TESTING ALTERNATIVE THEORIES OF THE FIRM: TRANSACTION COST, KNOWLEDGE-BASED, AND MEASUREMENT EXPLANATIONS FOR MAKE-OR-BUY DECISIONS IN INFORMATION SERVICES

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Firms' boundary choices have undergone careful examination in recent years, particularly in information services. While transaction cost economics provides a widely tested explanation for boundary choice, more recent theoretical work advances competing knowledge-based and measurement cost explanations. Similar to transaction cost economics, these theories examine the impact of exchange attributes on the performance of markets and hierarchies as institutions of governance. These theories, however, offer alternative attributes to those suggested by transaction cost economics or offer alternative mechanisms through which similar attributes influence make–buy choices. Traditional empirical specifications of make–buy models are unable to comparatively test among these alternative theories. By developing and testing a model of comparative institutional performance rather than institutional choice, we examine the degree of support for these competing explanations of boundary choice. Hypotheses are tested using data on the governance of nine information services at 152 companies. Our results suggest that a theory of the firm and a theory of boundary choice is likely to be complex, requiring integration of transaction cost, knowledge-based, and measurement reasoning. © 1998 John Wiley & Sons, Ltd.

INTRODUCTION

Boundary choices are decisions of primary strategic importance. If competitive advantage stems ultimately from valuable, difficult-to-imitate resources (e.g., Barney, 1986; Collis and Montgomery, 1995; Lippman and Rumelt, 1982; Prahalad and Hamel, 1990; Wernerfelt, 1984), then boundary choices define the possession and composition of such resources (Chesbrough and Teece, 1996). Over the past 20 years, transaction cost economics (TCE) has emerged as a predominant theoretical explanation of boundary choice. TCE argues and empirically finds that boundary choices are driven largely by the specificity of assets involved in an exchange (Shelanski and Klein, 1995). Specific assets trigger a threat of opportunistic behavior that requires costly contractual safeguards to deter. Hence, in the presence of exchange-specific assets, vertical integration may offer a preferred governance solution. In recent years, this primary argument of transaction cost economics has confronted widespread criticism. A recent and widely published critique, often characterized as 'a knowledge-based theory of the firm,' argues that the link between asset specificity and boundary choice has little to do with opportunistic behavior and failed markets. Increasing the firm specificity of activities, rather than triggering market failure, enhances the efficiency with which such activities are coordinated through internal governance. Within firms, increased firm specificity generates shared language, knowledge, and routines that enhance the efficiency of coordination (Grant,

1996; Kogut and Zander, 1992; Monteverde, 1995; Moran and Ghoshal, 1996).

Scholars in the property rights and agency theory traditions have also questioned TCE's focus on asset specificity. These scholars argue instead that boundary choice turns on measurement issues. Internalizing an activity avoids costly measurement and contracting costs (Barzel, 1982; Demsetz, 1988). Still other scholars question the entire notion of a discrete make-or-buy choice, arguing instead that markets and hierarchies are points on a continuous spectrum and that the same exchange conditions (e.g., asset specificity and measurement accuracy) which hinder market performance also hinder the performance of hierarchical exchanges (Alchian and Demsetz, 1972; Bradach and Eccles, 1989; Jensen and Meckling, 1976). Consequently, these scholars argue for a focus on understanding the details of contracts, regardless of whether internal or external to the firm, and not the boundary choice.

Collectively, these arguments represent a rather significant challenge to the prominence of TCE as an explanation for boundary decisions. For the most part, existing empirical work, because it examines the effects of exchange conditions on boundary choice rather than exchange performance (Masten, 1993), does not resolve the questions raised by these critiques. Testing these critiques requires a comparative examination of the effects of exchange attributes on exchange performance for each governance mode.

Our paper attempts to fill this void by developing and testing competing hypotheses from the transaction cost, knowledge-based, agency, and measurement literature regarding boundary choice *and* governance performance. As discussed below, this type of empirical analysis raises significant methodological difficulties that determined our empirical design. While governance forms are quite easily observed and measured, the performance of governance forms is not. Moreover, in examining performance, significant sample selection problems arise which demand empirical correction (Masten, 1993; Masten, Meehan, and Snyder, 1991). Our sample uses data collected from top computer executives concerning the performance, governance, and exchange characteristics of internally and externally sourced information services. These information services include data entry, software application development, software applications

maintenance, support for end users, and the design of data networks. Evaluating sourcing decisions and the performance of internal and external providers was typically a primary responsibility of these executives. During the time period of this survey, outsourcing of information services was escalating (Lacity and Hirschheim, 1993) and debate about the relative merits of internal and external sourcing was considerable (Clemons and Row, 1991; McFarlan, 1990; Porter and Millar, 1985; Vitale, 1986).

A MODEL OF COMPARATIVE INSTITUTIONAL PERFORMANCE

Efficiency models of governance begin with the premise that boundary decisions are based on a comparison of the performance of alternative governance institutions, e.g., markets and firms (Williamson, 1991b). Managers seek to maximize performance by matching exchanges, which differ in attributes, to governance structures, which differ in performance (Williamson, 1991a: 79). A manager's choice of governance form is determined by the comparative performance, particularly transaction cost and production cost efficiency, of alternative forms. Transaction costs encompass the costs of negotiating, monitoring, and enforcing contracts that arise directly from opportunistic behavior (Klein, Crawford, and Alchian, 1978; Williamson, 1985) or from difficulties in measuring the goods or services being exchanged (Barzel, 1989; Demsetz, 1988). Transaction costs also typically encompass the management costs associated with internally governing these exchanges. Production costs include the direct costs of producing and delivering a product or service and may reflect differences in scale or production capability. Managers will choose governance structures that maximize performance through the minimization of transaction and production costs. Thus, if P_m represents the performance of a service purchased in the market, and P_f the performance of the same service governed through a firm, managers will choose a firm when $P_f > P_m$, and markets when $P_m > P_f$.

Direct empirical tests of this proposition, however, are problematic: the performances of the chosen governance forms are observed, while the performances of those governance forms not chosen are not observed (Masten, 1993; Masten

et al., 1991). Previous empirical work has circumvented this problem by examining directly the effects of exchange attributes on governance choices rather than performance (Masten, 1984; Walker and Weber, 1984). Yet, in these empirical models, the critical theoretical relationships between exchange attributes and market or firm performance are assumed, not tested (see Figure 1). This absence of a direct empirical test limits our ability to test accurately and comparatively competing theories of boundary choice. In particular, we are unable to differentiate between the competing knowledge-based and transaction cost explanations regarding the empirical relationship between asset specificity and vertical integration. The absence of performance-level data also makes it impossible to dismiss yet another alternative governance theory: that exchange attributes impose equal damage (or benefit) on markets and hierarchy (Alchian and Demsetz, 1972; Eccles and White, 1988). Evidence of similar effects of exchange attributes on both internal and external performance would be important, because it would suggest, contrary to TCE and the knowledge-based view, that markets and firms are not discretely different organizational forms.

In this paper, we estimate a model of the influence of exchange attributes on the performance of both markets and firms. We use a model similar to that of Masten *et al.* (1991), in which the performances of both market exchanges, P_m, and firm exchanges, P_f, are determined by a vector $\mathbf{x}$ of common attributes such as the firm specificity of skills and assets, technological uncertainty, internal production scale, measurability of outputs, and size of the required skill set. However, unlike previous work (Masten *et al.*, 1991; Walker and Poppo, 1991), to incorporate both production and governance efficiency, we examine overall exchange performance rather than governance costs. Thus, the models are

$$P_f = \alpha\mathbf{x} + e$$

$$P_m = \beta\mathbf{x} + u$$

where α and β are coefficient vectors, and e and u are normally distributed random variables. As stated previously, managers will choose markets when $P_m > P_f$ and firms when $P_m < P_f$. The probability that managers will choose firm organization is thus $\Pr(P_f > P_m) = \Pr((\alpha\mathbf{x} + e) > (\beta\mathbf{x} + u))$. Hence, propositions about how an attribute, x, influences market and firm performance are tested by examining independently the magnitude of the coefficients, α_x and β_x. Propositions about the impact of a particular exchange attribute on the decision to vertically integrate involve a comparison of the relative magnitude of the parameter coefficients, α_x and β_x. For instance, if measurement difficulty has a larger negative effect on the performance of market exchanges than on the performance of internally governed exchanges ($\alpha_x > \beta_x$), then increased measurement difficulty
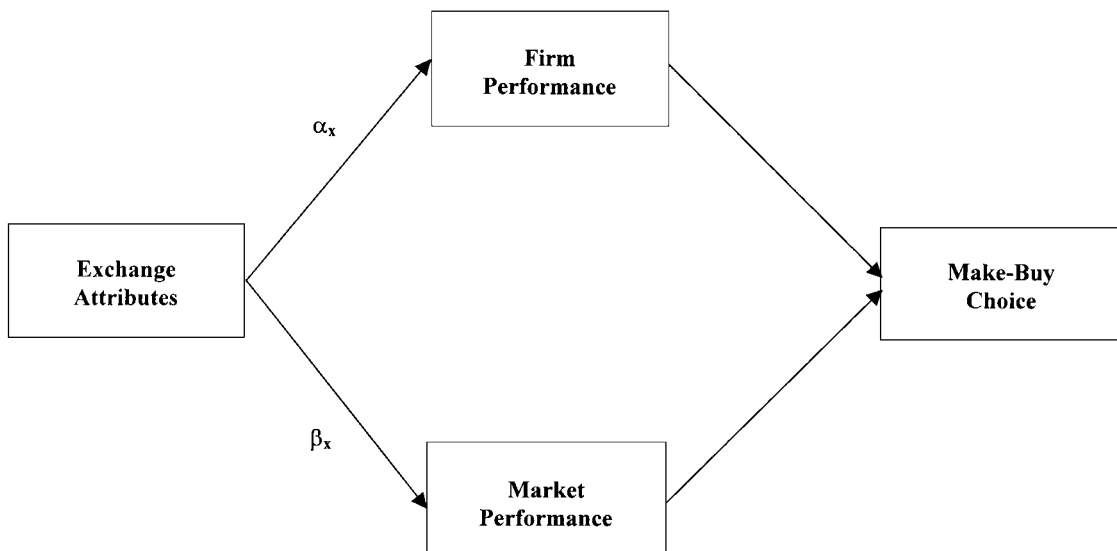

Figure 1. Assessing comparative institutional performance

should result in an increased probability of internalization. By examining the direct effects of exchange attributes on the boundary choice, we can also examine consistency between traditional models and our more complete specification. A summary of the hypotheses developed below is provided in Table 1.

DETERMINANTS OF COMPARATIVE PERFORMANCE

Asset specificity: Transaction cost vs. knowledge-based predictions

Both transaction cost and knowledge-based explanations of boundary choice begin with the assumption that efficient production necessitates specialized investments in physical and human assets. Customizing physical assets and developing firm-specific human assets enable firms to reduce production costs, innovate, and

meet product specifications (Klein *et al.*, 1978; Williamson, 1985). However, according to transaction cost logic, such specific assets damage the performance of simple market governance by creating hold-up hazards. Because exchange-specific assets are of lesser value in alternative uses, partners in an exchange have incentives to appropriate returns from these specialized investments through postcontractual bargaining or threats of termination (Klein *et al.*, 1978). In order to induce firms to make firm-specific asset investments, contractual safeguards are often required. Negotiating, monitoring, and enforcing the contractual safeguards necessary to protect specific assets is likely to be costly. Hence, increasing the specificity of an activity raises the transaction costs of market governance (Williamson, 1985). The net effect of specialized investments in market exchanges is, however, somewhat ambiguous. Exchange-specific investments by a supplier enhance production

Table 1. Predicted relationships among exchange attributes, governance performance, and governance choice

Exchange attributes	Theoretical perspective	Empirical prediction		
		Market performance	Firm performance	Boundary choice
Asset specificity	Transaction costs	−(?) (H1a)		Internalize (H1c)
	Knowledge-based/resource-based		+ (H1b)	Internalize (H1c)
	Hybrid forms (Eccles)	−	− (H1d)	? (H1d)
Measurement difficulty	Property rights Agency theory	− (H2a)	− (H2b)	? (H2c)
	Institutional agency theory (Holmstrom and Milgrom 1991, 1994; Milgrom and Roberts, 1992)	−	− − (H2d)	Internalize (H2d)
Technological uncertainty	Transaction costs	− (H3a)		Internalize
	Technological obsolescence		− (H3b)	Outsource
Economies of scale	Production cost	(H4)	+ (H4)	Internalize (H4)
Magnitude of skill set	Production cost	+ (H5)	− (H5)	Outsource (H5)

efficiency, yet damage governance efficiency. Thus, we hypothesize:

> *Hypothesis 1a: Increases in the specificity of an activity may negatively affect the performance of governance through the market ($\beta_x < 0$).*

Knowledge-based theories of the firm also regard the specificity of assets, particularly human assets embedded in firm-specific routines, language, and skills, as critical to the performance of the firm (Barney, 1986, 1991). Firm-specific investments are the source of valuable knowledge and capabilities. Recently, theorists have sought to develop knowledge-based or capability-based explanations for the boundaries and existence of firms. This work extends knowledge-based reasoning beyond the simple and perhaps tautological prediction that firms internally source that which they perform well and outsource that which others perform well.[1] Instead, this recent theoretical work examines how boundary choices influence the *formation* and transfer of capabilities and knowledge. Much like transaction cost economists, these theorists point to the firm specificity of activities as the primary driver of boundary choice. For instance, Conner argues:

> ... the scale and scope of the firm ... depends critically on the degree to which new undertakings actually *are* specific to the firm's existing asset base. It is such 'relatedness' that provides opportunity for the gains from generating new, redeployable resources ... [emphasis in original] (1991: 141).

Knowledge-based explanations, however, depart from transaction cost reasoning in describing the mechanism through which asset specificity influences boundary choice. Rather than damaging the efficiency of market governance, as predicted by TCE, increased asset specificity enhances the governance efficiency of hierarchy (Conner, 1991; Demsetz, 1988; Kogut and Zander, 1992, 1996; Monteverde, 1995). The most common knowledge-based explanation follows Arrow's (1974) logic surrounding the beneficial role of language

within organizations.[2] Hierarchy's comparative efficiency arises through the formation of firm-specific language and routines that both enhance the performance of an activity itself and aid in ensuring its efficient governance. As an activity becomes more specific to the firm, it increasingly accesses and develops a 'common organizational communication code' (Monteverde, 1995: 1629) which both codifies knowledge and facilitates its efficient dissemination and protection (Kogut and Zander, 1992: 389, 1996). As Kogut and Zander argue, 'Complex organizations exist as communities within which ... expertise can be communicated and combined by a common language and organizing principles' (1992: 390). Monteverde (1995: 1628) further argues that firm-specific language is the 'defining essence of what we recognize as organizations.' Consequently, 'when communication is imperative,' the virtue of hierarchy is that it provides 'one single organization-specific dialect' (Monteverde, 1995: 1629). In part this language is developed through the continuity of association that 'makes it easier for firm-specific and person-specific information to be accumulated' (Demsetz, 1988: 160). Thus, relative to markets, firms simply possess advantages in generating firm-specific language and routines that efficiently yield valuable capabilities (Demsetz, 1988; Kogut and Zander, 1992, 1996; Monteverde, 1995; Moran and Ghoshal, 1996).[3]

Using the above logic, knowledge-based theorists reinterpret previous empirical findings in TCE by arguing that specialized activities are internalized due to the enhanced governance efficiency that accompanies increased asset specificity within the firm (Monteverde, 1995; Moran and Ghoshal, 1996). The more firm-specific is an activity, the greater use it makes of firm-specific language and routines, and hence the more

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[1] Argyres (1996) characterizes this knowledge-based hypothesis as 'bordering' on the tautological.

[2] Scholars also point to other knowledge-based advantages of hierarchy. For instance, Demsetz (1988) and Conner and Prahalad (1996) argue that hierarchies possess the capacity to substitute authority for education. Unlike parties to a market exchange, which must convince and educate each other regarding the virtues of the knowledge they possess, hierarchies can simply dictate optimal forms of knowledge transfer.

[3] Note that there is significant overlap between the knowledge-based explanation of firm boundaries, typically vertical boundaries, and the similarity or relatedness prediction of the diversification literature. Acquisitions and product expansions that are more similar to existing activities and capabilities of the firm are more likely to utilize firm-specific language and routines and thereby be more efficiently governed.

efficient its internal governance.[4] These scholars further contend that this explanation entirely circumvents the assumption of opportunism. Vertical integration is thus a 'creator of a positive' rather than an 'avoider of a negative' (Conner, 1991: 139). Thus, we hypothesize:

Hypothesis 1b: Increases in the specificity of an activity will positively affect the performance of governance through firm organization ($\alpha_x > 0$).

TCE and knowledge-based theorists reach a common prediction concerning boundary choice. While the knowledge-based perspective suggests that the effect of asset specificity on firm performance (α), is clearly positive, TCE argues that the effects of asset specificity on the performance of market exchanges may be negative (β). The net effect of increases in asset specificity is therefore unambiguous across both theories; greater firm specificity promotes the choice of firm organization. Thus, we hypothesize:

Hypothesis 1c: Increases in the specificity of an activity will have stronger positive effects on firm governance than market governance ($\alpha_x > \beta_x$). Consequently, increases in the specificity of an activity encourage vertical integration.

Some scholars have questioned whether the effects of asset specificity on the performance of internally governed exchange differ in any way from the effects of asset specificity on market performance (Eccles, 1985; Eccles and White, 1988). Demsetz (1988: 150) argues that 'asset specificity problems may be almost as easy to resolve through contract as through vertical integration.' Specific assets are dedicated to specific uses and thus their governance through the market may become increasingly routine as assets become increasingly firm specific. Others have also argued that markets and hierarchies exhibit few differential features. Markets can function much like firms and firms can function much like markets (Hennart, 1993). Eccles and White (1988) contend that the same problems of bar-

gaining and negotiation that plague market exchanges also plague exchanges governed by hierarchy. This line of reasoning therefore dismisses the relevance of asset specificity and argues that boundary decisions turn on other factors (Perrow, 1986). If, as these scholars imply, markets and hierarchies possess a common capacity to cope with asset specificity, then α and β, the effects of firm specificity on firm and market performance, respectively, should be of equal magnitude. Hence:

Hypothesis 1d: Increases in the specificity of an activity will have similar effects on firm and market governance ($\alpha_x = \beta_x$). Consequently, increases in the specificity of an activity will be unrelated to the choice of boundary.

Measurement difficulty

While TCE acknowledges the role of measurement in determining boundary choice (Williamson, 1991a), measurement issues have been comparatively ignored in the empirical literature. In the property rights and agency theory literatures, accuracy in measuring asset values, both physical and human, defines the effectiveness of markets (Alchian and Demsetz, 1972; Barzel, 1989). Markets succeed when they meter effectively—when they effectively link rewards to productivity (Alchian and Demsetz, 1972). As a result, when contributions from an outside supplier cannot be accurately assessed, adequate contracts will be costly to craft (Barzel, 1989; Milgrom and Roberts, 1992). Under these circumstances, the purchasing firm must choose between expending resources to improve performance measurement and simply enduring the lower performance that results from an inability to accurately measure and reward performance. Thus, consistent with measurement and agency reasoning, we hypothesize:

Hypothesis 2a: Increased difficulty in measuring the performance of an activity will negatively affect the performance of exchanges governed through the market ($\beta_x < 0$).

Internalizing an activity does not entirely circumvent the need to measure its performance. Indeed, agency theory reasoning suggests that the performance of an internal activity may significantly

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[4] Masten *et al*. (1991) in their study of boundary choice in the shipbuilding industry find some evidence to support this alternative reasoning.

depend on the capacity to measure its performance accurately (Milgrom and Roberts, 1992). As argued in a variety of literatures, more accurate performance measurement enables firms to escalate the link between pay and performance (Barzel, 1989; Basu, Srinivasan, and Staelin, 1985; Brown, 1990; Eisenhardt, 1988; Pfeffer and Langton, 1993). Thus, while rewards for employees are often rather low powered within firms (Baker, Jensen, and Murphy, 1988; Williamson, 1985), when performance can be easily measured, higher-powered incentives can be infused. These higher-powered incentives, which more closely link pay and performance, increase effort toward performance and thereby increase performance (Lawler, 1981; Leventhal, 1976; Milgrom and Roberts, 1992). On the other hand, when measuring performance is difficult, managers must adopt low-powered incentives that deliver lower performance. Hence:

Hypothesis 2b: Increased difficulty in measuring the performance of an activity will negatively affect the performance of exchanges governed through firm organization ($\alpha_x < 0$).

Beginning with Alchian and Demsetz's (1972) arguments about the equivalence of firing your grocer and firing an employee, the traditional view in agency theory has also been that the boundary distinction is of rather limited significance. If measurement difficulty damages the performance of both markets and firms (Alchian and Demsetz, 1972; Fama, 1980; Jensen and Meckling, 1976), then the choice of forms may be of limited consequence. Under these conditions, measurement accuracy simply defines the performance of the governance devices regardless of their placement inside or outside the firm. As Jensen and Meckling argue:

> it makes little or no sense to try to distinguish those things which are 'inside' the firm from those things that are 'outside' of it. There is in a very real sense only a multitude of relationships (i.e., contracts) between the legal fiction (the firm) and the owners of labor, material and capital inputs and the consumers of output. (1976: 311)

Demsetz similarly suggests that we 'brush aside the question of absolutes—"When is a nexus of contracts *a firm?*"—and substitute instead a question of relatives—"When is a nexus of contracts

more *firm-like*?" (1988: 155). Thus, much like the prior critique of asset specificity, this vision of the firm in its strongest form suggests that exchange attributes, such as measurement accuracy, will have common effects on the performance of both market and firm-governed exchanges. Thus:

Hypothesis 2c: Increased difficulty in measuring the performance of an activity will have similar effects on market and firm performance ($\alpha_x = \beta_x$). Consequently, changes in measurement accuracy will be unrelated to the choice of boundary.

More recent work by agency theorists (Holmstrom and Milgrom, 1991, 1994; Milgrom and Roberts, 1988), however, recognizes discrete differences between markets and hierarchies. This institutional agency theory correspondingly implies differing magnitudes to the effects of measurement accuracy on the performance of markets and hierarchies. In particular, measurement difficulty damages the performance of markets more than the performance of firms. Within firms, when measurement becomes problematic, managers can simply substitute authority and behavioral monitoring (Holmstrom and Milgrom, 1994). Markets, by contrast, lack the capacity for such managerial intervention: when measurement is highly problematic, markets simply fail. Alternatively, when performance is accurately measured, markets deliver high-powered incentives through prices. Within firms, however, managers are constrained in crafting high-powered incentives (Williamson, 1991b) by employees' costly influence activities designed to alter pay distributions (Milgrom and Roberts, 1988; Poppo, 1995) and by similarly costly, social comparison processes (Adams, 1965; Deutsch, 1985; Zenger, 1994, 1992). Through comparison processes, employees respond to pay comparisons perceived to be inequitable with costly reductions in effort, departure, or efforts to alter the pay distribution. Thus, when performance measurement is highly accurate, markets are preferred. We, therefore, hypothesize:

Hypothesis 2d: Increases in the difficulty of measuring an activity will have a weaker negative effect on the performance of internally governed exchanges than on market-governed exchanges ($\alpha_x > \beta_x$). Consequently, increases

in measurement difficulty increase the likeli-hood of vertical integration.

Technological uncertainty

A high level of technological change characterizes the provision of information services. Advances in computing, communications, image processing, data base management, and expert systems have dramatically altered firm operations in ways completely unanticipated (McFarlan, 1990). Such technological change may have an important effect on the performance of alternative institutions of governance. Hayek (1945: 523) argues that facilitating rapid adaptation is the principal objective of economic institutions. Debate arises, however, regarding the preferred form for accommodating adaptation. One position is that uncertainty damages market performance (Williamson, 1985, 1991b). Uncertainty triggers the need to continually update contracts and incur the considerable costs of renegotiations. More importantly, constant change means that during the extensive periods of negotiation contracts are misaligned; they fail to reflect this environmental change (Williamson, 1991b). The greater the degree of uncertainty, the more frequent this misalignment and the more costly are these resulting renegotiations (Williamson, 1991b). Thus, we hypothesize:

> *Hypothesis 3a: Increased technological uncertainty will negatively affect market performance ($\beta_x < 0$).*

Technological uncertainty may also negatively affect firm performance because integrating activities under conditions of rapid technological change imposes inflexibility precisely when flexibility is most needed. Investments in technology are commonly quite specialized. Consequently, rapid technological change increases the likelihood that technological investments in knowledge and routines will be rendered obsolete (Balakrishnan and Wernerfelt, 1986). The knowledge sets required to deliver information services have expanded rapidly in recent years (Lacity and Hirschheim, 1993). Many firms have become locked into 'legacy systems' which carry with them idiosyncratic routines, language, and operating procedures. Because technological uncertainty heightens the probability that internal capabilities and routines become obsolete, technological uncertainty should discourage vertical integration (Balakrishnan and Wernerfelt, 1986). Markets have a comparative advantage in flexibly responding to technology change; within market exchanges, the declining value and prices of obsolete technology curb investments and supply (Hayek, 1945: 528; Williamson, 1991b). However, within firms strong market signals about the value of various information technology investments are less likely to reach critical decisionmakers. Further, the rather low-powered incentives discourage attention to those signals received. Consequently, within hierarchies, obsolete technologies are likely to persist beyond their useful life and new technologies to be completely overlooked (Lacity and Hirschheim, 1993). Thus, we hypothesize:

> *Hypothesis 3b: Increased technological uncertainty will negatively affect firm performance ($\alpha_x < 0$).*

The same direction predictions for technological uncertainty provide no obvious prediction for boundary choice. The boundary decision hinges on the differential effects of technological change on firm and market performance. Differences in the magnitude of these effects may be determined in large part by the form of technological uncertainty (Williamson, 1991b). If technological change mandates extensive coordinated adaptation and knowledge transfer, then uncertainty should more strongly damage market performance and thereby encourage integration. If, however, technological change does not necessitate such coordination, then technological uncertainty should more severely damage internal performance and lead to greater outsourcing. Given these contrasting hypotheses and the equivocal empirical findings of past studies regarding the direction of this relationship (Anderson and Schmittlein, 1984; Balakrishnan and Wernerfelt, 1986; Harrigan, 1986; Walker and Weber, 1984), we offer no hypothesis about the comparative magnitude of these effects in information services.

Other determinants: Production costs and economies of scale

Both TCE and the knowledge-based literature recognize the role of production cost differences

in determining boundary choices (Demsetz, 1988; Williamson, 1985). The simple prediction is that firms produce internally that which they produce efficiently. Variance in production efficiency arises from differences in scale and underlying production capability. Unfortunately, separating knowledge-based and transaction cost explanations for differences in capabilities is highly problematic. Typical knowledge- or resource-based reasoning argues that firms internalize and maintain internally those activities in which their superior capabilities enable efficient production (Argyres, 1996). Activities in which firms lack superior capabilities are simply outsourced. By contrast, transaction cost logic suggests that capabilities, unrelated to scale, are simply the outgrowth of firm-specific investments. Decisions to internalize both facilitate such specialized investments and once capabilities are formed, protect them from appropriation by other firms. Thus, while traditional knowledge-based reasoning examines the effects of capabilities on boundary choice, TCE and the more recent knowledge-based literatures, previously discussed, examine the role of boundaries in *generating capabilities*. Disentangling how capabilities determine boundaries and boundaries influence capabilities requires longitudinal data unavailable in this study. To measure and control for differing capabilities in a cross-sectional design, therefore, tests neither transaction cost nor knowledge-based arguments. Furthermore, controlling for capabilities directly confounds our capacity to examine the effects of asset specificity on boundary choice, since firm-specific investments may simultaneously deliver capabilities and demand internalization. We limit, therefore, our examination of production cost differences to those related to scale.

Production efficiency in many information services is sensitive to scale. Larger internal scale increases the probability of efficient internal production and thereby encourages vertical integration. Small internal scale limits internal production efficiency and encourages outsourcing where external suppliers have the capacity to aggregate the demands of a wide set of buyers.[5]

By contrast, diminishing internal scale (or demand for an activity) should be of no relevance to the performance of outsourced exchanges, except to the degree that the scale of demand influences volume discounts in purchasing. Thus, we predict:

Hypothesis 4: Increases in the scale of demand for an internally sourced activity will positively affect firm performance ($\alpha_x > 0$), but have no sizable effect on the performance of externally sourced activities ($\beta_x = 0$). Consequently, an increase in the scale of internal demand for an activity increases the likelihood of vertical integration ($\alpha_x > \beta_x$).

Scale-related production efficiency may also be influenced by the magnitude of the skill set required to perform an activity efficiently. The more extensive the skill set, the less likely a firm will have sufficient internal demand to justify the acquisition and support of the skill set. Thus, the design and installation of a voice communications network requires extensive knowledge that is primarily not firm specific. Few firms possess internal demand sufficient to justify the development and maintenance of such a skill set. Hence, controlling for other effects, as skill sets required to perform an activity escalate in size, performance of internally sourced services should decline.

Internal and external providers of an information service also differ in their incentives to keep abreast of escalating skill sets. The managers of an external firm have high-powered incentives pushing them to update skill sets in order to improve performance through an expanding customer base. By contrast, internal providers have captive demand. Management incentives are unlikely to be strongly attached to performance improvements that arise from enhancing skill sets. Therefore, controlling for asset specificity, as the magnitude of the skill set required to efficiently perform an activity rises, the performance of market-governed exchanges relative to firm governance should escalate. In market exchanges, rising skill set demands are accompanied by rising accumulation of skill sets. For internalized activities, this is less likely to be true. Indeed,

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[5] Williamson (1985: 92) argues that even these scale-related determinants of boundary choice are potentially driven by transaction costs. Internal providers can overcome scale disadvantages from insufficient internal demand by simply selling the output from excess capacity to external buyers. Presum-

ably, the internal governance costs of accessing supply in this manner exceed the transaction cost associated with an external provider.

for internalized activities, escalation in associated skill sets may increasingly undermine satisfaction with internal performance, because skill sets are viewed as increasingly deficient. Thus, we predict:

Hypothesis 5: Increases in the magnitude of the skill set required to perform an activity will damage internal performance ($\alpha_x < 0$) and positively affect market performance ($\beta_x > 0$). Consequently, increases in the magnitude of skill sets increase the likelihood of outsourcing ($\alpha_x < \beta_x$).

METHODS

Data collection

We obtained data to test our model and hypotheses through a key informant technique. Key informants were top computer executives who held one of two positions: (1) the senior corporate information services (IS) manager who provided overall guidance and planning for information services; or (2) the manager who had control over major data-processing facilities in operating departments, divisions, or subsidiaries. The use of a single key informant in evaluating exchange performance is consistent with prior studies (Goodman *et al*., 1995; Mohr and Spekman, 1994) and should not threaten measurement validity. Anderson and Narus (1990) find that buyers and suppliers share consistent perceptions of the performance of exchange relationships. Moreover, Heide and John (1990) find that buyers and suppliers share consistent perceptions of the attributes of exchanges.

We obtained a list of key informants from the *Directory of Top Computer Executives*. The directory, which has been in existence since 1972, included top computer executives of companies with an annual data-processing budget of $250,000 or more.[6] Also included in this directory were all *Fortune* 500 companies. By using this broad population of key informants, we sought to enhance the external validity of the study. Most previous studies of governance choice constrain their analysis to single firms or single industries.

Obtaining survey responses from executives is rather problematic, and response rates among information service/computing executives are particularly low. Rapid technological change, considerable investment in information technology equipment, and widespread interest in outsourcing had made IS managers a common target of surveys, particularly from vendors. Several industry contacts indicated that at the time of the survey (1992), IS executives were receiving three to five surveys a week. A common technique in surveying executives is to define populations and response rates based on those who will precommit to respond. With this technique, response rates are high, but bias is introduced potentially through population selection. To avoid bias at this stage, we instead chose to mail surveys broadly to a randomly selected set of 3000 names from the *Directory of Top Computer Executives*. We obtained 181 responses and of these 152 were usable. To gauge comparability with studies that use a precommitment technique, we performed a supplemental telephone survey of 300 names from the *Directory* soliciting completion precommitments. Eleven percent responded that they would complete surveys. Extrapolating this number to the broader population of names suggests that our response rate is quite consistent with studies which use precommitment techniques (Anderson and Narus, 1990; Mohr and Spekman, 1994).[7] Each respondent provided data on nine IS functions. Therefore, although the sample size varied by analysis, partly due to missing data, the core sample was nine IS functions across 152 companies for a total sample of 1368 information service exchanges.

To test for a potential response bias in our sample of firms, we compared the industries and the geographic locations represented in the sample to the population (see the Appendix). Manufacturing firms were underrepresented in the sample by about 15 percent. One explanation is that manufacturing companies tended to be larger and, therefore, more bureaucratic than service companies. Authorization is more of a challenge to

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[6] In general, companies with a data-processing budget of $250,000 or more had in-house general-purpose main-frames.

[7] One of the advantages of a precommitment approach is that bad addresses caused by turnover, location changes, and general organizational changes are avoided. While the publishers of the *Directory of Top Computer Executives* are quite thorough in updating their data base on a yearly basis, they estimate that more than half have some change to their address each year.

obtain in a bureaucratic organization, leading to lower response rates (Tomaskovic-Devey, Leiter, and Thompson, 1994). The sample and population did not appear to differ by geographic location.

To further test for nonresponse bias, we used a procedure suggested by Armstrong and Overton (1977). We compared early-returned question-naires to late-returned questionnaires on a number of variables: respondent position, company size, industry, IS attributes, and performance. The assumption of this analysis was that late respon-dents shared similar characteristics and response biases with nonrespondents. Analyses indicated that no significant mean differences existed between early and late respondents. Thus, there was no evidence of obvious response bias in the sample, other than the underrepresentation of manufacturing companies.

The survey requested information on nine com-monly used information services: data entry; data center operations; network design; network oper-ations (data); network operations (voice); end user support; training and education; applications development; and applications maintenance.[8] For each information service we collected data on the perceived performance of internally sourced activities and, if present, of externally sourced activities. Further, we collected data on the under-lying attributes of each activity (e.g., the level of firm specificity, measurement ease). For data analysis purposes, all information services, except applications development and applications mainte-nance, were classified as internally or externally sourced based on a 75 percent cutoff. We chose 75 percent as a cutoff point because it was a natural break in a rather skewed distribution. The mean level of outsourcing was 17 percent. Over 50 percent of the sample provided information services totally in-house and 70 percent of the sample outsourced 10 percent or less. Our pilot testing indicated that applications maintenance and applications development were categorically different from the other information services. Out-sourcing, particularly partial outsourcing, was far

more prevalent. IS managers were very likely to outsource some application-based projects while internally sourcing others. Hence, for these two information services, key informants provided separate information on the attributes for those applications they outsourced and those that they internally sourced.

Measurement

Table 2 presents summary statistics for each of the measures in the study. Questionnaire items, unless stated otherwise, were measured using a 7-point scale in which '1' represented 'low degree' and '7' represented 'high degree.' Table 3 presents correlations.

Dependent measures

Exchange performance

Measures of exchange performance are quite problematic to obtain. Simple accounting meas-ures fail to document costs associated with man-aging an exchange and provide no evaluation of the quality of outcomes. Some previous attempts to measure empirically dimensions of exchange performance have focused either narrowly on comparative negotiation costs using Likert scales (Walker and Poppo, 1991) or on internal man-agement costs using simple estimates of time spent multiplied by a wage rate (Masten *et al.*, 1991). Our interest was in a broader measure of institutional performance—one that could encompass a broad range of performance features, across both market and hierarchical exchanges, and across a diverse set of information services. Recent studies have developed broad perceptual measures exchange performance (Goodman *et al.*, 1995; Mohr and Spekman, 1994). These percep-tual measures distinguish whether the vendor has realized preestablished performance expectations: high levels of satisfaction represent realized per-formance expectations. In our study, we measure the level of satisfaction with three common per-formance goals central to exchange performance: (1) the overall cost; (2) the quality of the output or service; and (3) responsiveness to problems or inquiries. The degree of satisfaction was measured using a 7-point scale in which '1' represented 'dissatisfied' and '7' represented 'satisfied.'

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[8] There were two reasons for choosing a service rather than a transaction for the level of analysis. First, the respondents were more likely to have general knowledge of information services than detailed knowledge of specific exchanges. Second, based on our pilot study and initial interviews, when evaluating the performance and sourcing of information ser-vices, top management considered the total set of functionally similar activities.

Table 2. Summary statistics for independent and dependent variations

Variable			Means (S.D.)		
			Entire sample	In-house	Outsourced
Firm-specific assets					
1 ———— 7			4.63	4.68	4.41
Low	High		(1.51)	(1.52)	(1.49)
Measurement difficulty					
1 ———— 7			2.27	2.24	2.39
Low	High		(1.49)	(1.44)	(1.44)
Technological uncertainty					
1 ———— 7			4.63	4.65	4.52
Low	High		(1.57)	(1.57)	(1.55)
Scale economies					
1 ———— 7			5.11	5.25	4.45
Low	High		(1.60)	(1.49)	(1.83)
Skill set					
1 ———— 7			4.84	4.84	4.81
Low	High		(1.67)	(1.66)	(1.70)
Log (size)			7.06	7.03	7.16
			(1.55)	(1.56)	(1.48)
Size			3922	3967	3718
			(8278)	(8485)	(7289)
Cost					
1 ———— 7				5.29	4.63
Dissatisfied	Satisfied			(1.29)	(1.59)
Quality					
1 ———— 7				5.40	5.12
Dissatisfied	Satisfied			(1.16)	(1.34)
Responsiveness					
1 ———— 7				5.36	4.91
Dissatisfied	Satisfied			(1.28)	(1.58)
% Outsourced			16.75		
			(28.17)		
Reject[a]					
0 = Reject outsourcing option			0.66		
1 = Has not rejected outsourcing option			(0.47)		

[a]Reverse coded

Boundary choice

Most empirical work in TCE measures the governance choice as a discrete event: companies choose either to make or buy. A functionally similar set of activities, however, can be wholly or partially outsourced. In order to measure the boundary choice more accurately, we measured the percentage of outsourcing for each service that was outsourced. We also constructed a dichotomous measure of the make-or-buy choice: above 75 percent outsourced was coded as wholly

outsourced, as indicated previously. As a third measure of boundary choice, we distinguished between those companies which had rejected the possibility of outsourcing for a given service from those companies which either currently outsourced or which planned to consider outsourcing. We used the decision-making process measure because boundary choices were unlikely to be optimally defined at any point in time. Indeed, in information services, boundary decisions appear to be in a state of evolution toward greater outsourcing.

Table 3.   Correlations

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	Scale economics	1.00														
2.	Measurement difficulty	−0.27	1.00													
3.	Technological uncertainty	0.08	0.03	1.00												
4.	Skill set	0.16	0.02	0.64	1.00											
5.	Log (size)	0.13	−0.07	0.09	0.07	1.00										
6.	Size	0.16	−0.11	0.08	0.10	0.72	1.00									
7.	Firm-specific assets	0.26	−0.04	0.52	0.67	0.07	0.13	1.00								
8.	Cost satisfaction (internal)	−0.10	−0.25	−0.05	−0.05	0.15	0.08	−0.21	1.00							
9.	Cost satisfaction (outsourced)	0.26	−0.26	−0.04	−0.01	0.05	0.08	−0.01	0.00	1.00						
10.	Quality satisfaction (internal)	−0.01	−0.06	−0.08	−0.01	0.15	0.11	−0.17	0.61	0.00	1.00					
11.	Quality satisfaction (outsourced)	0.40	−0.27	−0.00	0.00	0.06	0.12	0.05	0.00	0.62	0.00	1.00				
12.	Satisfaction with responsiveness (internal)	−0.01	−0.01	−0.04	−0.02	0.20	0.15	−0.21	0.52	0.00	0.70	0.00	1.00			
13.	Satisfaction with responsiveness (outsourced)	0.34	−0.27	−0.01	0.00	0.06	0.10	0.01	0.00	0.61	0.00	0.73	0.00	1.00		
14.	Average of satisfaction measures (internal)	0.38	−0.30	−0.02	−0.00	0.06	0.12	0.00	0.00	0.85	0.00	0.88	0.00	0.89	1.00	
15.	Average of satisfaction measures (outsourced)	−0.04	−0.10	0.08	−0.05	0.19	0.12	−0.24	0.83	0.00	0.88	0.00	0.87	0.00	0.00	1.00

Independent measures

Firm-specific assets

Firm-specific assets were defined by human assets, physical assets, and company-specific routines and knowledge that were not redeployable to alternative uses (Williamson, 1985). Since human capital was a critical component of information services, our measurement items focused primarily on human assets and specialized knowledge or skills. We used three items to measure the degree to which the human and physical assets used to produce an information service were custom-tailored to a firm. The interitem reliability was quite high (Cronbach alpha = 0.82), and hence the three items were combined to represent one construct:

1. To what degree must individuals acquire company-specific or division-specific information to adequately perform the IS function?
2. To what degree is your approach to this function (or set of applications) custom-tailored to the company?
3. How costly in terms of time and resources would it be to switch to outsourcing this function? Or, if you already outsource the function, how costly would it be to switch outsourcing vendors? (Consider the time required to locate, qualify, train, make investments, conduct testing, and develop a working relationship).

Measurement difficulty

Consistent with previous work (Anderson and Schmittlein, 1984), our measurement focused on the level of difficulty in measuring worker performance. We employed one indicator of the accuracy with which the performance of an IS function could be measured:

> To what degree is it difficult to measure the collective performance of those individuals who perform this function?

Technological uncertainty

In general, information services have had high levels of technological change. Still, there is likely to be variation in the level of technological stability across firms and within services. We measured the degree of change in both skills and technology using two items. These items demonstrated a high level of interitem reliability (correlation = 0.83), and were combined to form a single construct:

1. To what degree are the underlying skills associated with this IS function (or set of applications) rapidly changing?
2. To what degree is the optimal configuration of hardware and software required to perform this function (or set of applications) rapidly changing?

Skill set

The skill set required for an IS activity varied depending on the scope of knowledge required to perform a particular task. A job that required extensive knowledge and skills required personnel with significant training and education. One item measured this construct:

> To what degree does performing this function require personnel with extensive knowledge and skills?

Economies of scale

The degree to which a firm had scale sufficient to support the efficient production of a services was measured by a single item:

> To what degree do you have sufficient scale in your operations to perform this function efficiently in-house?

Firm size

We measured firm size as the number of employees in the company and used the log of size in the analyses.

RESULTS

Determinants of performance

Our primary theoretical interest was in analyzing the effects of exchange attributes on the performance of markets and firms. Our model estimation was guided by the fact that a fundamental selection problem could arise when analyzing the performance of both outsourced and internal exchanges: the set of internally sourced observations was not a random sample of all observations. Indeed, whether observations were in the outsourced or internalized samples depended

precisely on the factors that predicted performance. Potentially serious biases could result if regression equations of market or firm performance were estimated without correction: parameter estimates could be too large or too small.[9]

To more accurately specify models of market performance and firm performance, we used a sample selection model, specifically a maximum likelihood Heckman model (Greene, 1992; Heckman, 1979; Stata, 1993). This model corrected for sample bias through the addition of a second sample selection equation—in this study, a boundary choice model. The technique, therefore, computed the effect of the exchange attributes on market performance (or in-house performance) while simultaneously correcting for the bias in the estimates (by computing a correction factor, sigma). Consistent with Masten *et al.* (1991), we found justification for the Heckman selection method. The Heckman correction term (sigma) indicates whether the addition of a second sample significantly influenced the findings. For the models reported in Table 4, the coefficients of the Heckman correction term were significant for the performance models of outsourced exchanges, but not for the models of internal exchanges (Sigma for Outsourced Exchanges: Cost Satisfaction ($z = 1.74$, $p = 0.08$); Satisfaction with Quality ($z = 2.02$, $p = 0.04$); and Satisfaction with Responsiveness ($z = 2.50$, $p = 0.01$)).[10]

Table 4 presents one set of results: maximum

likelihood estimates of the effects of asset specificity, measurement difficulty, technological uncertainty, scale, skill set, and firm size on the performance of both internal and outsourced services. Estimated equations were presented for all three performance measures, satisfaction with overall cost, quality, and responsiveness as well as a composite performance measure: the average of the three performance measures. The results for both internal and outsourced services were generally consistent across the performance measures, except for the effect of measurement difficulty on the performance of outsourced exchanges. When reporting the findings we generally interpreted the models for the composite performance measure.

Table 4 suggests that, consistent with the transaction cost hypothesis (Hypothesis 1a), managers become less satisfied with the cost, quality, and responsiveness of outsourced activities as these activities become more firm-specific. The parameter estimates across the models were significant and negative ($\beta = -0.46$, $p < 0.01$, for the composite model). However, contrary to the knowledge-based hypothesis (Hypothesis 1b), our results suggest that managers do not become more satisfied with performance as internal activities become more firm-specific: the parameter estimates across the models were close to zero ($\alpha = -0.04$, $p > 0.05$, for the composite model). Finally, consistent with Hypothesis 1c, a *t*-test comparison of α and β indicates α is significantly greater than β ($p < 0.01$): firm specificity has a strong negative effect on market performance and no clear effect on firm performance. Hence, our results suggest that decisions to vertically integrate when information services are firm-specific hinge on performance losses that arise or would arise from using market governance, rather than internal governance efficiency increasing with firm-specific investments. In confirming Hypothesis 1c, our results also strongly disconfirm Hypothesis 1d, which argues that asset specificity has equivalent effects on the performance of market and hierarchical governance. We instead find evidence consistent with a discrete choice framework. Asset specificity triggers governance choices because hierarchies more effectively cope with asset specificity than markets.

The results partially support Hypothesis 2a: when IS managers could not easily measure the performance of an outsourced activity, they were

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[9] Such sample selection models are commonly used in computing wage models (Greene, 1992). Although the wages of women who worked can be observed, the wages of women who chose not to work cannot. If women made this decision randomly, then we can ignore the fact that not all wages are observed and, therefore, used an ordinary regression to estimate a wage model. There is, however, a bias that affected the attributes of women who did not work: women with children were less likely to work. A selection model corrected for this bias by computing a correction factor, sigma, through the estimation of two models: one which predicted women who were likely to work and the second which predicted wages.

[10] We also compared Heckman performance results to OLS results and found that the coefficients were generally consistent and of the same magnitude. However, for the hypothesized effects there was one exception: for outsourced exchanges, the effect of measurement difficulty significantly improved satisfaction with quality for the OLS model, while the effect was positive but not significant for the Heckman model. For nonhypothesized effects, there was one exception: for outsourced exchanges the coefficient of scale economies was no longer significant for each performance measure, when estimated by OLS. In Table 4 we do not present the boundary decision equations, since the results are similar to those presented in Table 5.

Table 4. The determinants of performance in internal and outsourced information services

	Dependent variable: Cost satisfaction Heckman		Dependent variable: Satisfaction with quality Heckman		Dependent variable: Satisfaction with responsiveness Heckman		Dependent variable: Average overall performance Heckman	
	Internal	Outsourced	Internal	Outsourced	Internal	Outsourced	Internal	Outsourced
Firm-specific assets	−0.03 (0.04)	−0.44*** (0.11)	0.00 (0.03)	−0.38*** (0.09)	−0.06 (0.04)	−0.52*** 0.10	−0.04 (0.03)	−0.46*** (0.09)
Measurement difficulty	0.16*** (0.03)	−0.30*** (0.08)	−0.13*** (0.03)	−0.08 (0.07)	−0.16*** (0.03)	−0.00 (0.08)	−0.14*** (0.03)	−0.11* (0.07)
Uncertainty	−0.04 (0.04)	−0.01 (0.08)	0.01 (0.03)	−0.05 (0.07)	−0.00 (0.04)	0.04 (0.08)	0.00 (0.04)	−0.00 (0.07)
Scale economies	0.18*** (0.03)	−0.08 (0.07)	0.26*** (0.03)	−0.01 (0.06)	0.23*** (0.04)	−0.00 (0.07)	0.23*** (0.03)	−0.01 (0.06)
Skill set	0.03 (0.04)	0.22** (0.09)	−0.03 (0.03)	0.19** (0.08)	0.02 (0.04)	0.15* (0.09)	0.02 (0.03)	0.18** (0.08)
Log (size)	0.02 (0.02)	0.20*** (0.08)	0.00 (0.02)	0.20*** (0.06)	0.03 (0.03)	0.32*** (0.08)	0.02 (0.02)	0.23*** (0.06)
Constant	3.65*** (0.28)	2.50*** (0.68)	3.44*** (0.25)	3.70*** (0.61)	3.43*** (0.31)	2.83*** (0.70)	3.57*** (0.24)	3.20*** (0.58)
Sample size	1090	1090	1090	1090	1090	1090	1090	1090
Test statistic	185.98	189.12	169.55	185.91	194.25	179.64	183.27	178.84
p-Value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: Coefficient (standard error) is given for each independent variable. t-Tests for hypothesized effects are one-tailed; otherwise they are two-tailed.
*p < 0.10; **p < 0.05; ***p < 0.01

less satisfied with its cost ($\beta = -0.30$, $p < 0.01$). No further support for Hypothesis 2a was found (for Quality, $\beta = -0.08$, $p > 0.05$; for Responsiveness to Problems, $\beta = -0.00$, $p > 0.05$). Consistent with Hypothesis 2b, the negative effect of increased measurement difficulty on the performance of internal activities was consistent across all performance dimensions: managers were less satisfied with the cost, quality, and responsiveness of internal activities when they could not easily measure performances ($\alpha = -0.16$, $\alpha = -0.13$, $\alpha = -0.16$, for cost, quality, and responsiveness respectively, $p < 0.01$).

t-Test comparisons of the measurement difficulty coefficients, α and β did not provide consistent support for either Hypothesis 2c or Hypothesis 2d. Hypothesis 2d hypothesized that since measurement difficulty has a stronger negative effect on market performance than on firm performance, increased measurement difficulty will trigger greater levels of integration. As hypothesized, measurement difficulty has a greater negative effect on cost performance in markets than firms ($p < 0.01$). However, contrary to Hypothesis 2d, measurement difficulty has a stronger negative effect on quality and responsiveness performance within firms than within markets ($p < 0.01$). Thus, the influence of measurement accuracy on outsourcing decision may depend on which performance dimensions managers place the most emphasis. The inconsistent results also fail to provide clear support for Hypothesis 2c, which hypothesized equal effects of measurement accuracy on firm and market performance.

Contrary to Hypothesis 3a and Hypothesis 3b we found no support that managers were less satisfied with the performance of activities characterized by higher levels of technological change for either outsourced activities or internal activities ($\beta = -0.00$, $p > 0.05$; $\alpha=0.00$, $p > 0.05$) Further, *t*-test comparisons obviously yielded no significant difference between the estimated effects of increased uncertainty on performance for outsourced or internal activities. This finding suggests that uncertainty should have no effect on boundary choices for information services.

Consistent with Hypothesis 4, we found that internal demand for an activity had a strong positive effect on satisfaction with the performance of internalized activities. Also, as expected, internal demand had no effect on the level of satisfaction with the performance of outsourced activities. We also found evidence partially consistent with Hypothesis 5, which argued that the magnitude of skill sets supporting an activity will damage performance satisfaction with internally sourced activities while escalating performance satisfaction with activities sourced externally. Table 4 indicates that increases in skill set size had a significant positive effect on managers' perceptions of cost, quality, and responsiveness performance for outsourced exchanges ($\beta = 0.18$, $p < 0.05$). However, increases in skill set size had no effect on internal performance ($\alpha = 0.02$, $p > 0.05$). Consistent with Hypothesis 5, *t*-test comparisons of the coefficients of skill set indicated β is significantly greater than α ($p < 0.01$). Thus, increases in skill set should enhance the probability of outsourcing because as skill sets increase in size, market governance yields higher performance gains than firm governance.

Determinants of the boundary choice

Table 5 presents models predicting the boundary choice. The general comparative institutional theory argues that these results will be consistent with the performance models of Table 4. In particular, if an attribute (e.g., asset specificity) differentially impacts performance in internal and outsourced exchanges, then as suggested in TCE and institutional agency theory, increases in the attribute increases the probability that managers will select the governance form for which performance improvement is greatest. The three dependent measures listed in Table 5 are: the percentage of outsourcing for the information service; the dichotomous make-or-buy measure; and the decision of whether companies had rejected outsourcing as an alternative. For each dependent measure, Table 5 presents three different model specifications. With the exception of technological uncertainty and skill set, estimates of the hypothesized effects appear to be relatively stable across these models. Furthermore, except for measurement difficulty, observed differences in the effect of a given attribute on performance across internal and outsourced exchanges (see Table 4) led to the predicted governance choice (see Table 5).

Consistent with Hypothesis 1c, the results show that the presence of firm-specific assets encourages internalization. This result was consistent across all model specifications as well as across

Table 5. The determinants of governance choice

	OLS Dependent variable: % outsourced (0–100%)			PROBIT Dependent variable: 0 = in-house 1 = outsourced			PROBIT Dependent variable: Reject 0 = has rejected outsourcing 1 = has not rejected outsourcing		
	1	2	3	4	5	6	7	8	9
Firm-specific assets	−1.48** (0.68)	−2.93*** (0.78)	−4.05*** (0.79)	−0.047* (0.036)	−0.098** (0.042)	−0.284*** (0.050)	−0.062** (0.032)	−0.128*** (0.036)	−0.183*** (0.039)
Measurement difficulty	−1.10** (0.61)	−1.37** (0.61)	−1.96*** (0.61)	0.008 (0.033)	0.002 (0.033)	−0.074** (0.037)	0.012 (0.029)	0.002 (0.029)	−0.025 (0.030)
Technological uncertainty	0.88* (0.63)	−0.25 (0.71)	0.12 (0.74)	0.006 (0.034)	−0.029 (0.038)	−0.028 (0.042)	0.080*** (0.029)	0.017 (0.034)	0.015 (0.037)
Scale economies	−6.04*** (0.56)	−6.03** (0.56)	−5.02*** (0.56)	−0.157*** (0.029)	−0.157*** (0.029)	−0.154*** (0.033)	−0.175*** (0.027)	−0.181*** (0.027)	−0.133*** (0.029)
Skill set		2.80*** (0.77)	1.11 (0.83)		0.093** (0.042)	0.021 (0.049)		0.139*** (0.036)	0.057 (0.041)
Log (size)	−0.16 (0.56)	−0.16 (0.55)	−0.26 (0.54)	0.058** (0.030)	0.057* (0.030)	0.063** (0.033)	0.069*** (0.026)	0.075*** (0.026)	0.076*** (0.026)
Data center operations			4.91 (3.52)			0.627** (0.268)			−0.006 (0.162)
Network design			10.94*** (4.21)			0.758** (0.308)			0.375* (0.201)
Data network operations			2.09 (3.87)			0.378 (0.295)			0.245 (0.183)
Voice network operations			3.72 (3.73)			0.347 (0.289)			0.186 (0.174)
End user support			4.16 (4.08)			0.448 (0.309)			0.477*** (0.194)
Training and education			22.25*** (4.05)			1.099*** (0.286)			0.949*** (0.205)
Applications maintenance			14.19*** (4.26)			1.736*** (0.279)			0.828*** (0.210)
Applications development			22.22*** (4.33)			1.923*** (0.283)			1.173*** (0.224)
Constant	45.77*** (5.41)	42.97*** (5.42)	37.88*** (5.65)	−0.329 (0.283)	−0.413 (0.287)	−0.719* (0.357)	0.807*** (0.256)	0.693*** (0.259)	0.535*** (0.280)
Sample size	1089	1086	1086	1091	1090	1090	1158	1155	1155
Test statistic	29.24	26.59	17.11	41.89	45.63	179.59	69.05	83.78	145.58
p-Value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Adjusted R^2	0.11	0.12	0.18	0.04	0.04	0.17	0.05	0.06	0.10

Note: Coefficient (standard error) is given for each independent variable. *t*-Tests for hypothesized effects are one-tailed; otherise they are two-tailed.
*p < 0.10; **p < 0.05; ***p < 0.01

the three dependent variables (for percentage outsourced, $\beta = -4.05$, $p < 0.01$ (Model 3); for the dichotomous make-or-buy decisions, $\beta = -0.284$, $p < 0.01$ (Model 6); for the decision to reject outsourcing, $\beta = -0.183$, $p < 0.01$ (Model 9)). Information services that required firm-specific assets were more likely to be performed in-house, and managers were more likely to have rejected the outsourcing alternative.

Table 5 indicates that increases in measurement difficulty consistently discouraged outsourcing for only one dependent measure, the percentage of the activity which was outsourced, providing partial support for Hypothesis 2d (for percentage outsourced, $\beta = -1.96$, $p < 0.05$ (Model 3)). Based on the results of Table 4, this result suggests that when managers can more readily assess the performance of an activity, they seek to maximize cost performance, not quality or responsiveness, by increased outsourcing. No further support, however, for Hypothesis 2d was found: measurement difficulty had no effect on the decision variable of whether companies had rejected outsourcing as an alternative. Furthermore, the effect of measurement difficulty on the make-or-buy decision was not consistent across models. The absence of measurement accuracy effect in these latter findings is broadly consistent with Hypothesis 2c, which argues that because measurement accuracy has equivalent effects internally and externally that governance choices will hinge on other factors.

Consistent with Hypothesis 5 and the performance equations in Table 4, managers were less likely to reject the outsourcing alternative if the information services required extensive skills. This effect, however, appears to depend on model specification: activities requiring extensive skills increased the likelihood of outsourcing (for percentage outsourced, $\beta = 2.80$, $p < 0.01$ (Model 2); for the dichotomous make-or-buy decisions, $\beta = 0.093$, $p < 0.05$ (Model 5); for the decision to reject outsourcing, $\beta = 0.139$, $p < 0.01$ (Model 8)). This effect disappeared, however, when the type of information service was controlled for in the regression analysis (for percentage outsourced, $\beta = 1.11$, $p > 0.05$ (Model 3); for the dichotomous make-or-buy decisions, $\beta = -0.021$, $p > 0.05$ (Model 6); for the decision to reject outsourcing, $\beta = 0.057$, $p > 0.05$ (Model 9)). The relevant variance in skill sets appears to occur across, not within, IS functions.

Consistent with our lack of a hypothesized direction and consistent with the results found in Table 4, we found no clear support for the effect of technological uncertainty on governance choice (Hypothesis 3): technological changes did not appear to affect outsourcing decisions (Models 2, 3, 5, 6, 8, and 9). However, Models 1, 4, and 7, which did not control for the magnitude of the skill set and for the IS dummy variables, confirmed a significant positive effect of technological uncertainty for two of the three dependent variables. High technological uncertainty in Models 1 and 7 encouraged outsourcing. Skill set appears to capture the relevant variance in technological uncertainty; the correlation between these two measures was 0.65. However, removing *skill set* from the performance equations found in Table 4 did not yield significant coefficients for *technological uncertainty*.

Table 4 also confirms that the effects of internal scale are consistent with Hypothesis 4 and with the performance equations. Firms possessing internal scale sufficient to enjoy economies of scale were more likely to provide services in-house and were more likely to have rejected the outsourcing alternative (this finding is consistent across all model specifications for each dependent variable and has corresponding *p*-values of less than 0.05). Firm size appears to increase the likelihood of outsourcing an entire IS function (probit Models 4–9) and appears to discourage the outright rejection of outsourcing as an option. Firm size, however, had no significant effect on the percentage of a service that was outsourced. Finally, the results of the OLS model showed that the following IS activities were most likely to be outsourced: network design, training and education, application maintenance, and application development. These results were not surprising. Training and education, application maintenance, application development, and network design require skills and capabilities that were rapidly changing and were generally not company-specific.

Other analyses

We took several steps to check the statistical validity of the findings reported in Tables 4 and 5. First, we standardized the scores for each key informant, given the informant's scores for each variable (in effect, we computed a *z*-score for

each variable, given the respondent's scores on that variable for each of the nine IS activities). It was possible that respondents' idiosyncratic uses of the scale generated variation that was captured by the hypothesized effects. Respondents might have also demonstrated a negative or positive bias when evaluating the performance of in-house and outsourced IS activities. By computing a z-score, we reduced these biases. Comparisons of the analyses for standardized and nonstandardized responses indicate that the interpretations of the hypothesized effects were not different.

Second, we included additional controls in the regression models. We controlled for the type of industry since industries may have different practices or constraints that affect information services, outsourcing, and performance. We also controlled for the background of the chief information officer (e.g., finance, systems and programming, or operations) since his/her functional orientation may bias the performance or outsourcing of information services. In addition, since key informants could have different information about IS, we controlled for their position. None of these controls affected the interpretation of the hypothesized effects. Therefore, for simplicity, these controls were not included in the models found in Tables 4 or 5.

Finally, we tested whether our results in the performance equations were sensitive to our differing treatment of applications development and applications maintenance from the remaining IS functions. The significant parameter estimates for asset specificity were consistent across both types of information services. Furthermore, results of the probit equations of Table 5 (columns 4–7) were significantly improved when applications maintenance and applications development were classified using the 75 percent cutoff.

DISCUSSION

TCE vs. knowledge-based theories of the firm: Asset specificity and governance

Our results provide strong support for the central explanation of boundary choice in TCE: increasing asset specificity leads to the diminishing effectiveness of market governance. Our results suggest that significant performance losses accrue as firms choose to coordinate firm-specific IS activities in the market. Markets simply lack

effective mechanisms for resolving coordination problems and opportunism that arise as exchanges become increasingly specialized. By contrast, our results fail to support the widely advanced knowledge-based critique and reinterpretation of TCE findings.[11] Contrary to the prediction of this critique, the effect of escalating the firm specificity of an IS activity had no significant effect on the performance of internal exchanges. Indeed, where evident, the effect was directionally negative.

In our view, this finding is not surprising in this empirical setting and suggests the need for refinement in knowledge-based explanations of boundary choice (Zenger and Poppo, 1997). When underlying technological change is rapid, as is the case in information services, internal routines, language, and embedded forms of knowledge may easily become rigidities that hamper performance. Unique language, while efficient, may quickly become the wrong language. For instance, while the routines and language surrounding mainframe computer systems and long-entrenched software promote efficient dialogue and governance within a firm, such language and routines also deter the acquisition of critical new knowledge which requires a fundamentally new language and set of routines. Under some circumstances, therefore, increasing the firm specificity of an internal activity simply damages performance.

Our contention is that a knowledge-based explanation of boundary choice requires contingent reasoning. Hierarchies are largely unstoppable engines of cospecialization yielding increasingly firm-specific language and routines. To the extent that cospecialization generates language and routines that prevent the acquisition of new knowledge sources, then internalizing activities can destroy value for the firm. Thus, similar to transaction cost logic, the boundary choice from a knowledge-based perspective is driven by an estimate of the benefits from cospecialization—the benefits from highly firm-specific language and routines. When valuable

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[11] It is important to keep in mind that our results do not diminish the potential importance of differential capabilities as an explanation for boundary choice. As discussed previously, cross-sectional research designs cannot adequately explore differential capabilities as a competing explanation. Our test of the knowledge-based theory of the firm is restricted to the recent and widely published reinterpretation of the relationship between asset specificity and boundary choice.

knowledge can be generated by the formation of firm-specific language and routines, hierarchy is preferred. When firm-specific routines and language generate impediments to the creation of valuable knowledge, markets are preferred. Markets, of course, also have clear advantages in generating incentives that motivate knowledge formation. Groups of individuals governed by markets are more likely to directly benefit from the formation of new knowledge.

We suspect that herein lies the explanation for the divergence between our results and those of Masten *et al.* (1991) and Walker and Poppo (1991), who find a positive relationship between asset specificity and hierarchical performance. These studies focus on settings where technological change, on average, was less frequent and, therefore, the value of firm-specific language and routines is more enduring. As a result, the probability of firm-specific routines and language becoming impediments to new acquisition is simply not as high. In our study, customization may indeed lower organizational costs, but this positive effect is negated by the rigidities and inflexibility imposed by such customized investments in rapidly changing technological environments.

Agency theory and measurement explanations

Consistent with the agency theory and property rights literature, our results confirm the role of measurement difficulty as a determinant of governance performance in both markets and hierarchies. Difficulty in measuring the internal performance of an activity leads to assessments of lower internal performance along all dimensions—cost, quality, and responsiveness. This finding is entirely consistent with the predictions of principal–agent models. Imprecise measurement constrains the incentive intensity of rewards and low-powered rewards limit performance. While managers may employ centralized decision making and behavioral monitoring to mitigate measurement problems, these governance devices appear to fail as output measures become increasingly imprecise.

Our results are less consistent in demonstrating that measurement difficulty damages the performance of markets. Consistent with predictions in the property rights literature, measurement difficulty appears to strongly damage cost

performance. However, contrary to prediction, measurement difficulty has only insignificant negative effects on quality and responsiveness as performance measures. Perhaps reputations for quality and responsiveness are important for vendors to maintain even when measurement difficulty creates opportunities for short-term gains.

Do boundary choices matter?

Our results provide clear support for the theoretical arguments that hierarchies and markets possess discretely different sets of governance tools. All of the exchange attributes examined, other than technological uncertainty, had significantly different effects on the performance of market governance compared with the performance of hierarchical governance. Consequently, consistent with theoretical work recognizing discrete differences between markets and hierarchies (Holmstrom and Milgrom, 1991, 1994; Williamson, 1991b), the study provides strong evidence that boundary choice matters; markets and hierarchies possess distinctly different capacities to govern exchanges with various exchange attributes. Thus, while it remains important to examine the combinations of market and hierarchical elements that compose intermediate forms, our results suggest that these two governance forms possess distinctly different capacities to cope with or exploit various exchange attributes.

Consistent with this conclusion, the results confirm that while escalating asset specificity damages markets, hierarchies are quite unaffected. The results further suggest that, as a consequence, increases in the firm specificity of an activity cause managers to integrate; decreases in specificity cause managers to deintegrate.

The results for measurement accuracy present a somewhat more confusing picture. While markets and hierarchies present consistent differences in their capacity to cope with measurement difficulty, the direction of these differences are inconsistent, as noted previously. As measurement becomes more difficult, markets increasingly fail to deliver vendors with acceptable cost performance. Consistent with the discrete choice hypothesis, hierarchies similarly fail, but to a *lesser* degree, presumably because they can substitute monitoring for output measurement (Holmstrom and Milgrom, 1994). Also, consistent with this discrete choice prediction, we find that managers

are more likely to choose hierarchy when performance measurement is difficult. However, as discussed previously, the comparative magnitude of the effects of measurement difficulty on both quality and responsiveness as performance measures is contrary to the direction of the discrete choice prediction. Measurement difficulty appears more problematic for hierarchies than for markets in yielding quality and responsiveness.

Technological uncertainty and performance

Our results are not informative on the role that technological uncertainty has on governance performance and optimal boundaries because this is the weakest hypothesized result. Increases in the level of technological uncertainty had no effect on performance, making it unclear how the comparative performance of such activities affects the boundary decision. We find, however, that managers are more likely to increase their level of outsourcing as changes in IS technology and skills become more rapid.[12] Given the absence of significant performance effects, the interpretation of this result is somewhat ambiguous. The results suggest that managers may respond to technological uncertainty in IS by seeking the flexibility of market governance. Organizations are simply less skillful at adapting to such radical changes. Or, consistent with Balakrishnan and Wernerfelt (1986), rapid levels of technological change render internal routines obsolete, decreasing any motive to vertically integrate.

Limitations

Our choice of empirical setting raises some theoretical and methodological issues. At the time of examination, information services as an industry and internal activity were changing rapidly. Managers were actively shifting boundaries and changing the nature of their activities. This setting is considerably different from the rather stable industries and settings, which characterize most studies of make-or-buy decisions. This greater rate of change in IS is of some concern because

our model assumes that decision-makers are operating under norms of rationality: they can make comparative assessments of performance. For many IS executives, however, this may have been a difficult task due in part to unfamiliarity with outsourcing. Moreover, executives may have had trouble establishing performance benchmarks because of the high levels of technological uncertainty and change. Thus, while one benefit of this empirical context is that most IS executives were actively considering the boundary choice, it suffers from the noise introduced by industry dynamism. The fact that our empirical results confirm many of our hypotheses and are consistent with previous empirical studies is encouraging. Still, the non-equilibrium state of this industry is unique and warrants empirical verification in other dynamic industry settings.

Our study is also not a comprehensive test of all knowledge-based theories that address boundary decisions. As we mention earlier, we only test the increasingly prominent stream of knowledge-based reasoning in which efficiencies accrue from asset specialization at the transaction level of analysis. Other knowledge-based explanations for boundary choice that emphasize hierarchy's capacity to substitute authority for education require alternative forms of empirical testing (Conner and Prahalad, 1996; Demsetz, 1988). Similarly, our study does not address the fact that knowledge-based explanations may be more applicable to core functions of the firm than to peripheral functions within which IS often falls.

CONCLUDING COMMENTS

While there has been clear theoretical and empirical progress in our understanding of boundary choice, important gaps remain. Further work needs to extend our understanding of how, when, and why markets and hierarchies are discretely different. What impedes hierarchies from fully replicating markets internally or markets from adopting vast elements of hierarchical control? Further work also needs to explore explanations for hierarchical failure. TCE and recent knowledge-based theories have focused primarily on the failures of markets and the contrasting virtues of hierarchy. However, the focus of these theories on directionally explaining vertical integration seems at least somewhat misplaced given the

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[12] This finding is sensitive to model specification. It appears the skill set and technological uncertainty account for similar variance when predicting the percentage of outsourcing for a given activity. When skill set is added to the model, the technological uncertainty effect drops to an insignificant level.

apparent trends in recent decades toward disintegration, downsizing, and refocusing (Zenger and Hesterly, 1997). Theoretical efforts to understand and document shrinking boundaries have been limited. We believe a complete theory of the firm requires a deeper understanding of organizational costs—costs that restrain the size of firms and restrain their capacity to internally bundle capabilities and activities. Until theories of the determinants of organization costs are carefully crafted and empirically explored, our theory of the firm remains significantly underdeveloped.

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APPENDIX: Comparison of sample to population of companies with annual data-processing budgets of $250,000 or more and *Fortune* 500 companies

	Percentage	
	Sample	Population
A. Industry		
Banking	10.6	11.8
Diversified financial services	17.2	10.1
Insurance	17.9	14.9
Manufacturing	35.1	50.0
Retail	19.2	13.3
B. Geographic location		
Northeast	29.8	28.2
West	18.7	13.7
South	22.0	26.5
Mid-West	29.5	31.6