Bidding Behavior and Profits in Pay-per-bid Auctions

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Abstract—**This paper studies the bidding behavior and the expected profits in the pay-per-bid auctions. By collecting auction data on bidxi.com, we make the two-step cluster analysis to divide bidders into irrational bidders and rational bidders. It shows that no matter what strategies bidders are used, their expected profits are always negative. Then, we analyze the impact of some factors on the auction price. We find that the number of two types of bidders has the significant positive impact on the final auction price. In addition, we find that in the pay-per-bid auctions, the auction price changes periodically with the end time.**

Keywords-pay-per-bid action; bidding behavior; bid fees; auction price; online auction

I. INTRODUCTION

Over the past several years, Internet has changed the way of the trading dramatically. Online auctions have recently gained widespread popularity, and have become one of the most successful forms of electronic commerce.

As a pioneer of online auctions, eBay is a source for a large amount of high quality data and serves as a natural testing ground for existing theories of bidding. A large number of papers in economic theory have studied the bidding behavior in eBay. Bapna[1] classified bidders into three categories, i.e. evaluators, participators, and opportunists. Ma jun[2] revealed that bidders using the late-bidding strategy will win the auction with the lower price, but their winning probability is lower. Ward and Clark[3] found that auctions won by bids submitted early in the auction resulted in higher revenues than auctions won by bids submitted during the latter of the auction, and auctions won by early bids result in higher revenues than auctions won by minimum-increment bids. Wilcox[4] collected data across four product categories to explore the bidding behavior of consumers. He pointed out that more experienced bidders will be less likely than less experienced bidders to place multiple bids in the same auction. Bajari and Hortacsu[5] showed that the late-bidding strategy turns out to be an equilibrium strategy when bidders' valuations are affiliated. By collecting computer and antique auction data from eBay and Amazon, Roth and Ockenfels[6,7] found that the rule for ending an auction can affect bidding behavior. They pointed out that the fraction of bids submitted in the closing seconds of the auction is substantially larger in eBay with the fixed end time than that in Amazon with the extended end time.

With the development of online auction, some new forms have emerged in recent years, such as the pay-per-bid auction. The greatest difference from the traditional online auction is that in the pay-per-bid auction each bid need to pay a certain amount of bid fee which cannot be returned. The bidding for the item starts at zero and with quite low increment. The final auction price is always very low, when bidders win the auction. Hence, integrated the low price, entertainment and interaction into the competition, the pay-per-bid auction spread all over the internet in a short time and attract a large number of consumers.

The pay-per-bid auction is originated from swoopo.com. Some scholars have studied the bidding behavior in Swoopo. MacDonald[8] disclosed that the average revenue obtained by the auctioneer increases with the market price of the item being offered. He also proposed that the auctioneer should provide more auctions to attract a larger number of bidders to increase their revenue. Augenblick[9] noted that bidders overbid more and more as the auction continues. He revealed that, the majority of the auctioneer's revenue is derived from the bid fees collected throughout the auction, and over-supplying auctions lead the auctions to end prematurely, which can produce negative profit for the auctioneer. By collecting auction data from Swoopo, Byers, Mitzenmacher and Zervas[10] argued that even small asymmetries across players can increase the auction duration significantly and thus improve the auctioneer's profits. According to the rules of Swoopo, Nanney[11] proposed a general asymmetric full-information model, and concluded that the seller's expected revenue is higher than the bidders'. Hinnosaary[12] analyzed the behavior of bidders and sellers using game theory and described the equilibrium strategy.

As a new form of the online auction, the pay-per-bid auction appeared in China in 2010. Now, there are many websites which are running the pay-per-bid auctions, i.e. bidxi.com, lx987.com and havepai.com. In the pay-per-bid auctions, a wide range of items are offered, and bidders can choose as they wish. By collecting auction data from bidxi.com, this paper makes an analysis on the bidding behavior and the effect of some factors on the auction price.

The rest of the paper is organized as follows. Section 2 describes auction rules used in Bidxi. In Section 3, we make a two-step cluster analysis on bidding behavior and explore the characteristics of different bidding strategies. Section 4 studies the effect of some factors on the final auction price. Finally, it is summarized in Section 5.

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II. PROBLEM STATEMENT

Bidxi runs a "pay-per-bid" auction website, which launched in March, 2010. As with the standard online English auctions, the pay-per-bid auctions for items begin at a starting price (generally 0), and have an associated countdown timer. When a player places a bid, the current auction price is incremented by a fixed amount, and some additional time is added to the timer in order to allow other players the opportunity to bid again. When the clock expires, the last bidder must purchase the item at the final auction price. The important variation of the pay-per-bid auction is that each time a player increments the price and becomes the current leader of the auction, they must pay a bid fee. On Bidxi, the price increment is 0.01 yuan and placing a bid costs 1 yuan. As a result, on the traditional online English auctions the sellers derive all of their profits from the final auction price, while on the pay-per-bid auctions they derive their profits from the bid fees.

The items offered on Bidxi ranges from the electronic products, household appliances to leisure outdoor products. We collect 303 auction data of "50Xibi" run on Bidxi from June 22nd to August 3rd, in 2010. Xibi is a virtual currency, which is used to pay for the bid fee. Based on it, we make an analysis of the bidding behavior and the effect of some factors on the final price in pay-per-bid auctions.

III. EMPIRICAL ANALYSIS ON BIDDING BEHAVIOR

In this section, we make the two-step cluster analysis to classify 3944 players participating in 303 pay-per-bid auctions. We select user ID, the number of his bids and the number of auctions in which he participated as sample variables. Table I presents the process of the cluster analysis. The first column is the number of clusters, and the other columns are the statistics which are used to determine the optimal number of the cluster. The smaller the value of the BIC is, the more exact the model is. But the value of the BIC decreases with the number of cluster. So, the ratio of BIC changes and the ratio of distance measures are used to determine the optimal number of the cluster. According to Table I, we decide that the number of the cluster is two.

Table II presents the percentage of two types of bidders and Table III shows the statistical data of the outcome of cluster. One type has 54 bidders, and the other has 3,890 bidders. The first type of bidders participates in more than 7 pay-per-bid auctions. Among these bidders, one participates in 95 auctions at most. Each bidder participates in 25.2 auctions on average. They show more active and aggressive in every auction. One bidder places 153 bids in a pay-per-bid auction. They placed 32.91 bids on average in one auction. However, the second type of bidders participates in no more than 5 auctions. Among these bidders, 72.2 percent participate in only one pay-per-bid auction. Each bidder participates in 1.52 auctions on average. Compared with the first type of bidders, they show cautious and less aggressive in every auction. They placed 5.32 bids on average in one auction. According to the characteristics of their bidding behavior, we define the first type as irrational bidders and the second type as rational bidders. Correspondingly, their bidding strategies are defined as irrational strategy and rational strategy, respectively.

TABLE I. THE PROCESS OF THE CLUSTER

Numer of Clusters	Schwarz's Bayesian Criterion(BIC)	BIC Change[a]	Ratio of BIC Change[b]	Ratio of Distane Measures[c]
1	5499.665			
2	885.849	-4613.815	1.000	20.380
3	690.956	-194.893	0.042	1.081
4	513.104	-177.852	0.039	3.880
5	491.848	-21.256	0.005	1.114
6	476.161	-15.687	0.003	1.174
7	467.725	-8.436	0.002	1.320
8	469.372	1.647	0.000	1.076
9	473.255	3.883	-0.001	1.483
10	486.656	13.400	-0.003	1.490
11	506.540	19.884	-0.004	1.013
12	526.592	20.052	-0.004	1.150
13	548.346	21.754	-0.005	1.084
14	570.980	22.634	-0.005	1.051
15	594.120	23.140	-0.005	1.031

a. The changes are from the previous number of cluster in the table.

b. The ratios of changes are relative to the change for the two cluster solution.

c. The ratios of distance measures are based on the current number of cluster against the previous number of cluster.

Next, we make a comparison of the average profits and the winning probabilities of the two types of bidders, seen in Table IV. There are 54 irrational bidders, among which 41 bidders win the pay-per-bid auctions. They win 184 auctions in all and each bidder win 3.4 auctions on average. Their winning probability is 0.105 and the average profit is -28.03. We explain that, the main reason that the negative profit is obtained by the bidders is the non-refundable bid fees. Bidxi requires that bidders must pay 1 yuan to place a bid each time. The more bidders bid, the more they loss. Irrational bidders participate in more auctions and show active in each auction. Consequently, their winning probability is higher, whereas their bid fees is also higher, which lead to their negative profits.

On the other hand, there are also 3890 rational bidders, among which 99 bidders win the pay-per-bid auctions. They win 119 auctions in all and each bidder win 0.03 auctions on average. Their winning probability is only 0.012 and the average profit is -4.74. We find that the average profits obtained by two types of bidders are both negative. Then, we calculate the auctioneer's profits obtained from the pay-per-bid auctions. The result indicates that the rate of the auctioneer's profits amount to 490.91%.

TABLE II. THE ANALYSIS OF CLUSTER

	N	% of Combined	% of Total
Cluster 1	54	1.4%	1.4%
2	3890	98.6%	98.6%
Combined	3944	100.0%	100.0%
Total	3944		100.0%

TABLE III. THE STATISTICAL DATA OF THE OUTCOME OF CLUSTER

	The number of auctions				The number of bids				The number of bids in one auction		
	Min	*Max*	*Mean*	*Std. Deviatin*	*Min*	*Max*	*Mean*	*Std.Deviatin*	*Min*	*Max*	*Mean*
Cluster1	7	95	25.2	782.726	74	3518	861.17	782.726	1	153	32.91
2	1	5	1.52	24.375	1	269	10.81	24.375	1	101	5.32
Sum	1	95	1.84	136.340	1	3518	22.45	136.340			

TABLE IV. COMPARISON OF TWO TYPES OF BIDDERS

The type of bidders	The number of bidders	The number of the winners	The total Number of winning auctions	The number of the winning auctions on average	Winning probability	The profit on average
Irrational bidders	54	41	184	3.4	10.5%	-28.03
Rational bidders	3890	99	119	0.03	1.2%	-4.74

Therefore, we conclude that the profits obtained by bidders in the pay-per-bid auctions are always negative no matter what bidding strategies they used. If a player decides to participate in a pay-per-bid auction, then the winning probability which the irrational bidding strategy causes is higher than that of rational bidding strategy. However, the expected profits of irrational bidders are lower than that of rational bidders. Rational bidders bid cautiously and less aggressively in every auction, so the bid fees they pay are relatively lower. Combined the features of these two types of bidders, we consider that when a player participates in a pay-per-bid auction, he shouldn't participate in too many auctions and bid too more in one auction. The bid fees he pays in one auction shouldn't exceed the market price of the item. By doing so, he must obtain the positive profit, if he wins the auction. Otherwise, he can purchase the item at a difference price that equals the market price minus his bid fees, if he lost the auction.

IV. THE EFFECT OF SOME FACTORS ON AUCTION PRICE

Based on our discussion about the bidding behavior, in this section we will analyze the effect of some factors on the final auction price.

A. The Effect of the Number of Bidders

It has been proved that the final auction price increases with the number of bidders in the traditional auctions. So, we hypothesize that the number of rational bidders and irrational bidders has the impact on the final auction price in the pay-per-bid auction. Thus, we construct the following linear regression equation:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \varepsilon. \quad (1)$$

where y is defined to be the final auction price, and x_1, x_2 is the number of irrational bidders and rational bidders, respectively. The outcomes of the regression are shown in Table V. The multiple correlation coefficients is 0.848, adjusting to be 0.847. The model has the higher accuracy and has no multicollinearity. The equation of the linear regression is

$$y = -0.376 + 0.529x_1 + 0.047x_2 + \varepsilon. \quad (2)$$

Through the regression analysis, we know that both the number of rational bidders and the number of irrational bidders have the significant impact on the final auction price. It indicates that the final auction price will increase with the number of bidders, no matter what strategies bidders use. In addition, we also find that compared with the number of rational bidders, the number of irrational bidders has more important impact on the final auction price. One additional irrational bidder can increase 0.529 yuan in the final auction price, while one additional rational bidder can increase 0.047 yuan in the final auction price. It can be explained that the irrational bidders show more active and aggressive. They placed 32.91 bids on average in a pay-per-bid auction, which increase the final auction price and the auctioneer's profits. However, the rational bidders placed 5.32 bids on average in an auction, which has a little impact on the final auction price. Hence, we suggest that the auctioneers should offer more pay-per-bid auctions to attract more bidders. Through the participation and the competition of bidders, the auctioneers

TABLE V. THE OUTCOME OF THE REGRESSION

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	*Std.Error*	*Beta*			*Tolerance*	*VIF*
constant	-0.376	0.158		-2.376	0.018		
Irrational bidders	0.529	0.016	0.842	32.320	0.000	0.746	1.341
Rational bidders	0.049	0.009	0.141	5.415	0.000	0.746	1.341

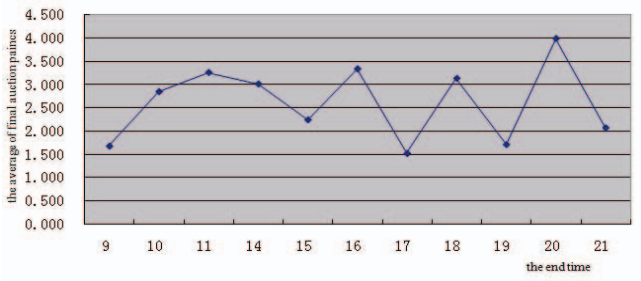

Figure 1. The changes of the final auction price with the end time

can obtain more profits.

B. The Effect of the Ending Time

Bidxi offers a wide range of items. And players can participate in the pay-per-bid auctions as they wish. About 10 "50 Xibi" auctions run every day. By collecting 303 auction data of "50 Xibi", we find that the competition and the final auction price vary greatly with the end time in the pay-per-bid auctions. Fig. 1 shows the changes of the final auction price with the end time. The horizontal axis represents the end time, which is from 9 a.m. to 9 p.m. (there isn't a pay-per-bid auction running between 12 a.m. and 2 p.m.). The vertical axis represents the average of final auction prices in different periods of the end time. Fig.1 indicates that the average final prices vary greatly in the different end time. So, we suggest that the bidders should avoid the peak period of bidding. When the competition in this pay-per-bid auction is fierce, the bidder should wait to participate in the next auction.

V. CONCLUSION

By collecting 303 auction data at bidxi.com, we study the bidding behavior and the effect of some factors on the final auction price in the pay-per-bid auctions. First, we make the two-step cluster analysis to classify bidders into rational bidders and irrational bidders. We point out the characteristics of their bidding behavior, and calculate the winning probabilities and the expected profits of two types of bidders. We find that no matter what strategies they use, the expected profits obtained by bidders are always negative. If players tend to participate in pay-per-bid auctions, we suggest that they shouldn't participate in too many auctions and bid too more in one auction. The bid fees they pay in one auction shouldn't exceed the market price of the item. Then, we analyze the effect of some factors on the final auction price and obtain some conclusions.

Pay-per-bid auctions are the relatively new kind of Internet auctions. It is worth doing more extensive study of bidding behavior for future work. For instance, we note that when they are bidding, chatting rooms and forum are open at bidxi.com, where bidders can communicate with each other. Consequently, it is possible to form the collusion among bidders, which has a strong negative effect on the auctioneer's profits. How does the auctioneer promote communication among bidders and restrict their collusions effectively?

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