendors more reluctant to make client-specific investments. Which of these two effects dominates will likely depend on project size. In large projects, client-specific investments may still pay off for vendors, and enhanced competition through multisourcing may further enhance vendor commitment. Conversely, in small projects, client-specific investments may not pay off for vendors, and the prospect of competing with other vendors after contract settlement may make investments for the vendor even less attractive. We expect:

H5: The relationship between client-specific software and multisourcing depends on project size. The relationship is positive for large projects and negative for small projects.

2.2 Knowledge-based View

The KBV (Conner and Prahalad 1996; Grant 1996; Hodgson 1998; Kogut and Zander 1996) differs from incomplete contracting theories in a key assumption related to knowledge acquisition. While incomplete contracting theory assumes that knowledge acquisition is possible but more costly in some settings than in others, the KBV assumes that knowledge acquisition is often impossible within reasonable time. Thus knowledge differences between firms are often *irreducible* (Conner and Prahalad 1996). The knowledge of a firm is a resource that is not easily replicated by another firm because of cognitive (Cohen and Levinthal 1990; Conner and Prahalad 1996) and social (Hodgson 1998; Kogut and Zander 1996; Zimmermann et al. in press) challenges associated knowledge acquisition.

Irreducible knowledge differences affect multisourcing decisions in three important ways. First, a frequent argument in the multisourcing literature is that clients choose multisourcing to work with best-of-breed vendors, i.e., to access the knowledge of specialized vendors (Bapna et al. 2010; Su and Levina 2011; Wiener and Saunders 2014). The implicit assumption in this argument is that differences in knowledge between vendors are irreducible. If knowledge differences are irreducible, then those clients that seek access to knowledge through outsourcing may prefer multisourcing because the chance that multiple vendors collectively possess the required knowledge are higher than the chance that one vendor possesses the knowledge. This suggests:

H6: The likelihood of multisourcing is higher in projects in which clients seek knowledge.

Although clients may choose multisourcing to gain access to knowledge, a prerequisite for this strategy is that multiple vendors need to possess the knowledge that is most relevant to the project. This prerequisite may not always be given. Some projects may rely on proprietary technology, i.e., technology owned by one of the vendors (Argyres et al. 2007, p. 11). In such a case, there may be only one vendor who is intimately familiar with the technology and, hence, is able to deliver the project. For instance, in one project in our dataset, the veterinary department of the university hospital Zurich contracted the small software firm GP.Software to implement a packaged laboratory information system that is suited to the demands of veterinary healthcare. GP.Software was not only the implementor at the university hospital but also the owner of the software package (i.e., GP.Sofware has developed and sells the software package). Given GP.Software's unique knowledge resulting from the developing the software package and from implementing their own package at many clients, it would have been difficult for the university hospital to find other vendors with similar project-relevant knowledge. We expect:

H7: The likelihood of multisourcing is lower when technology is proprietary.

A third mechanism of how irreducible knowledge differences affect multisourcing decisions regards the knowledge of the client. The literature on product development multisourcing shows that multisourcing requires substantial knowledge from clients (Brusoni et al. 2001; Takeishi 2002). Brusoni and colleagues found that aircraft engine manufacturers made strong efforts to acquire and retain knowledge even in domains related to those products that were developed by external vendors. This knowledge was essential to integrate the services delivered by different vendors. Indeed, clients may need strong management capabilities to cope with the challenges of multisourcing, which include: devising effective services level agreements for multiple suppliers, setting up coordination mechanisms that help cope with task and knowledge interdependence across multiple organizational boundaries, motivating competing vendors to help each other, and diagnosing and attributing finger-point behavior due to accountability problems (Bapna et al. 2010; Wiener and Saunders 2014). Clients who lack experience with managing IS outsourcing projects may lack the capabilities required to cope with these challenges. We therefore hypothesize:

H8: The likelihood of multisourcing is higher when clients have high IS outsourcing experience.

3 Methods

3.1 Dataset

We tested our theoretical model on a comprehensive dataset of 1093 application projects that 229 public Swiss organizations awarded 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. In Switzerland, all federal organizations and most cantonal and local administrations are legally required to publish bid invitations and contract awards of projects that exceed a value of 250,000 Swiss Francs (CHF) (about 250,000 USD) on the simap platform, although they may also publish smaller projects. The platform has been in operation since 2008.

We used the simap database because it offered a number of advantages. First, selection bias was lower than in survey designs given that publishing transactions on the simap database is mandatory. Second, since the database has been in operation since 2008, the database provided objective data related to the client's prior IS outsourcing experience and prior joint experience of client and vendor. Third, the database allowed us to draw a random sample of 1093 application projects, out of which 972 were single-sourcing and 121 were multisourcing projects. Analyzing multisourcing decisions requires such a relatively large sample size because our dichotomous dependent variable (multisourcing versus single-sourcing) calls for logistic regression approaches and logistic regression requires 10 observations per group and per estimated parameter (Hair et al. 2010, p. 318). Our data include 121 observations in the multisourcing group, which is slightly above the 110 observations required for estimating the 11 parameters of our model.

3.2 Extraction and Coding Process

We used a crawler to extract data from the simap database. The data was then subject to an extensive data cleansing process, the details of which are omitted here due to space constraints (but are available on request from the authors). Two coders then coded each project based on a detailed coding scheme (available on request from the authors). The coders were blind to the hypotheses of the study. 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 how we measured the variables of our theoretical model. The variables include multisourcing, the predictors of our theoretical model and three control variables: client size, vendor size, and the application phase. The variables multisourcing, client size, vendor size, prior joint experience, project size, and IS outsourcing experience were automatically extracted from the database. The variables client-specific software, proprietary technology, application phase, knowledge sought were coded according to the coding procedure mentioned above. Information on whether clients sougth knowledge was available only for the projects that were awarded through public tendering (n = 562).

Our operationalization of multisourcing as awarding services *within one project* to multiple vendors in line with our definition, which reserves multisourcing to interdependent subtasks are awarded to multiple vendors. The simap database showed whether a particular project was awarded to one or more vendors. Examples of projects included the implementation of a clinical software package, requirements analysis for a new tax management system, or integrating a set of regional traffic control applications. When one such projects was awarded to more than one vendor, the subtasks of these vendors would be interdependent because the vendors had to collaborate within a common project.

Variable	*Description*	*Measurement Approach*
Multisourcing	1 if the project was awarded to more than one vendor; else 0	Automatically extracted from the database
Client Size	Total volume in CHF of projects awarded by the client on the simap platform (natural logarithm)	Automatically extracted from the database
Vendor Size	Total volume in CHF of projects awarded to the vendor on the simap platform (natural logarithm); in case of multiple vendors: average of all vendors	Automatically extracted from the database
Application Phase: Maintenance	1 if the project started during the maintenance phase (i.e., the software was live at that client); else 0	Coded based on the project descriptions
Client-specific Software	1 if the project involved custom-developed software; else 0	Coded based on the project descriptions
Proprietary technology	1 if the project involved a software package developed by the vendor; else 0	Coded based on the project descriptions
Prior Joint Experience	1 if the client had previously awarded a contract to the same vendor; else 0; in case of multiple vendors: average of 0/1 values	Automatically extracted from the database
Project Size	Project volume in CHF (natural logarithm)	Automatically extracted from the database
IS Outsourcing Experience	The number of IS projects that the client had awarded on the simap platform before (natural logarithm)	Automatically extracted from the database
Knowledge Sought	1 if the need for in knowledge in a particular domain was mentioned in the bid invitation; else 0	Coded based on project descriptions

Table 2. Variable Description and Measurement

3.4 Regression Approach

Given the dichotomous nature of our dependent variable, we used logistic regression. Although our data were nested at two levels, with multisourcing decisions being nested within clients, the intraclass correlation coefficient was 0.2%, suggesting that decisions made by the same client hardly correlated with each other. Hence, we refrained from using multi-level regression strategies such as generalized linear mixed models, although we verified that these strategies yielded very similar results. Following a hierarchical regression strategy, we first estimated models that included main effects only and then included interaction effects in a second model. Moreover, we separately estimated models using the subsample of projects with public tendering, where information about knowledge sought was available, and in the whole sample, where we excluded the knowledge sought as a predictor.

4 Results

Table 3 shows descriptive statistics per subsample and bi-variate correlations. Table 4 shows the regression results. Models 1a and 2a include main effects only, whereas models 1b and 2b also include interaction effects. Models 1a and 1b refer to the full sample, while models 2a and 2b refer to the subsample of projects with public tendering. We refer to model 1a in examining main effects, with the exception of H7, which we examine using model 2a because information on knowledge sought was available only in public tendering projects. We refer to model 1b in testing interaction effects.

	Single-Sourcing: Mean(SD)	Multi-sourcing: Mean(SD)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Multisourc.	-	-	1									
(2) Client Size	286m(607m)	674m(943m)	.15	1								
(3) Vendor Size	167m(1.2 bn)	138m(487m)	.18	.23	1							
(4) Maintenance	.51(.50)	.45(.50)	-.04	.19	.14	1						
(5) Client-sp. Sw	.35(.48)	.51(.50)	.11	.17	.12	.13	1					
(6) Propr. Tech.	.40(.49)	.04(.20)	-.23	-.10	-.13	-.10	-.54	1				
(7) Prior Jt. Exp.	.31(.46)	.27(.32)	-.03	.36	.38	.27	.17	-.06	1			
(8) Project Size	3m(13m)	24m(46m)	.44	.31	.47	-.10	.11	-.13	.09	1		
(9) IS Outs. Exp.	31(38)	44(47)	.11	.74	.11	.24	.19	-.13	.42	.08	1	
(10) Gen. Know.	.38(.49)	.75(.44)	.29	.27	.26	.20	.32	-.24	.17	.36	.21	1

Table 3. Descriptive Statistics and Bi-variate Correlations

Variable	*Model 1a (main effects, full sample)*	*Model 1b (main and interaction effects, full sample)*	*Model 2a (main effects, public tendering subsample)*	*Model 2b (main and interaction effects, public tend. subsample)*
Constant	-13.74 (1.67)	-10.74 (1.91)	-11.64 (1.86)	-8.28 (2.14)
Client Size	-0.19 (0.10)	-0.17 (0.1)	-0.20 (0.12)	-0.20 (0.12)
Vendor Size	0.05 (0.07)	0.06 (0.07)	0.01 (0.08)	0.00 (0.08)
Phase: Maintenance	-0.01 (0.24)	0.1 (0.25)	**0.71* (0.29)**	**0.83** (0.29)**
Client-specific Software	-0.33 (0.25)	**-7.89** (2.8)**	0.00 (0.29)	**-7.73* (3.24)**
Prior Joint Experience	**-1.21*** (0.34)**	**-1.14* (0.46)**	**-1.19** (0.43)**	-0.57 (0.57)
Project Size	**0.97*** (0.11)**	**0.74*** (0.13)**	**0.84*** (0.13)**	**0.61*** (0.16)**
Knowledge Sought	-	-	**0.73* (0.30)**	**0.80** (0.30)**
Proprietary Technology	**-2.83*** (0.51)**	**-2.67*** (0.49)**	**-3.02*** (0.78)**	**-2.74*** (0.77)**
IS Outsourcing Experience	**0.41** (0.13)**	**0.39** (0.13)**	**0.44** (0.15)**	**0.45** (0.15)**
Client-spec. × Prior Joint Exp.	-	-0.11 (0.61)	-	-1.19 (0.77)
Client-spec. × Project Size	-	**0.51** (0.19)**		**0.54* (0.22)**
Sample Size	1093	1093	562	562
Chi^2 Delta (df)	**261.40*** (8)**	**7.88* (2)**	**196.15*** (9)**	**7.49* (2)**
Fraction of Correct Predictions	91.2%	91.5%	86.8%	87.2%
Nagelkerke R^2	.42	.44	.47	.48
*** p <.001, ** p <.01, * p <.05, figures are beta regression coefficients (standard errors in parentheses), significances indicate the results of Wald tests, significant number in bold				

Table 4. Logistic Regression Results

The hypothesis deduced from incomplete contracting theory earned substantial support, although the support for TCE was weaker than for PRT. We begin with the three hypotheses derived from TCE. H1 predicted multisourcing to be more frequent in projects that involve client-specific software. Yet, the relationship was not significant (β = -.33, p >.05, model 1a), providing no support for H1. H2 predicted multisourcing to be more frequent when clients and vendors lack prior joint experience. The results support the hypothesis (β = -1.21, p <.001, model 1a). The regression coefficient implies that the odds for multisourcing decreased by substantial 70% (= 100%-exp(-1.21)) when clients and vendors had prior joint experience. H3 predicted a negative interaction effect between client-specific software and prior joint experience. This interaction effect was not significant (β = -.11, p >.05, model 1b), providing no support for H3. The two hypotheses derived from PRT earned strong support. H4 predicted a positive relationship between project size and multisourcing. The relationship was positive and strong (β =.97, p <.001, model 1a). H5 predicted a positive interaction effect of client-specific knowledge and project size on multisourcing. The results provide strong support for such an interaction effect (β =.51, p <.01, model 1b). The interaction plots shown in Figure 2 provide an intuition of these results. As the plots show, the probability of multisourcing was relatively low for small projects, with probabilities being marginally lower for projects that involved client-specific software. Conversely, the probability for multisourcing increased strongly for large projects, in particular if the software was client specific. For instance, projects of a size of 50 million Swiss Francs (or about 50 million USD) were multi-sourced with a probability of 73% if the software was client specific and of 46% if the software was not client specific. The intersection point of the two graphs was at 5.2 million Francs. That is, for projects larger than 5.2 million Francs, the probability of multisourcing was higher when the software was client specific.

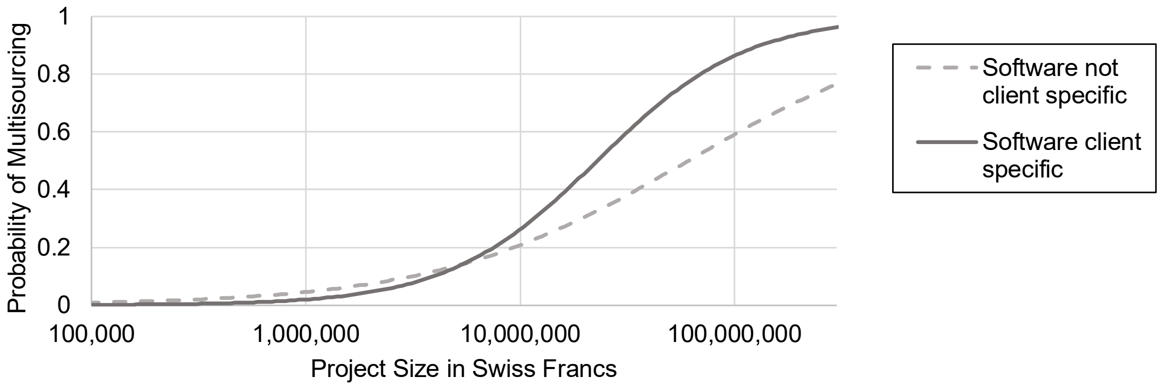

Figure 2. Interaction Plot: Project Size and Client-specific Software

The results support the three hypotheses derived from the KBV. As expected in H6, clients were more likely to choose multisourcing when they sought knowledge through the outsourcing project (β =.73, p <.05, model 2a). The coefficient implies that the odds for mulitsourcing more than doubled when clients sought knowledge. As predicted in H7, multisourcing was less frequent when the technology was proprietary (β = -2.83, p <.001, model 1a). The odds for multisourcing dropped by dramatic 94% when technology was proprietary. Moreover, in line with H8, we found that clients were more likely to choose multisourcing when they had large IS outsourcing experience (β = .41, p <.01, model 1a).

As the Nagelkerke R^2 value of .44 and the fraction of correct predictions of 91.5% (model 1b) show, our model had strong fit with the data, supporting the validity of our empirical specification.

5 Discussion

Although interest in multisourcing is strongly increasing among IS outsourcing practitioners and scholars, theoretical explanations for multisourcing decisions are in a nascent stage, and empirical evidence about multisourcing decisions is difficult to find. In this paper, we develop a model based on incomplete contracting theory (including TCE and PRT) and the KBV to explain multisourcing decision, and we provide an empirical test of this model based on a large dataset of sourcing decisions.

5.1 Incomplete Contracting Theory and Multisourcing Decisions

Our results show that, in tandem, the incomplete contracting theories TCE and PRT explain multisourcing decisions well. The basic argument derived from TCE is that multisourcing allows clients to combat opportunistic threats by extending competition beyond the contract settlement and that clients therefore choose multisourcing when opportunistic threats are high. Our analysis focused on two drivers of opportunistic threats: knowledge specificity, as empirically indicated by client-specific software, and behavioral uncertainty, as empirically indicated by the lack of prior joint experience. Although we did not find support for an unconditional effect of knowledge specificity on multisourcing decisions (see our results on H1), our results showed that, in large projects, knowledge specificity augmented the likelihood of multisourcing (see our results on H5 and the interaction plots shown in Figure 2). Moreover, in line with TCE reasoning, clients chose multisourcing more frequently when behavioral uncertainty (as indicated by the lack of prior joint experience) was high (see our results on H2). By and large, these results support the TCE-based idea that clients choose multisourcing when opportunistic threats are high. The observation that multisourcing is chosen to mitigate opportunistic threats also resonates with multisourcing research that described vendors in multisourcing relationships as highly committed (or little opportunistic), given constant competition in the project (Levina and Su 2008, p. 561; Wiener and Saunders 2014).

Although our results broadly support the idea that opportunistic threats explain multisourcing decisions, there are two important qualifications. First, clients appear to respond to high knowledge specificity through multisourcing only if projects are reasonably large (see our results on H5 and Figure 2). This pattern is well predicted by PRT, which argues that projects need to be large enough to motivate vendors to make client-specific investments despite uncertain residual rents. Hence, PRT is a useful extension of TCE in the context of multisourcing decisions. Although IS multisourcing research has not drawn on PRT, our findings related to PRT are consistent with the empirical observation that multisourcing clients need to make strong efforts to demonstrate the potential for future business to vendors (Su and Levina 2011; Wiener and Saunders 2014). A second qualification is that although behavioral uncertainty matters only in conjunction with knowledge specificity according to TCE, we did not find support for an interaction effect (see our results on H3). Possibly, even if the software is not client specific, application projects may still be of at least moderate knowledge specificity, given that clients need to acquire idiosyncratic knowledge about the client's business and of interfaces software systems. In such projects, clients may still want to safeguard against vendor opportunism. As a result, the main effect may dominate over the interaction effect. This interpretation is in line with prior results in IS outsourcing studies, which also found insignificant interaction effects (Alaghehband et al. 2011, p. 134).

5.2 The Knowledge-based View and Multisourcing Decisions

Our results demonstrate that the KBV helps explain variance in multisourcing decisions above and beyond what can be explained by incomplete contracting theory. Our study points to three mechanisms of how knowledge-based issues affect multisourcing. First, we found that clients were more likely to choose multisourcing when they sought to access vendor knowledge through the outsourcing project (see our results on H6). Although our empirical measure did not focus on the variety of knowledge required in a project, this finding broadly echoes the prevailing view that multisourcing can help clients to access knowledge (Bapna et al. 2010). Second, we found that clients chose multisourcing by far less frequently when projects relied on proprietary technology. When technology is proprietary, an important prerequisite for multisourcing is frequently not met: the availability of multiple vendors that possess the knowledge that is most relevant for the project. Third, we found that clients were more inclined to choose multisourcing when they were experienced in IS outsourcing (see our results on H8). This finding empirically substantiates the position that multisourcing is complex and therefore requires considerable management capabilities from clients (Bapna et al. 2010). While this finding echoes the perspective that multisourcing requires strong architectural knowledge from clients (Brusoni et al. 2001), our results emphasize knowledge in managing outsourcing relationships, rather than architectural knowledge related to a particular software.

5.3 Contributions

Our study makes important contributions to the multisourcing literature and to the broader outsourcing discourse. Our contributions to the multisourcing literature are threefold. First, we develop a theoretical framework that helps organize themes that emerged from multisourcing research. While prior multisourcing research has rarely explicitly drawn on TCE, PRT, and the KBV (Bapna et al. 2010; Levina and Su 2008; Wiener and Saunders 2014), we show how theoretical reasoning from these perspectives can enlighten our understanding of multisourcing. Second, to the best of our knowledge, our study is the first to provide empirical evidence about multisourcing decisions. Our comprehensive dataset allowed us to empirically test relationships that would be difficult to test in smaller samples, given the nature of our dependent variable (dichotomous) and the relatively low probability for multisourcing. Third, while the existing multisourcing literatue emphasizes benefits and challenges of multisourcing, our study provides insights into the prerequisites that constrain multisourcing decisions in organizational realities. Specifically, we find that clients may struggle to leverage multisourcing when they rely on proprietary technology, when they conduct primarily small projects, and when they lack IS outsourcing experience. This suggests that multisourcing decisions are not only forward looking decisions in which clients anticipate opportunistic threats and knowledge needs; multisourcing decisions are also constrained by technology choices, IS budgets, and experience in managing IS outsourcing projects

Our study also offers two contributions to the broader outsourcing literature. First, while empirical tests of TCE have often reported mixed findings (Alaghehband et al. 2011; Lacity et al. 2011), our study shows that TCE can well predict multisourcing if TCE is complemented by PRT and if the operationalization of knowledge specificity focuses on application knowledge. This reinforces calls to pay greater attention to the nature of application knowledge in IS outsourcing research (Krancher and Dibbern 2015). Second, while the existing outsourcing literature emphasizes the role of client-specific knowledge, our results points to the important role of knowledge associated with proprietary technologies. We show that proprietary technology make clients dependent on vendors and thereby constrain sourcing decisions.

5.4 Limitations

Although our study provides initial empirical insights into multisourcing decisions, the insights are associated with a set of caveats. First, our data stem from public procurement. Studies in other industries may show to what extent our findings apply to the private sector. Second, since we relied on archival data, our study offers limited insights into the mediating factors that link the constructs of our study with decisions. Surveys and case studies are thus likely to provide complementary insights. Such studies could also provide additional insights into the knowledge that clients require in multisourcing, into the types of knowledge that clients aim to access through multisoucing, and into the practices through which clients can effectively engender competition among vendors. Third, we studied multisourcing decisions rather than performance. Yet, an important question is whether multisourcing is associated with performance benefits under particular circumstances. This is left to future research. Fourth, our measure of prior joint experience does not allow us to separate the trust effect from the knowledge effect associated with prior joint experience (Benaroch et al. 2016). This calls for more differentiated measures. Fifth, our project-level operationalization of multisourcing is relatively narrow. Clients may undertake a sequence of temporally overlapping projects and involve different vendors in these projects. While such settings may also qualify as multisourcing, they are not grasped by our measure. We are currently coding projects to larger programs to enable such an analysis.

5.5 Implications for Practice

Our study provides a number of tentative implications for practice. Clients may consider multisourcing as a strategy to discourage vendor opportunism and to access valuable vendor knowledge. Multisourcing may be an effective strategy to discourage opportunism, in particular when the software is client specific (i.e., custom-developped), when clients lack prior experience with the vendor, and when projects are large. Clients may also make deliberate attempts to tailor larger projects in order to make them amenable for multisourcing. However, clients should be aware that they may not be able to leverage multisourcing under all conditions. Clients with little experience in managing IS outsourcing relationships may be advised to first gather experience in managing single-sourcing projects before they move on to multisourcing. Moreover, clients should be aware that their choice of technologies that are mastered by one or few vendors may constrain them in their ability to leverage multisourcing.

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