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A multi-level investigation of information technology outsourcing ☆

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ABSTRACT

This study proposes and tests a model of the information technology (IT) outsourcing decision that includes antecedents of both transaction costs and production costs. Production costs show the most robust influence on governance. Skills required to execute the activities, interdependence between the activities, and firm-level characteristics – uncertainty and knowledge intensity – are the main explanatory variables of the decision. Transaction-level uncertainty is the only transaction cost variable found to influence the decision.

1. Introduction

Deciding whether an activity should be conducted within the firm or contracted out is an ongoing concern for both research and practice, including in the information systems (IS) field (Lacity et al., 2010). Transaction cost theory (TCT) has been influential in explaining this decision in many domains. Under TCT, the choice of the governance structure depends on two sets of costs: transaction costs (searching for suppliers, negotiating contracts, monitoring and evaluating performance) and production costs, the sum of which firms aim to minimize (Williamson, 1985).

Interestingly, while TCT explicitly mentions both transaction costs and production costs, the vast majority of TCT-based studies focus on transaction costs and transaction-level variables (Geyskens et al., 2006) and omit production costs. In the IS field, an exception of note in terms of costs is Ang and Straub (1998) who found that supplier production cost advantage led to a greater degree of IT outsourcing and that transaction costs were negatively related to the degree of outsourcing. In terms of variable level, Loebbecke and Huyskens (2006) examined the role of firm-level variables and found that capability-related elements (relevance of applications and vulnerability associated with capabilities) had significant influence on the outsourcing decision.

The literature on the boundary of the firm suggests that production costs can be accounted for in explanations of outsourcing decisions along three perspectives: economies of scale, coordination of interdependent activities, and capabilities (Langlois and Robertson, 1995). Economies of scale provide an unsatisfactory explanation (Langlois and Robertson, 1995). In IS, Lacity and Willcocks (1998) showed that economies of scale did not explain outsourcing decisions: comparable percentages of large and small datacenters achieved cost savings through outsourcing, and when they selected insourcing, small and large datacenters were able to reach cost saving targets.

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The need to coordinate interdependent activities leads firms to keep these activities under their control. If activities are independent, outsourcing one of them does not create coordination problems and does not affect the efficiency of the other activities (Langlois and Robertson, 1995). Outsourcing an interdependent activity would create such problems and would limit the firm's innovative capacity, because it would not control all the interdependent components (Langlois and Robertson, 1992). In IS, Bahli and Rivard (2005) are among the few who refer to task interdependence as a risk factor in an outsourcing decision. They suggest that outsourcing activities that are interdependent with other activities entails coordination problems, misalignments, and higher production costs.

The capabilities perspective suggests that organizations retain the activities for which they have superior capabilities, ensuring efficient production (Espino-Rodríguez and Padrón-Robaina, 2006). Alternately, firms outsource those activities for which they lack capabilities. This corresponds to two IT outsourcing motivations identified by Lacity et al. (2010): focus on core capabilities and access to expertise. Capability analysis involves both transaction-level variables, – e.g., the skills required to perform an activity (Poppo and Zenger, 1998) – and firm-level variables, – e.g. capabilities that firms develop to compete in their industry (Loebbecke and Huyskens, 2006).

This study aims at advancing current knowledge on the antecedents of IT outsourcing decisions by proposing and testing a model that includes antecedents of both transaction costs and production costs. With respect to transaction costs, the model retains two key transaction-level characteristics: uncertainty and asset specificity. With respect to production costs, it includes transaction-level characteristics – transaction-level capabilities and interdependence among activities – and firm-level characteristics – uncertainty and knowledge intensity. The study also aims to refine our understanding of IT outsourcing by analyzing decisions about several IT activities, rather than about a portfolio of activities. This approach addresses an issue raised by Dibbern et al. (2004) who mentioned that by looking at IT activities as a group, researchers were overlooking the issue of interdependence between activities. This study expands this line of research by analysing simultaneously several activities inside each firm, thus measuring transaction-level elements and enabling an assessment of interdependence, and by analyzing firm-level elements, thus providing a multi-level analysis of the outsourcing decision.

The study does not attempt to assess which perspective provides the best explanation, or which level of analysis offers more explanatory power. Instead, it contributes to knowledge by providing a richer analysis that includes both production and transaction costs, and both transaction and firm level perspectives. In doing so, the study espouses Garrouste and Saussier's (2005) view that the establishment of a theory of the firm depends on the integration of its various components. It is a step toward a dialog between different theories (Madhok, 2002) and between IS and its reference disciplines, the former informing the latter (Lacity et al., 2010).

2. Theoretical development

The following paragraphs introduce the key variables influencing transaction costs and those influencing production costs, and derive research hypotheses.

2.1. Transaction costs

Exchanges between client and supplier entail transactions costs. When they become too high, the firm might decide to internalize the activity. Three transaction characteristics explain the magnitude of transaction costs: asset specificity, uncertainty, and frequency (Williamson, 1985).

Asset specificity is the difference between the value of an asset in its first best use and its value for an alternative usage (Pisano, 1990). It creates a lock-in problem where one party can be held hostage and asked an unfair price. Contracting for activities requiring specific assets is more costly than contracting for generic activities. This leads organizations to manage these activities in-house. The role of asset specificity has been supported in many sectors: auto parts (Monteverde and Teece, 1982), aerospace (Masten, 1984), and aluminum (Hennart, 1988). However, asset specificity was not found to lead to integration in the semiconductor industry (Leiblein and Miller, 2003). In IS, the results are mixed (Lacity et al., 2010). For example, in the presence of specific assets, Poppo and Zenger (1998) found that firms kept activities in-house and Barthelemy and Geyer (2005) observed that firms used subsidiaries instead of relying on outsourcing. However, Nam et al. (1996) obtained conflicting results. Using three different measures of specificity, they obtained significant results solely for the implicit knowledge associated with the transaction. Similarly, Lacity and Willcocks (1995) and Loebbecke and Huyskens (2006) could not find support for the role of asset specificity in the outsourcing decision. Aubert et al. (2004) found asset specificity to be positively linked to outsourcing, contradicting the prediction from TCT. Assessing TCT-based studies explaining IT outsourcing decisions, Karimi–Alaghehband et al. (2011) found support for the role of asset specificity in only 40% of 23 studies. It is suggested here that these mixed results could be due to the fact that earlier studies took into account only a transaction cost perspective, at only one level, that of the transaction. Not accounting for production costs and/or firm-level differences could explain the mixed findings. Therefore, this study will test the basic transaction cost hypothesis, in terms of the role of asset specificity.

H_1. Asset specificity will be negatively associated with the extent of outsourcing.

The second TCT transaction characteristic is uncertainty, which refers to lack of information. The more uncertainty surrounds a transaction, the more difficult it becomes to devise, negotiate, and enforce a contract. If it becomes too difficult, the activity will be kept in-house (Williamson, 1985). An activity is a set of related tasks, which produce one or several outputs, at a given quality level. This suggests that assessing the uncertainty surrounding an activity should take into account three related dimensions: lack of standardization (pertaining to the nature of the tasks), complexity (referring to the difficulty of determining the expected outputs), and measurement problems (pertaining to the assessment of the quality of the outputs of the activity).

Lack of standardization implies that activities cannot easily be described in detailed guidelines, which renders their governance more difficult (Van de Ven and Ferry, 1980). Complex activities lead to multiple possible outcomes and make prediction difficult (Krickx, 2000), which increases the cost to devise a contract. Therefore, complex activities are likely to lead to higher transaction costs than simple ones and are more likely to be kept in-house. Finally, even if activities could be described, measurement problems might prevent the parties to assess the performance achieved. For an activity to be outsourced, parties have to be able to measure it (Alchian and Demsetz, 1972).

Krickx (2000) found that only one form of uncertainty (measurement problems) consistently matched TCT predictions. In IS, Lacity et al. (2010) found that uncertainty (excluding measurement) had led to consistent results. However, findings with regard to measurement problems were mixed. Thus, the following hypotheses are formulated:

H_2. Complexity will be negatively associated with the extent of outsourcing.

H_3. Standardization will be positively associated with the extent of outsourcing.

H_4. Measurement problems will be negatively associated with the extent of outsourcing.

The last TCT transaction characteristic is frequency. Firms will avoid integrating activities they are not executing regularly (Williamson, 1985). They will outsource these activities even in the presence of asset specificity or uncertainty. Our study focuses on the management of IT operations, IT operations, and maintenance activities. These activities are executed continuously (meaning that frequency is infinite). Therefore, transaction-level frequency is not assessed. However, the notion of demand uncertainty discussed in the firm-level section parallels in some aspects the notion of frequency.

2.2. Production costs

Production costs are influenced by both transaction-level characteristics and firm-level characteristics.

2.2.1. Transaction-level characteristics

Extant research suggests that two key transaction-level characteristics influence production costs: transaction-level capabilities and interdependence of activities.

The capabilities nurtured inside the firm to conduct its activities and the notion of core competency provide several insights linked to production costs. The limited resources that a firm can develop and nurture are important investments and should be used for core activities (Barney, 1991). Resources are valuable when they allow firms to perform specific activities. Sheehan and Foss (2007) suggest that looking at the use of resources at the activity level would increase the potential of resource-based view (RBV).

The role of core competencies and RBV is supported by several IS studies (Poppo and Zenger, 1998; Slaughter and Ang, 1996; Teng et al., 1995). In order to assess the relationship between activities and the core of an organization, the types of skills required to perform the activities can be measured. Authors have usually measured one type of skills (e.g., extent of skill set (Poppo and Zenger (1998); technical skills (Slaughter and Ang, 1996). Skills are not homogenous. Although some firms may view technical skills as a core competency and accordingly develop a higher level of technical skills internally, such skills are not a core competency for most organizations. Therefore, it is anticipated that the client firm will be better at maintaining business-domain skills, while vendors will have an advantage at maintaining technical skills, which are closer to their own core business. This would lead to specific patterns of outsourcing.

H_5. The importance of technical skills associated with an activity will be positively associated with the extent of outsourcing.

H_6. The importance of business-related skills associated with an activity will be negatively associated with the extent of outsourcing.

Langlois and Robertson (1992) suggest that independent activities (not dependent on other activities for their execution, with few and easily identifiable links with the other activities of the firm) are more likely to be outsourced than interdependent – systemic – activities, because they can be executed in a self-contained way. They found support for the role of interdependence in the micro-computer and stereo components and the automotive industries. These results suggest that interdependent activities will be kept together.

H_7. The interdependent character of an activity will be negatively associated with the extent of outsourcing.

2.2.2. Firm-level characteristics

Organizations tend to keep in-house the resources they use regularly, making full utilization of their resources, and letting suppliers absorb low probability demand (Carlton, 1979). This argument resembles the TCT frequency argument (Williamson, 1985). However, it is not simply frequent activities that are kept in-house, but activities for which volume is stable. Firms transfer fluctuating activities to suppliers. Fluctuation in volume makes externalization more attractive, since a firm will not want to own excess assets. Leiblein and Miller (2003) found that demand uncertainty increased the reliance on outsourcing.

H_8. Firm-level uncertainty (fluctuation in volume) will be positively associated with the extent of outsourcing.

When assessing IT outsourcing, it is important to consider the proximity of IT activities with the core capabilities of the firm. Earl (1996) mentions that companies operating in sectors for which information systems can provide a strategic advantage might find themselves at risk of loss of innovative capacity if they do not keep control on IS activities. This would be detrimental to production cost. In an economy that relies increasingly on knowledge (Godin, 2006), companies that are more intensive users of information could be more likely to keep their information systems in-house. Firms in knowledge intensive sectors are more likely to be able to use IT strategically than firms in sectors of low knowledge intensity.

H_9. Knowledge intensity of the enterprise will be negatively associated with the extent of outsourcing.

3. Methodology

The model was tested with a survey of 200 Canadian organizations. A questionnaire presented a list of 16 IT activities from three groups (IT operations, management of IT operations, or IT maintenance). The unit of analysis is thus an activity, within a group, within a firm. Each respondent provided information pertaining to each activity.

The relationships between the transaction-level variables and the outsourcing decision are identified through variations between activities and across firms. By observing multiple activities within a firm, we separate the effect of the transaction-level variables from firm-level variables. In addition, the organization of activities might differ for reasons that are unrelated to the transaction-level or firm-level variables explicitly measured. This is modeled by incorporating a set of random effects.

3.1. Model development

The governance structure comprises three choices: in-house, with the activity performed using the firm's physical assets and employees; mixed-mode, where the client keeps the ownership of the physical assets with the supplier providing the service; and outsourcing, with the activity performed by the supplier having authority over both employees and assets. These modes are ordered with respect to the degree of control delegated to suppliers. Firms use a threshold strategy when deciding which structure to use. Letting π_j denote the benefit of outsourcing activity j, firms' decision is described as:

$$Y_j = \begin{cases} \text{in-house} & \text{if } \pi_j \leqslant \mu_{j0} \\ \text{mixed-mode} & \text{if } \mu_{j0} < \pi_j \leqslant \mu_{j1} \\ \text{outsourced} & \text{if } \pi_j > \mu_{j1} \end{cases}$$

This reflects the trade-off between the benefits of allocating more control to a supplier relative to using a hierarchical structure and the costs of doing so.

The benefit π_{ij} can be written for firm $i \in \{1, \ldots, N\}$ and activity firm $j \in \{1, \ldots, J\}$, as a linear function of the variables (X_{ij}): $\pi_{ij} = X_{ij}\beta + u_{ij}$.

The variable u_{ij} is the threshold for firm i to outsource activity j. If u_{ij} is independently normally distributed across firms and activities according to a standard normal distribution, the econometric model would take an ordered probit form. We depart from this standard assumption by writing u_{ij} as the sum of a firm's unobserved heterogeneity parameter $\theta_i = \{\theta_{i1}, \ldots, \theta_{iG}\}$, and an iid standard normal random variable $\in_{ij}$: $u_{ij} = \theta_{ig(j)} + \varepsilon_{ij}$ where $g(j)$ is a function indicating the group of activities to which j belongs.

The unobserved heterogeneity parameter is allowed to be different across groups of activities within the same firm. The correlation between the unobserved benefit parameters is estimated jointly with the other parameters. We assume that the vector θ is normally distributed across firms with mean zero and covariance matrix Ω. It is an ordered probit model with multiple random effects (Hedeker and Gibbons, 1994).

The probability of choosing each governance structure for activity j, conditional on the firm's unobserved heterogeneity, is:

$$\Pr(Y_{ij} = \text{in-house} | \theta, \mu, \beta, \Omega) = \Phi(\mu_{j0} - [\theta_{g(j)} + X_{ij}\beta])$$
$$\Pr(Y_{ij} = \text{mixed-mode} | \theta, \mu, \beta, \Omega) = \Phi(\mu_{j1} - [\theta_{g(j)} + X_{ij}\beta]) - \Phi(\mu_{j0} - [\theta_{g(j)} + X_{ij}\beta])$$
$$\Pr(Y_{ij} = \text{outsourcing} | \theta, \mu, \beta, \Omega) = 1 - \Phi(\mu_{j1} - [\theta_{g(j)} + X_{ij}\beta])$$

where the threshold parameters $\{\mu_1, \ldots, \mu_j\}$ are allowed to vary across activities.

Grouping firm i choices in a vector $Y_i = \{Y_{i1}, \ldots, Y_{ij}\}$, the likelihood of observing Y_i from a firm of type θ is the product of each activity's probability:

$$l(Y_i|\theta, \mu, \beta, \Omega) = \prod_{j=1}^{J}\prod_{k=1}^{3}[\Pr(Y_{ij} = k|\theta]^{d_{ijk}} \text{ where } d_{ijk} = \begin{cases} 1 & \text{if } Y_{ij} = k, \\ 0 & \text{if } Y_{ij} \neq k. \end{cases}$$

The likelihood of Y_i in the population, unconditional on firm's unobserved heterogeneity, is obtained by integrating out θ from the preceding equation:

$$h(Y_i|\mu, \beta, \Omega) = \int_{\theta} l(Y_i|\theta)g(\theta)d\theta$$

where $g(\theta)$ is the density function of multivariate normal random variables with mean zero and covariance matrix Ω. The parameters are estimated by solving the following maximum likelihood problem:

$$\{\mu, \beta, \Omega\} \equiv \arg\max \sum_{i=1}^{N} \log h(y_i).$$

Since the cost of computing the integral increases exponentially in the dimension of the θ, we restrict the number of groups to be less or equal to 3, and the thresholds μ to be constant within each group. The multi-dimensional integral is approximated using an adaptative-quadrature method (Rabe-Hesketh et al., 2005).[1]

Finally, the posterior-mean of the random effects, denoted by $\hat{\theta}_j$ can be computed (Rabe-Hesketh et al., 2004). Two steps are taken in order to avoid bias estimates. First, model parameters (μ, β, Ω) are estimated and the posterior mean of the random effects rationalizing the observed choices are recovered. Then, the correlation between $\hat{\theta}_j$ and a vector of firm-level covariates Z_j is observed by estimating a simple Probit model predicting the probability that the firm is incline to choose outsourcing. The following conditional probability model is estimated:

$$\Pr(\hat{\theta}_j > 0|Z_j) = \Phi(Z_{j\gamma})$$

3.2. Variable definition and construction

3.2.1. Governance structure

As discussed previously, governance structure (Y) is an ordered variable, taking a value of 1 when the activity is performed in-house, 2 for mixed-governance and 3 for total outsourcing.

3.2.2. Transaction-level variables

The transaction-level variables comprise asset specificity, measurement problems, standardization, complexity, technical skills, and business-related skills. It was essential to measure the transaction-level characteristics of each of the 16 activities composing IT services. Using multiple-items instruments to measure six characteristics for each of the 16 activities would have deterred potential respondents. To alleviate this, we drew from extant validated multi-item measures to construct succinct and clear conceptual definitions of each construct. Respondents were asked to assess on a scale from 1 to 7 each of the 16 activities with respect to each of the six conceptual definitions, which were presented to three experts who commented on how each encapsulated its operationalized version. The definitions were also presented to IS managers to ensure that they were well understood. Finally a separate survey was conducted to assess multi-item measures along with the definitions to determine whether the definitions represented the concepts adequately. The multi-item measures used were: complexity (Aubert et al., 1996), asset specificity (Bahli and Rivard, 2005), business-related skills (Fink and Neumann, 2009, technical skills (Tippins and Sohi, 2003), and measurement problems and standardization (Wullenweber et al., 2008). Sixty IS managers completed this separate survey. The definitions showed the same characteristics as the items in the corresponding multi-item variable. If the definitions had been included in the corresponding multi-item measure, they would all have been retained as reliable items.

Following the recommendations of the managers who reviewed the survey, the activities were grouped under management, operations, and maintenance. The interdependence among the three groups was measured indirectly through the use of random effects specific to group of activities.

3.2.3. Firm-level variables

Firm-level uncertainty was estimated following Levy (1985). The volatility of the industry demand was measured for each firm: the monthly GDP of 73 economic sectors, from 1987 to 1999, was used. An auto-regressive model with 12 lags and the appropriate deterministic effects (monthly dummies (D) and linear trend T) was estimated separately for each industry $j = 1, \ldots, 73$. Data were obtained from Statistics Canada.

[1] The estimation is performed in STATA using the GLAAMM package developed by Rabe-Hesketh et al. (2004).

$$\log GDP_{jt} = D_t\alpha_j + \delta_j T_t + \sum_{i=1}^{12} \phi_{ji} logGDP_{jt-i}\varepsilon_{jt}$$

From this model, two variables were constructed to evaluate the ability of firms to anticipate demand volatility. The first is the U-Theil statistic associated with the quality of the *GDP* forecast using the auto-regressive model:

$$U_j = \left[\frac{\sum_{m=2}^{M} \log GDP_{jT+m} - \log \widehat{GDP_{jT+m}}}{\sum_{m=2}^{M} \log GDP_{jT+m} - \log GDP_{jT+m-1}}\right]^2$$

The U-Theil statistic is interpreted as the ability of the auto-regressive model to forecast industry demand (i.e. $\log \widehat{GDP_{jT+m}}$), relative to the forecast of the naive mode: $\log \widehat{GDP_{jT+m}} = \log GDP_{jT+m-1}$ An increase in this variable implies an increase in the unexpected volatility of the industry, since an increase U_j is associated with weaker predictions.

The other variable is the absolute value of the trend coefficient δ_j. It measures the ability of firms to anticipate the volatility of their industry. An increase in this variable is associated with a decrease in the degree of uncertainty faced by firms in the sector, since demand changes are more easily anticipated.

The knowledge-based concentration index (KB) classifies 55 Canadian industrial sectors in three categories (high, medium, and low KB-intensity), with respect to the amount of knowledge embedded in firms in these sectors (Lee and Has, 1996). The index uses three indicators of knowledge intensity: the share of R&D expenses and two measures of the proportion of high-skilled workers in the work-force.

3.2.4. Control variables

Three control variables were used: size, organization type, and individual thresholds. The relative size is measured by total sales divided by the median of the industry. A ratio of *x%* indicates that the sales of the firm are *x%* larger than the median of its sector. This controls for possible economies of scale (even if the literature does not support this effect Lacity and Willcocks, 1998).

Dummy variables were introduced for organization type. For similar levels of sales, private companies tend to use more labor than publicly-traded ones (Trostel and Nichols, 1982) which suggests lower pressure for efficiency. Government-owned corporations, which may be less driven by efforts to reduce production costs and more by political considerations, might have less incentive to outsource for cost efficiency motives (Gantman, 2011).

Finally, different firms may have different thresholds for outsourcing (Monteverde and Teece, 1982). This was controlled using individual thresholds in the model.

3.3. Survey procedure

The questionnaire was mailed (without prior contact) to 1496 IT senior managers. Two hundred questionnaires were completed, for a response rate of 13.3%. This is comparable to rates reported in the literature (Barthelemy and Quelin, 2006: 11%, Poppo and Zenger, 1998: 6%). Respondents belonged to a variety of industries, representing the Canadian industrial composition.

Each respondent provided information on 16 IT activities. Four questionnaires were dropped because of rates of missing responses over 30%. The final sample includes 3011 observations over 196 different firms. The average number of valid observations per firm is 15.36. The data show that the governance modes are not uniformly distributed across firms or across types of activities. This difference observed in the outsourcing patterns highlights the importance of incorporating firm-level random effects which differ between groups of activities. Appendix A presents descriptive statistics.

4. Results

Table 1 presents the results. Each column represents a different specification: no random effect, one firm-level random effect, and three random effects specific to each activity group/firm. Each specification has heterogeneous thresholds between activity groups. The last two columns separate the maintenance activities from the management and operation activities.

Variables related to transaction costs offer mixed results. Complexity has a significant effect in the basic model and when group-specific random effects are included. It is not significant when firm-level random effects are included. The fact that it remains significant with group-specific random effects suggests that the activities outsourced tend to be simpler than the ones kept in-house.

Measurability of supplier's performance has a significant effect in the first two specifications, but it is not significant when group-specific random effects are introduced. This suggests that the capacity to measure the activities is strongly associated with the group to which the activities belong. Finally, the effects of standardization and asset specificity are not statistically significant different from zero.

Measures related to production costs show better explanatory power. Firms are more likely to delegate authority to suppliers if the degree of technical skills required is high, and less likely to do so if the degree of business-related skills is high. These two effects are very robust across specifications and large in magnitude.

Table 1
Results.

	No random effect	Firm-level random effect	Activity-group/firm random effect	Activity-group/firm random effect	
				Management and operations	Maintenance
Transaction characteristics					
Technical skills (7 = High)	**0.1272 (6.44)**	**0.1009 (3.62)**	**0.1189 (3.59)**	**0.1093 (2.32)**	**0.1174 (2.49)**
Business-related skills (7 = High)	**−0.05554 (3.99)**	**−0.1222 (5.73)**	**−0.1656 (6.42)**	**−0.1732 (4.60)**	**−0.1666 (4.80)**
Standardization (7 = Low)	0.01558 (0.94)	0.03036 (1.28)	0.01413 (0.50)	−0.05709 (1.29)	0.05473 (1.48)
Measurement (7 = Low)	**−0.06468 (3.82)**	**−0.04957 (2.06)**	−0.03495 (1.21)	0.0401 (0.91)	**−0.09462 (2.48)**
Complexity (7 = Low)	**0.03401 (1.95)**	0.0145 (0.60)	**0.06341 (2.30)**	−0.0657 (1.52)	**0.1446 (4.01)**
Specificity (7 = Low)	−0.00571 (0.42)	0.007246 (0.35)	0.009267 (0.37)	0.02681 (0.76)	−0.01386 (0.41)
Thresholds 1					
Group 2 (Operation)	0.04377 (0.63)	0.06322 (0.72)	−0.3899 (1.28)	−0.3596 (1.18)	
Group 3 (Maintenance)	**−1.06 (15.0)**	**−1.505 (16.50)**	**−2.537 (7.56)**	**−1.886 (2.75)**	
Constant	**1.218 (6.71)**	**1.224 (4.44)**	**2.389 (5.15)**	**1.86 (3.20)**	
Thresholds 2					
Group 2 (Operation)	0.05212 (0.67)	0.07377 (0.72)	−0.5138 (1.48)	−0.4865 (1.40)	
Group 3 (Maintenance)	**−0.458 (6.00)**	**−0.7759 (7.70)**	**−2.031 (5.53)**	**−1.364 (1.93)**	
Constant	**1.51 (8.22)**	**1.736 (6.21)**	**3.19 (6.52)**	**2.669 (4.42)**	
Log-likelihood	−2377.0726	−1920.6298	−1815.0182	−1802.7886	
No. firms	196	196	196	196	
No. observations	3011	3011	3011	3011	

T-statistics are in parenthesis (absolute value). Significant coefficients are in bold.

Table 2
Estimated covariance matrix between random effects.

	Group 1	Group 2	Group 3
Group 1: Management of IS	6.384 (1.74)	*0.903*	*0.5913*
Group 2: Operation of IS	4.408 (0.90)	3.732 (0.37)	*0.6347*
Group 3: Maintenance of IS	1.755 (0.78)	1.44 (0.27)	1.38 (0.22)

Standard-errors are in parenthesis. The lower diagonal is the estimated covariance between random effects. The upper diagonal (italic) is the corresponding estimated correlations.

The results suggest that a portion of the variation between firms is explained by firm-level unobserved characteristics, and that these factors are different between groups of activities. This provides support for the interdependence between activities of a given group. Organizations keep together activities that belong to the same group. This can be observed by comparing the log-likelihood statistics across specifications: the inclusion of the three random effects is statistically significant.

Table 2 shows that the variance of the random effects is the largest for management activities, and the smallest for maintenance ($\sigma_{11} > \sigma_{22} > \sigma_{33}$). This indicates that firm specific variables explain a higher proportion of the variance for outsourcing decisions of management activities than for the outsourcing decisions of other activities, and a higher proportion of the variance for decisions related to operations than decisions related to maintenance. The correlation between the random effects of the first two groups is large, indicating that similar factors are affecting the decision to outsource management and operation activities. This correlation is smaller for the third, suggesting that the factors influencing the decision to outsource maintenance are different from the ones influencing management and operation activities.

The similarity in the outsourcing decision between management and operation activities is also reflected in the estimation of the thresholds in the various specifications. These thresholds are not significantly different between operation and management activities. However, thresholds are systematically significant between operation and maintenance activities, indicating that firms are more inclined to outsource maintenance activities.

Since maintenance activities present a significantly different outsourcing pattern than management and operation activities, a model separating these two groups is estimated (last column of Table 1). It shows that two TCT variables (complexity and measurement) and the production cost variables (at the transaction level) are significant and in the expected direction for maintenance activities. For management and operations, only the technical and business-related skills, which are associated with production cost considerations, showed significant relationships with the decision to outsource. Transaction-cost variables are not significant.

Firm-level results are presented in Table 3. As expected, knowledge intensiveness was associated with lower extent of outsourcing. Firm-level uncertainty was positively related to outsourcing. Firms in sectors which are following a stable trend (downward or upward) are less likely to outsource their IT services, as shown by the negative coefficient in Table 3. Similarly, firms operating in sectors where aggregate demand is difficult to anticipate (as measured by the U-Theil statistic in Table 3)

Table 3
Probit estimates – posterior mean of the firm-level random effect.

	Specification 1: Trend (ability to predict)	Specification 2: U-Theil (unexpected volatility)
Volatility	**−0.8426 (2.04)**	**0.4922 (1.79)**
High-knowledge industry	**−0.5083 (2.17)**	**−0.7216 (3.03)**
Public traded corp.	0.1042 (0.52)	0.1453 (0.73)
Crown corp.	**−1.003 (2.28)**	**−0.9005 (2.05)**
Size (relative sales)	**0.0146 (1.91)**	0.0107 (1.54)
Constant	0.112 (0.71)	−0.3583 (1.67)
Log-likelihood	−121.5186	−122.7705
No. firms	196	196

T-statistics are in parenthesis (absolute value). Significant coefficients are in bold.

are more likely to outsource their IT services. Government-owned organizations use significantly less outsourcing than others. No significant difference was observed between publicly traded and non-traded companies. Size effect is weak and only significant in specification 1.

5. Discussion

The results show a split picture. Maintenance activities are influenced by both transaction cost and production cost considerations. Management and operations are solely influenced by production cost elements, both at the transaction and the firm levels.

Transaction cost hypotheses	
H1: Asset specificity (−)	Not supported
H2: Complexity (−)	Supported for maintenance activities
H3: Standardization (+)	Not supported
H4: Measurement problems (−)	Supported for maintenance activities
Production cost hypotheses	
H5: Technical skills (+)	Supported
H6: business-related skills (−)	Supported
H7: interdependence of the activities (−)	Supported
H8: Demand uncertainty (firm-level) (+)	Supported
H9: Knowledge Intensity (−)	Supported

5.2. Transaction-level

In the results, transaction costs solely depended on uncertainty. It shows the need to adequately match the measure of uncertainty with the facet of theory we are referring to. Measurement problems and complexity were significant in two of the three specifications, and both were significant for maintenance activities. These results support the TCT argument suggesting that writing and enforcing contracts is more difficult in situations of transactional uncertainty.

Asset specificity has no significant effect on the extent of outsourcing. It questions the emphasis TCT has put on asset specificity and the use of TCT in the IT outsourcing literature. In confirms the lack of support described in Lacity et al. (2011). Studies finding support for asset specificity were mostly looking at traditional industries. Maybe the effect of asset specificity can only be observed for extreme cases, where the investments are very large and durable. In IT services, such effect could not be found.

The variables showing the most consistent results at the transaction level, significant and in the direction expected, are related to the core competency argument and influence production costs rather than transaction costs. By splitting the skills into two types, current results build on Poppo and Zenger (1998) and increase the understanding of the role of skills and competencies in the outsourcing decision. It is not merely the intensity of the skills required to perform an activity that influences the decision; the type of skills is key.

5.3. Firm-level analysis

At the firm level, many conclusions can be drawn about production costs. As observed by Leiblein and Miller (2003), firms appear to keep in-house assets they can use continuously and rely more on suppliers when they can transfer them the burden of variable production. Firms operating in highly volatile environments tend to outsource the provision of their IT services instead of making important investments that would not be used continuously. This provides a different reading of the idea behind the frequency argument offered by Williamson (1985).

It should be noted that organizations operating in high-knowledge industries were not relying on outsourcing as much as those in low-knowledge industries. This is especially interesting in the context of IT outsourcing. This suggests that IT plays a more important role in the production function of these organizations.

5.4. Multi-level analysis

Results show that different sets of activities are influenced by different sets of variables. Operations and management were influenced by variables associated with production costs: firm-level variables and the types of skills. Maintenance activities were influenced by both transaction cost and production cost variables. Each level of analysis provides complementary information on the outsourcing choices.

When introducing firm random effects, we note that while they have a significant effect on the outsourcing decision, most of the transaction-level variables that were significant in the specification without random effects are still significant. This strengthens the confidence in the influence of these variables. It suggests that while different firms have different attitudes or thresholds with respect to outsourcing, they seem to be influenced by the same decision variables. It also suggests that transaction-level characteristics are independent of firm characteristics.

Another interesting element is the effect of interdependence. The significant group-firm random effects suggest that groups of activities are managed as ensembles. There are two possible explanations. First, each activity in a given group is influenced by the same (unobserved) factors when governance mode decisions are made. Second, the activities are, within each group, co-dependent. Keeping them together reduces production costs. This supports the role of interdependence.

Interestingly, operations and management of operations effects are highly correlated. Their correlation with the maintenance group is lower (Table 2). This suggests that outsourcing decisions on maintenance activities might be rely on a slightly different logic than decisions about operations and management.

As Table 1 shows, technical and business-related skills have a significant effect for all groups of activities. Measurement problems and complexity significantly influence the outsourcing of maintenance activities only. In other words, operations and management are influenced by antecedents of production costs: firm characteristics and RBV variables. Maintenance activities are also influenced by these variables (in similar magnitude), and by TCT variables (measurement and complexity). It raises a question: why are maintenance activities influenced by TCT considerations, while management and operations are not?

It might be because maintenance activities are further away from the organization's everyday activities. Therefore, organizational level influence on production costs might not be as strong for maintenance as it is for management and operations (suggested by Table 2). Management and operations activities seem more influenced by firm specific effects, which can limit the effect of transactional characteristics.

These elements could be seen as different sources of influence having different pull-strength on the decision depending on factors analogous to proximity. When activities are closer to the daily conduct of the firm, production cost considerations explain in larger part the decision taken. When activities are more remote from the activities of the organization, TCT elements become influential.

This might be understood by examining the premises of the various theoretical explanations. In TCT, activities are expected to be managed similarly from one organization to another. In contrast, in the RBV, heterogeneity is posited and each decision depends on the characteristics of the activities in relation with the firm resources. One possibility that might explain why complexity and measurability are significant for maintenance activities would be that the resources required to perform these activities are less heterogeneously distributed than the activities required for management and operations.

6. Conclusion

This paper presents a model explaining the IT outsourcing decision. It considers both transaction costs and production costs, and includes a multi-level analysis. The results suggest that the governance structure of an activity is influenced by transaction-level and firm-level variables simultaneously, and that the influence of each variable depends on the type of activities. Governance of the activities that are closer to the firm's core (management and operations) was driven by variables influencing production costs. Transaction costs did not influence these activities. However, transaction costs influenced maintenance activities, which are less affected by firm-level considerations.

On a theoretical level, the results offer a plausible explanation for apparently conflicting past results. Some studies found that uncertainty decreased the use of outsourcing while others found that it increased it. Results suggest that transaction-level uncertainty (like measurement problems and complexity) might reduce the use of outsourcing for some activities while firm-level uncertainty increases the reliance on external suppliers.

Some findings highlight unique characteristics of IT outsourcing. For instance, firms in knowledge intensive industries using less outsourcing than firms in less knowledge intensive ones suggests that information processing activities might be treated somewhat differently from other activities.

Overall results underline the importance to take into account simultaneously variables influencing transaction costs and production costs, the latter including variables at the transactional-level and the firm-level. Future research will benefit from taking into account multiple levels in order to further develop a comprehensive theory of the firm.

In addition, results show that the activities are not totally independent. Any outsourcing decision has to take into account activities within an ensemble. Managing these activities without acknowledging this would lead to coordination problems and inefficiencies. This might explain why some activities that seem perfect candidates for outsourcing are actually better managed inside the firm.

Finally, the results suggest practitioners to consider their unique situation (notably the demand uncertainty and the knowledge intensity of the domain in which their firm operates). Recipes that have worked in one organization might not work in the other. Managers have to be aware of these influences that are independent from the activities themselves.

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Appendix A. Descriptive statistics

	Governance choices (%)		
	In-house	Mixed-mode	Outsourcing
Management			
Scheduling of operations	86.2	4.1	9.7
Control of operations	86.7	4.1	9.2
Production support services	68.4	14.8	16.8
Operations			
Operation of applications	83.2	5.6	11.2
Operation of operating system	77	7.7	15.3
CPU operation	77	8.2	14.8
Operation of client/server systems	84.2	7.7	8.2
Operation of telecommunication software	65.3	19.4	15.3
Printer operation	84.2	5.1	10.7
Disk space management	77.6	9.7	12.8
Maintenance			
Operating system maintenance	57.7	21.4	20.9
Hardware maintenance	23	43.9	33.2
PC maintenance	36.2	36.2	27.6
Network maintenance	52.6	30.1	17.3
Printer maintenance	23	45.4	31.6
Telecommunication lines maintenance	17.9	39.3	42.9

Firm characteristic.

	No. obs.	Mean	Std. dev.	Minimum	Maximum
Relative size (sales)	196	8.89	31.7	0.0002462	355.6
Public corporation	196	0.3827	0.486	0	1
Crown corporation	196	0.06633	0.2489	0	1
Volatility (U-Theil)	196	0.661	0.3536	0.128	1.976
Volatility (abs(trend))	196	0.00257	0.003647	0.000144	1.86
High knowledge-based industry	196	0.2347	0.4248926	0	1

Appendix B. Definitions

B.1. Skills

For the optimal execution of any activity, different skills are needed. For IS operations, some of these skills are very technical and involve knowledge of the technology. Others are organizational, and involve knowledge of the information the firm is processing or the business in which the firm is engaged.

<technical skills and business-related skills were evaluated in sequence>

B.2. Complexity

Complexity is the extent to which the conduct of a given activity is hard to predict, always new, varied, and frequently subject to change. Complex tasks are also subject to unexpected problems that take time to resolve.

B.3. Standardization

Standardization is the extent to which rules, procedures, and standards exist to guide the conduct of an activity and to evaluate performance.

B.4. Measurement problems

The measurability of an activity is the extent to which it is easy to evaluate the activity, both in terms of quality and quantity. It is also the extent to which these measures are verifiable and unchallengeable.

B.5. Asset specificity

Asset specificity is the unique use of the assets required to perform an activity. These assets can be physical or linked to acquisition of skills or knowledge. Their uniqueness means that they have little or no salvage value outside their use for that particular activity.

References

Alchian, A., Demsetz, H., 1972. Production, information costs, and economic organization. American Economic Review 62 (2), 777–795.
Ang, S., Straub, D.W., 1998. Production and transaction economies and IS outsourcing: a study of the U.S. banking industry. MIS Quarterly 22 (4), 535–552.
Aubert, B.A., Rivard, S., Patry, M., 1996. Development of measures to assess dimensions of IS operation transactions. Omega 24 (6), 661–680.
Aubert, B.A., Patry, M., Rivard, S., 2004. A transaction cost model of IT outsourcing. Information & Management 41, 921–932.
Bahli, B., Rivard, S., 2005. Validating measures of information technology outsourcing risk factors. Omega 33 (2), 175–187.
Barney, J., 1991. Firm resources and sustained competitive advantage. Journal of Management 17 (1), 99–120.
Barthelemy, J., Geyer, D., 2005. An empirical investigation of IT outsourcing versus quasi-outsourcing in France and Germany. Information & Management 42, 533–542.
Barthélemy, J., Quélin, B.V., 2006. Complexity of outsourcing contracts and ex post transaction costs: an empirical investigation. Journal of Management Studies 43 (8), 1775–1797.
Carlton, D.W., 1979. Vertical integration in competitive markets under uncertainty. The Journal of Industrial Economics 27 (3), 189–209.
Dibbern, J., Goles, T., Hirschheim, R., Jayatilaka, B., 2004. Information systems outsourcing: a survey and analysis of the literature. Database for Advances in Information Systems 35 (4), 6–102.
Earl, M.J., 1996. The risks of outsourcing IT. Sloan Management Review (Spring), 26–32.
Espino-Rodríguez, T.F., Padrón-Robaina, V., 2006. A review of outsourcing from the resource-based view of the firm. International Journal of Management Reviews 8 (1), 49–70.
Fink, L., Neumann, S., 2009. Exploring the perceived business value of the flexibility enabled by information technology infrastructure. Information & Management 46 (2), 90–99.
Gantman, S., 2011. IT outsourcing in the public sector: a literature analysis. Journal of Global Information Technology Management 14 (2), 48–83.
Garrouste, P., Saussier, S., 2005. Looking for a theory of the firm: future challenges. Journal of Economic Behavior and Organization 58, 178–199.
Geyskens, I., Steenkamp, J.-B., Kumar, N., 2006. Make, buy, or ally: a transaction cost theory meta-analysis. Academy of Management Journal 49 (3), 519–543.
Godin, B., 2006. The knowledge-based economy: conceptual framework or buzzword? Journal of Technology Transfer 31 (1), 17–30.
Hedeker, D., Gibbons, R., 1994. A random effects ordinal regression model for multilevel analysis. Biometrics 50 (4), 933–944.
Hennart, J.-F., 1988. Upstream vertical integration in the aluminum and tin industries, a comparative study of the choice between market and intrafirm coordination. Journal of Economic Behavior and Organization 9 (3), 281–299.
Karimi–Alaghehband, F., Rivard, S., Wu, S., Goyette, S., 2011. An assessment of the use of transaction cost theory in information technology outsourcing. The Journal of Strategic Information Systems 20 (2), 125–138.
Krickx, G., 2000. The relationship between uncertainty and vertical integration. The International Journal of Organizational Analysis 8 (3), 309–329.
Lacity, M.C., Willcocks, L.P., 1995. Interpreting information technology sourcing decisions from a transaction cost perspective: findings and critique. Accounting, Management and Information Technology 5 (3/4), 203–244.
Lacity, M.C., Willcocks, L.P., 1998. An empirical investigation of information technology sourcing practices: lessons from experience. MIS Quarterly 22 (3), 363–408.
Lacity, M.C., Khan, S., Yan, A., Willcocks, L.P., 2010. A review of the IT outsourcing empirical literature and future research directions. Journal of Information Technology 25 (4), 395–433.
Lacity, M.C., Willcocks, L.P., Khan, S., 2011. Beyond transaction cost economics: towards an endogenous theory of information technology outsourcing. Journal of Strategic Information Systems 20 (2), 139–157.
Langlois, R.N., Robertson, P.L., 1992. Networks and innovation in a modular system: lessons from the microcomputer and stereo component industries. Research Policy 21, 297–313.
Langlois, R.N., Robertson, P.L., 1995. Firms, Markets, and Economic Change. Routledge, NY, p. 185.
Lee, F.C., Has, H., 1996. A quantitative assessment of high-knowledge vs. low-knowledge industries. In: Howitt, P. (Ed.), The Implications of Knowledge-Based Growth for Micro-Economic Policies. University of Calgary Press, pp. 39–78.
Leiblein, M., Miller, D., 2003. An empirical examination of transaction- and firm-level influences on the vertical boundaries of the firm. Strategic Management Journal 24, 839–859.
Levy, D.T., 1985. The transactions cost approach to vertical integration: an empirical examination. Review of Economics and Statistics 67 (3), 438–445.
Loebbecke, C., Huyskens, C., 2006. What drives netsourcing decisions? An empirical analysis. European Journal of Information Systems 15 (4), 415–423.
Madhok, A., 2002. Reassessing the fundamentals and beyond: Ronald Coase, the transaction cost and resource-based theories of the firm and the institutional structure of production. Strategic Management Journal 26 (6), 535–550.
Masten, S.E., 1984. The organization of production: evidence from the aerospace industry. Journal of Law and Economics 24 (2), 403–418.

Monteverde, K., Teece, D.J., 1982. Supplier switching costs and vertical integration in the automobile industry. The Bell Journal of Economics 13 (1), 206–213.
Nam, K., Rajagopalan, S., Rao, A., 1996. A two-level investigation of information systems outsourcing. Communications of the ACM 39 (7), 37–44.
Pisano, G., 1990. The R&D boundaries of the firm: an empirical analysis. Administration Science Quarterly 35 (1), 153–176.
Poppo, L., Zenger, T., 1998. Testing alternative theories of the firm: transaction cost, knowledge-based, and measurement explanations for make-or-buy decisions in information services. Strategic Management Journal 19 (9), 853–877.
Rabe-Hesketh, S., Pickles, A., Skrondal, A., 2004. GLLAMM: A general class of multilevel models and a STATA program. Technical report.
Rabe-Hesketh, S., Skrondal, A., Pickles, A., 2005. Maximum likelihood estimation of limited and discrete dependent variable models with nested random effects. Journal of Econometrics 128, 301–323.
Sheehan, N.T., Foss, N.J., 2007. Enhancing the prescriptiveness of the resource-based view through porterian activity analysis. Management Decision 45 (3), 450–461.
Slaughter, S., Ang, S., 1996. Employment outsourcing in information systems. Communication of the ACM 39 (7), 47–54.
Teng, J.T., Cheon, J., Grover, V., 1995. Decisions to outsource information systems functions: testing a strategy-theoretic discrepancy model. Decision Sciences 26 (1), 75–104.
Tippins, M.J., Sohi, R.S., 2003. IT competency and firm performance. Is organizational learning a missing link? Strategic Management Journal 24 (8), 745–761.
Trostel, A.O., Nichols, M.L., 1982. Privately-held and publicly-held companies: a comparison of strategic choices and management processes. Academy of Management Journal 25 (1), 47–62.
Van de Ven, A., Ferry, D.L., 1980. Measuring and Assessing Organizations. Wiley, New York, NY.
Williamson, O., 1985. The Economic Institutions of Capitalism. Free Press, New York, NY.
Wullenweber, K., Beimborn, D., Weitzel, T., Konig, W., 2008. The impact of process standardization on business process outsourcing success. Information System Frontiers 10 (2), 211–224.