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Abstract (structured along the lines of: background, aim, method, results, conclusion – 150 – 200 words):

Online auctioning is one of the more successful business innovations on the Web. The auction format at eBay, the leading online auctioneer, has some unique characteristics including a fixed closing time for the bids and the use of a proxy bidding system that that is capable of acting as a bidder's agent. These features, coupled with third party products such as sniping software, have introduced novel bidder behaviours that may not occur in more traditional auction formats. In an attempt to study these behaviours, we collected and analyzed data from over 11,000 eBay auctions. This paper presents the results of the analyses including descriptive information about the auctions and the classification of bids and bidders based on bid timing, frequency, and strategy employed. The different types of bidders and their success rates offer insights into the nature of bidder participation in eBay auctions. In addition, chi-square analyses reveal significant differences among the bidding strategies with respect to auction outcome. Implications of the findings and a framework to guide future research on online auctions are presented.

Who Wins on eBay: An Analysis of Bidders and Their Bid Behaviours

Introduction

For many hundreds of years, auctions have been used as a market mechanism for determining the value of an item (Beam and Segev, 1998). With the advent of the "Internet age", both the popular press and academic journals have heralded online auctions as the way that pricing for goods and services will become dynamic (Bapna, Goes and Gupta, 2001; Benjamin and Wigand, 1995; Brynjolfsson and Smith, 2000; Dykema, Delhagen and Ardito, 1999; Hof, Green and Judge, 1999). Currently, one online auction market dominates all others – ***eBay*** (eBay, 2002). eBay has country specific sites in Austria, Australia, Canada, France, Germany, Ireland, Italy, Japan, Korea, New Zealand, Switzerland and the UK. The Company also operates iBazar S.A., a provider of online trading services in Europe and Brazil. eBay owns and operates "Half.com", which provides an alternative, fixed-price format for trading books, recorded music, movies (VHS and DVD) and video games. In addition, eBay also owns and operates Butterfields Auctioneers and Kruse International, which provide traditional offline auction services for fine art, antiques and collectibles and collector cars, respectively. In their latest reporting period (Quarter 4, 2002), eBay generated $4.6 billion in gross merchandise sales, hosted 195 million listings, and had almost 62 million registered users. In Fiscal Year 2002, eBay generated more than $400 million in net revenues. Ninety-five percent of the auctions at eBay follow a format that is eBay's variation of the English oral auction. However, the eBay variation of the English oral auction has some unique features, which seem to produce bidding behaviours that merit investigation. In this article we describe the unique features of eBay auctions, explore on-line bidder behaviour, and analyze the implications of bidding strategies on auction outcomes based on data collected for over 11,000 eBay auctions.

Literature Review and Research Questions

The basic auction mechanisms outlined by Vickrey (1961) are the English oral auction, Dutch auction, first-price sealed bid auction, and second-price sealed bid auctions. By far the most common format is the English oral auction, where the auctioneer accepts bids in ascending order until no more bids are forthcoming. The highest bidder at that moment receives the item and pays the amount of their bid. Rothkopf and Harstad (1994) provide a

behavioural reason for holding auctions by asserting that one of the critical reasons for the use of bidding is that the formality of the auction process provides legitimacy (price discovery).

eBay has implemented a variation on the English auction format that incorporates several proprietary "features" distinguishing it from the more formal English oral auction. However, at this writing, no formal research has been done to explore bidder behaviour with eBay's special auction format.

The first special feature of eBay's English auction is the imposition of a deadline at which time an auction will end. This takes the place of a physical auctioneer sensing when all the bids are in. Second, eBay allows bidders to submit proxy bids, i.e. a bidder can load their proxy with the maximum that they are willing to pay for the item and the proxy will bid against all comers (using a defined bid increment) until the maximum has been exceeded. Thus, a bidder need not be online all the time monitoring the auction. Bid ordering information is used to break ties, e.g. the first bidder in a proxy bidding war wins the tie. Third, eBay provides a "buy-it-now" opportunity where the seller offers an amount that if accepted will end the auction. All these features combine to cause eBay's online version of an English oral auction to look more like a second-price sealed-bid auction (Roth and Ockenfels, 2000).

The pre-announced end time of an eBay English auction appears to provide alternative bidding strategies, such as bid sniping which involves the placement of a bid just prior to the end of the auction (Malone, 2000; Rimbey and Guilfoyle, 2000). While bid sniping appears to have no formal definition, eBay, auctionwatch, and yahoo describe it as "bidding at the last minute". Malone implies that bid sniping is somehow improper:

> *"eBay and its like are a free-for-all for con artists, sleaze balls, shady operators, and outright thieves…when snipers enter the picture, bidding strategies go out the window…" Forbes ASAP, Michael Malone,* 11.27.00.

EBay's position on sniping is that it gains the bidder no advantage. If bidders put their maximum willingness to pay into the proxy system, then the only way they will lose the auction is if the sniper's bid is higher. If such an event, the proxy bidder shouldn't be disgruntled; they were just outbid by the marketplace. Nevertheless, it appears that many bidders prefer to bid late in the auction. Roth and Ockenfels (2000) report that of the 585 online auctions they examined, 18 percent had bids in the last sixty seconds. They suggest that sniping might be a best response to sentry bidding (see below), or other pricing behaviours such as shill bidding, bid stalking, bid nibbling or probe bidding. Furthermore, they propose that experienced bidders may wish to bid late because other bidders could potentially use bid information to update their prior valuations. Of course, there may be other non-strategic reasons to bid late, i.e. procrastination, unwillingness to delay gratification, flexibility (to bid on similar

auctions), and endowment effects. We found over 50 websites that either sell sniping software or distribute advice about how to snipe. In addition, at least 20 articles from the popular press decry sniping as the number one customer complaint. This leads us to our first set of research questions:

Q1: What percentage of bidders chooses to bid once just prior to the end of an auction on eBay?

Q2: Is there an advantage to bidding once late in an auction on eBay?

The proxy system used on eBay also provides opportunities for alternative bidding strategies. Roth and Ockenfels (2000) found that most of their bidders preferred not to use the proxy system. Ward and Clark (2002) found that bidders who won auctions using the proxy system did not gain any economic advantage. Nevertheless, the proxy system introduces changes to the auction market. For example, since the proxy system conceals information regarding its maximum authorized bid, a new strategy seems to have emerged on eBay: "probing" or "bid nibbling." We define probing bids as consecutive incremental bids that eventually reveal the maximum bid price used by a proxy agent. The auction literature generally assumes that all bidders have private, yet probably affiliated values (Lucking-Reiley, 1999; Milgrom and Weber, 1982). A probing strategy allows a bidder to reveal information concerning a proxy bidder's private valuations. Probing and the proxy system are interrelated, which leads us to our next set of research questions:

Q3: What percentage of bidders uses the proxy system on eBay?

Q4: Is there an advantage to using the proxy system on eBay?

Q5: What percentage of bidders uses a probing strategy on eBay?

Q6: Is there an advantage associated with the probing strategy on eBay?

Although the introduction of the proxy system on eBay enables a bidder to enter just one bid (if they choose) for the entire auction, some bidders continue to bid multiple times during an eBay auction. As mentioned above, probing bids are one such multiple-bid strategy. Another is sentry bidding, which refers to the practice of placing a bid, and then monitoring the auction and quickly placing additional incremental bids every time one is out-bid. Roth and Ockenfels (2000) suggest that sentry bidding on eBay may be the result of inexperienced bidders incorrectly applying a useful strategy from English oral auctions. This leads us to the following research questions:

Q7: What percentage of bidders engages in sentry bidding on eBay?

Q8: Is there an advantage to sentry bidding on eBay?

Q9: Do sentry bidders have less experience than the average bidder on eBay?

It appears that probing, sniping, and sentry bidding represent different mechanisms for responding to eBay's unique auction format. What prescriptions can we offer the prospective eBay user? Does any strategy, or combination of strategies, offer an advantage over the others? We explore this issue with our final research question:

Q10: Among auctions in which a variety of strategies are observed, which strategy offers the greatest chance of success?

Method

Using Microsoft's web server component model, SQL Server and Visual Basic, we developed a program that "screen-scrapes" all the data available about any completed auction on eBay's websites. The program is designed to access and download data from the auction summary page (Figure 1) and the auction detail page (Figure 2). From the summary page, we capture an auction's: unique identifier, description, category, first bid, location, country, start date/time, end date/time, seller and seller rating. From the detail page, we capture an auction's bid history, including bidder ID, bidder rating, bid amount, and bid date/time. From the highest bid, we determine the winner and the sale amount.

-- Please insert Figures 1 and 2 here --

Profile of Auctions and Bidders

To date, we have captured data on 24,887 auctions that were randomly chosen from all item categories by the "screen scrape" program. From this set, which included auctions hosted from 36 different countries, we first removed 7,783 auctions that had only one bid each, because the behaviours of interest (e.g., probing and sentry bidding) require multiple bids.

Next, to reduce possible moderating effects of cultural differences, we decided to use only those auctions hosted in the USA. The USA had the largest number of auctions for a single country in our sample (other countries with significant number of auctions included Germany - 2,882 and the United Kingdom - 1,077). The 11,495 USA based auctions, used in our current analyses, covered a wide variety of items including collectibles, computers, consumer electronics, books, music, movies, clothing, home appliances, garden tools, and sporting goods. The auctions had durations of three (1,197), five (1,585), seven (7,602) and ten (1,088) days. Other pertinent descriptive information about the auctions such as the number of bids and the first and winning bid amounts are presented in Table 1.

-- Please insert Table 1 here --

There were a total of 40,754 unique bidders in our sample with an average experience rating (the number of "feedbacks" received by a bidder was used as a surrogate measure of experience) of 112. We used two different criteria for classifying the auction bids and the bidders. First, we performed the classification based on the timing and frequency of a bidder's placement of bids. Second, we grouped bids and bidders based on the bid placement strategy. We next explain in more detail the two classification criteria and the success rates for the classified groups.

Bid Timing and Frequency

We classified each participant in an auction into two types based on the number of bids they had placed. If a bidder had placed only one bid in an auction, she was classified as a single bid participant, and if a bidder had placed more than one bid in an auction, she was categorized as a multi-bid participant. We further classified the single bid participant as an early, late, or in-between bidder based on the timing of her bid. Since there are no existing guidelines on what constitutes an early or late bid, we analyzed the timing of the bids in our sample set to arrive at reasonable cut-off points for the classification. First, we determined the points of time (in minutes) when the first 15 percent (from the start of the auction) and the last 15 percent (from the end of the auction) of the bids were received. Next, we used these points of time, which were approximately 1,440 minutes and 60 minutes for the first 15 percent and the last 15 percent of the bids respectively, to classify the bidders. If a bidder had placed his bid prior to the cut-off time for the first 15 percent of the bids, he was labelled an early bidder, if his bid had been made after the cut-off time for the last 15 percent of the bids, he was deemed a late bidder, and finally, if his bid had been received between the two cut-off times, he was grouped as an in-between bidder.

Since it can be argued that the percentage of bids (15%) chosen to arrive at the cut-off points for early and late bids is somewhat arbitrary, we performed sensitivity analyses using three other percentages (5%, 10%, and 15%) for the classifications. The results presented in Table 4 show that the success rates of the late and early bidders are fairly consistent, ranging between 5.26 percent and 8.33 percent for the former and between 73.09 percent and 77.46 percent for the latter.

The multi-bid participant was also sub-classified into a probing bidder or sentry bidder. eBay displays the amount of the current high bid. If the high bid was placed using their proxy system, the amount displayed will be the minimum amount (including the bid increment) required to outbid the previous bidder. The proxy system will

continue to bid the minimum amount required to outbid any new bidder, until it reaches its maximum authorized bid. We observed that some bidders would often place a series of consecutive incremental bids to discover the maximum authorized amount of a proxy agent. We assigned the label "probing bidder" to bidders who engaged in this type of bidding. Sentry bidding refers to the practice of bidding repeatedly in response to another bidder so as to remain the high bidder. Since a bidder could engage in both probing and sentry bidding at different times during an auction, it was possible for her to be classified as both a probing and a sentry bidder for a given auction.

Table 2 indicates that there were more bids received from multi-bidders (61.37%) than single bidders (38.63%). Among the bids received from multi-bidders, there were more probing bids than sentry bids. Not surprisingly, single bids received either early in the auction or late were the fewest in comparison to the other categories.

-- Please insert Table 2 here --

Table 3 lists the number of participants in each category, the number of auctions won by bidders in each category, the number of auctions won as a percentage of the total number of auctions, the number of auctions that bidders in each category participated in, their success rate, and their average experience rating. For example, there were 4,090 bidders with an average experience rating of 176 who placed a single bid in the last minutes of an auction. These bidders won 2,491 of the 11,495 auctions; leading to the observation that 21.67% of all auctions were won by late single bids. Furthermore, late bidders won 2,491 of the 3,314 auctions in which they participated, giving them a success rate of 75.17 percent.

-- Please insert Table 3 here --

We performed a series of chi-square analyses to test for significant differences among the bidder types with respect to their auction wins and losses. These results are presented in Tables 5, 6, and 7. In order to ensure a fair comparison, for each analysis, we included only those auctions in which all the bidder types compared had participated. For example, in the analysis comparing the single bidders (Table 5), we included only those auctions which had at least one early, one in-between, and one late bidder as participants. Among bidders who only bid once, we found that the strategy of bidding late was significantly more successful (Chi-square = 2343, $p < .000$). Table 6 presents an analysis of multiple-bid strategies, and Table 7 compares all bidder types based on bid-timing and bid-frequency. From these analyses it is clear that late single bidders are, by far, the most successful among all bidder types, at a distant second, are multi-bidders who either employ a pure sentry bidding style or a combination of

sentry and probe bidding, and the least successful are probing bidders and single bidders who bid early or in-between.

-- Please insert Tables 5, 6, and 7 here --

Proxy vs. Manual Bidding

We also classified the bids and bidders by the method they employed in the placement of their bids. Under proxy bidding, bidders can submit their maximum willingness to pay and have the system automatically place counter bids on their behalf until the maximum amount is reached. In contrast, a strategy of incremental bidding involves the bidder choosing to place each bid manually. We identified proxy bids by comparing the bid amount to the sum of the previous high bid amount and the appropriate bid increment. If the bid amount was greater, then we classified the bid as a proxy bid; if not, it was assumed to be an incremental bid. Based on the type of bids placed by a bidder in an auction, we classified her as an incremental bidder if she had placed only incremental bids, as a proxy bidder if she had placed only proxy bids, and an incremental and proxy bidder if she had placed both types of bids. Unfortunately, eBay does not reveal the actual bid type of the last bidder, if that bidder also happens to be the winner of the auction. Therefore, it wasn't possible to definitively classify a last bid, if it was the winning bid, and consequently the bidder, who placed this bid, was placed in the non-classifiable category.

As shown in Tables 8 and 9, the majority of the bids (75.01%) were proxy bids, and proxy bidders outnumber incremental bidders by a ratio of almost 4 to 1. Further, the success rates of the two types of bidders suggest that proxy bidders are far more successful in comparison to their incremental counterparts. This observation is supported by the results of a chi-square analysis presented in Table 10 that show, that in auctions in which all three types of bidders participated, the proxy bidders had the clear edge, winning 60.1 percent of the auctions. This percentage could even be higher if the strategy of the unclassified bidders could be discerned.

-- Please insert Tables 8, 9 and 10 here --

Answers to Research Questions

Our research questions Q1 and Q2 were related to late-bidding. We asked what percentage of bidders tends to bid only once, late in the auction. Is there an advantage to late bidding? We found that relatively few bidders employ this strategy (about 10%), but that they are disproportionately successful (winning 75% of the auctions in which they participated). This leads us to conclude that there is an advantage to late bidding.

Research questions Q3-Q6 were related to the eBay proxy system, and the emergence of a probing strategy in response to the proxy system. We found that most bids were placed using the proxy system (75%), and that most bidders (70%) could be characterized as using the proxy system exclusively. We found that the success rate for exclusive users of the proxy system was much higher (81%) than that of bidders who placed incremental bids (13%), and bidders who placed both incremental and proxy bids (29%). We, therefore, conclude that there is an advantage to using the proxy system.

About 28 percent of all bids placed were classified as probing bids, the most frequent of all bids. About one-fourth of all bidders engaged in probing. However, the success rate of probing bidders was no better than average (39%). Therefore, we conclude that there is no advantage to probing.

Research questions (Q7-Q9) were related to sentry bidding. Only about 9 percent of all bidders engaged exclusively in sentry bidding. The success rate for users of the sentry bidding strategy was marginally higher than other non-sniping strategies (44% vs. 39%) suggesting that that there is a small advantage to sentry bidding. Roth and Ockenfels (2000) suggested that sentry bidding on eBay was a misguided adaptation of a strategy from English oral auctions, and that sentry bidders on eBay would most likely be low in experience. However, our data does not support this conjecture since the average feedback score for sentry bidders (136) was higher than the average for all bidders (112).

Finally, Q10 asked, when all strategies are compared, is there one that emerges as being the best. We found 110 auctions in which there were bids of every possible strategy. A summary of the results from these auctions is shown in Table 7. Of the 1,271 unique bidders, there were 157 who used a strategy of bidding only once late in the auction. These 157 bidders won 73 of the 110 auctions (66.4%). Thus, in our sample the single best strategy was sniping (Chi-square = 352, $p < .000$). Table 11 summarizes our research questions and answers.

Discussion, Implications and Limitations

While we captured several auctions for items that sold for over $1,000, the majority of items sold for less than $18. We found the low value of the average item to be somewhat surprising. For the seller, the minimum transaction cost for an item that sells for the median price of $17.51 is $1.22 or about 7 percent. For the buyer, shipping costs average between $4 and $10 (determined by inspection of a random sample of these auctions). Thus for the buyer, the cost of shipping represent a large percentage of a transaction on eBay. The implication is that

buyers and sellers on eBay must believe that there aren't any better options available to trade their low-priced goods. In order to address this potential bias to lower priced goods, we are in the process of gathering auctions of higher priced goods (i.e. eBay Motors auctions). This additional data will help us perform comparative analyses between auctions classified by the value of the goods auctioned.

The most common form of bid observed was the "probing bid," comprising more than 38 percent of all bids. Probing bids are interesting because they invite a discussion of rationality. If one might interpret probing as irrational, the argument would be as follows: a rational bidder knows his own assessment of the value of an item, and will never bid more than he believes it is worth. The proxy system gives an advantage to bidders who know the maximum amount they are willing to bid, because it bids only the minimum amount required to win, and it wins tie-breakers against new bidders. This advantage is illustrated in Table 9, where we can see that the success rate among bidders who used the proxy system exclusively was about 72 percent; much greater than the 13 percent success rate among people who exclusively placed incremental bids. A rational bidder has no regret losing an auction to someone who is willing to pay more than she thinks the item is worth. Thus a rational bidder should use the proxy system. Any bidder making consecutive incremental bids is irrational. As mentioned earlier, this view represents eBay's official position on this bid strategy. However, by this definition, 20 percent of our observed bids were irrational. One could address this more fully in the laboratory, where all behaviour can be more closely monitored. And, as we suggest below, surveying eBay participants should shed more light on this bidding behaviour.

It might be argued that most users on eBay simply don't understand the advantages of the proxy system, and therefore do not use it. However, in Table 8 we can see that of the 77,926 bids that we recorded, there were 58,453 bids placed using the proxy system. This represents 75 percent of all bids that we observed. From this data, it seems unlikely that most users are unfamiliar with the advantages of the proxy system. Therefore, we think there must be another reason for the large number of probing bids.

One possible explanation emerges if we were to alternatively interpret probing as a rational, information seeking behaviour. In this interpretation, a bidder recognizes that his own assessment of an item's value may differ somewhat from the market value of the item. Thus a probe provides an opportunity to discover if another bidder shares a similar valuation of the item. The probing bidder continuously revises his belief (updates his priors) concerning the value of the item, as more information becomes available. At the heart of this argument is the notion that the actual value of any item is precisely what somebody is willing to pay for it. A logical consequence of this

argument is that there is no objective way to place a value on an item, and therefore, any bid is rational. One way to shed some light on this question is to study eBay auctions for items that have known values. If probing is designed to reveal shared valuations, then there should be fewer probing bids observed in auctions for items with known values. For example, Hayne, Smith and Vijayasarathy (2002) have captured auction data for several new model digital cameras. Internet pricing for these commodity items is published at such sites as "pricegrabber", "pricescan", "mysimon" and others. By examining bids, they are able to determine if bidders engage in price discovery in these auctions. It is even possible that probing is a result of participants engaging in "social facilitation" (Rafaeli and Noy, 2002), however, it is impossible to measure the degree of message traffic between bidders, outside of the actual eBay bidding pages.

The fact that 28 percent of the bids placed in our sample were probes suggests that a large number of the participants on eBay subscribe to the belief that each bid represents a useful piece of information regarding the value of the item being auctioned. There is additional evidence to support this assertion. In Table 2 we report that only 5 percent of all bids were placed by a bidder bidding once during the final minutes of the auctions. However, bidders using the strategy of placing a late single bid won the auction about 75 percent of the time. By placing a single bid late in the auction, a bidder gives other participants the least opportunity to update their priors concerning item valuation. Thus late bidding, or "bid sniping," appeared to be a successful strategy to minimize the dissemination of useful information to competitors in the eBay auction marketplace. In our sample, bid-snipers had the highest average feedback score (176) among the various groups, suggesting that this strategy is used by bidders with more experience.

It is worth noting that the next-most successful bid strategy was that of sentry bidding. Sentry bidders were successful about 44 percent of the time, compared to about 39 percent for other non-snipers. One might hypothesize that sentry bidding sends a signal to other bidders, "I intend to win this auction, no matter what." Such a signal might serve to discourage some bidders, leading to a slightly higher success rate than the other non-sniping strategies**.** We calculated the average number of unique bidders and the average number of bids for all auctions. When we compared auctions won by sentry bidders with other auctions, we found that auctions won by sentry bidders actually had a larger number (8.2 vs. 6.6) of bids and somewhat more unique bidders (4.2 vs. 4.0) than other auctions. Therefore, sentry bidding did not appear to discourage participation by other bidders. These data suggest

that sentry bidders may be more successful simply because they are somewhat more vigilant than other non-snipers. In other words, sentry bidders may expend more effort monitoring the status of their bids.

Proposed Framework for Future Research

Our data analyses reveal that bidders in eBay's online auctions exhibit novel behaviours that may be of interest to behavioural researchers in different disciplines. In order to guide future research, we present a framework (Figure 3) that identifies some of the components that are integral to the study of online bidding strategies. The criteria and indicators that are presented in the research framework are not exhaustive, and intended primarily to be illustrative of how the factors could be differentiated.

The research framework suggests that four factors – Auction, Bidder, Product/Service, and Seller - have an influence on bidding strategies. Each of the bulleted points is a criterion on which the factor could be classified or differentiated. For example, a product/service could be classified as being either a collectible or a commodity item. Similarly, a seller could be rated on their experience and reputation.

Relationships between factors are denoted by the lines connecting them, and the arrow heads on one or both ends of the line capture the directionality of the influence. Interpretation is conventional. For example, bidding strategy is expected to be influenced by product/service. In other words, the type of product, whether it happens to be a collectible item (whose value may not be readily determinable) as opposed to a commodity item (whose value is readily determinable) may trigger different bidding strategies. The result might be that an auction for a collectible item may witness a number of probing bids for the purpose of assessing the value of the product.

Relationships shown with the bi-directional arrows are more complex. The line connecting bidder and bidding strategy with arrows on both ends depicts a reciprocal relationship between these two factors because it can be argued that just as the bidder's experience, risk propensity, and intent may influence her choice of bidding strategy, so too could the prevailing bidding strategy at an auction have an impact on the type of bidders who are either attracted or detracted from participating in that auction. For example, a shill bidder, whose intent may be to spark interest in an auction and/or drive up the price, may place probing bids. Reciprocally, an experienced bidder who suspects the presence of a shill bidder by the pattern of probing bids may decide not to participate in that auction or refrain from bidding until late in the auction. The auction type, length and pricing determines bidding strategy, e.g. a multi-item auction with no reserve may generate more early bids than an auction with a reserve price.

Conversely, the frequency, timing and bid-placement strategies witnessed in an auction may have a bearing on the high bid at any given time during the duration of that auction.

We have also defined a recursive relationship within bidding strategy. This is intended to capture the possibility of the prevalent bidding strategy having an influence on the placement of future bids. For example, the presence of a proxy bid may prompt probing bids aimed at uncovering the maximum value of the proxy bid. Or, the placement of sentry bids may tip a bidder to hold off their bid until the auction's close.

We hope that our framework, which identifies the principal players, processes and relationships of relevance to the study of online bidding behaviour, will be useful in guiding future research. This research will have to employ different data collection strategies including controlled and field experiments, surveys, and "screen scraped" data to examine the causal, reciprocal, and recursive associations suggested in our model.

Conclusion

Our study has raised some interesting questions about eBay auctions. We found that bidding once, late in an auction leads to greater success. We also uncovered the popularity of probing bids, and discussed the possible motivations for them. The popularity of probing bids is especially puzzling given the lack of success that we observed for users of the probing strategy. The issue of, "why do bidders place multiple consecutive bids?" remains unresolved. This issue is difficult to resolve because many of the items sold on eBay have uncertain valuations. But as we mention, one can study commodity items to gain insight here.

Finally, we believe that a survey of eBay participants would be enlightening. As part of our investigations into bidding behaviours, we have observed several behaviours for which the motivations can best be ascertained by querying the bidders themselves. One situation that elicits such interesting behaviours occurs when a seller lists several identical items for sale in separate auctions whose end-times are in close proximity. We observed that many of the same bidders participate in these auctions, and sometimes the unsuccessful bidders from an early auction would bid *less* on subsequent auctions. Why do unsuccessful bidders lower their valuations in subsequent auctions? We are also interested in discovering if there are particular bidding strategies that work best when bidders have the opportunity to bid in consecutive auctions for identical items. We look forward to our investigations of these and other questions in the emerging eBay marketplace.

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Figure 1: eBay Auction Summary Page

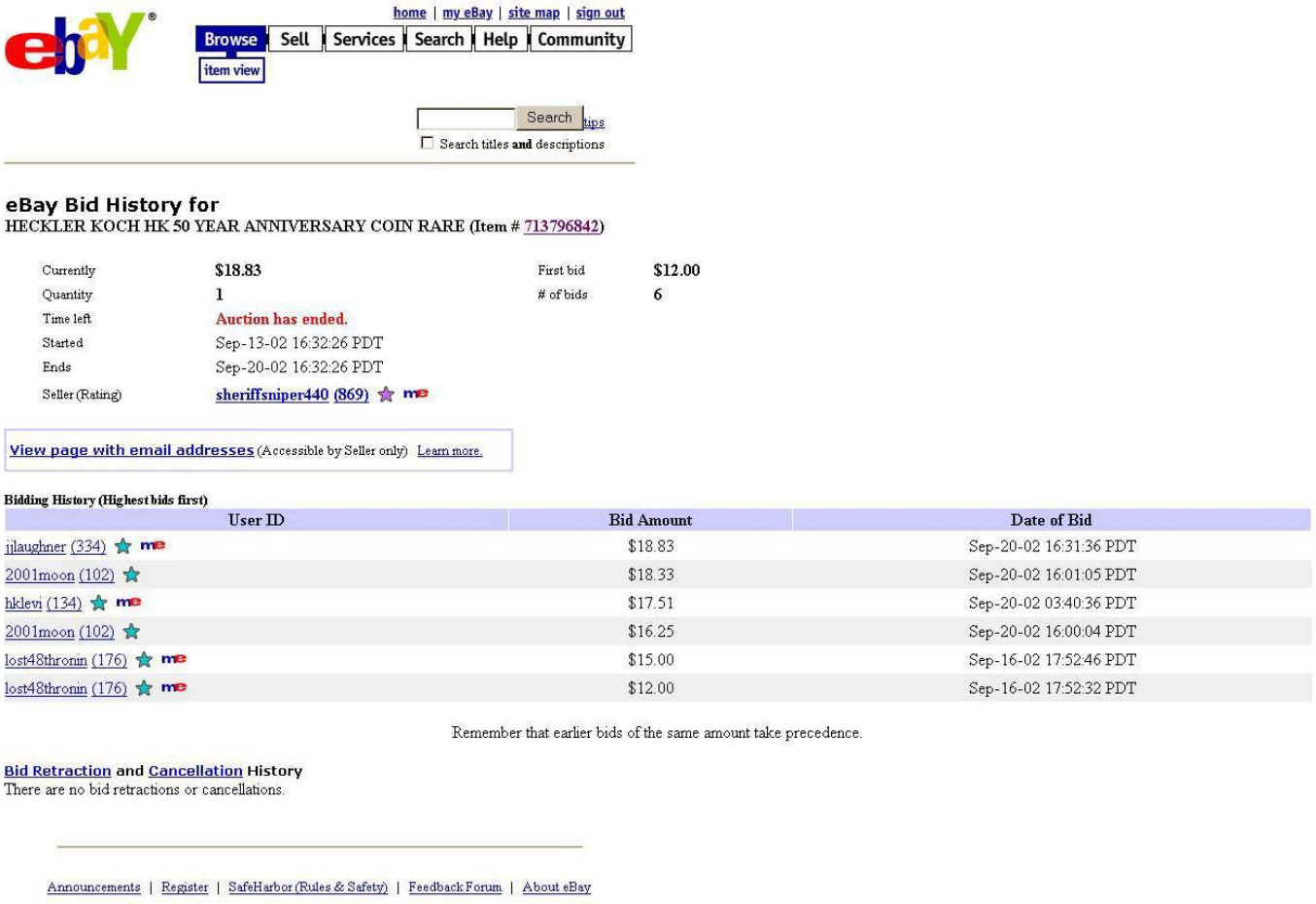

Figure 2: eBay Auction Detail Page

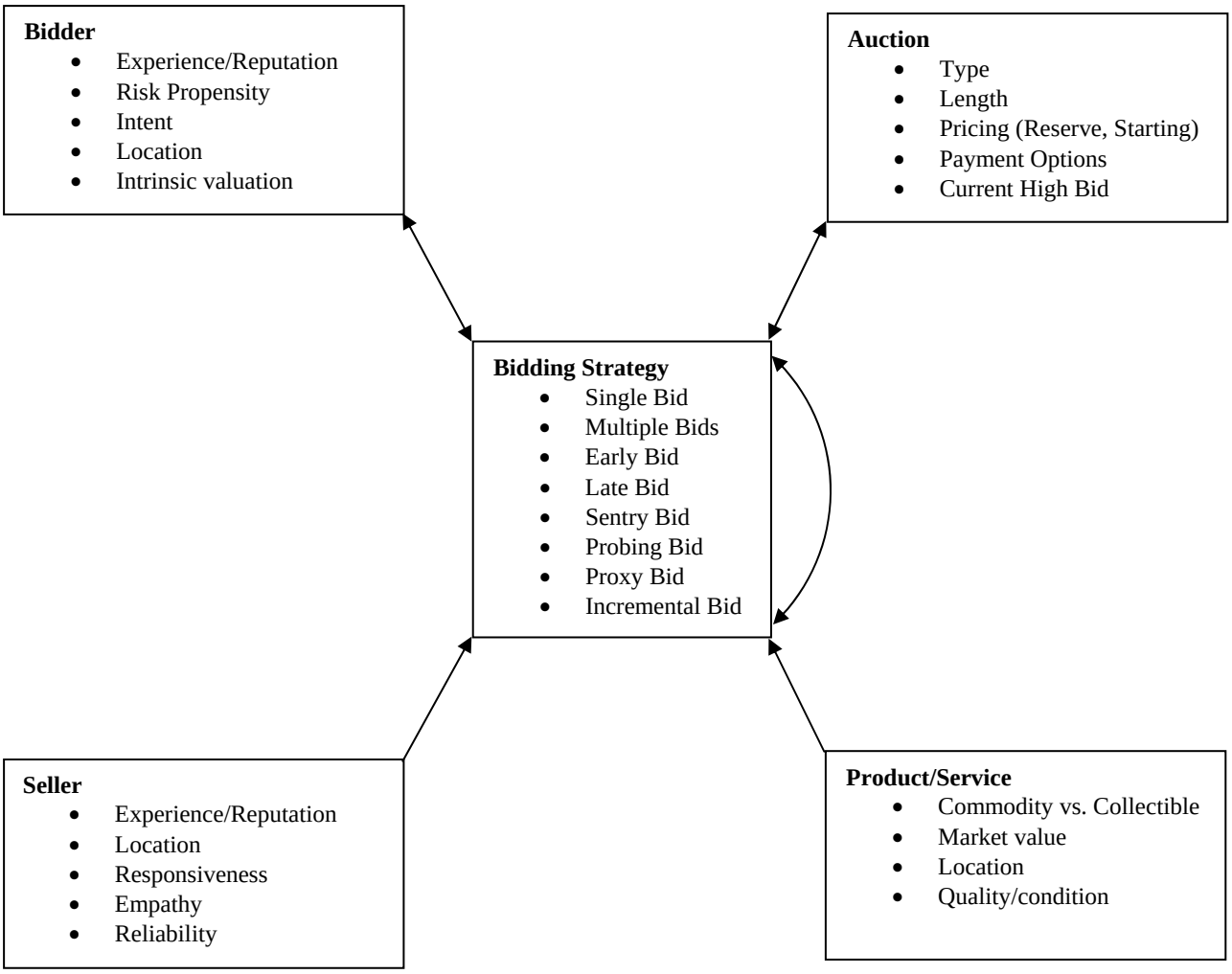

Figure 3: A Research Framework for the Study of Online Bidding Behaviour

Table 1: Key Auction Attributes

Statistics	Number of Bids	Number of Unique Bidders	First Bid Amount (US$)	Winning Bid Amount (US$)
Mean	6.78	3.98	19.36	63.10
Median	5.00	3.00	6.95	17.51
Mode	2.00	2.00	9.99	15.50
Std. Dev.	5.59	2.54	89.76	212.29
Minimum	2	1	0.01	0.01
Maximum	58	22	5,000.00	8,100.00

Table 2: Bids Classified by Bid Timing and Frequency

Bid Timing	Number of Bids	Percent of Total Bids
Single Bid		
Early	6,057	7.77%
In-Between	19,953	25.61%
Late	4,090	5.25%
Multi Bid		
First Bid[1]	15,697	20.14%
Probe Bid	22,078	28.33%
Sentry Bid	10,051	12.90%
Total Bids	77,926	100.00%

[1]: The first bid placed by a multi-bidder

Table 3: Auction Success of Bidders Classified by Bid Timing and Frequency

Bidder Type	Number of Bidders	Auctions Won (a)	Percent of Auctions Won (a / 11,495)	Auctions Participated in (b)	Success Rate (a / b)	Experience Rating[1]
Single Bid						
Early	6,057	294	2.56%	4,013	7.33%	162
In-Between	19,953	3,874	33.70%	9,565	40.50%	149
Late	4,090	2,491	21.67%	3,314	75.17%	176
Multi Bid						
Only Probe	7,753	2,152	18.72%	5,600	38.43%	90
Only Sentry	4,157	1,494	13.00%	3,418	43.71%	136
Both	3,787	1190	10.35%	2,996	39.72%	79

1: ANOVAs showed that a) single and multi bidders (*F=342.43, df = 1, p < .000*), and b) all six bidder types (*F=85.83, df = 5, p<.000*) were significantly different on bidder rating.

Table 4: Sensitivity Analysis for the Timing of Single Bids

Bid Classification Percentage	Bidder Timing	Number of Bidders	Auctions Won (a)	Percent of Auctions Won (a / 11,495)	Auctions Participated in (b)	Success Rate (a / b)	Experience Rating
5%	Early	2,234	93	0.81%	1,769	5.26%	156
	In-Between	25,447	4,931	42.90%	10,319	47.79%	150
	Late	2,419	1,635	14.22%	2,108	77.46%	207
10%	Early	4,239	188	1.64%	3,035	6.19%	160
	In-Between	22,775	4,448	38.70%	10,021	44.39%	150
	Late	3,086	2,023	17.60%	2,622	77.15%	187
15%	Early	6,057	294	2.56%	4,013	7.33%	162
	In-Between	19,953	3,874	33.70%	9,565	40.50%	149
	Late	4,090	2,491	21.67%	3,314	75.17%	176
20%	Early	7,727	404	3.51%	4,852	8.33%	163
	In-Between	16,986	3,229	28.09%	8,958	36.05%	147
	Late	5,387	3,026	26.32%	4,140	73.09%	169

Table 5: Chi-Square Analyses of Auction Results by the Timing of Single Bidders

Bid Timing		Auction Result		
		Lost	**Won**	**Total**
Early	Count	1,451	10	1,461
	Row%	99.3	0.7	
	Col %	24.5	1.1	
In-Between	Count	2,289	90	2,379
	Row%	96.2	3.8	
	Col %	38.6	9.8	
Late	Count	532	681	1,213
	Row%	43.9	56.1	
	Col %	9.0	73.9	
Other[1]	Count	1,653	140	1,793
	Row%	92.2	7.8	
	Col %	27.9	15.2	
Total		5,925	921	6,846

Pearson Chi-Square*: Value = 2343.22, df = 3, p < .000*

[1]: Multi-bid participants in this set of auctions

Table 6: Chi-Square Analyses of Auction Results by the Type of Multi-Bidders

Multi-Bid Type		Auction Result		
		Lost	**Won**	**Total**
Probe	Count	918	91	1,009
	Row%	91.0	9.0	
	Col %	20.7	14.4	
Sentry	Count	636	165	801
	Row%	79.4	20.6	
	Col %	14.4	26.2	
Probe & Sentry	Count	654	182	836
	Row%	78.2	21.8	
	Col %	14.8	28.9	
Other[1]	Count	2,224	192	2,416
	Row%	92.1	7.9	
	Col %	50.2	30.5	
Total		4,432	630	5,062

Pearson Chi-Square*: Value = 171.32, df = 3, p < .000*

[1]: Single bid participants in this set of auctions

Table 7: Chi-Square Analyses of Auction Results by all Bidder Types

Bidder Type		Auction Result		
		Lost	**Won**	**Total**
Single				
Early	Count	239	0	239
	Row%	100.0	0.0	
	Col %	20.6	0.0	
In-Between	Count	353	1	354
	Row%	99.7	0.3	
	Col %	30.4	0.9	
Late	Count	84	73	157
	Row%	53.5	46.5	
	Col %	7.2	66.4	
Multiple				
Probe	Count	197	3	200
	Row%	98.5	1.5	
	Col %	17.0	2.7	
Sentry	Count	140	16	156
	Row%	89.7	10.3	
	Col %	12.1	14.5	
Probe & Sentry	Count	148	17	165
	Row%	89.7	10.3	
	Col %	12.7	15.5	
Total		1,161	110	1,271

Pearson Chi-Square*: Value = 352.45, df = 5, p < .000*

Table 8: Bids Classified by Bid Strategy

Bid Strategy	Number of Bids	Percent of Total Bids
Proxy Bids	58,453	75.01%
Incremental Bids	15,630	20.06%
Unclassifiable Bids	3,843	4.93%
Total Bids	77,926	100.00%

Table 9: Auction Success of Bidders Classified by Bid Strategy

Bidder Type	Number of Bidders	Auctions Won (a)	Percent of Auctions Won (a / 11,495)	Auctions Participated in (b)	Success Rate (a / b)	Experience Rating[1]
Only Proxy	33,497	8,288	72,10%	10,203	81.23%	145
Only Incremental	6,218	640	5.57%	5,074	12.61%	133
Both	4,602	1,087	9.46%	3,704	29.35%	78
Not Classified	1,480	1,480	12.87%	1,480	100.00%	136

1: ANOVA showed that the four groups (*F=59.19, df = 3, p<.000*) were significantly different on bidder rating.

Table 10: Chi-Square Analyses of Auction Results by Bidder's Strategy

Bidder's Strategy		Auction Result		
		Lost	**Won**	**Total**
Proxy	Count	4,788	786	5,574
	Row%	85.9	14.1	
	Col %	60.8	60.1	
Incremental	Count	1,698	69	1,767
	Row%	96.1	3.9	
	Col %	21.6	5.3	
Proxy & Incremental	Count	1,391	310	1,701
	Row%	81.8	18.2	
	Col %	17.7	23.7	
Not Classified	Count	0	142	142
	Row%	0.0	100.0	
	Col %	0.0	10.9	
Total		7,877	1,307	9,184

Pearson Chi-Square*: Value 1,032.47, df = 3, p < .000*

Table 11: Research Questions and Answers

Question Number	Question	Answer
Q1	What percentage of bidders chooses to bid just once prior to the end of an auction on eBay?	10%
Q2	Is there an advantage to bidding once late in an auction on eBay?	Yes
Q3	What percentage of bidders uses the proxy system on eBay?	70%
Q4	Is there an advantage to using the proxy system on eBay?	Yes
Q5	What percentage of bidders uses a probing strategy on eBay?	25%
Q6	Is there an advantage associated with the probing strategy on eBay?	No
Q7	What percentage of bidders engages in sentry bidding on eBay?	9%
Q8	Is there an advantage to sentry bidding on eBay?	Yes, to some extent
Q9	Do sentry bidders have less experience than the average bidder on eBay?	No
Q10	Among auctions in which a variety of strategies are observed, which strategy offers the greatest chance of success?	Bid once, late