INTERORGANIZATIONAL RELATIONSHIPS
AND BIDDING BEHAVIOR IN INDUSTRIAL
ONLINE REVERSE AUCTIONS*

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Forthcoming at the Journal of Marketing Research 2008.

December 2007

* This research was supported by research grants from the Center for EBusiness@MIT (now called the MIT Center for Digital Business), the MIT Leaders for Manufacturing Program, and the MIT-Ford Alliance at the Massachusetts Institute of Technology. Special thanks to the
buying organizations, sourcing managers, suppliers, and auctioneers for their cooperation throughout the data-collection process as well as the JMR review team, Andrei Strijnev and Fang Wu for comments on earlier drafts of the paper.
The authors model (i) the impact of the supplier’s relationship propensity prior to the auction on the supplier’s bidding aggressiveness in the auction (in terms of the number of bids it submits, the rate at which the bids are submitted, and the price concessions offered) and (ii) the impact of bidding behaviors in the auction on the buyer-supplier relationship post-auction via longitudinal survey data from twelve online reverse auctions across a variety of product categories. Results suggest that incumbency, many bidders, and a willingness to make specific investments lead to less aggressive bidding, while the total number of bids from competing suppliers increases aggressiveness. In turn, aggressive bidding behavior reduces suppliers’ disposition toward developing a relationship with the buyer and sours incumbent satisfaction with the relationship. Finally, auctions that are longer in duration can improve the relationship, but may risk bidding competition. Collectively, the results suggest that pricing and relationships are intertwined and traded off against each other in complex ways and the auction does not operate in isolation of key organizational variables.

**Keywords:** Online reverse auctions, e-procurement, auction bidding behavior, buyer-supplier relationships.
Online reverse auctions, in which sellers bid prices down instead of buyers bidding prices up, are widely used across a wide range of industries (Fuller 2004) and their use is growing; even non-users of these auctions indicate that they recognize they could be at a serious disadvantage unless they add these auctions to their mix of sourcing strategies (Beall et al 2003). Academic interest in online reverse auctions is also on the rise, with growing streams of research on the benefits and risks of online reverse auctions (Mabert and Skeels 2002; Smeltzer and Carr 2003) as well as the performance implications of auction design choice which are both economic (Carter et al 2004; Engelbrecht-Wiggans et al 2007; Millet et al 2004) and relational (Jap 2003, 2007).

By their very nature, procurement auctions involve repeated interaction, long-term dynamics, and considerable economic stakes. Additionally, bidder behaviors in these auctions might be influenced by a host of issues external to the auction such as gaining a strategic position with the buyer or accounting for its own economic concerns (Engelbrecht-Wiggans et al 2007). Given these considerations, procurement auctions cannot and should not be viewed as standalone auctions the way consumer auctions have often been analyzed. The present paper provides an insight into one aspect of these dynamics -- namely relationships. We consider how ongoing relationships (and the potential for relationships) *ex ante* impact bidding behaviors in the auction event and how those individual bidding behaviors, along with the specific auction event characteristics impact the relationship (and its potential) *ex post*. Specifically, we consider how the bidders in an industrial auction “trade off” potential economic and non-economic investments into the relationship against their bid prices. Hence, we generate insights for the crafting of
successful interorganizational exchange. While there has been research that has considered bidding behavior in procurement auctions (the most notable being the winner’s curse), there is little that considers how the behavior of individual bidders might influence and be influenced by factors external to the auction itself.

Our innovation is in jointly examining industrial procurement auction behaviors with pre- and post-auction characteristics. Most work to date has focused on (i) post-auction outcomes such as final prices and overall savings (Millet et al 2004), and relational effects (Jap 2003, 2007) as a function of auction design and (ii) psychological explanations for bidding (see Kagel 1995 for an overview)¹. We go beyond these research streams to provide insight into how complex relationships (and the potential for these relationships) outside the auction interact with the bidding demands and design factors of technology-based auctions.

We utilize data from 60 participants in 12 industrial online reverse auction events using point-by-point bid data and confidential reports of the state of the buyer-supplier relationship before and after the auction. Since the data involves a single event for each bidder, dynamics and economic considerations not captured by the relationship variable we consider will translate into substantial heterogeneity in bidding preferences and we capture this heterogeneity using random effects panel methods. The data that we utilize is extremely difficult to obtain and imperfect, yet despite shortcomings, offer unique insights that may spur additional interest and research on this critical topic. We consider various forms of aggressive bidding behavior, including the total number of bids a supplier makes, the rate at which these bids are made, and the degree of price concessions offered. Finally, we account for auction characteristics such as

¹ Recently, more aspects of behavior have been examined, including learning (Neugebauer and Selten 2006), impulse balance (Ockenfels and Selten 2005), hierarchical thinking (Gneezy 2005), spiteful bidding (Morgan et al. 2003), and regret (Engelbrecht-Wiggans and Katok 2006).
the number of bidders who participate in the auctions, the number of bids that are made over the
course of the auction, and the duration of the auction. The results provide strong evidence that
interorganizational relationships and auction design exert systematic effects that can impact both
individual bidding behavior and relationship outcomes.

The paper is organized as follows. In the next section, we review the relevant literatures
and develop several hypotheses. We then describe the research setting and specific empirical
analysis. Finally, we conclude with a discussion of key results, limitations, managerial
implications and directions for future research.

CONCEPTUALIZATION

In this section, we briefly describe the general online reverse auction process and related
research and then develop hypotheses relating these aspects. We also describe a number of
auction format variables such as incumbency, competition and event duration.

The Online Reverse Auction Process

Many online procurement auctions begin with the buyer issuing a request for purchase
that details the nature of the contract as well as product, delivery, and handling specifications and
expectations. Then, a set of prequalified\(^2\) suppliers are invited to bid in an online auction for the
potential opportunity to win the purchase contract. Many industrial auctions are “buyer-
determined,” meaning that the buyer reserves the right to select the winner on any basis; this
allows buyers to integrate non-price considerations (e.g., quality and reliability) into their
selection decision.\(^3\) The suppliers are not told who their competitors are or how many suppliers

\(^2\) Prequalification procedures might include site visits, research, extensive surveys on capabilities and manufacturing
processes, or other buyer designed, quality inspection processes.

\(^3\) It is important to note that though the auction itself may not determine the winner, a buyer-determined auction
nevertheless plays a critical role in the buyer’s price discovery efforts and supplier choice. Instead of thinking of
each bidder as submitting a price, one could think of each bidder as submitting a score involving a price + non-price
attributes. The winner is not the lowest bidder, but the one that presumably scores the highest on both price and
would bid against them. The purchase contract is typically broken into lots or sub-groups of multiple items typically organized according to the suppliers’ capabilities to bid on or produce each lot, similarities in manufacturing processes, delivery regions, etc.

Once the auction begins, in a full price visibility format such as those examined in this research, suppliers can view each of their competitors’ bids and respond in real time. Many procurement auctions feature a “soft close,” meaning that last minute bids automatically extend the auction. The buyer may then take 4-6 weeks to evaluate the individual bids and select a winner.

**Bidding Behavior**

In online industrial procurement auctions, the theory of how and why bidders bid as they do is still emerging. Some exceptions include the winner’s curse and some behavioral observations in regard to intimidation and collusion in auctions, with the latter being largely anecdotal (Cramton and Schwarz, 2000, 2002). In contrast, the proliferation of online consumer auctions and availability of bid data has facilitated investigations into a wide range of process-based bidding behaviors that affect auction outcomes. Bajari and Hortacsu (2004) overview sniping, the winner’s curse, and response to feedback mechanisms as three research areas that have gotten a great deal of attention. A key characteristic of this research is that it has neglected how bidder behaviors in the auction are related to bidder or context factors outside of the auction, either *ex ante* or *ex post*. A notable exception in consumer auctions is Anwar et al. (2006) and Engelbrecht-Wiggans and Katok (2006) in procurement auctions.4

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4 Anwar et al (2006) examine cross-bidding behavior across competing eBay auctions and find that such behavior is common while Engelbrecht-Wiggans et al find that auctions followed by negotiations with an incumbent can improve buyer surplus.
Forms. The behavioral literature has focused on several forms of bidding behavior, which we incorporate and examine here: the total number of bids submitted by an individual supplier, the rate at which these bids are submitted, and the price concessions offered via the bids. The number of bids, including multiple bids submitted over the course of the auction is a common measure of bidding behavior (Ariely and Simonson 2003; Wilcox 2000) that may reflect the supplier’s commitment to winning and responsiveness to other bids.

The rate at which the bids are submitted provides a complementary measure of aggressiveness, underscoring the speed of the supplier’s response. Speed of response in auctions has been studied by Häubl and Popkowski-Leszczyc (2006), Katok and Kwasnica (2002), and Tuunainen, van Heck and Koppius (2001). The rate is defined as the total number of bids submitted divided by the auction duration. As such, it can be thought of as a rescaling or normalization of the first measure.

Finally, the level of price concessions (i.e., the difference between the bidder’s first and last bids) offered (cf., Ariely and Simonson 2003, Heyman et al 2004; Ku et al 2005) provides insight into the degree of commitment toward winning or fending off competitors. While we acknowledge that there may be more alternative measures to consider, we utilize these measures as a first step in providing insight into the individual level bidding processes and behaviors that may occur in industrial procurement auctions.

The Relationship and Bidding Behavior

The large body of research on interorganizational relationship management in marketing suggests that such relationships systematically impact how the parties interact with each other and into the future (Dwyer, Schurr and Oh 1987; Ring and Van de Ven 1994). Relationships also allow for the creation of key benefits such as trust, commitment, collaboration, and higher
economic returns. As such, we would expect that suppliers account for this asset by trading off these relationship benefits against their bid price – that is, higher prices are justified when relationships (or their potential) are positive. While relationship can comprise a complex interface of multiple factors, for simplicity and the sake of initial research on this topic we consider two aspects that speak to key economic and non-economic aspects: willingness to make specific investments on the part of the buyer and willingness to develop or maintain a long-term, functional relationship.

**Willingness to make specific investments.** In many buyer-supplier relationships, one or both parties may make specific economic investments to increase the effectiveness and efficiency of one or both parties (Heide 1994; Lusch and Brown 1996; Noordewier, John, and Nevin 1990). These non-fungible investments might represent tangible (plant equipment, tooling, and design systems) or intangible (human resources, training) adaptations and represent a credible signal of a supplier’s commitment to the buyer (Anderson and Weitz 1992). By taking on significant economic risk, suppliers lose the incentive to act opportunistically (cf., Williamson 1975) and enable the creation of additional value (Jap 1999; Rokkan, Heide and Wathne 2003). As such, a supplier’s willingness to make such investments might supplement or substitute for price, leading her to bid less aggressively in the auction. If there exists an implicit tradeoff between a supplier’s economic investments and its bid price, the reverse should also hold true. That is, suppliers who are less willing to make specific investments into the relationship *ex ante* might instead apply the economic resources towards price concessions. Hence, less willingness to make relationship-specific investments could also lead to higher (or more active) bidding aggression.

_H1: Suppliers who are willing to make specific investments will bid less aggressively_
There are plausible counterarguments to this directional hypothesis. One-sided investments create a hold-up risk for the supplier that must be strategically managed. This might mean that suppliers are more willing to give up price in the short-term (i.e., bid more aggressively) in lieu of making specific investments. Additionally, it is possible that suppliers might come to experience a sense of ownership over the purchase contract to the point that they discount the value of their willingness to make specific investments, leading them to bid aggressively. Evidence of this can be found in consumer auctions (Heyman et al, 2004).

Relationship propensity. Along with economic tendencies, suppliers can approach interorganizational exchanges with intentions and expectations of developing a long-term relationship with the buyer – this is a key strategic decision, requiring time, effort and energy. We index this propensity for incumbents via satisfaction with their ongoing relationship with the buyer and for new suppliers via the concept of solidarity, a critical precursor to healthy relationships. The supplier’s satisfaction with the relationship is a key performance outcome reflecting a positive affective assessment of all aspects of a working relationship to date and is one of the most studied outcome variables in interorganizational management research (see Gaski 1984 and Geyskens, Steenkamp and Kumar 1999 for reviews; Ruekert and Churchill 1984); it is the best indicator of an incumbent supplier’s propensity for future relationships. New suppliers can only possess a propensity for, or readiness to develop, an ongoing relationship. We index this tendency for new suppliers via the concept of solidarity, defined as “a bilateral expectation that a high value is placed on the relationship” (Heide and John 1992, p.36). Solidarity is a widely used concept in the sociological literature on interpersonal and group relations, reflecting the extent and intensity of affective bonds (Cramer and Champion 1975). Suppliers who are willing to develop solidaric bonds are more likely to solve problems jointly in
an integrative manner, share information, and make efforts to improve the relationship (cf., Lusch and Brown 1996).

Collectively, we anticipate that suppliers with a propensity for developing a relationship with the buyer (whether they be new suppliers who are willing to develop a beneficial relationship or incumbent suppliers who are satisfied with their ongoing relationship) may bid differently from suppliers without such tendencies. For suppliers who desire a long-term relationship with the buyer, the potential for greater value is created by moving beyond the basic transaction of goods for money. As a result, price becomes only one aspect of the total exchange. Another way of stating this effect is that we would expect that such suppliers may substitute or add in non-economic benefits from their experience with the buyer as part of their pricing strategy, resulting in higher prices. The converse should also hold true; that is, if suppliers tradeoff their willingness to develop a long-term relationship with their pricing strategy, then suppliers with low relationship propensity might instead substitute such efforts against their bid price (i.e., bidding more aggressively), thus enabling them to compete against suppliers who are higher in relationship propensity (and less price aggressive).

**H2: Suppliers who are high in relationship propensity will bid less aggressively**

A downside to the development of close relationships is that the buyer may learn critical competencies or cost information from the supplier that could reduce the supplier’s bargaining position and lead to expectations of buyer opportunism (Srivastava, Chakravarti and Rapoport, 2000). In consumer settings, Reinartz and Kumar (2000) have shown that long-term customer relationships do not always translate into the most profitable relationships. In this case, suppliers would need to give up more price concessions and bid aggressively.
Bidding Behavior and Post Auction Relationship Outcomes

Research has shown that the auction characteristics such as the type of auction format, the number of bidders, the economic stakes, etc. can systematically impact the ex post buyer-supplier relationship (Jap 2003, 2007). We add the possibility that individual bidding behavior might also impact the buyer-supplier relationship. Specifically, suppliers who desire a long-term relationship with the buyer may view the focus on price in the auction as a source of opportunism and haggling that is hostile to their exchange. This is because in long-term relationships, participants tend to move away from price as a governing mechanism and may instead rely on “average cost pricing,” whereby they abandon a constant price focus and supplement or substitute other non-economic benefits and information with the result that there is less variability in transaction prices as a function of the buyer’s activity levels (Bradburd and Caves 1987). If suppliers feel forced to bid aggressively in the auction, they may believe that buyers are using the auctions to strong-arm additional price concessions from them. In online reverse auctions, these perceptions persist, despite the fact that buyers are not at all intending or attempting to act opportunistically (Jap 2003). Because of this, we would expect that the more aggressive the supplier’s bidding behavior in the auction, the greater the detriment posed to their relationship; i.e., the lower the propensity for a long-term relationship. Similarly, suppliers who do not bid aggressively may not feel strong-armed into giving up price concessions and may be more willing to develop a long-term exchange relationship with the buyer (as there is no threat of opportunism, but the potential to grow the business together).

H3: Suppliers who bid aggressively are likely to have lower relationship propensity post-auction

The impact of aggressive bidding on the supplier’s willingness to make specific investments post auction is more difficult to predict. Assuming that the impact of pre-auction

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5 This might be due to the compressed nature of bidding and the aggregate price drop (Stein et al 2003).
willingness to make investments is held constant, then in general, a supplier who bids aggressively will have fewer resources to make specific investments. Additionally, the need to give up substantial price concessions can have a demoralizing impact on bidders which might dampen motivation to further make costly specific investments on the buyer’s behalf. And specific investments create a non-trivial holdup potential.

On the other hand, aggressive bidding might lead the supplier to realize the need for specific investments, either to differentiate their offering or reach cost curves that competitors have attained. This is the general result that Jap (2003) found. She observed incumbent suppliers in full price visibility auctions matching the willingness of new suppliers to make specific investments; however, she could not attribute this increased willingness to any specific behavior or incidences in the auction, which is our goal here. It is possible that the mere observation of the drop in competitive pricing was sufficient to motivate suppliers’ willingness to make specific investments; suppliers did not necessarily have to give up the price concessions to come to the same conclusion. Hence, we propose the following hypothesis.

**H4:** Suppliers’ aggressive bidding behavior is related to their willingness to make specific investments post-auction (controlling for suppliers’ pre-auction willingness to make specific investments).

**Auction Format Variables**

Our interest is primarily in how bidding behavior is affected by and affects key interorganizational relationship states and outcomes. However, we also control for a variety of differences across the auctions that might affect both bidding behaviors and relationship states: incumbency, competition, and event duration. Incumbent suppliers possess the current supply contract that is up for bid in the auction. As such, they have the most recent history of exchange with the buyer and a current understanding of the buyer’s needs and constraints. Competing suppliers may be incumbents or completely new. We account for the level of competition via the
number of bidders (Ariely and Simonson 1993; Ku et al 2005) -- not including the focal supplier -- and the total number of bids made by these bidders (Ariely and Simonson 1993; Heyman et al 2004). The more bidders and bids in an event, the higher the level of competitive arousal. Alternatively, as the number of bidders increases, bidders may become more conservative since the potential for the winner’s curse grows as the number of bidders does (Hong and Shun 2002 show this in a procurement setting). Finally, the duration of the event has been shown to systematically impact bidding behavior in auctions (Heyman et al 2004; Ku et al 2005). Specifically, as the duration increases, bidders tend to develop a sense of ownership, or bonding with the item, causing them to bid more aggressively in order to avoid losing the item (Heyman et al 2004).

**METHODOLOGY**

*Procedure*

The hypotheses are examined around online reverse auction events held in the supply bases of two Fortune 50 firms in the automotive and high-tech industries. Each firm was offered customized analyses and a summary report in return for its participation. Each firm identified 6 auction events (for a total of 12 events) for which they provided point-by-point bid data and allowed us to obtain confidential survey reports from suppliers before and after the auction. However, the firms did not allow us to intervene in these events such as create untreated control groups or matched pairs of events or to interview the participants. Suppliers in the auctions were classified as incumbents and non-incumbents to distinguish those who were the current suppliers. All of the auctions were full price visibility buyer-determined events and bidders did not know the exact identity of their competitors.
The auctions covered a variety of product categories ranging from hoses, pulleys, subassemblies, and cables, metal and plastic parts, and electronic connectors to name a few. The products were all materials used directly in their manufacturing processes and the combined contract value of the 12 auctions was approximately $125.5 million. The average value of the purchase contract was $10.5 million (sd = $12.5m, range $1m to $47.7m) and the mean number of lots was 4.2 (sd = 2.8, range 1 to 10). Sixty nine percent of the participants in these events were incumbent suppliers. All of the products differed in their non-price characteristics, so supplier relationships could play a role in the negotiation process.

Respondents were typically senior executives, vice-presidents, and even owners of the supply business who handled large customer accounts with authority to determine major investment decisions and make price concessions. An invitation email was sent one week prior to the event, specifying that the respondent should be knowledgeable about the firm’s specific relationship with the buyer and should be someone who would participate in the upcoming auction. Across the events, 130 suppliers were invited to complete the survey. Fifty eight suppliers participated, resulting in a response rate of 45%. An examination of the data from early versus late respondents fails to reject the null of no difference among the responses (Armstrong and Overton 1977). We also examined whether there were differences in the bidding behavior of respondents and non-respondents. There were no significant differences in the number of bids (p<0.36), bidding rate (p<.41), price concessions (p<0.84) or incumbency status (p<0.64). Collectively, these results suggest that there were no notable differences between those who responded to the survey and those that did not.

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6 Incumbency data for non-respondents was available for 6 out of 12 events. However, bidding behavior data for non-respondents were available for all events.
Since the relationship measures rely heavily on the respondent’s perceptions, we included specific and global measures of the respondent’s knowledge of the relationship and competency. The global measure was the respondent’s tenure with a firm. The respondents averaged 3.3 (sd = 1.1, range .7 to 8 years) years of experience in their area and had been with their firms 7.0 (sd = 3.0, range .7 to 18 years) years on average. The respondent’s knowledge of the relationship with the buyer was assessed by questions at the conclusion of the survey. The respondents were asked, “How knowledgeable are you about the following aspects?” Below were listed items such as “Your firm’s willingness to work with the buyer firm,” “The state of your firm’s relationship with the buyer firm,” or “Your firm’s willingness to invest in a customer.” Responses varied along a 7-point rating scale (1=Not Very Knowledgeable, 7=Very Knowledgeable) with a mean of 6.3 (sd = .55, range 4.5 to 7). Collectively, these measures suggest that the respondents were qualified key informants, knowledgeable about their relationship with the buyer and competent in their roles to be reporting on the state of the buyer-supplier relationship.

The invitation directed suppliers to the survey on a university website, guaranteed individual anonymity to the buyer and reassured suppliers that the buyer would not have access to individual responses. The survey directed the supplier to complete all items in reference to the specific buying organization. The post-test survey was administered within a week following the event; it is important to note that at this time, buyers had not begun any post-auction negotiations and suppliers were not yet informed as to whether they had won the event, implying that the post-test scores are a direct function of the auction process and uncontaminated by the auction outcome or buyer interventions. Throughout the data collection, we monitored the buyer’s
activities to insure that no major events or initiatives (e.g., retroactive charge backs) occurred to disrupt or alter supplier perceptions and attitudes.

**Measurement.** All of the items used to measure the interorganizational relationship constructs are listed in Table 1. Multi-item scales (where 1=strongly disagree and 7=strongly agree) are used to measure the various relationship facets and all of the scales were adapted from past research. The three items for satisfaction with the relationship were adapted from Ruekert and Churchill (1984), while the three items for solidarity were adapted from Heide and John (1992) and Dwyer and Oh (1988). The seven scale items for willingness to make specific investments were adapted from Jap (2003). Table 2 displays the construct means, correlations, and reliabilities for the latent factors.

**Analysis**

**Factor analysis.** A confirmatory factor model of the three first-order latent constructs, including the observable indicators, measurement errors, and intercorrelations between the constructs is estimated using full-information maximum likelihood techniques in LISREL 8.54 (Jöreskog and Sörbom 2003). The overall chi-square for the model is 155.83 (62 df, p<.00) with a comparative fit index and incremental fit index of .88, a Tucker-Lewis index of .86, and a root mean square error of approximation of .15.

The measure of relationship propensity is comprised of average response of relationship satisfaction items and solidarity items. To further validate the use of this measure, we considered its relationship to a multi-item measure of opportunism suspicions (from Jap 2003). Presumably, the more relationship propensity a supplier has toward the buyer, the less suspicions

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7 Although minimum CFI, IFI, and TLI values of .9 is generally recommended, in sample sizes of less than 200, these indices are unlikely to achieve this rule-of-thumb benchmark (Bearden, Sharma & Teel 1982; Marsh, Balla & Hau 1996; Marsh, Balla & McDonald 1988).
of opportunism it should have about the buyer. The correlation between these two measures is
significant and negative (-.36, p<.01), providing some face validity support of our measure.

Regression analysis. We ran two sets of regressions. The first set of regressions
examined the impact of pre-auction relationships on bidder aggressiveness in a given auction.
The second set of regressions examined the effect of auction characteristics, including bidding
aggressiveness, on the post-auction relationship. We considered alternative specifications such
as the addition of a supplier covariate (i.e., supplier dependence on the buyer) and interaction
terms (i.e., between bidder behaviors, incumbency, relationship states, and auction
characteristics), but these effects were mostly non-significant and did not change the observed
pattern of results, which we report below.

In the first set of regressions (reported in table 3), we examined the effect of pre-auction
relationships on bidding behavior in the auction. The unit of analysis in this set of regressions is
bidder behavior in each individual lot. The total number of observations is 132, with 44 distinct
individual bidders (this is panel data estimation with an unbalanced panel). That is, if a bidder
participated in three different auctions, we would count this as three observations and account for
the correlation in the error structure using random effects modeling, wherein each individual
bidder has its own intercept which comes from a distribution with a mean of zero and a standard
deviation to be estimated. Hence, the relevant regression takes the form of Equation 1:

\[ y_i = \beta' x_i + \epsilon_{it} + u_i \]  

(1)

where \( y_i \) is the observed dependent measure for the \( i^{th} \) observation, \( x_i \) is the vector of
explanatory variables, and \( \beta \) is the vector of coefficients to be estimated. There are two error
terms, \( \epsilon_{it} \) and \( u_i \). The first error term, \( \epsilon_{it} \), is the traditional error term unique to each
observation. The \( u_i \) represents the extent to which the intercept of the \( i^{th} \) bidding firm differs
from the overall intercept. Each of the two error terms is assumed normally distributed with a variance to be estimated.

The estimation is done by a two-step Generalized Least Squares (GLS). In the first step, we estimate the variance components using consistent estimators—the within- and between-group residuals, respectively—to estimate $\sigma_e$ and $\sigma_u$. In the second step, we substitute these estimates into the variance covariance matrix in the GLS to obtain estimates (for more detail, see Hsiao 1995, pp 34-38).

The dependent variable in this set of regressions is bidder aggressiveness. As a measure of bidder aggressiveness, we investigated three alternative forms: (1) the number of bids entered by the supplier, (2) bidding rate—the number of bids entered by supplier divided by duration, and (3) price concession—the price drop by the supplier from its first to its last bid. These three dependent variables are highly correlated, supporting the claim that they likely measure the same construct. Two explanatory variables are the pre-auction relationship variables of relationship satisfaction and willingness to make investments. Other explanatory variables were the number of bidders, the number of bids by others (excluding one’s own bids to avoid endogeneity), and indicator variable for incumbency, and event duration in minutes. Since the dependent variables are highly correlated and the predictors for each are identical, a simultaneous estimation is not possible.

The second set of regressions (reported in table 4) examines the impact of the auction process on the post-auction relationships. Since relationships were elicited after all auctions were completed, the unit of observation is the individual bidder’s perception over all product lots. That is, whereas the unit of analysis in the first set of regressions is bidder behavior in each individual

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8 The correlation between bidding rate and concessions is .67. The correlations between bidding rate and supplier bids and between supplier bids and concessions are both .76.
lot (accounting for the panel structure with random effects), here the data is purely cross-sectional with the bidder as the unit of observation (n=58). Accordingly, the values of the explanatory variables were pooled over all auctions in which a bidder actively participated in.

There were two dependent variables, which were the post-auction relationship propensity and willingness to make investments. The explanatory variables included the pre-auction state of the dependent variable, the number of bidders participating in the auction, the number of bids by other suppliers, an indicator variable for incumbent, and event duration. The last explanatory variable was bidder aggressiveness. We investigated the same three alternative measures as in the first set of regressions, one at a time, as they are highly correlated: the number of bids entered by the supplier, bidding rate, and price concession. Given the nature of the linkages between the dependent variables, error terms corresponding to some of the equations could be correlated. Each pair of regressions was therefore simultaneously estimated using a seemingly unrelated regression (SUR), which uses the correlation in errors across equations to yield more efficient regression estimates (Johnston and DiNardo 1997).

Results. The parameter estimates for the impact of prior relationships on bidding behavior are displayed in Table 3. Supplier willingness to make investments prior to the auction is negatively related to the supplier’s total bids in the auction (-.203, p<.02), bidding rate (-.134, p<.05) and price concessions (-.256, p<.00), providing support for H1. Relationship propensity prior to the auction is marginally related to the supplier’s total bids (-.175, p<.10) and the bidding rate (-.187, p<.06), but not price concessions (-.098, p<.23). Thus, while the results are directionally correct, there is only partial support for H2. Perhaps with a larger sample size or more auction events, these estimates would approach a higher level of significance.
Additionally, the results suggest that incumbency has a significant negative impact on the bidding rate (-.385, p<.01) and total number of bids (-0.415, p<.01), but not on their price concessions (-.205, p<.19). The number of bidders in the auction also has a significant negative impact on all three forms of bidding behavior: the supplier’s total bids (-.130, p<.03), bidding rate (-.206, p<.01) and price concessions (-.180 p<.01). The total number of bids in the auction by other suppliers also appears to raise bidding aggressiveness, significantly impacting the supplier’s total bids (.322, p<.01), bidding rate (.438, p<.01), and price concessions (.315, p<.01). Last, the longer the duration, of the event the lower the rate of bidding (-.465, p<.01).

The parameter estimates for the impact of bidding behavior on post-auction relationship satisfaction and willingness to make investments are displayed in Table 4. The supplier’s bidding rate (-.261, p<.02), price concessions (-.266, p<.01), and the total number of bids (-.186, p<.07) have a significant impact on relationship propensity. To corroborate this further, we find that over the course of the auction, suppliers were significantly (Cochran t-test = 2.68, p<.01) more likely to agree with the statement, “This process does not give a supplier a fair opportunity to bid on business (1=strongly disagree, 7=strongly agree)” post auction (4.31) than pre auction (3.57), suggesting that the suppliers saw the auction process as unfair. Together, there is strong support for H3.

The impact of bidding behavior on supplier willingness to make specific investments is consistently positive but marginally significant only for price concessions (0.268, p<0.09). Hence, there is partial support for H4.

Combined, the results of H1 and H4 provide insight into a potentially cyclical pattern over time. The result of H1 shows that higher willingness to make investment results in lower bidding aggressiveness, whereas the result of H4 suggests that higher bidding aggressiveness
leads to higher willingness to invest, controlling for pre-auction willingness to invest. In a repeated auction context, we might expect this type of pattern (assuming the marginal productivity of specific investments decrease over time) possibly converging to a long-run equilibrium or state marked by incrementally smaller changes in supplier willingness to make investments as the supplier dynamically adjusts her investment and bidding towards optimal levels.

Additionally, the results suggest that incumbents experience a significant negative drop in relationship propensity (−.372, p<.01; −.458, p<.01 and −.378, p<0.01). To corroborate this further, we find that incumbents’ agreement with the statement, “This auction process reduces the likelihood that we will win the business (1=strongly disagree, 7=strongly agree)” is significantly (Cochran t-test = 2.03, p<.05) higher (3.46) than new suppliers (2.58), suggesting that the incumbents did view the auction experience as inhibiting their chances of success and this belief could have affected their desire to develop a long-term relationship with the buyer. Event duration has a positive significant or marginally significant effect on relationship propensity in two out of three cases (.379, p<.01; .231, p<.12; .346, p<.01) and on willingness to make investments with bidding rate as an explanatory variable (.311, p<.08). The number of bidders and the total number of bids by others are not significant.

**DISCUSSION**

*Relationship Management Insights*

The results of this study suggest that economic and non-economic relational factors, whether they are assessments of ongoing relationships or willingness to invest in future relationships, are a systematic part of the bargaining effort, both before and after the online procurement auction. The results suggest that suppliers trade off these relational factors with
their pricing strategy (i.e., bidding aggressiveness). Specifically, suppliers who are willing to make specific investments with the buyer prior to the auction will also submit fewer bids, bid less often, and make fewer price concessions as a result. The results also suggest that the same is true of supplier willingness to develop a long-term relationship with the buyer. Together, these results give insight into the strategic bidding behavior of suppliers in which they appear to trade off potential economic and relational investments in long-term exchange with short-term pricing concessions. Consistent with this, we also observed that incumbents’ total number of bids is higher and the speed of response to competitive bids is slower than new suppliers, suggesting that the value of their history of exchange and idiosyncratic knowledge of the buyer is being traded off with their pricing policies. Collectively, this supports the view of industrial exchange relationships as more than one-shot deals, but ongoing, systematic exchange structures that can systematically impact behavior over the course of the auction.

The interrelationship between buyer-supplier relationships outside of the auction and bidding behavior does not stop there. We also observe that aggressive bidding behavior over the course of the auction can take its toll on relationships post-auction. Specifically, the results indicate that suppliers who rapidly submitted bids or made price concessions have lower propensity for a relationship post auction, supporting the notion that the auction experience is a negative price haggling process. Bidders believed that the auction process was unfair and reduced the probability of retaining their business. This negative sentiment was particularly acute for incumbents suggesting that the auction process had soured their satisfaction with the buyer.

While past research has found evidence of full visibility auctions increasing supplier willingness to make idiosyncratic investments (Jap 2003), we find only marginal support for this
effect. It could be that over time, as suppliers gain more experience with the auction format and improve their sense of market pricing, that the auction becomes a less effective wake-up call. To this end, it is worth noting that the auctions studied in Jap (2003) involved the buyer’s initial introduction of auctions to their supply base, while the auctions in this research occurred in later stages, with experienced buyers and suppliers. Over the long run, one might imagine that a supplier’s willingness to make specific investments in a buyer is calibrated over time, as a result of its learning about what the optimum levels of investments should be over a number of auction experiences. This might explain why Jap (2003) observes a strong effect of post-auction willingness to make investments but we observe a weaker effect. Perhaps suppliers are still adjusting their willingness to make investments and have not yet settled into a long-term equilibrium or point of convergence. Future research is needed to investigate this possibility.

Auction Design Insights

In addition to these relationship effects, we find several key findings in regard to auction design. First, we find suppliers bid less aggressively as the number of bidders in an auction increases. Perhaps too many bidders in an auction raise suspicions that there may be non-qualified bidders present (cf., Jap 2007). In some product categories, suppliers are well aware of the number of viable competitors who can provide specific products. If the number of suppliers exceeds the known number of viable alternatives, suppliers may refuse to bid aggressively against non-viable suppliers.

Second, bidders appear to be very responsive to the number of bids collectively submitted by the competition, increasing their total bids, rate of submission, and price concessions offered. Apparently, this is a more credible signal of competitive threat than the number of bidders. It might also be that this is the element of competitive intensity that mostly motivates industrial
bidders and adds to auction fever – the emotionally charged and frantic behavior that can result in over-bidding (Ku et al 2005), a sense of “quasi-endowment” of the purchase contract (Heyman et al 2004) and aversion to losing the auction. To this end, bidding aggressiveness in response to the total number of bids by others may represent a psychological escalation of commitment (Staw 1976).

Finally, the length of the auction event represents a trade-off between competitive bidding activity and relationship states. As the event duration increases, suppliers’ tend to slow down their response to competitive bids, which could impact overall price savings and the level of competitive arousal. On the other hand, longer auction events are gentler on the relationship, increasing suppliers’ propensity for a relationship with the buyer and willingness to make specific investments on the buyer’s behalf.

**Implications for Management**

This research holds several implications for management. In particular, it underscores the importance of interorganizational relationships and their associated tradeoffs with auction design and price in online procurement activities. To this end, we view recent attempts to quantify relationships as an important stepping stone. Consider for example, Procter and Gamble’s efforts to develop an expressive language of its constraints and preferences including rich forms of capabilities and efficiencies, which have resulted in a 9.6% savings on over $3 billion in sourcing commitments over a 2.5 year period (Sandholm et al 2006).

The results also give buyers insight into how aggressive bidding is viewed by suppliers vis-à-vis their relationship with the buyer. Specifically, buyers should recognize that suppliers trade off their intangible value (e.g., their willingness to make specific investments) against their price concessions. Hence, high bids do not necessarily mean that suppliers are not bidding
aggressively; the “total value” of suppliers is more than just price. This “total value” perspective of prices and relationship value has implications post-auction. The results suggest that suppliers who feel forced into making price concessions in the auction, will also reduce their willingness to engage in and develop the relationship more deeply with the buyer. As the exchange loses the “shadow of the future” and becomes more transaction and price focused, suppliers are motivated to actively seek alternative buyers, retaliate, or act opportunistically against the buyer in the short-run (Dal Bó 2005). One approach that buyers can use to preserve relationship propensity post-auction is to lengthen the auction duration, though this might put some level of price competition at risk.

**Limitations and Directions for Future Research**

There are clearly many more antecedents and consequences of auction bidding behavior that could have been considered and we encourage future research to explore these possibilities. The data is limited in that point-by-point bid data does not give us insight into each supplier’s sense of how aggressive its behaviors really are. Additionally, the data does not include the ultimate auction outcome which may have a larger impact on the post-auction relationship over time. However, the impact of the auction process itself is more of an unknown effect, and this is why we have focused on it here. Ideally, we would have liked to exert more control. Specifically, we would have liked to create control groups of comparable suppliers or to be able to randomly assign suppliers to events, but this was well beyond the limits of what the host firms would allow.

While this research has attempted to stimulate additional interest in the relationship-technology interface, there are many stones yet unturned. In particular, more research is needed on the bidding behavior and strategies that suppliers use in these auctions. In this research we
considered aggregate forms of bidding behavior, but more work is needed that would illuminate the specific dynamic strategies that suppliers use in buyer determined auctions, where the need to be the lowest bidder is not necessarily a winning strategy.

Future research might also examine aggressive bidding behavior in terms of the bidder’s actual “bottom lines.” This is the real benchmark for whether a bid is aggressive or not. Additionally, future research should account for the actual auction outcome – whether the supplier won or lost the auction – and the impact on interorganizational relationships in the long-term. Still unknown is the cumulative effect of many online reverse auction experiences on the state of interorganizational relationships over time.

The present research focused on supplier perceptions and intentions before and after a single event and bidding behavior during that event. However, the interaction between suppliers and buyers is typically repeated and a data set of a series of auctions might shed light on the patterns and of and relationships between investment and bidding aggressiveness over auction events. In particular, our results suggest that higher investment intention prior to the auction leads to lower bidding aggressiveness but that lower bidding aggressiveness leads to lower investment intentions following the auction. Hence, patterns of oscillation in investment levels and bidding aggressiveness may result over auctions and it would be of interest to identify such patterns more clearly in data sets that include multiple auction events over time.
### TABLE 1
**SURVEY ITEMS**

For all items, responses are indicated on a scale in which 1=strongly disagree; 7=strongly agree

**Satisfaction with the Relationship**  
Cronbach’s alpha = .76  
This section assesses your firm's relationship with the buyer firm. In the items that follow, "They" refers to the buyer firm, and "We," "Our," and "Us" refer to your firm. Please indicate the extent to which you agree or disagree with the following statements.

Our relationship with them has more than fulfilled our expectations.  
We are satisfied with the outcomes of our relationship.  
Our relationship with them has been a successful one.

**Willingness to Develop Solidarity**  
Cronbach’s alpha = .57  
How willing is your firm to do the following for the buyer firm? 1 = Very Unwilling, 7 = Very Willing

View problems that arise in the course of this relationship as joint rather than individual responsibilities  
Be committed to improvements that may benefit the relationship as a whole, and not only the individual firms  
Not mind owing each other favors

**Willingness to Provide Dedicated Investments**  
Cronbach’s alpha = .93  
In working with the buyer firm, your firm may have opportunity to make investments in time, energy and/or money specifically to accommodate them. These investments would be lost if your firm switched to another customer.  
1=strongly disagree; 7=strongly agree

**Just for the buyer firm, we would be willing to provide dedicated…**  
Support personnel  
Technology investments  
Design systems (i.e., CAD)  
Training for buyers  
Production procedures  
Capital equipment and tools  
Plant capacity
### TABLE 2
**VARIABLE MEANS AND CORRELATIONS**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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<tbody>
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<td><strong>Pre-Auction Relationship States</strong></td>
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<td>1. Relationship Propensity</td>
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<td>1.17</td>
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<td>2. Willingness to Make Specific Investments</td>
<td>5.90</td>
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<td>7</td>
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<td><strong>Post Auction Relationship States</strong></td>
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<td>3. Relationship Propensity</td>
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<td>7</td>
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<td>4. Willingness to Make Specific Investments</td>
<td>5.61</td>
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<tr>
<td>5. Supplier’s Total Bids</td>
<td>9.27</td>
<td>12.86</td>
<td>0</td>
<td>54</td>
<td>.12</td>
<td>-.20</td>
<td>.06</td>
<td>.04</td>
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<td>6. Bidding Rate</td>
<td>.15</td>
<td>.20</td>
<td>0</td>
<td>.74</td>
<td>.05</td>
<td>-.24</td>
<td>-.10</td>
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<td>7. Price Concessions</td>
<td>.15</td>
<td>.17</td>
<td>0</td>
<td>.58</td>
<td>.08</td>
<td>-.41</td>
<td>-.08</td>
<td>-.05</td>
<td>.76</td>
<td>.66</td>
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<td><strong>Auction Characteristics</strong></td>
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<tr>
<td>8. Number of Bidders</td>
<td>6.63</td>
<td>2.44</td>
<td>2</td>
<td>11</td>
<td>.02</td>
<td>.36</td>
<td>-.02</td>
<td>.26</td>
<td>-.10</td>
<td>-.24</td>
<td>-.18</td>
<td>1.0</td>
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<tr>
<td>9. Total Number of Bids by Other Suppliers</td>
<td>42.25</td>
<td>51.20</td>
<td>0</td>
<td>179</td>
<td>.05</td>
<td>.19</td>
<td>.05</td>
<td>.18</td>
<td>.47</td>
<td>.21</td>
<td>.43</td>
<td>.27</td>
<td>1.0</td>
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<tr>
<td>10. Event Duration</td>
<td>63.35</td>
<td>38.52</td>
<td>6</td>
<td>213</td>
<td>-.04</td>
<td>.02</td>
<td>.16</td>
<td>.20</td>
<td>.43</td>
<td>-.07</td>
<td>.32</td>
<td>.09</td>
<td>.68</td>
<td>1.0</td>
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<tr>
<td><strong>Supplier Status</strong></td>
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<td></td>
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<tr>
<td>11. Incumbent</td>
<td>.69</td>
<td>.47</td>
<td>0</td>
<td>1</td>
<td>-.68</td>
<td>.12</td>
<td>-.54</td>
<td>-.23</td>
<td>-.13</td>
<td>-.28</td>
<td>-.08</td>
<td>.10</td>
<td>.23</td>
<td>.24</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Correlations greater than .26 are significant at p<.05
### TABLE 3
**BIDDING BEHAVIOR REGRESSION RESULTS**

All estimates are standardized. Standard deviations are provided in parentheses.

**BIDDING BEHAVIOR IN AUCTION**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Supplier’s Total Bids</th>
<th>Bidding Rate</th>
<th>Price Concessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-.091 (.129)</td>
<td>-.093 (.099)</td>
<td>-.103 (.114)</td>
</tr>
<tr>
<td>RELATIONSHIP STATES PRIOR TO AUCTION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relationship propensity</td>
<td>-.175 (.133)*</td>
<td>-.187 (.117)*</td>
<td>-.098 (.131)</td>
</tr>
<tr>
<td>Willingness to make investments</td>
<td>-.203 (.096)**</td>
<td>-.134 (.079)**</td>
<td>-.256 (.089)***</td>
</tr>
<tr>
<td>SUPPLIER STATUS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incumbent</td>
<td>-.415 (.169)***</td>
<td>-.385 (.137)**</td>
<td>-.205 (.156)</td>
</tr>
<tr>
<td>AUCTION CHARACTERISTICS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of bidders</td>
<td>-.130 (.062)**</td>
<td>-.206 (.064)***</td>
<td>-.180 (.069)***</td>
</tr>
<tr>
<td>Total number of bids by other suppliers</td>
<td>.322 (.091)***</td>
<td>.438 (.092)***</td>
<td>.315 (.099)***</td>
</tr>
<tr>
<td>Event duration</td>
<td>.018 (.063)</td>
<td>-.465 (.071)***</td>
<td>.016 (.074)</td>
</tr>
<tr>
<td>R²</td>
<td>.19</td>
<td>.27</td>
<td>.22</td>
</tr>
</tbody>
</table>

* p< .10, ** p< .05, *** p< .01. These are significance levels to a two-sided t-test, except for the significance levels on relationship propensity and willingness to make investment which are reported on a one-sided basis, as the corresponding hypotheses (H1 and H2) are one-sided.
**TABLE 4**  
**RELATIONSHIP REGRESSION RESULTS**

All estimates are standardized. Standard deviations are provided in parentheses.

<table>
<thead>
<tr>
<th>Predictor</th>
<th>POST AUCTION RELATIONSHIP</th>
<th>Willingness to Make Investments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Relationship Propensity</td>
<td></td>
</tr>
<tr>
<td><strong>BIDDING BEHAVIOR</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supplier’s total bids</td>
<td>-.186 (.126)*</td>
<td>.183 (.148)</td>
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<tr>
<td><strong>SUPPLIER STATUS</strong></td>
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<td></td>
</tr>
<tr>
<td>Incumbent</td>
<td>-.372(.152)***</td>
<td>.181 (.125)</td>
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<tr>
<td><strong>AUCTION CHARACTERISTICS</strong></td>
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<td></td>
</tr>
<tr>
<td>Number of bidders</td>
<td>-.035 (.108)</td>
<td>.123 (.128)</td>
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<tr>
<td>Total number of bids by others suppliers</td>
<td>-.047 (.158)</td>
<td>-.207 (.181)</td>
</tr>
<tr>
<td>Event duration</td>
<td>.379 (.141)***</td>
<td>.202 (.163)</td>
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<td><strong>RELATIONSHIP PRIOR TO AUCTION</strong></td>
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<tr>
<td>Relationship propensity</td>
<td>.396 (.142)***</td>
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<tr>
<td>Willingness to make investments</td>
<td>-----</td>
<td>.477 (.129)***</td>
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<tr>
<td>System R²</td>
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<td>.421</td>
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<td><strong>BIDDING BEHAVIOR</strong></td>
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<td>Bidding rate</td>
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<td>.169 (.146)</td>
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<td><strong>SUPPLIER STATUS</strong></td>
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<td>.184 (.127)</td>
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<td><strong>AUCTION CHARACTERISTICS</strong></td>
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<tr>
<td>Number of bidders</td>
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<td>.144 (.133)</td>
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<td>Total number of bids by others suppliers</td>
<td>.058 (.171)</td>
<td>-.236 (.195)</td>
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<td>Event duration</td>
<td>.231 (.146)</td>
<td>.311 (.174)***</td>
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<td><strong>RELATIONSHIP PRIOR TO AUCTION</strong></td>
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<tr>
<td>Relationship propensity</td>
<td>.319 (.147)**</td>
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<td>System R²</td>
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<tr>
<td><strong>BIDDING BEHAVIOR</strong></td>
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<tr>
<td>Price concession</td>
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<td>.268(.157)*</td>
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<td><strong>SUPPLIER STATUS</strong></td>
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<tr>
<td>Incumbent</td>
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<tr>
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<td>Total number of bids by others suppliers</td>
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<td>Relationship propensity</td>
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<tr>
<td>Willingness to make investments</td>
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<td>.565 (.142)***</td>
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<tr>
<td>System R²</td>
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<td>.447</td>
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* α = .10, ** α = .05, *** α = .01. These are significance levels to a two-sided t-test, except for significance levels for Bidding Behavior in the Relationship Propensity column which are reported on a one-sided basis, as the corresponding hypothesis (H3) is one-sided.
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