USER BEHAVIOR IN AN ONLINE PENNY AUCTION

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ABSTRACT. In this paper, we give an empirical study of user behavior on the online penny auction website `www.swoopo.com`. Using data from 35000 auctions which took place between September 2008 and March 2009, we find two distinct groups of site users. We then study the behavior of these novice and experienced users and draw some conclusions about the strategy employed by the latter group.

1. INTRODUCTION

In the last few years, several online auction sites known as "penny auction" sites have grown in popularity, creating some controversy in the media [6]. These sites auction off new items such as televisions and laptop computers at very low prices, often below 10 percent of their retail value. There are, however, two caveats: (1) users must pay a fixed bidding fee (usually around \$1) to place each bid, and (2) each bid only increases the price of the item by a fixed amount (usually less than \$0.20). Thus, while the winner of an auction may purchase an item at a steep discount, the bidding fees paid by other users in the course of the auction are often more than enough for the site to recoup the difference many times over.

A typical example of such a site is `www.swoopo.com`, which we will simply refer to as Swoopo. Established in Germany in 2005, Swoopo has been running auctions in the United States since September 2008 and claims over 1.2 million registered users bidding on roughly $10,000$ items each month [1]. According to one representative, Swoopo had annual revenue of \$29 million in 2008 and makes money on roughly half its auctions [7]. As such, Swoopo seems to be solidly profitable, meaning that its users must lose money on average. On the other hand, an analysis of the summaries of completed auctions posted on the Swoopo website (available at [3]) reveals a number of users who have won a substantial number of auctions on the site, suggesting that Swoopo is profitable for these users.

This observation suggests that there are two classes of Swoopo users pursuing distinctly different strategies in auctions, and the purpose of the present paper is to distinguish between these strategies and to explain their emergence. We use empirical data gathered from roughly 35000 completed auctions posted on Swoopo to examine user behavior [3]. By aggregating information about the winners of these auctions, we are able to identify individual bidding behaviors.

Using this data, we find that the user population of Swoopo contains two types of users, novice and experienced, who are employing distinctly different bidding strategies. Based on the rationality assumption that these experienced, or repeat, users of Swoopo are profitable, we are able to give some properties of the strategy followed by these users and to propose a potential candidate for such a strategy.

The rest of this paper is structured as follows. In Section 2, we further detail the mechanics of auctions on Swoopo. In Section 3, we explain our process of data collection and give some immediate consequences of the data. In Section 4, we perform a statistical analysis of the auction data. In Section 5, we conclude with the resulting implications for user behavior. We would like to note here that all statistical analysis in this paper was done using R 2.9.0.

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2. Swoopo Site Mechanics

In this section, we describe the rules for auctions on Swoopo and give some initial qualitative observations for the auction dynamics.

2.1. **Auction Rules.** The basic rules governing an auction on Swoopo are as follows; note that a brief summary can be found at [4], with a more detailed version at [5].

(1) An item is placed up for auction at a starting price of $0.00 and with an initial amount of time on the clock (usually 24 hours).
(2) At any time, users may pay a bidding fee of $0.75 to place a bid on an item, raising the price by a fixed increment. There are two types of auctions, **regular auctions**, where the increment is $0.15, and **penny auctions**, where the increment is $0.01.
(3) If the time remaining in the auction is below 20 seconds, then any bid will extend the time back to 20 seconds.
(4) The auction ends when time expires, and the last user to bid is declared the winner. This user must then pay the final price of the item in return for the item itself.

In addition to this basic setup, users may use a "BidButler," an automated bidding service provided by Swoopo, to watch an auction and automatically place bids subject to a user-specified price range.

Auctions on Swoopo may be placed into different classes based on the slightly different rules which apply. The rule modifications, which are applied independently to each auction, are:

- **Penny Auctions:** Each bid raises the price of the item by $0.01 instead of $0.75.
- **Nailbiter Auctions:** No BidButlers are allowed.
- **Beginner Auctions:** Only users who have never won an auction may participate.

Finally, Swoopo places some restrictions on the bidding of its users. Users may win a maximum of 8 auctions per month, and, as a consequence, may bid on at most 8 auctions at once.

2.2. **An Example.** To illustrate some of the behavior resulting from these rules, we will examine a typical auction (Auction ID 154397) from February 18, 2009 using the results posted at [2]. This auction was a penny auction, and the auctioned item was an Sony VAIO laptop computer with a retail value of $1799.99. The auction ended at a price of $67.05 and was won by user OBAMA, who placed 712 bids at a total cost of $534.00.

We may compute that the winner OBAMA has made a profit of $1799 - $534.00 - $67.05 = $1198.94 on this auction. Notice here that the cost of bidding is much higher than the actual final price of the item for OBAMA; however, despite the high price of bidding, the user still makes a sizable profit on this auction. On the other hand, while Swoopo has nominally sold a $1799 laptop for $67.05, this is a penny auction, meaning that there have been 6705 bids placed on this item. At a price of $0.75 per bid, we may compute Swoopo's profit on this auction to be $6705 \cdot \$0.75 + \$67.05 - \$1799.99 = \$3295.81$. Therefore, we find that both Swoopo and OBAMA have made a profit, with the remaining cost of $6705 \cdot \$0.75 - \$534.00 = \$4494.75$ being paid by the bidding fees of the losing users.

2.3. **Qualitative Behavior.** One possible strategy for Swoopo users would be to collectively avoid bidding on auctions, allowing them to expire at very low prices and collecting the profits. In view of the previous example, however, for any losing user, there is a high marginal return for placing an additional bid that would cause them to win the auction. This creates a large incentive for each user to bid and seize the profits for themselves, making this an unstable equilibrium.

On the other hand, the user must balance this return against the possibility of wasting their bid (and the corresponding bidding fee) if another user makes a higher bid. However, the bidding fee is extremely low in comparison to the potential gain from winning the auction, while the chance that any particular bid will be winning is essentially unknown to most uninformed users. This might influence some users to overestimate this probability, creating a strong incentive to bid when an auction is ending. Indeed, auctions often last for hours at times below 20 seconds, with users

bidding each time time runs down to extend the auction back to 20 seconds. This is the most common qualitative characteristic of auctions on Swoopo, and, viewed from this perspective, a bid is a wager that the auction will end within 20 seconds.

3. Data Collection and Preliminary Observations

In this section, we detail our data collection procedure and give some initial analysis. All data referred to in this section was collected from the Swoopo website at [3].

3.1. **Data Format.** We study the behavior of users on Swoopo by using the summaries of each ended auction posted on the Swoopo website at [3]; a typical summary is posted at [2]. For each auction, the auction summary contains the following information.

- **Item:** The type of item being sold.
- **Auction Type:** Whether the auction is a penny auction, nailbiter auction, and/or a beginner auction.
- **Time:** The time that the auction ended.
- **Winner:** The username of the winner.
- **Item Value:** The retail value of the item being sold.
- **# Winner Bids:** The number of bids the winning user placed, along with their total cost.
- **Final Price:** The ending price of the auction.

We may also deduce the following statistics which will be relevant to our analysis.

- **Winner Profit:** Profit made by the winning user in the auction.
- **Swoopo Profit:** Profit made by Swoopo in the auction.
- **Number of Wins of Winner:** The number of auctions that the winning user has won in the sample period.

We will focus our statistical analysis on determining the difference in these variables between more experienced and novice users.

3.2. **The Data Itself.** Results of 35474 auctions conducted on Swoopo between September 22, 2008 and March 26, 2009 were downloaded from the auction summary pages linked from [3]. The auxiliary variables were computed for each of these auctions. Further, for each unique user who has won an auction, a summary of each auction won by this user was computed.

3.3. **Observations.** A first glance at the data from these auctions reveals some interesting conclusions. One of the most salient features of Swoopo is the rather large difference between the final auction price of an item and its retail value. Indeed, the data confirms this disparity, as the histogram in Figure 1 demonstrates that the vast majority of items end at an auction price well below retail value. Relative to the value of the item, this price seems to drop for regular auctions as the value increases, while remaining constant for penny auctions. This suggests that, unlike in a usual auction, the price is not the central factor determining when a Swoopo auction will end.

Having examined the final prices of the auctions, we are now motivated to study the amount of profit that both users and Swoopo are making from each auction. We compute for each auction the profit of the winner and of Swoopo, giving the distributions shown in Figure 2. Notice here that both distributions are peaked at positive values with long tails on the positive end, meaning in particular that Swoopo sometimes makes large profits on single auctions. In addition, we may compute in Table 1 the decomposition of the profit into Regular, Penny, and Beginner auctions. Observe that Penny auctions account for over $5 million of the almost $9 million in profit that Swoopo accrued over this sample; this results from the high level of profit on each individual Penny auction. Thus, we see that Penny and Regular auctions seem to have qualitatively different behaviors, so we will analyze them separately.

	All Auctions	Regular Auctions	Penny Auctions	Beginner Auctions
Total Swoopo Profit	8915312	3233327	5424515	257470
Average Swoopo Profit	251 ± 5	114 ± 2	1120 ± 36	98 ± 9
Average Winner Profit	156 ± 1	106 ± 1	564 ± 7	71 ± 2

TABLE 1. Average Profits Per Auction, Various Parameters

Finally, we make some observations about the distribution of winning users on Swoopo. From our auction data, we find that a total of 13910 unique users won auctions in our sample. In Figure 3, we create a histogram of the number of auctions won by each user; the numerical values displayed in this histogram are shown in Table 2.

# Auctions Won	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45
# Users	12525	777	280	158	83	55	24	7	1

TABLE 2. Frequency of Auctions Won

In addition, we provide a list of the 12 users who have won the most auctions. Notice here that OBAMA, the winner of the auction we examined earlier, has in fact the 8th most auctions won among all Swoopo users.

As shown by the histogram, the vast majority of users win only a small number of auctions; however, there are some users who have won quite significantly more auctions. In particular, the 12 users who have won the most auctions have each won more than 35 auctions, which is very close to the monthly limit of 8 auctions over the 6 month sample period. This suggests that they have some special knowledge or strategy that allows them to consistently win auctions, implying a stratification of Swoopo's user pool into groups of experienced and notice users. We make distinguishing between the behavior of these groups of users the subject of our more detailed analysis.

4. STATISTICAL ANALYSIS

In this section, we apply a more detailed statistical analysis to determine the difference in user behavior between novice and experienced users. We will first examine the profitability of auctions won by different types users and then attempt to find another characteristic with predictive power between the two types of users. Our overall goal will be to try to use this characteristic to discern the strategies being employed by experienced users.

For the purpose of this analysis, we will take novice users to be those with at most 2 auction victories, experienced users to be those with at least 10 auction victories, and beginner users to be those winning beginner auctions. This choice is somewhat arbitrary, but does conform to the rough dichotomy of user types shown in Figure 3 and Table 2.

4.1. **Profits.** Because bid histories are not part of the posted auction summaries, we do not have information about the number of bids that any particular user placed on an auction that he did not win. As a result, we cannot definitively conclude the overall profitability of any particular user. However, the large number of auctions won by the experienced users suggests that they are continuing to bid on Swoopo with full knowledge of their probable returns, giving a reasonable expectation that they are in fact profitable. Thus, it makes sense to examine the profit of both each user and Swoopo on each auction.

In Tables 3 and 4, we have computed the sample means of absolute and normalized profit of both the winner and Swoopo, separated by the type of the winning user. Each row in which all differences are significant at the 95% level is marked with a *. Notice that for both Regular and
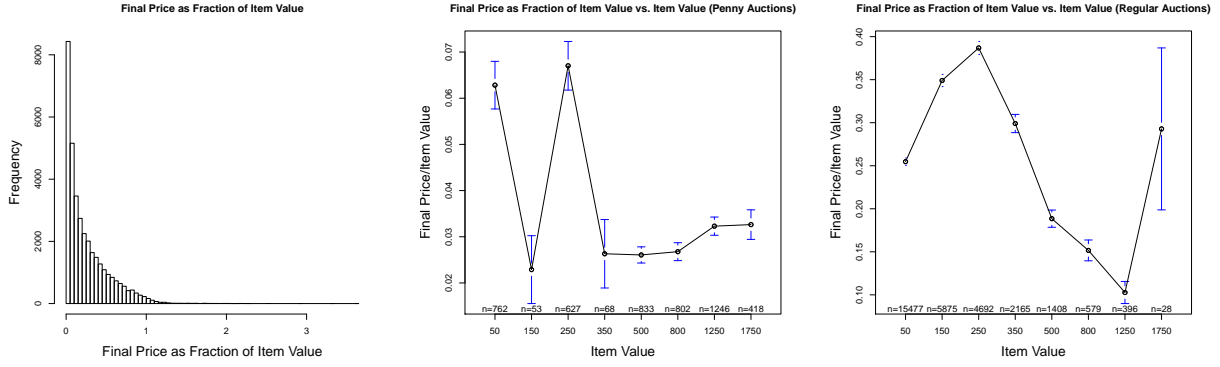
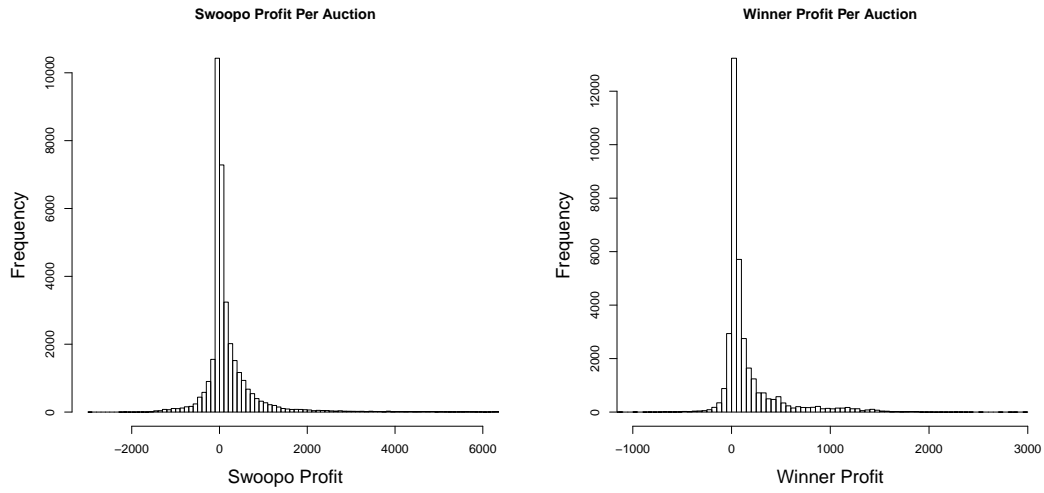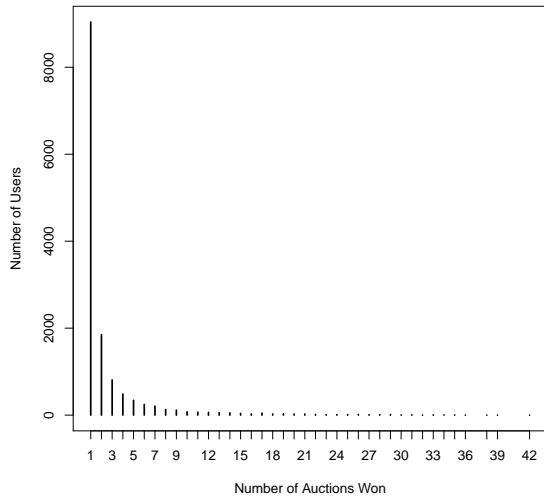FIGURE 1. The Interaction between Final Price and Item Value

FIGURE 2. Profit Per Auction for Swoopo and Users

12 Users With Most Auction Wins

Username	# Auctions Won
Kavvamartin	42
Toertchen	39
Digiitv	38
Exklusivgaragen	38
XX1973XX	38
27Q10	36
ichbinhier	36
PitBull	36
HFW-BW	35
Leoniehei	35
OBAMA	35
winni1958	35

FIGURE 3. Experience in Users

	Experienced Winner	Novice Winner	Beginner Winner
Average Absolute Swoopo Profit	108	119	22.2
*Average Absolute Winner Profit	97.9	84.1	66.8
*Average Normalized Swoopo Profit	0.696	0.745	0.056
*Average Normalized Winner Profit	0.440	0.537	0.701
*Average Item Value	192	152	99

TABLE 3. Average Profits for Regular Auctions

	Experienced Winner	Novice Winner	Beginner Winner
Average Absolute Swoopo Profit	979	936	574
*Average Absolute Winner Profit	651	432	100
*Average Normalized Swoopo Profit	1.150	2.930	4.310
*Average Normalized Winner Profit	0.696	0.769	0.720
*Average Item Value	922	533	136

TABLE 4. Average Profits for Penny Auctions

Penny auctions, experienced users make significantly more absolute profit per auction won than novice or beginner users. However, when we normalize profits relative to the value of the item, we see that novice and beginner users make much larger relative profits. This discrepancy may be explained by the fact that experienced users win items of much higher average value than novice users, allowing them to make a higher *absolute* profit despite a lower *relative* profit.

4.2. **Item Value.** Indeed, when we control for the different item values won by experienced and novice users, we obtain Figure 4, which shows that, for items of the same range of values, novice winners attain equal or higher profits than experienced winners for both regular and penny auctions. Here, the difference between the absolute profits at value 900 for regular auctions and values 1000, 1400, and 1800 for penny auctions is significant at the 99% level.
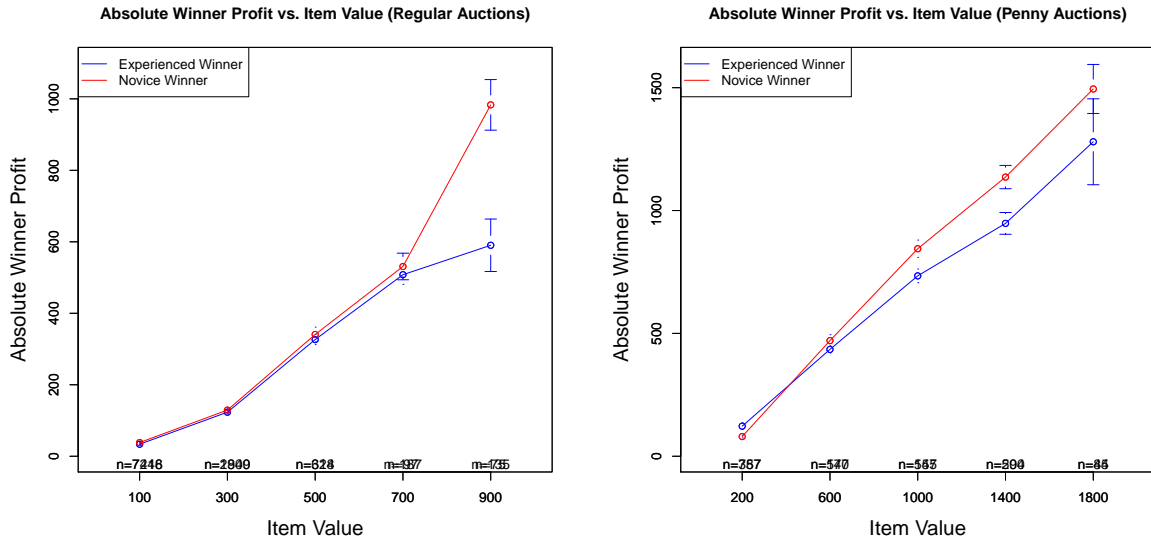

FIGURE 4. Average Absolute Winner Profit for Different Item Values

4.3. **Number of Bids.** Notice that absolute winner profit is related very closely to the number of bids placed by the winning user, hence we are motivated to examine the relation between experience and the number of bids placed in winning auctions. Plotting the number of bids placed by both experienced and novice users on auctions they have won in Figure 5, we find that, as expected, experienced winners place more bids than novice winners on won auctions. Here all differences are significant at the 95% confidence level.
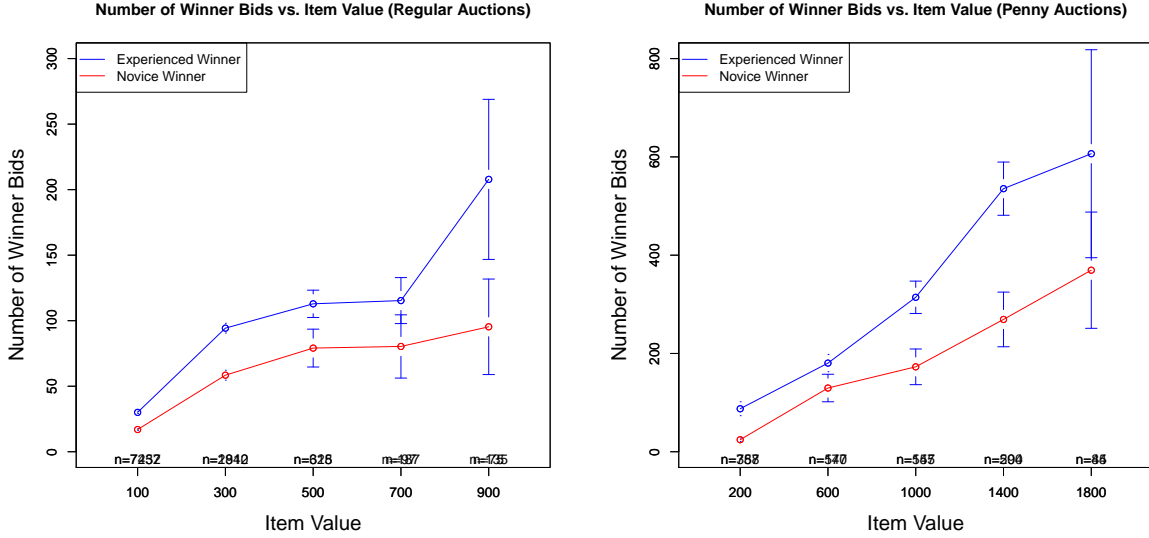

FIGURE 5. Average Number of Winner Bids for Different Item Values

4.4. **Correlations.** We have now seen that Winner Profits, Item Value, and Number of Winner Bids all seem to be related to the experience of the winner. In Table 5, we present the correlations between the number of auctions won and the other variables involved for both penny and regular auctions. We have bolded correlations of magnitude greater that 0.1.

Type	Value	Winner Bids	Winner Profit	Norm Final Price	Norm Bids	Norm Winner Profit
Penny	**0.216**	**0.138**	**0.1458**	**-0.199**	**-0.199**	-0.0221
Regular	0.08351	**0.126**	0.0398	-0.0185	-0.0185	-0.0468

TABLE 5. Correlations between Number of Auction Wins and Other Variables

Notice here that all the variables we discussed before seem to have some correlation for penny auctions, but that the number of Winner Bids is the only variable with significant correlation for both types of auctions.

5. CONCLUSIONS AND FUTURE DIRECTIONS

Recall that the basic premise of our analysis was that experienced users were bidding on Swoopo actions repeatedly and therefore must be making some type of profit. However, our analysis has shown that novice users make larger absolute profits than experienced users on victorious auctions of the same item value by placing fewer bids. While this means that novice users make greater profits on the *auctions that they win*, our assumption of profitability suggests then that experienced users must lose less money on *auctions that they do not win*.

Indeed, it may be conceivable that the additional bids placed by experienced users are the result of continuing to bid on auctions that novice users would have given up on. By continuing to pursue these auctions, it is possible that experienced users limit bids on auctions they lose, increasing their profitability. Based on this plausible inference and our previous analysis, we may formulate the following estimate of experienced users' bidding strategy:

- Bid on items with high retail values.
- Bid on penny auctions.
- Once a decision is made to bid on an auction, be willing to bid a large number of times on that auction.

While this bidding strategy is somewhat vague, we may conclude more strongly that the behavior of the experienced users that we have described is distinct from that of novice users and that they do form two distinct groups in the user population with distinct behaviors.

Future work in this direction might use the partial bid histories of the final 10 bids in the auction summaries to find some heuristics to decide when to start or stop bidding. In addition, while our study has focused on empirically describing the behavior of two distinct user groups, it does not address the issue of their formation in this disequilibrium situation. It would be interesting to find a dynamic model of user strategies that could explain this effect.

References

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