DETERMINANTS OF GOVERNANCE CHOICE IN BUSINESS-TO-BUSINESS ELECTRONIC MARKETS: AN EMPIRICAL ANALYSIS

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ABSTRACT

IT-enabled exchange in electronic markets has significant implications for buyer-supplier relationships. Use of electronic reverse auctions in the procurement process implies buyer willingness to deal with larger numbers of suppliers and thus provides an opportunity to test governance predictions of the widely cited ‘electronic markets hypothesis’ (EMH) and ‘move to the middle hypothesis’ (MMH) in the information systems literature. Building on previous research that emphasizes the role of intangible assets in inter-organizational relationships, this study argues that buyers are less likely to use reverse auctions for supplier relationships involving a high degree of non-contractibility, complementing traditional transaction cost arguments that focus on the impact of asset specificity. We operationalize six dimensions of non-contractibility: quality, supplier innovativeness, information sharing, responsiveness, trust, and flexibility. The results show that non-contractibility helps explain the selective use of reverse auctions by buyers and has greater explanatory power than asset specificity. This study provides evidence for the importance of supplier investments in non-contractible elements of exchange relationships in the modern economy.

Keywords: Electronic Markets, Reverse Auctions, Transaction cost economics, Inter-organizational relationships, Resource based view.
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1.0 INTRODUCTION

Newly emerging Internet-based supply chains have created opportunities for many buyers and suppliers to deal with each other electronically, while at the same time posing difficult questions concerning the nature of supply relationships. Industry observers have reported significant cost saving potential through use of electronic market reverse auctions, such as Covisint and FreeMarkets (Fox 2001). However, buyers face a dilemma in switching from traditional supply relationships to electronic reverse auctions because using such markets imperils their relationships with existing suppliers (Dai and Kauffman 2001; Hart and Saunders 1998). Indeed, early use of reverse auctions by buyers has fallen far below expectations. Several ventures that began with highly optimistic projections have failed and firms have become more cautious in using electronic markets (Hayes 2002). Perhaps the most common explanation for the limited success of arms length mechanisms such as reverse auctions draws on the notion of asset specificity (Malone, Yates and Benjamin 1987), emphasizing that the IT-mediated exchange may not suit relationships that require substantial investment in specialized assets. However, a second class of problems that arise from the need for non-contractible commitments such as quality and trust may be at least as large a barrier as asset specificity (Bakos and Brynjolfsson 1993a; Bakos and Brynjolfsson 1993b). These different explanations reflect differing assumptions concerning the key elements of IT-mediated exchange and imply differing expectations of how buyer-supplier relationships in electronic markets will evolve.

This paper uses the emergence of Internet-enabled markets as an opportunity to explore arguments about governance structures that arise in two views of information technology: the ‘electronic market hypothesis’ (EMH) and ‘move to middle hypothesis’ (MMH). The EMH (Malone, Yates and Benjamin 1987) posited that greater use of information technology will
Determinants of governance choice cause a shift towards markets relative to hierarchies for economic transactions, owing to reduced asset-specificity in buyer-supplier transactions. Asset specificity involves assets that require specialized investments (Williamson 1985). The notion of markets in EMH implies that buyers will tend to interact with many suppliers in order to minimize procurement costs. The MMH perspective (Clemons and Row 1992) contrasts with the EMH argument. ‘Move to the middle’ refers to the movement from two ends of the spectrum, i.e., away from both hierarchies and markets toward the middle territory of a small number of long-term buyer-supplier relationships. Although MMH agreed with the ‘move to market’ part of EMH, MMH predicted that the use of electronic markets will lead to establishing long-term relationships with a few suppliers, owing to the presence of non-contractible issues in many supply relationships. Non-contractible factors are product or supplier characteristics that buyers can observe but that third parties such as courts cannot easily verify, so that non-contractible factors are difficult to specify in contracts. Examples of non-contractible factors in a buyer-supplier relationship include quality, supplier innovativeness, information sharing, responsiveness, trust, and flexibility. Despite calls for an empirical examination of the EMH and MMH (Bakos and Brynjolfsson 1993b), and particularly their conflicting predictions about how information technology will affect the number of suppliers that buyers deal with, no rigorous empirical work has tested their predictions in the context of the use of electronic markets. Reverse auctions provide an opportunity to examine firms’ use of market-based mechanisms to procure goods and services. During the 1980s and early 1990s, firms in many industries reduced their supplier bases, in part because of the proprietary use of available inter-organizational IT systems (Steinfield, Kraut and Plummer 1995). Newer IT systems that reflect open standards, such as reverse auctions, now allow buyers to interact with and choose from multiple suppliers. Use of such reverse auctions denotes the willingness of buyers to use larger
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number of suppliers. Thus, studying buyer willingness to use reverse auctions allows us to test
governance predictions of the EMH and MMH.

The research also has practical implications. Buyers face a tension in choosing the
optimum number of suppliers. Having fewer suppliers improves co-ordination but also creates
potential for hold-up by suppliers (Gosain, Malhotra and El Sawy 2004; Grover, Cheon and Teng
1996; Hart and Saunders 1998). Firms need to know how the use of electronic markets such as
reverse auctions affects the balance between collaboration benefits and hold up risks.

We undertook a study of reverse auction use by U.S. automotive assemblers and
component manufacturers. The study included discussions with executives to shape the
theoretical model and provide contextual details, followed by a detailed survey of firms in the
industry. The study finds that both asset specificity and non-contractibility influence reverse
auction use, with non-contractibility having greater influence.

2.0 BACKGROUND AND HYPOTHESES

2.1 Electronic Markets and Hierarchies

Transaction cost economics (TCE) provides an initial theoretical lens to assess trends in
governance structure. The transaction costs literature argues that firm boundaries are determined
by a trade-off between production cost advantages of outside procurement in market
relationships and the transaction cost advantages of internal production within hierarchies (Ang
and Straub 1998; Grover, Cheon and Teng 1996). Markets and hierarchies entail different levels
of production and transaction costs. Markets may offer lower production costs because of
economies of scale or specialization, but these advantages come at the expense of higher
transaction costs. The transaction costs arise because of dedicated investment in specialized
assets. Environmental uncertainty, bounded rationality of economic agents, and partners’
potential for opportunistic behavior lead firms to employ a variety of safeguards to protect their
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specialized investments (Williamson 1985). These safeguards range from formal mechanisms such as financial or specialized investment hostages (Klein and Leffler 1981) to informal mechanisms such as relational trust and reputation (Dyer 1997).

Information system researchers have used the transaction cost perspective to argue that growing use of information technology may affect the mechanisms that firms choose to govern their inter-firm relationships. Malone, Yates and Benjamin (1987) suggested that information technology reduces transaction costs because flexible manufacturing technology reduces investment in specific assets, facilitates product description, and reduces communication and information processing costs. Although this argument recognized that electronic hierarchies might be desirable when asset specificity is high, the principal prediction was that information technology would cause increased use of market outsourcing. This prediction is known as the electronic markets hypothesis. Malone et al. (1987: p.495) suggested that “electronic hierarchies frequently develop into biased, then unbiased markets when the products themselves are not asset specific and are easily described in standardized terms”. They further noted “in the long run, the significant additional benefits to buyers possible from the electronic brokerage effect will drive almost all electronic markets toward being unbiased channels for products from many suppliers (p. 491).” The basic premise of the EMH was that information technology would lead to lower transaction costs, both because of reduction in specialized investment in production assets and because of greater ease of inter-firm communication, which in turn would lead to greater reliance on arm’s length relationships with many suppliers.

Subsequent research has qualified the governance implications of the EMH, arguing that information technology innovation will not necessarily lead firms toward arms length market relationships involving many suppliers. Clemons et al. (1993) agreed with the EMH that information technology would lead to a contraction in firm boundaries. However, they argued
that the contraction would influence firms to move toward long-term relationships with a smaller
set of suppliers. The authors referred to such a combination of greater outsourcing but with a
reduced supplier base as the move to the middle hypothesis.

At the core of the MMH is the notion that a reduction in asset specificity and an increase
in the ease of communication are not sufficient to lead to arm’s length relationships with many
suppliers. The MMH argues that firms will use fewer suppliers to leverage transactional
economies of scale and to provide incentives to suppliers to invest in non-contractible aspects of
the relationship. The MMH also argues that search benefits decline as products become more
complex and service intensive. Analytical work by Bakos and Brynjolfsson (1993a; 1993b)
provided conceptual support for the MMH. They argued that tightly coupled operations
supported by IT require increased investments by suppliers in non-contractible resources that
support the relationships with buyers. Suppliers will tend to invest in non-contractible aspects of
relationships if buyers restrict their options ex-ante by committing to a smaller supply base.

The MMH argument emerged at a time when the use of electronic data interchange (EDI)
was growing. As such, it is possible that the characteristics and limitations of EDI influenced the
MMH reasoning and associated predictions. The capital-intensive nature of EDI entails
significant investments by suppliers, which are not always willing to invest in relationship-
specific investments for a particular buyer. With the advent of the Internet, however, more
flexible technology may provide greater latitude in the choice between hierarchical or market
governance, depending on the strategy and preferences of a firm (Steinfield, Kraut and Plummer
1995). It is in this context that internet-enabled reverse auction marketplaces provide an
opportunity to resolve the apparently competing predictions of EMH and MMH regarding
buyers’ willingness to use large or small number of suppliers in market exchange.
2.2 Use of Reverse Auctions for Testing the EMH and MMH

Reverse auctions are a particularly relevant form of electronic procurement mechanism for this study. Other electronic mechanisms – such as Internet-based EDI or joining private marketplaces that industry consortium operate in order to enforce common standards – largely transfer existing exchanges with current suppliers to an alternative network. These other electronic procurement mechanisms do not provide information regarding whether buyers are willing to interact with a larger number of suppliers. In contrast, the use of reverse auctions, as a potent signaling mechanism, informs us about buyers’ willingness to use a larger pool for their supplier base and, therefore, is relevant for testing the EMH and MMH arguments.

Empirical research in inter-organizational information technology systems has focused on questions about the use or effect of inter-organizational systems (Chatterjee and Ravichandran 2004). Much of the research on inter-organizational networks uses case studies (Choudhury, Hartzel and Konsynski 1998; Clemons and Row 1992; Dai and Kauffman 2001; Hart and Estrin 1991; Hart and Saunders 1997; Hess and Kemerer 1994; Kambil and Heck 1998). A few large scale studies have used surveys to study inter-organizational networks but these studies focus on EDI systems that relied on proprietary networks and applications (Monczka, Peterson and Handfield 1998; Mukhopadhyay, Kekre and Kalathur 1995; Mukhopadhyay, Rajiv and Srinivasan 1997). Recent work by Hart and Saunders (1998) and Subramani (2004; 2003) studies conditions under which suppliers are likely to use EDI systems and benefit from such use. More recently, researchers have explored issues related to bidder heterogeneity and trust building in electronic markets (Ba and Pavlou 2002; Bapna et al. 2004). However, much of the recent research in electronic markets concerns business-to-consumer transactions and there is limited work in the business-to-business domain (Pavlou and Gefen 2004; Wood 2004).

Few large-scale studies have compared the governance implications of the MMH and
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EMH. Among early works, Hess and Kemerer (1994) used five detailed case studies to study adoption of computerized loan origination systems, but did not find conclusive evidence supporting the EMH. Steinfield, Kraut and Plummer (1995), based on their review of literature, noted that: “While Malone and his colleagues (1987) predicted that in the steady state, greater use of inter-organizational networks would lead to more market-like relationships among firms, the empirical evidence … does not support this expectation (p. 9).” Steinfield, Kraut and Plummer (1995) also observed the limitations of EDI based studies in resolving governance based predictions of the EMH and MMH and noted that: “It is useful … to explore the outcome of earlier experiences with ubiquitous data networks, in order to better understand the dynamics of electronic commerce on the Internet and other future electronic commerce platforms (p. 10).”

2.3 The Influence of Asset Specificity and Non-Contractibility on Governance Structures

This study examines the governance predictions of EMH and MMH by assessing the relative influence of asset specificity and non-contractibility on reverse auction use. If the EMH applies, then the most relevant issue that will determine whether buyers use reverse auctions is the degree of asset specificity underlying the products that buyers purchase from suppliers. In the EMH view, buyer-supplier relationships that require general investments, involving little asset specificity, will suit reverse auctions. Relationships that require substantial asset specificity will not. Among empirical studies, Choudhury et al. (1998) lent support to this argument based on a case study of the aircraft parts industry. They noted that electronic markets have limited value for transactions involving products that require specialized investment. By contrast, if the MMH applies, then the degree of non-contractibility in the exchange relationship between the buyer and supplier also will affect whether buyers use reverse auctions. Asset specificity may be a less important issue in such cases. Indeed, asset specificity is not a problem if firms can write complete contracts to govern the exchange processes, even if the relationships involve highly
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dedicated assets. Arms length agreements such as reverse auctions would be most uncommon when the issues associated with non-contractibility are more salient in the exchange relationship.

Despite potential correlation between non-contractibility and asset specificity, the two concepts differ conceptually. Asset specificity does not always imply non-contractibility. If buyers and suppliers can contract on the contingencies that might arise in a relationship, then even a dedicated asset can be made fully contractible and will not pose an opportunism-related hazard to the contracting parties. However, if the parties cannot write a fully contingent contract for even a general asset, then one or both the parties will be exposed to the requirements of non-contractible performance parameters.

To illustrate further, consider an auto component manufacturer (A) that buys slit and cut-to-length steel sheets from a steel service center (B). Although B may not have invested in slitting or cut-to-length production lines specifically for A’s requirements, so that its investments involve general assets, during the course of working together B may gain a better understanding of A’s requirements than what A could specify in a contract. Thus, B’s understanding of A’s operations is a non-contractible parameter that does not involve asset specificity. This example illustrates a case in which non-contractibility arises in a relationship without a supplier having to make specific investments to support particular transactions for a buyer.

The relative importance of non-contractibility and asset specificity becomes particularly critical when buyers need unspecifiable exchange support from suppliers. Typically, non-contractibility becomes more salient when the degree of uncertainty concerning the nature of the support that the firms will need to provide each other rises to such an extent that parameters such as performance guarantees and non-compliance penalties become vague and impossible to enforce. Such issues are common in many modern supply relationships, particularly those involving products that face ongoing changes in underlying technology or in the nature of market
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1 demand. The role of non-contractibility becomes even more important as the service sector
grows in the modern economy, even as information technology and flexible manufacturing
technologies are progressively causing a decline in asset specificity (Milgrom and Roberts 1990).
Thus, there is a need to focus on the effects of the intangible and largely non-contractible aspects
of underlying relationships that may not co-vary with transaction specific investments.

2.4 Hypotheses

The discussion gives rise to two hypotheses, one related to asset specificity and the other
to non-contractibility. It is possible that both hypotheses will hold, if elements of asset specificity
and non-contractibility in a relationship complement each other in their influence on use of
reverse auctions. Alternatively, one effect might dominate the other.

In predicting a ‘move to market’, with an implicit use of a large number of suppliers,
EMH focuses on specificity of the assets that underlie an exchange relationship. This gives rise
to the first hypothesis. Evidence in favor of hypothesis 1 would support the EMH.

Hypothesis 1. The greater the asset specificity in an exchange relationship, the less likely
that buyers will use reverse auctions in electronic markets.
The EMH does not address the non-contractible elements of inter-organizational
exchanges, particularly the generation and accumulation of firm-specific routines and
capabilities to provide competitive advantage. We posit that analysis of how information
technology affects governance mechanisms must consider these aspects of a relationship.

Evidence for hypothesis 2 would support the MMH.

Hypothesis 2. The greater the non-contractibility in an exchange relationship, the less
likely that buyers will use reverse auctions in electronic markets.

2.5 Multi-Dimensional Attributes of Non-Contractibility

Before moving to the empirical setting, we develop the notion of non-contractibility
further, treating it as a multi-dimensional concept. We draw on prior research to identify non-
contractible relationship characteristics that are common in many settings. We focus on six non-
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contractible characteristics: quality, supplier innovativeness, information exchange, responsiveness, trust, and flexibility.

Conceptually, non-contractibility has two related dimensions: task and interaction. The task dimension of non-contractibility is important for ensuring product quality, while the interaction dimension is important for relationship longevity. We view quality, supplier innovativeness, and information exchange as task elements of the exchange relationship. In parallel, we view responsiveness, trust, and flexibility as interaction elements of non-contractibility. Thus, we posit non-contractibility as a second order latent construct that contains two sub-dimensions. In turn, six first order characteristics of non-contractibility reflect these two sub-dimensions. We outline the conceptual background of the first order elements of non-contractibility here and validate their measurement in the empirical section.

Quality. Quality is a non-contractible aspect of a buyer-supplier relationship because quality typically encompasses attributes that satisfy customers’ unstated needs. While contracts can easily specify some quality attributes, such as tolerances and defect rates, many other attributes – particularly those relating to ‘fit’ or relative ‘customization’ for a specific buyer – typically remain unstated because of difficulty in specifying them ex-ante. Even for a commodity product such as steel, buyers often prefer a particular steel plant, even though product specifications that competing steel plants offer may be the same (Deming 1993: 140). Given that specifying all desired quality parameters is costly and in some cases impossible (Barzel 1982), buyers are less likely to use reverse auctions to chose suppliers when quality is critical for the performance of the end product.

Innovativeness. Buyers competing on innovation and newer technologies need to develop partnerships with selected suppliers. Such partnerships encourage suppliers to support ongoing innovation and adopt newer technologies. Helper (1991) conducted a survey of supplier
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relations in the US and Japan, and found that the presence of long term contracts was a
significant determinant of adoption of technologies such as CAD/CAM and CNC machines. She
argued that “higher levels of information sharing and commitment…encourage suppliers to make
investments that enable them to improve performance in …product and process innovation”
(Helper 1991, p.16). Since use of newer technologies and willingness to support innovation are
discretionary investments by suppliers, innovativeness is non-contractible to the extent that
contracts cannot specify novel advances ex-ante.

Information Exchange. The need to exchange information as markets change is often a
non-contractible feature of buyer-supplier relationships. The ability to adapt products and
sourcing arrangements depends on the ability of buyers and suppliers to share tacit knowledge,
which in turn benefits from hierarchy or long-term supplier relationships. Continuity of
association facilitates sharing tacit knowledge because accumulating firm-specific and person-
specific information causes emergence of “one single organization specific dialect” (Monteverde
within a supplier network via a learned and shared code. Helper (1991), Takeishi (2001), and Rai
et al. (2003) have argued that increased communication and integrated problem solving are
important for improving design quality and overall performance. It is difficult to specify the
exchange of specific contextual knowledge and to mandate and enforce all the desirable
information exchanges in a contract, making such information exchanges a non-contractible
parameter of a buyer-supplier relationship.

Responsiveness. The increasing demand for responsiveness to meet changing customer
expectations and address heightened competition has led firms to evolve specialized governance
mechanisms that resemble neither market nor hierarchy arrangements. Johnston and Lawrence
(1988) provide a rich description of such hybrid mechanisms, defining value-adding partnerships
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as a set of independent companies that work closely together to manage the flow of goods and services along the entire value-added chain. Value-adding partnerships arise as hybrid governance mechanisms between markets and hierarchies. Each of the companies in a value-adding partnership has an incentive to stay in touch with environmental changes and be ready to react quickly, because otherwise it could lose business to other producers. Responsiveness influences governance mechanisms because each player in the value-added chain has a stake in the others’ success. This success in turn requires the ability of a unit to tailor aspects of its organization, such as personnel, plant, compensation schemes, career tracks, accounting systems and management styles, to the task at hand. The ability of a supplier firm to customize its production and delivery systems for a customer helps the buyer reap the positive aspects and avoid the negative impact of markets and hierarchies. Since responsiveness has a dynamic and contextual meaning, it is costly to specify the level of responsiveness for each contingency in a contract, thereby giving it a non-contractible character.

Trust. Trust is a non-contractible attribute of a relationship. Moorman et al. (1992) define trust as “the willingness to rely on an exchange partner in whom one has confidence (p. 315).” Trust facilitates coordination and leads to lower transaction costs (Barzel 1982; Dyer 1997: 548; Gulati, Nohira and Zaheer 2000: 209). Researchers distinguish between deterrence and knowledge-based trust (Gulati 1995; Kale, Singh and Perlmutter 2000), where knowledge-based trust is non-contractible. Several studies confirm the role of trust and coordination in cooperative relationships (Monczka, Peterson and Handfield 1998; Smith, Carroll and Ashford 1995). Barney and Hansen (1994) have argued that trust can be a source of competitive advantage for firms. Buyers will be reluctant to replace trusted suppliers, given that trust building occurs over a period of time and involves substantial costs.

Flexibility. Flexibility refers to the ability of a partner to adjust its behavior or the terms
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of an agreement to respond to changes in the environment or to the needs of its partners (Heide and John 1992). Flexibility is a non-contractible parameter because it is a reaction to unexpected situations that are not enumerated in the contract. Given the bounded rationality of partners, the viability of a relationship may depend on the flexibility with which partners can modify and go beyond the terms of the contract for continued value creation. Conner and Prahalad (1996) suggest that the flexibility with which people can change responsibilities on an ongoing basis, in order to respond to new learning or other unexpected situations, may determine the choice of organizational mode. In their view, hierarchies offer greater flexibility compared to markets because an employment contract need not be renegotiated to alter the duties of an employee.

Conner and Prahalad (1996, p.488) argue that the cost of implementing flexibility under a market contract is higher than under firm organization, such that “firm organization is more likely to be preferred on knowledge-based flexibility grounds, the more dynamic and uncertain is the competitive environment.” We extend this reasoning to governance structure of outsourcing relationships and argue that buyers valuing flexible suppliers are less likely to risk entering new contracts instead of negotiating more favorable contracts with their existing suppliers.

3.0 RESEARCH METHODOLOGY

3.1 Research Setting

The U.S. automotive industry, with a market size of about $600 billion, is an appropriate setting to examine the use of reverse auctions because of the variation in the type of components and firm characteristics within the industry. Over the past decades, U.S. based automakers have lost market share to Japanese producers. One reason for the success of Japanese automakers is a close partnership between these automakers and their suppliers (Martin, Swaminathan and Mitchell 1998). In response, U.S. based automakers moved towards closer relationships with their suppliers, leading to consolidation within the supply chain (Cusumano and Takeishi 1991;
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Mudambi and Helper 1998). Supplier consolidation has helped forging of closer relationships between OEMs and their suppliers, particularly through use of information technologies such as EDI. However, many suppliers stayed outside collaborative networks because of the significant set up costs and commitment that EDI technology required.

Against this backdrop of supply chain consolidation, newly emerging internet-based electronic markets pose serious questions for purchasing executives. The flexibility of newer technologies allows interconnections with a much larger global supply base promising competition induced savings. However, indiscriminate use of such technologies might nullify efforts in consolidating the supply chain as well as cancel any gains that accrue by dealing with a smaller set of more familiar incumbent suppliers.

The unit of analysis in this research is the buyer-supplier relationship for products involving varying degrees of asset specificity and non-contractibility. We obtained data from business units that make independent procurement decisions. Because reverse auctions are a recent phenomenon, our analysis requires interviews and surveys of managers, rather than archival data. Following initial interviews, we collected the data through a survey of U.S. based automotive assemblers and component manufacturers.

Survey development proceeded in four phases. First, several faculty members, doctoral students, industry executives, and survey methods consultants reviewed the questionnaire for content, wording, and understandability. Wherever applicable, we used existing measurement items to develop constructs, modifying them for the context of this study. Early in the conceptual development of the study, one of the authors worked with a tier-one automotive component manufacturer in developing their reverse auctions strategy. Interactions with purchasing executives and reverse auctions vendors during the engagement helped ensure the face validity of the items we developed. Second, we refined the questionnaire based on feedback received
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from our interactions with industry executives and automotive industry researchers during a major industry conference in August 2001. Third, we pre-tested the refined version of the instrument from phase two with a random sample of thirty suppliers selected from an automobile industry database. Fourth, after incorporating changes based on the responses in the pretest, we administered our instrument to firms in the automotive sector during the winter of 2002.

3.2 Dependent Variable

Likelihood of reverse auction use (RAU): Each respondent firm rated the likelihood of using reverse auctions for two categories of production goods (commodity and specialized types of production goods) with varying degrees of asset specificity and non-contractibility. We defined production goods as items that buyers use directly in manufacturing their end products. Examples of commodity production goods are forgings, castings, steel, copper, and plastic resin; examples of specialized production goods are engineering applied polymers, engineered mold plastics, injection molded parts, and specialty chemicals. We distinguished between these classes to control for the conventional explanation that commodities suit reverse auctions better than specialized goods. Each respondent evaluated the likelihood of using reverse auctions on a 1 to 7 scale (one=low likelihood, seven=high likelihood).

3.3 Independent Variables

Asset specificity (AS): We measured asset specificity through a five-item scale capturing specific equipment (Dyer 1997; Mudambi and Helper 1998), labor skills (Walker and Poppo 1991), business processes (Zaheer and Venkatraman 1994), JIT requirements, and product customization (Bensaou and Anderson 1999).

Non-contractibility (NC): We developed a new scale to assess the non-contractibility items that we described in the previous section, because the concept has received little empirical attention. In developing our scale, we relied on prior conceptual descriptions and empirical
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measures of elements of non-contractibility. We verified the content validity of the items through expert appraisals and discussions with key informants from buyers, suppliers, and electronic marketplace organizations. Later, we describe the convergent and discriminant validity of the items developed for this research.

Table 1 shows the definitions of the six non-contractible dimensions. *Quality* contains three items: manufacturing quality of the product, the extent to which a product affects performance of other parts, and the risk a product poses in terms of warranty liabilities. *Innovativeness* contains three items: the need that a supplier stays abreast of technological developments, the need for continuous production innovation, and the degree to which a supplier develops new technology products critical to buyer success. *Information exchange* contains four items: the need for exchange of buyer’s proprietary information related to products, the need for supplier’s proprietary information, the need for detailed information on cost structure, and the need for buyer participation in supplier’s planning and goal setting activities. *Responsiveness* contains three items: supplier’s proactive anticipation of buyer needs, supplier’s responsiveness to buyer requests, and the need for a supplier to keep the buyer updated on its requests. *Trust* contains three items: the willingness of the supplier to modify the contract, to make necessary adjustments on a continuous basis, and to go beyond the terms of a contract in fulfilling buyer needs. *Flexibility* contains three items: the willingness of the supplier to modify the contract, to make necessary adjustments on a continuous basis, and to go beyond the terms of a contract in fulfilling buyer needs.

We used five control variables to address alternative explanations for the use of reverse auctions. The commodity and specialty product distinction provided a measure of *product specialization*; some managers in our field interviews suggested that specialty products are less suitable for reverse auction compared to commodity products. Eight items measured *information
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system compatibility, by examining legacy investments (EDI technologies) and current web

technologies (Grover 1990b; Mishra, Konana and Barua 2001). We controlled for information

system compatibility because previous research suggests that firms with greater information

system sophistication are more likely to use newer technologies such as reverse auctions (Grover

1990a). Two items measured a firm’s supply chain strategy in terms of buyer orientation: a

relational orientation emphasizes developing long-term relationships with major suppliers

(Grover 1990a), while a transactional approach emphasizes frequent change of suppliers to gain

the better prices. We assessed the competitive strategy of a firm by measuring the extent to

which the firm emphasizes competing on cost or differentiation (Porter and Millar 1985). Firms

competing on differentiation may be less likely to use reverse auctions. Finally, we measured

firm size based on annual sales revenues, because larger firms may have greater ability to create

the infrastructure needed for mechanisms such as reverse auctions.

3.4 Sample and Data Collection

We used a list of automotive industry firms operating in the U.S. from the ELM database

(2001), a listing of more than fourteen hundred automotive assemblers and component

manufacturers. Of those, 706 met our sampling criterion of more than $10 million sales annually,

including assemblers and tier-one through tier-four component manufacturers. We mailed the

surveys during the winter of 2002 in two waves. The survey package included the questionnaire,
a cover letter explaining the purpose of the study and seeking the cooperation of participants, a
one-dollar bill as a token of appreciation for the respondent’s time and effort in filling up the

survey, and a return envelope. We assured confidentiality and promised that we would report

only aggregate results in any publication (Phillips 1981). We sent two follow-up reminders, two

weeks and four weeks after the first mailing.

To minimize key informant bias, we administered the surveys to the key executive
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responsible for the purchasing function for the firms in our sample. Such executives have a
vantage point for providing relevant data and are likely to be the most knowledgeable informants
(Bagozzi and Phillips 1982). This approach for relying on a single most knowledgeable
informant is consistent with the practice of previous studies (Zaheer and Venkatraman 1994). We
received responses from senior executives (typical designations were President, Senior Vice
President, Vice-President, Director, and Manager) responsible for purchasing, materials or
procurement. Because reverse auctions were generating excitement when we sent the survey and
many firms were thinking about participation in such auctions, the survey respondents could
knowledgeably assess the questions relating to the use of reverse auctions in their firms.

We received 152 responses. This response rate (22%) is reasonable and comparable to
previous empirical studies using survey questionnaires of firm activities. Table 2 shows the
characteristics of the respondent firms in terms of firm type (OEM v. component manufacturer),
annual sales, and number of employees. There was a reasonable distribution of firm types among
the respondents, with about 20% having OEM activities and the remaining being distributed
among four tiers of component manufacturers (most in the first and second tiers). There also was
a reasonable size distribution; about 60% had sales of less than $100 million or fewer than 500
employees, while the remainder ranged up to more than $1 billion in sales and more than 5,000
employees. In addition, 76% of the respondents were American-owned firms, while 24% had
Japanese ownership. Several automotive firms in our sample had made significant use of reverse
auctions and procured millions of dollars worth of production goods using such auctions.

We examined the data to assess potential issues related to non-response bias, common
method bias, merging of samples from two waves of survey administration, reliability, and
validity. To check for the non-response bias, we compared number of employees and annual
sales for the respondents and non-respondents. We did not find any statistically significant
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differences, suggesting that respondent firms form a representative sample of automotive firms in the US. We limited the risk that common methods bias might arise from respondents' concerns about social desirability and/or their implicit theories about the phenomenon by assuring our respondent of the anonymity of their response and by the fact the many of our predicted relationships are non-obvious at the level of individual items. We also used Harman's one-factor test which involves entering all the independent and dependent variable items into a factor analysis (Podsakoff and Organ 1986). The principal component factor analysis of all measurement items yielded several factors with eigen value exceeding one, accounting for 68 percent of the variance, while the factor with the greatest eigen value accounted for 27 percent of the variance. Since no single factor emerged as a dominant factor accounting for most of the variance, common method variance is unlikely to be a serious problem in the data.

We conducted a non-parametric Kolmogorov-Smirnov two-sample test on the dependent variable to check for any systematic bias in the wave 1 and wave 2 responses. A non-significant result implies that one can treat data from two survey waves as arising from the same population. The Kolmogorov-Smirnov test is more general than the two-sample t-test because it does not impose distributional assumptions. We merged the data obtained from the two waves of the survey because we found no evidence of any systematic difference between the two samples.

4.0 RESULTS

We used structural equation modeling to test our hypotheses. Structural models bring together psychometric and econometric analyses in the same framework. In addition, structural models permit us to model unobserved constructs and the measurement error associated with our variables explicitly. We used Lisrel version 8.52 for estimating measurement and structural models. Following the two-step approach that Anderson and Gerbing (1988) recommend, we first present the measurement model of the structural equation and then discuss estimates from
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alternative models that test our hypotheses.

4.1 Measurement Model: Reliability and Validity of Constructs

Use of multiple-item scales to measure latent constructs makes it necessary to assess the validity and reliability of scales (Anderson and Gerbing 1988). We base content validity on the selection of survey items based on past research, our fieldwork, and discussions with industry executives and researchers, as well as pre-testing of the instrument. To assess the reliability of the scale, we calculated composite reliability for each of the multiple items constructs (Appendix I shows the constructs and related items, Table 3 provides composite reliability estimates) and found these to be equal to or greater than the generally recommended value of 0.70 and well above the 0.60 threshold appropriate for newly developed scales (Nunnally 1988; Nunnally and Bernstein 1994).

Researchers have observed the difficulty in fitting structural models with a large number of items per latent variable (Williams and Hazer 1986). Bagozzi and Heatherton (1994, p.43) note that as the number of parameters and items increases, the model “can be unwieldy because of likely high levels of random error in typical items and the many parameters that must be estimated.” Given the large number of manifest variables and complexity of our research model, we adopted a partial aggregation approach for consolidating the manifest items of a latent variable into a smaller number of composite indicators (Bagozzi and Heatherton 1994). To construct a composite indicator for each sub-construct, we used the average score of the constituent manifest items corresponding to that sub-construct. This approach reduced the number of indicator variables for non-contractibility and reverse auction use to six and seven from the nineteen and twenty-four original manifest items. We used single composite indicators for information system compatibility, competitive strategy, and supply chain strategy.

Table 3 reports the measurement model for sub-dimensions of reverse auction use and
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non-contractibility, asset specificity, and other composite single indicator variables, while Table 4 reports the correlations between constructs. Table 3 reports the factor loadings and composite reliability for latent constructs. This measurement model evaluates the reliability and validity of constructs, based on a confirmatory factor analysis framework. The measurement model suggests that the measures satisfied the requirements of reliability and validity. As Table 3 shows, the significance of factor loadings for the effect indicators provides support for convergent validity of the respective scales. The overall measurement model provided an acceptable fit (Chi-square = 509.70, df=181, RMSEA=0.077, GFI=0.87, NFI=0.92, NNFI=0.93, CFI=0.95).

We assessed discriminant validity among latent constructs by comparing an unconstrained model to models with the pair-wise correlation among constructs constrained to one (Anderson and Gerbing 1988). The discriminant analysis shows that latent constructs are distinct from each other despite seemingly high correlations among sub-dimensions of non-contractibility and asset specificity. Support for discriminant validity ensures that multi-collinearity does not determine parameter estimates. Note that multi-collinearity, if present, inflates the standard errors of parameter estimates, making significant results more conservative.

4.2 Structural Models

As Table 4 shows, the sub-dimensions of non-contractibility and reverse auction use correlate with each other. These correlations suggest conceptualizing non-contractibility and reverse auction use as second order latent constructs for estimating a structural model (i.e., combine the first-order sub-constructs into single measures for reverse auction use and non-contractibility). The second order latent construct for non-contractibility (NC) includes the task (quality, innovation, information exchanges) and interaction (trust, flexibility, responsiveness) first order sub-constructs (NCA, NCB). The second order construct for reverse auction use (RAU) includes three first order sub-constructs (RAU1, RAU2, RAU3). Two correspond to the
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likelihood of using reverse auctions based on the two non-contractibility sub-constructs, while
the third corresponds to the likelihood of using reverse auctions based on the asset specificity of
production goods.

Therefore, we re-specified the measurement models by using the second order constructs
for reverse auction use (RAU) and non-contractibility (NC). These models performed better than
those with the first order constructs. The aggregation also made the research model more
parsimonious. Figure 1 depicts key constructs and associated sub-constructs in the model.

Table 5 presents results from the structural models, based on the second order constructs
for reverse auction use and non-contractibility. Before focusing on individual paths, we evaluate
the measures related to overall fit of the models. The models have reasonable values of absolute
fit indices. All the models have values of normed chi-squared (chi-squared/df) less than five,
suggesting a reasonable fit. The Goodness of Fit Index (GFI), which is an analogue of R-squared
in multiple regression, indicates that the co-variances implied by our models explain more than
80% of observed covariance in data. Since absolute fit indices such as normed chi-squared or
GFI are susceptible to sample size and model complexity, we considered measures that are less
susceptible to sample size. The Normed Fit Index (NFI) indicates the proportion in the
improvement of the overall fit of the research model relative to a null model that assumes no
correlation among observed variables. Our model yields a NFI value greater than 0.90,
suggesting that the proposed models are 90% better than a null model estimated with the same
sample data. The values for both the GFI and NFI indicate that the models have adequate overall
fit, as do other measures that Table 5 reports (Bollen 1989; Kline 1998).

Model 1 in Table 5 analyzes the effect of asset specificity on reverse auction use without
controlling non-contractibility. The asset specificity coefficient is negative and significant. This
result is consistent with the EMH prediction that firms are likely to use a larger number of


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suppliers for products with lesser asset specificity.

Model 2 in Table 5 analyzes the effect of non-contractibility on reverse auction use without controlling for asset specificity. Non-contractibility is negative and highly significant. This result suggests that as the degree of non-contractibility increases, buyers are less likely to use reverse auctions for procuring such products and lends support to the MMH prediction about the importance of non-contractibility as a determinant of supplier pool size.

Although the results of models 1 and 2, when assessed separately, offer support for both hypothesis 1 and hypothesis 2, a comparison of models 1 and 2 provides an interesting perspective on judging the relative strengths of the EMH and MMH arguments. Since models 1 and 2 are non-nested, it is not possible to use a likelihood ratio test for comparing the relative superiority of models. Therefore, we compare models 1 and 2 with the Akaike Information Criterion (AIC), a Bayesian fit statistic. The lower value of the AIC for model 2 compared to the AIC for model 1 shows that model 2 has greater fit, and suggests that non-contractibility has greater explanatory power compared to asset specificity in predicting the use of reverse auctions.

One can conduct a more direct test of EMH versus MMH reasoning by specifying a model with both asset specificity and non-contractibility. We estimated this structural model and found that non-contractibility had a significant negative impact on reverse auction use while asset-specificity had no significant impact in the combined model. Again, this result suggests a greater impact of non-contractibility on reverse auction use compared to that of asset specificity.

Because non-contractibility and asset specificity correlate with each other in a cross sectional dataset, we can use the structural equation framework to investigate alternative causal paths that explore the causal mechanisms that underlie the effects of asset specificity and non-contractibility on reverse auction use. (Longitudinal data would help resolve this causal question, but the challenges of collecting data on a consistently defined set of variables in a setting that is
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constantly changing make such research extremely difficult, hence the structural equation
approach provides a useful alternative.) Accordingly, we estimated two models that investigate
alternative paths that endogenize non-contractibility and asset specificity. Model 3 specifies that
asset specificity causes non-contractibility, which in turn may influence use of reverse auctions.
In other words, this model posits that asset specificity has both direct and indirect (mediated by
non-contractibility) effects on the use of reverse auctions. In contrast, model 4 posits that non-
contractibility has direct and indirect (mediated by asset specificity) effects on the use of reverse
auctions. The mediation models 3 and 4 provide reasonable values of fit indices. We find
significant and positive path relationships from asset specificity to non-contractibility (model 3)
and from non-contractibility to asset specificity (model 4).

Although asset specificity has a seemingly unexpected significant positive impact on
reverse auction use in models 3 and 4, one needs to interpret the results with care because of the
presence of indirect effects in model 3 and because asset specificity is an intervening variable in
model 4. Rather than considering only the direct effects of asset specificity and non-
contractibility, it is important to consider the total effects of the variables.

The comparison of the total effects of non-contractibility and asset specificity is
illuminating. The total effect of non-contractibility in model 4 [total effect= $\beta_2 + \beta_4 \times \beta_1 = \beta_2 + \beta_4 \times \beta_1 = -0.84$, $t=-3.197$] is negative and significant. Thus, consistent with hypothesis 2, non-contractibility is
associated with less reverse auction use, even accounting for its positive impact on asset
specificity. By contrast, the total effect of asset specificity in model 3 [total effect= $\beta_1 + \beta_3 \times \beta_2 = \beta_1 + \beta_3 \times \beta_2 = -0.20$, $t=-1.442$] has only an insignificant negative impact on reverse auction use. Once again, the
results offer stronger support for an explanation based on non-contractibility than the one based
on asset specificity and, in turn, for the MMH than for the EMH.

The controls in Table 5 provide useful insights. First, the significant negative coefficient
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for specialized products suggests that buyers are less likely to use reverse auctions for such products than for commodity goods. Second, the positive coefficient of information system compatibility implies that buyers are more likely to adopt reverse auctions if they have a compatible information system infrastructure in place. Third, buyers with a ‘relationship’ approach to supply chain strategy are less likely to adopt reverse auctions compared to buyers that take a ‘transaction’ orientation towards their suppliers. Fourth, the nature of competitive strategy (differentiation versus cost leadership) does not have a significant effect on reverse auction use. Finally, larger firms are more likely to use reverse auctions.

4.3 Additional Analyses

Exploratory analyses in Table 6 checked robustness. A buyer’s perception of the non-contractible investments that its suppliers make might correlate with the buyer’s satisfaction with its suppliers. If so, then buyers may be less likely to auction business for which suppliers have high satisfaction ratings. We created a three-item variable to measure buyers’ satisfaction with current suppliers. The items explore the extent to which current supplier performance influences the decision to use reverse auctions suppliers (Dai and Kauffman 2000; Helper 1991).

The results reject the argument that buyers avoid reverse auctions if they are satisfied with current suppliers. As Panel A of Table 6 shows, a comparison of item a and item b indicates that buyers are likely to use reverse auctions even if they are satisfied with their incumbent suppliers. This result indicates that buyers will not limit their use of reverse auctions only to those situations in which they are not satisfied with their incumbent suppliers. The difference between item a and item b is significant at p < 0.05 (Table 6, Panel B).

Nonetheless, incumbent suppliers do not necessarily lose because of increased competition, because buyers often reward loyal suppliers by continuing business even if they do not provide the lowest bids in the auction process (row c of Table 6, Panel A). Supplier loyalty is
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likely to involve investment in non-contractible parameters that support their buyer relationships. Thus, satisfaction with suppliers’ non-contractible investments increases buyers’ switching costs and makes such suppliers less vulnerable compared to suppliers with which buyers are less satisfied. Follow-up interviews with an electronic market service provider and a large buyer revealed that incumbents enjoy a 3%-6% relationship premium: buyers often set reverse auction reservation prices about this level below current prices.

5. DISCUSSION

This research highlights governance related arguments of two prominent information systems theories. By studying Internet-enabled reverse auctions that allow relationships with a larger supplier pool, we wanted to examine how asset specificity and non-contractibility affect buyer choice related to number of suppliers. Our study in the U.S. automotive industry suggests that non-contractible factors have substantial influence on reverse auction use, even controlling for asset specificity. The results provide strongest support for the arguments of the move-to-middle hypothesis. The MMH expects buyers to use a small number of supplier relationships even as IT innovation changes the way in which firms manage the relationships. We find that non-contractibility arising from needs for quality, supplier innovation, information sharing, responsiveness, trust, and flexibility leads buyers to avoid electronic markets in which they would deal with a wide range of suppliers. These results complement Subramani’s (2004) study of multiple suppliers of one buyer firm, which identified the importance of supplier investments in business processes and domain knowledge.

The study provides a formal empirical test of the electronic markets hypothesis, which suggested that information technology would lead to greater use of arms length relationships with many suppliers. Reverse auctions are an example of such arms length relationships. The EMH based this prediction on considering the impact of asset specificity. This study extends the
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EMH and points to the need to consider non-contractible factors. Recognizing the importance of non-contractible factors lends support to Hess and Kemerer’s (1994) perceptive observation that: “…the underlying hypothesis (i.e., electronic market hypothesis) will require augmentation in order to fully explain the results… (p. 251).”

Electronic markets attract buyers with the goal of finding lowest cost input suppliers. While price plays an important role in supplier selection, non-price factors are also important. One of the items in the Helper’s (1991) survey assessed the change in criteria that customers used to choose suppliers over a five-year period from 1983-1988. The analysis showed that: “price went up the least, while quality increased the most to become the most important single criterion (p. 20).” Our study builds on these findings by highlighting the importance of non-price factors in reverse auction use. Although market-mediated exchange may increase, the results suggest that non-contractibility will influence the exchanges, both in its own right and as an outcome of transaction specific investments. By augmenting the asset specificity argument with a consideration of non-contractible factors, we gain a more nuanced understanding of the complexities of buyer-supplier relationships (Dai and Kauffman 2001).

As well as testing the governance predictions of the EMH and MMH, this research points to non-contractibility as a complement of asset specificity. Although asset specificity is the locomotive of TCE, a recent meta-review of thirty years of empirical studies (David and Han 2003) found that out of 107 independent statistical tests for asset specificity, only 60% showed support for predictions and 4% significantly contradicted TCE. Clearly, there is a need to extend TCE either by enriching the notion of asset specificity to consider non-contractible attributes of exchange relationships or by considering non-contractibility as a separate and increasingly important dimension of exchange relationships that affects governance choice.

Although conceptually distinct, the notions of asset specificity and non-contractibility
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overlap in practice. One may also cause the other. For example, firms may initially develop non-contractible skills for a particular trading partner and then increasingly invest in specialized assets to support product exchanges with that partner (i.e., NC => AS). In reverse, firms may make specialized investments that may then lead them to develop non-contractible skills (i.e., AS => NC). In either case, the firm will end up with both transaction specific investment and non-contractible skills. In our exploration of these alternative mediation paths, we found support for the effect of non-contractibility on reverse auction use mediated through asset specificity.

However, our results provide only a tentative evidence of such a mediation relationship because our analysis is based on a covariance matrix of a cross-sectional dataset. There is need for longitudinal studies that tease out the paths of this relationship (Hart and Saunders 1997).

The results also have managerial implications. It is important for buyers to carefully choose products for procurement through electronic market mechanisms such as reverse auctions. An indiscriminate use of electronic markets by buyers may alienate loyal suppliers and such suppliers may react by under-investing in the non-contractible parameters of a relationship under the pressure to be competitive in reverse auctions. The results showing that satisfied buyers are likely to continue business with their suppliers even if they are not the lowest bidders in the auction process should be reassuring to suppliers. These findings suggest that there are payoffs from investment in non-contractible parameters and relational capital.

The study has two primary limitations. First, the research is based on self-reported reverse auction use behavior and the factors influencing such decisions for different categories of products. There is a need to extend our findings by collecting detailed product and supplier characteristics archival data at the firm level that may be considered more objective. Second, we covered a large cross-section of firms in the U.S. automotive industry in order to achieve generalizability. A useful extension of this research may be to conduct an in-depth study of a
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select group of companies that examines the buyer motivation for selective use of reverse
auctions for specific products. Such studies will enhance our understanding of the situational and
contextual factors that are difficult to control in large-scale survey based research.

Several other areas offer promise for future research. First, it would be useful to identify
parameters that affect cost savings from reverse auctions, particularly when firms adopt reverse
auctions for products that score low on non-contractible parameters. Reverse auction parameters
affecting cost reductions could include the number of participating suppliers, participation of the
incumbent supplier in the auction, reserve price, and information that is available to auction
participants (Bapna, Goes and Gupta 2001; Bapna et al. 2004). Second, it would be useful to
investigate the drivers of cost reductions through reverse auctions, such as whether cost
reductions arise from heightened competition or stem from IT-enabled reduced transaction and
co-ordination costs. Third, examining firms’ business processes, internal and external transaction
costs, and procurement cycle-time would help quantify the value of electronic markets.

In summary, this paper studies the importance of product and relationship characteristics
that influence buyers’ choice of governance mechanisms that affect the size of the supplier pool.
Based on field data collected from firms in the automotive industry, we found that greater non-
contractibility in an exchange relationship is associated with less use of reverse auctions. The
research validates the governance prediction of the move to middle hypothesis in the information
systems literature that posited buyers’ preference for a small number of suppliers. The study has
implications for research in transaction cost economics because the notion of non-contractibility
complements the concept of asset specificity that is the driver of transaction cost economics.
Non-contractibility becomes even more descriptive of the underlying transactions between
buyers and suppliers as the importance of intangibles and services grows in the economy.
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Figure 1: Conceptual Model
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Table 1: Dimensions of Non-Contractibility

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Definition</th>
<th>Adapted from</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality</td>
<td>Refers to manufacturing capability, warranty implications and criticality in terms of interaction with other components in an assembly.</td>
<td>Cusumano and Takeishi (1991), Takeishi (2001)</td>
</tr>
<tr>
<td>Innovativeness</td>
<td>Supplier’s track record of continuous improvement in existing products, development of new products and investment in keeping abreast with technological developments.</td>
<td>Helper (1991)</td>
</tr>
<tr>
<td>Information Exchanges</td>
<td>Exchange of proprietary information between buyer and supplier for cost reduction and involvement in planning and goal setting activities.</td>
<td>Cusumano and Takeishi (1991), Helper (1991), Takeishi (2001)</td>
</tr>
<tr>
<td>Responsiveness</td>
<td>Supplier’s sensitivity and ability to respond immediately to buyer’s needs and to keep buyer updated on the requests.</td>
<td>Johnston and Lawrence (1988)</td>
</tr>
<tr>
<td>Trust</td>
<td>Buyer’s perception about supplier’s trustworthiness, confidence in supplier and belief that supplier will honor its promises.</td>
<td>Johnston and Lawrence (1988)</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Willingness of supplier to modify the contract, make necessary adjustments continuously and being responsive to buyer’s requests that may be beyond the terms of contract.</td>
<td>Monczka et al. (1998), Young-Ybarra and Wiersema (1999)</td>
</tr>
</tbody>
</table>

Table 2: Profile of the Firms in the Sample (N=152)

<table>
<thead>
<tr>
<th>Firm Type(^a)</th>
<th>Percentage of Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>OEMs</td>
<td>20%</td>
</tr>
<tr>
<td>Tier 1 component manufacturer</td>
<td>84%</td>
</tr>
<tr>
<td>Tier 2 component manufacturer</td>
<td>66%</td>
</tr>
<tr>
<td>Tier 3 component manufacturer</td>
<td>30%</td>
</tr>
<tr>
<td>Tier 4 component manufacturer</td>
<td>8%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Firm Size – Revenues in Million $</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than $100 Million</td>
<td>58%</td>
</tr>
<tr>
<td>More than 100 million but less than $1 Billion</td>
<td>30%</td>
</tr>
<tr>
<td>More than $1 Billion</td>
<td>12%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Firm Size – Number of Employees</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 500</td>
<td>60%</td>
</tr>
<tr>
<td>More than 500 but less than 5000</td>
<td>28%</td>
</tr>
<tr>
<td>More than 5000 but less than 10000</td>
<td>3%</td>
</tr>
<tr>
<td>More than 10000 but less than 50000</td>
<td>6%</td>
</tr>
<tr>
<td>More than 50000</td>
<td>3%</td>
</tr>
</tbody>
</table>

\(^a\)Percent figures do not sum up to 100% because of multiple responses for firm type.
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Table 3. Measurement Model: Parameter Estimates and Reliability

<table>
<thead>
<tr>
<th>Construct and Indicators</th>
<th>Standardized Loading</th>
<th>t Value</th>
<th>Composite Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-Contractibility (NC): Second order construct</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality (NC1)</td>
<td>0.59</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Innovativeness (NC2)</td>
<td>0.80</td>
<td>9.71</td>
<td></td>
</tr>
<tr>
<td>Information Exchanges (NC3)</td>
<td>0.77</td>
<td>9.56</td>
<td></td>
</tr>
<tr>
<td><strong>NCA first order sub-construct</strong></td>
<td>0.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>NCB first order sub-construct</strong></td>
<td>0.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Responsiveness (NC4)</td>
<td>0.81</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Trust (NC5)</td>
<td>0.75</td>
<td>11.47</td>
<td></td>
</tr>
<tr>
<td>Flexibility (NC6)</td>
<td>0.64</td>
<td>10.24</td>
<td></td>
</tr>
<tr>
<td><strong>Asset Specificity (AS)</strong></td>
<td></td>
<td></td>
<td>0.74</td>
</tr>
<tr>
<td>AS 1</td>
<td>0.42</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>AS 2</td>
<td>0.70</td>
<td>6.62</td>
<td></td>
</tr>
<tr>
<td>AS 3</td>
<td>0.71</td>
<td>6.67</td>
<td></td>
</tr>
<tr>
<td>AS 4</td>
<td>0.74</td>
<td>6.76</td>
<td></td>
</tr>
<tr>
<td>AS 5</td>
<td>0.42</td>
<td>5.24</td>
<td></td>
</tr>
<tr>
<td><strong>Reverse Auction Use (RAU): Second order construct</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>RAU1 first order sub-construct</strong></td>
<td>0.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LNC1</td>
<td>0.96</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>LNC2</td>
<td>0.98</td>
<td>44.72</td>
<td></td>
</tr>
<tr>
<td>LNC3</td>
<td>0.96</td>
<td>39.84</td>
<td></td>
</tr>
<tr>
<td><strong>RAU2 first order sub-construct</strong></td>
<td>0.92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LNC4</td>
<td>0.76</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>LNC5</td>
<td>0.96</td>
<td>19.07</td>
<td></td>
</tr>
<tr>
<td>LNC6</td>
<td>0.95</td>
<td>18.64</td>
<td></td>
</tr>
<tr>
<td><strong>RAU3 first order sub-construct</strong></td>
<td>0.97</td>
<td>0.01</td>
<td>0.95</td>
</tr>
<tr>
<td>with single composite indicator</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Constrained Parameter for Identification of the Measurement Model
2 AS1 and AS5 have relatively small standardized factor loadings, but measurement and structural models that omitted AS1 and AS5 reported similar results.

Table 4. Correlations Among Constructs

<table>
<thead>
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<th>1</th>
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<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
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<tbody>
<tr>
<td>1 RAU1</td>
<td>1.00</td>
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<td>2 RAU2</td>
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<td>3 RAU3</td>
<td>0.89</td>
<td>0.94</td>
<td>1.00</td>
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<tr>
<td>4 Interaction related non-contractibility (NCB)</td>
<td>0.11</td>
<td>0.11</td>
<td>0.16</td>
<td>1.00</td>
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<td>5 Task related non-contractibility (NCA)</td>
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<td></td>
<td>1.00</td>
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<td>6 Asset Specificity (AS)</td>
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<td></td>
<td></td>
<td>0.66</td>
<td>0.82</td>
<td>1.00</td>
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<td>7 Information System Compatibility</td>
<td>0.10</td>
<td>0.19</td>
<td>0.16</td>
<td>0.07</td>
<td>0.16</td>
<td>0.20</td>
<td>1.00</td>
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<td>8 Competitive Strategy</td>
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<td>0.03</td>
<td>0.00</td>
<td>-0.01</td>
<td>-0.05</td>
<td>-0.03</td>
<td>0.04</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Supply Chain Strategy</td>
<td>-0.15</td>
<td>-0.18</td>
<td>-0.17</td>
<td>0.15</td>
<td>0.03</td>
<td>0.18</td>
<td>-0.03</td>
<td>-0.04</td>
<td>1.00</td>
<td></td>
<td></td>
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<tr>
<td>10 Specialized Products</td>
<td>-0.09</td>
<td>-0.13</td>
<td>-0.10</td>
<td>-0.08</td>
<td>0.09</td>
<td>0.06</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>1.00</td>
<td></td>
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<tr>
<td>11 Revenues</td>
<td>0.20</td>
<td>0.25</td>
<td>0.27</td>
<td>-0.18</td>
<td>0.13</td>
<td>0.08</td>
<td>0.33</td>
<td>-0.09</td>
<td>-0.08</td>
<td>0.00</td>
<td>1.00</td>
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</table>
Determinants of governance choice

Table 5. Parameter Estimates of the Structural Equation Models Explaining Reverse Auction Use  
(t values are in parentheses; n=304)

<table>
<thead>
<tr>
<th>Construct Relationship</th>
<th>Direct Effects</th>
<th>Direct Effects</th>
<th>Mediated Effects</th>
<th>Mediated Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model</td>
<td>Model</td>
<td>Model</td>
<td>Model</td>
</tr>
<tr>
<td>Asset Specificity =&gt; RA Use</td>
<td>( \beta_1 ) = -0.21* ((-1.85)) (5.26**) ((2.14)) ((2.37))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Contractibility =&gt; RA Use</td>
<td>( \beta_2 ) = -0.50** ((-2.42)) (-11.63**) ((-2.31)) ((-2.36))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asset Specificity =&gt; Non-Contractibility</td>
<td>( \beta_3 ) = 0.47** ((5.77))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Contractibility =&gt; Asset Specificity</td>
<td>( \beta_4 ) = 2.21*** ((5.90))</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Specialized Products =&gt; RA Use</td>
<td>( \beta_5 ) = -0.28** (-2.39) (-0.31**) ((-1.92)) (-0.25*) ((-1.68))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Information System Compatibility =&gt; RA Use</td>
<td>( \beta_6 ) = 0.14** ((2.17)) (0.14*) ((1.79)) (0.12) ((1.55)) (0.16*) ((1.95))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competitive Strategy =&gt; RA Use</td>
<td>( \beta_7 ) = 0.04 ((0.44)) (0.02) ((0.14)) (0.02) ((0.16)) (0.01) ((0.06))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relationship Orientation to Supply Chain Strategy =&gt; RA Use</td>
<td>( \beta_8 ) = -0.19*** (-3.06) (-0.18**) ((-2.18)) (-0.20**) ((-2.57)) (-0.19**) ((-2.44))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revenues =&gt; RA Use</td>
<td>( \beta_9 ) = 0.39*** ((4.99)) (0.33***) ((3.24)) (0.36***) ((3.70)) (0.39***) ((3.96))</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fit Indices

| Chi-Square | 318.34*** | 301.43*** | 622.22*** | 604.46*** |
| df         | (103)     | (117)     | (211)     | (211)     |
| GFI        | 0.90      | 0.90      | 0.85      | 0.85      |
| NFI        | 0.94      | 0.94      | 0.91      | 0.91      |
| NNFI       | 0.94      | 0.95      | 0.93      | 0.93      |
| CFI        | 0.96      | 0.96      | 0.94      | 0.94      |
| RMSEA      | 0.08      | 0.07      | 0.08      | 0.078     |
| AIC        | 418.34    | 409.43    | 752.224   | 734.460   |

*** p<0.01; ** p<0.05; * p<0.10

Table 6. Student’s t tests for the Effect of Buyer Satisfaction on Reverse Auction Use

<table>
<thead>
<tr>
<th>Panel A (survey responses)</th>
<th>Mean (1=Strongly disagree, 7=Strongly agree)</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. We would consider using reverse auctions <strong>only</strong> if we are dissatisfied with our incumbent suppliers.</td>
<td>3.24</td>
<td>1.82</td>
</tr>
<tr>
<td>b. We would consider using reverse auctions <strong>even</strong> if we are completely satisfied with our incumbent suppliers.</td>
<td>3.96</td>
<td>2.16</td>
</tr>
<tr>
<td>c. We are likely to reward our loyal suppliers by continuing business with them even if they are not the lowest bidders in the reverse auction.</td>
<td>4.68</td>
<td>1.70</td>
</tr>
</tbody>
</table>

Panel B (p-values)

- p value for a two sample t test with unequal variances between item a and item b above <0.05
- p value for a two sample t test with unequal variances between item b and item c above <0.05
Appendix 1: Constructs and Questionnaire Items

We are interested in knowing how important the following product and supplier characteristics are to the purchase of production inputs. Please indicate the importance (1=Low, 7=High) of each product or supplier characteristic. Then, indicate the likelihood (1=Low, 7=High) of your adopting reverse auctions for sourcing from a supplier with such characteristics.

**Non-Contractibility (NC):** This item included sub-constructs for Quality, Innovativeness, Information Exchanges, Responsiveness, Trust, and Flexibility. The sub-constructs used several items (1=strongly disagree, 7=strongly agree)

<table>
<thead>
<tr>
<th>Sub-Construct</th>
<th>Items</th>
</tr>
</thead>
</table>
| **Quality (NC1)** | a. Product has a high manufacturing quality requirement.  
b. Product performance critically affects performance of other parts or components.  
c. Product has a significant risk of warranty liabilities. |
| **Innovativeness (NC2)** | a. Product requires continuous technological innovation.  
b. Supplier that keeps abreast with latest technological developments.  
c. Supplier that develops new technology products critical to your success. |
| **Information Exchanges (NC3)** | a. Product requires significant sharing of your proprietary information with the supplier.  
b. Supplier that shares their proprietary information with you.  
c. Supplier that allows your participation in their planning and goal-setting activities.  
d. Supplier that shares detailed information on their cost structure. |
| **Responsiveness (NC4)** | a. Supplier that proactively anticipates your emerging needs.  
b. Supplier that is responsive to your requests.  
c. Supplier that keeps you updated on your requests. |
| **Trust (NC5)** | a. Supplier that is absolutely trustworthy.  
b. Supplier that honors their promises.  
c. Supplier that establishes a very high level of mutual confidence with your firm. |
| **Flexibility (NC6)** | a. Supplier that will be flexible in response to requests that may be beyond the terms of your contract.  
b. Supplier will modify the agreement rather than stick to original terms if an unexpected situation arises.  
c. Supplier will make continuous adjustments to cope with changing circumstances. |
| **Asset Specificity (AS)** | a. Product needs significant customization to meet your requirements. (AS1)  
b. Supplier will invest in manufacturing equipment specifically for your requirements. (AS2)  
c. Supplier has technical labor skills that are unique to your requirement. (AS3)  
d. Supplier understands your business processes in order to satisfy all your needs. (AS4)  
e. Supplier will be able to satisfy your JIT (Just in time) inventory requirements. (AS5) |

**Likelihood of Reverse Auction Use (RAU):** Respondents rated the likelihood of reverse auction use (1=low, 7=high) for production goods with varying asset specificity and non-contractibility. For regressions, we averaged the score across the non-contractibility and asset specificity categories. For structural equation modeling, we used second order constructs with partially aggregated sub-constructs as shown in Table 3.

Please indicate the extent to which you agree or disagree with each following statement. (1=Strongly disagree, 7=Strongly agree)

<table>
<thead>
<tr>
<th>Construct</th>
<th>Items</th>
</tr>
</thead>
</table>
| **Information System Compatibility** | a. We are comfortable with web-based information technologies.  
b. We have invested a substantial amount of time and money in EDI (Electronic Data Interchange) technologies.  
c. We already use the Internet for procurement purposes.  
d. We share procurement related information electronically between units within our firm.  
e. Our firm has automated the ordering process for production goods (raw materials).  
f. We can easily exchange and integrate data electronically from our major suppliers.  
g. Our major suppliers have computer systems in place to quickly respond to our product enquiries.  
h. Our major suppliers can electronically process business documents (e.g. invoices, designs, POs). |
| **Differentiation Competitive Strategy** | a. We continuous attempt to distinguish our products and services from those of our competitors on features other than price.  
b. We aggressively attempt to reduce our costs of providing products and services to our customers. (reverse scored) |
| **Relationship-Oriented Supply Chain Strategy** | a. We strive to develop long-term relations with our major suppliers.  
b. We change our suppliers frequently to get the best prices. (reverse scored) |
| **Sales Revenue** | last year: Scale of 1 to 5 (< $1 million, $1-$10 million, $10-$100 million, $100 million-$1 billion, > $1 billion). |
Determinants of governance choice