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The Effect of Different Reserve Prices on Auction Outcomes

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Abstract. To ensure that their item does not sell below a minimum value, auction sellers can set a reserve price or insert their own “shill” bids. We present results from a controlled experiment in which we auctioned identical \$20 Starbucks gift cards in order to test different price floors’ effects on sale prices and bidding activity. We find that all price floors decrease the number of bids and the number of bidders in an auction. Higher price floors increase the average sale price, but compared to a control group the difference is only significant at a binding level. In contrast, seller profits are maximized by setting no price floor, but we predict that the advantage of price floors will intensify with higher value items or items in thinner markets. We explain our results using the anchoring effect, selection effects and the eBay setup.

Keywords: Auctions, Reserve Price, Shill Bidding.

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1. Introduction

Auction sellers can ensure that their items sell for a minimum value through various mechanisms. On platforms such as eBay, public reserve prices and private reserve prices are two authorized methods. Public reserve prices are visible to buyers and no bid less than the public reserve can be placed. Private reserve prices are unknown to buyers, who are informed only whether the private reserve has been met or not. A third unauthorized method, not endorsed by eBay but known to occur in the marketplace, is shill bidding. Shill bids are bids placed by the seller or a confederate of the seller with the goal of pushing up the sale price or ensuring that the good does not sell below a certain value. In this paper we investigate the effect of varying both the type and level of price floor mechanism on the sale price, the number of bids and the number of bidders.

Our controlled experiment involves auctioning identical \$20 Starbucks gift cards on the eBay platform. Although this good has a known market value, our data reveal private valuations.² If reserve prices affect seller revenues in this setting, where the item sold is a widely available product, one can expect that this impact would only be stronger for common value items and items within thinner markets.

We simultaneously auctioned four identical cards each session. The first was a control in which the starting price was 1 cent without any constraints. The second had a public reserve price set at the fixed “treatment” level. The third had a private reserve price set at the treatment level, and the last was identical to the first (control) case but a confederate bid was placed at the level of the same reserve price employed in the second and third cases. Sessions were run at three treatment levels: \$10, \$15 and \$18.50. Using this methodology, the differences in the results can be attributed solely to the differences in the reserve price constraints. Past empirical research has found mixed results regarding the effect of reserve prices on sale prices. We fill in the gap in the empirical literature by first systematically comparing and jointly analyzing the differences between all three

² We believe that the private value paradigm is more appropriate because different people may have different uses for the cards and value them differently. Buyers have different discount factors. Bargain hunters who wanting to buy at cheap price (and the definition of “cheap” varies) are another element, among many. Most of our results are, in fact, consistent with the theory under the private value assumption. And, if it was a common value auction such that everybody values these cards at \$20, there should not have been any unsold cards.

types of price floors, and second by showing that in order for a reserve price to have a real effect it must be binding.

We found that the existence of any price floor, even unknown ones, reduces both the number of bidders participating in an auction and the number of bids submitted in an auction. In addition, on average, both the number of bidders and the number of bids decreased when the treatment level was increased via higher reserve prices. Generally, this was the case under all the different intervention strategies although it was most noticeable under the public reserve price treatment.

We found that sale prices significantly increased as the reserve price was raised. The average sale price under the \$10 treatment level was less than the average sale price under the \$15 treatment which was less than the average sale price under the \$18.5 floor. At the \$10 and \$15 treatment levels there was no statistical difference between the selling price of the control group cards and the other three groupings, possibly due to the short time for which the reserve was binding. At the low and medium treatment levels, bidders reached the price floor threshold long before the auction ended. At the high treatment level, the control group's average sale price was significantly lower than both the private reserve treatment's average sale price and the skill bid treatment's average sale price. This suggests that high price floors discourage only low-value bidders' entry. We attribute the selling price differences at the high treatment level to selection effects and the anchoring effect.

Despite higher selling prices, seller do not gain from price floors overall because of higher placement costs and unsold item costs. At the low and middle treatment levels, the sales rate was 100 percent. In contrast, at the \$18.5 treatment level, out of 13 different sessions, four cards with private reserve prices and three cards with public reserve prices went unsold because the bidders failed to meet the reserve. In addition, five cards in the skill bidding treatment group also went unsold because our confederate bidder "won" the item.

The control group without any price floor produced the highest average profits for the seller. However the generalization of this conclusion is questionable. First, we used a low value item for the experiment, for which placement costs and reserve price costs are high relative to the sale price. Higher value items may show greater gains from reserve

prices because the intervention costs would be comparatively lower. Second, our experimental design and the eBay format result in high overlap between our control group and our treatment groups. This may have raised the average sale price of our control groups due to spillover effects from the treatment groups, to some extent, masking the positive effect of reserve prices in our experiment.

The paper is organized as follows. In the next section we survey the literature regarding the different tools available for an auction seller to exert some control over the sale price. We contrast our findings with these of other empirical and experimental studies and demonstrate that any differences in the findings can be explained by the item type and value, the eBay format, and whether price floors are binding. In particular, unlike other research, we found a positive effect on sale prices, relative to the control group, only when the treatment level was binding. Section 3 describes the data and empirical analysis. A final section offers some concluding remarks.

2. Literature Review

Theoretical and empirical work on auction reserve prices has produced mixed results regarding the effect of different types of reserve prices and shill bidding on sale prices. Reserve prices can change bidders' valuations or their willingness to pay, thereby affecting the entry of certain bidders. These effects can work in both directions, and bidders' knowledge of tricks such as shill bidding can also come into play. An excellent detailed survey of online auctions, reserve prices and shill bidding can be found in Ockenfels et al. (2006).

Theoretical predictions of the effect of public reserve prices on sale prices are varied. Myerson (1981) and Riley and Samuelson (1981) claim that public reserve prices can raise seller revenue in independent value settings. They may also raise sale prices in common value item auctions (Milgrom and Weber (1982)). Vincent (1995) contradicts these proposed effects, claiming that setting a high public reserve price may actually decrease sale prices because reserve prices limit information on the common value by prohibiting bidding up to that price. Bidders may gain additional information about the value of an item through the bidding behavior of other potential buyers. Additional bid

shading may follow from risk averse bidders, who would value the item above the reserve price if there was full information disclosure.

In addition, low reserve prices can sometimes raise revenues by encouraging efficient levels of entry (Samuelson (1985), and Levin and Smith (1996)). This effect on entry is applicable to both public and private reserve prices. Entry effects will be less prevalent in a common item auction, where it is easier for bidders to determine their willingness to pay, and also in auctions without monetary costs of entry.

The theoretical predictions regarding private reserve prices are mixed. Li and Tan (2000) claim that private reserve prices can raise the sale price in first price private value auctions when bidders are risk averse. In contrast, Elyakime et al. (1994) demonstrate that private reserve prices may scare off potential buyers regardless of how low the reserve is set.

Theory regarding the overall effect of shill bidding is also unclear.³ Shill bidding could raise an item's sale price by giving the seller more information (Graham et al (1990)). This effect is counteracted if buyers shade their bids insofar as they suspect shill bidding (Sinha and Greenleaf (2000)). This response, coupled with the risk of winning your own auction and having to pay the associated fees, could make shill bidding unprofitable (Chakraborty and Kosmopoulou (2004)). In addition, eBay buyers have the option of sniping (bidding on an item with only few seconds left). This practice ensures that a shill bidder will not be able to react (Engelberg, J. and J. Williams 2005).

Several empirical and experimental investigations of reserve prices and shill bidding have been carried out, again showing mixed effects on sale prices. Häubl and Popkowski Leszczyc (2003) auctioned postage stamps on eBay and found that the minimum bid has a positive effect on the sale price. We show below that increasing the minimum bid increases the sale price. However, relative to a control group, the difference in sale prices is significant only at the high treatment level.

Ariely and Simonson (2003) analyze the effect of both the minimum bid and the number of bidders by looking at 275 tickets sold on eBay for the Rose Bowl. While their

³ As mentioned above, shill bidding is a way in which the seller can actively participate in her own auction after it has begun. Shill bidding can be used to set a floor price for the auction, to extract more money from a bidder, or to inspire more bidding due to "auction fever." In our experiment, we submitted one shill bid at the beginning of the auction, limiting ourselves to a consistent practice most closely related to a price floor.

analysis shows that both higher reserve prices and a higher number of bids increase the final sale price, they conclude that the anchoring effect⁴ of high reserve prices outweighs the potential auction fever⁵ inspired by many bids. Our data confirm an inverse relationship between reserve price levels and the number of bids and also show that increasing the reserve level increases the selling price.

Katkar and Reiley (2006) compare public and private reserve prices by selling matched pairs of pokemon trading cards; one with a public reserve price and one with a private reserve price. The private reserve price returned on average 10% less revenue and was 30% less likely to end in a sale. The authors conclude that private reserve prices strongly discourage entry of serious bidders, and should be avoided for items under \$25. Our data contradict their findings as, at low, non-binding reserve prices levels; we see no difference in sale price or sale rate. At higher, binding treatment levels, the private reserve price ended in a sale only 10% less often than the public reserve price and returned a higher average sale price than the public reserve.

Hoppe and Sadrieh (2005) conducted a study closely related to our experiment, selling DVDs and collectable coins. In their experiment, each session included one item that was auctioned with a minimum public reserve (similar to our control group), one item with a public reserve of 50% of the item's book value, and one item with a minimum public reserve which was then still bid up to 50% of the book value. The authors conclude that sale prices for both DVDs and collectable coins were unaffected by the treatments, and neither anchoring effects nor auction fever pushed the sale price up. One potential reason this study did not find any effect for the different treatments is that the treatment level was only 50% of the item's value and constant.

Bajari and Hortaçsu (2003) claim that the optimal selling strategy varies with the item value and type. They study coin auctions on eBay and find that public reserve prices deter bidding more than private reserve prices for high value items and that more experienced sellers were more likely to use private reserve prices.

⁴ The anchoring effect is a psychological effect that, when applied to auctions, suggests that when a bidder sees a reserve price their willingness to pay might change due to the posted reserve price.

⁵ Auction fever is the phenomena of bidders being caught up in an auction, and bidding higher than the value an item originally holds for them because of the competitive nature of bidding.

Dewally and Ederington's (2004) study of comic book auctions revealed that both public and private reserve prices affect the number of bidders participating in an auction, but not the sale price. The reserve price essentially works as a barrier to entry that stops non-serious bidders from entering the auction. In contrast, we demonstrate below that increasing the reserve price increases the selling price. In addition, relative to the control group, binding reserve prices affect the average sale price of an item as well as bidder entry.

Despite the risk involved in shill bidding,⁶ this practice remains prevalent on eBay. Engelberg and Williams (2005) estimate that at least 1.5% of all bids placed in ticket auctions on eBay are "discover and stop" shill bids. They looked only at shill bids meant to extract extra value out of the high bidder, so the actual number of shill bids on eBay could be much higher. Kauffman and Wood (2003) estimate that shill bidding occurs in 6% of coin auctions on eBay. They also looked for only "discover and stop" shill bidding, probably again underestimating the prevalence of the practice. Kauffman and Wood predict that shill bidding erodes trust in the marketplace, hurting sites like eBay in the long run.

Bidders' have been shown to respond strategically to the possibility of shill bidding by shading their bids in a controlled experiment. Kosmopoulou and De Silva (2007) conclude that, regardless of its actual presence, when bidders are unaware of the possibility of shill bidding the sale price is significantly higher than when bidders are aware of the possibility. This poses a dilemma for sellers, who benefit individually by shill bidding whether buyers suspect shill bidding or not, but as a whole would receive higher sale prices in an environment where buyers believed there was no shill bidding. Our experiment shows that sellers benefit from shill bidding on eBay. These results suggest that bidders are not universally aware of when shill bidding occurs in practice. We ignore the question of whether the presence of shill bidding on eBay is beneficial or harmful to sellers as a whole, but rather confirm that, from an individual perspective, shill bidding could raise seller revenue.

⁶ eBay policy prohibits shill bidding, and suspends or bans users who they catch.

3. Experimental Design and Analysis

We conducted our experiment on eBay, the most trafficked auction site at the time the experiment was run. We conducted 29 different sessions, each consisting of four identical \$20 Starbucks gift card auctions at the same time. Within each session of the experiment we varied only the type of price floor mechanism. We compared the sale price, the number of bidders and the number of bids in items with no reserve price, a public reserve price, a private reserve price, and items with shill bid placed.

Starbucks gift cards fall between the extremes of a thick market and a unique good. During the experiment there were approximately 200 Starbucks gift cards being sold on eBay, including both limited edition gift cards sold as collector's items and cards sold for their balance. The cards sold in the experiment were generic designs available at all of the chain's stores to ensure that there was no added value to bidders from the card itself. The gift card can be characterized as a private value item because different bidders might have different willingness to pay for it. Being a well known item, it minimizes the effect of information on the auction outcome. Differences in price could not plausibly be due to incomplete information.

Four auctions were run simultaneously during each session. Each auction title, description and picture was identical, and all cards sold were new items to ensure homogeneity. In each session, the control group auction had a starting bid of \$0.01; one auction had a public reserve price; one auction had a private reserve price; and one auction resembled the control group, but a confederate bid was placed at the same reserve price. During each individual session, only one reserve price level was used, but through the experiment as a whole the reserve price was set at 3 levels: \$10, \$15 and \$18.50. The highest level, set at 92.5% of the good's retail price, was sufficiently high to produce unsold items. The four auctions in each section were run simultaneously, and the market for Starbucks gift cards had many comparable and even identical products available elsewhere at the same time as each session, creating an environment of very high comparability. We predict that any results seen from this experiment would be intensified in a situation of low comparability.

The auctions ran for 3 days and started and ended at the same time to ensure that all four items faced exactly the same demand conditions and any differences in outcome

were due to the treatment effects. In order to reduce the effects of seller ratings on auction outcome we rotated the four different seller monikers between the four different treatments each session. Next we report the outcome of the sale price, number of bidders, and number of bids.

[Table 1 here]

Table 1 provides the sale prices summary statistics results. Each cell reports first the mean sale price in the category, then the standard deviation of the mean, and last the number of observations in that category respectively. We report the results of all auctions that ended in a sale. As mentioned above, there were 3 treatment levels as presented in the table rows: a \$10 treatment level, \$15 treatment level and \$18.5 treatment level. For each treatment level we conducted several auction sessions such that in each session we auctioned four identical items subject to different types of reserve price (no reserve, private reserve price, public reserve price, and shill bid).

The top left cell in Table 1 shows that, for the \$10 treatment level and the control group, there were eight different sessions. The mean sale price of the Starbucks gift cards in the control group for that treatment level was \$18.54 and the standard deviation was 0.426. We also had 8 different sessions at the \$15 treatment level, and 13 different sessions at the \$18.5 level. Some cards went unsold. One card from the control group at the \$15 treatment level went unsold because eBay suspended this account due to a dispute that was later resolved. Four cards with private reserve prices and three cards with public reserve prices went unsold at the \$18.5 treatment level because the bidders didn't meet the reserve. In addition, five cards in the shill bidding treatment group also went unsold because our confederate bidder won the item.

At this stage, we employed the procedure of two-way analysis of variance to test for the effect of the different treatments and the different treatment levels.⁷ We include the treatment level, the different types of reserve price, and the interaction between these two categorical variables as explanatory variables.⁸ Although, the model features an R-squared of 0.2719, only the treatment value has a significant effect on the sale price. As the differences between the numbers on the right column of Table 1 (the Total column)

⁷ Qualitatively, similar results were obtained when we used the appropriate regression analysis.

⁸ Similar results were obtained without the interactions variables.

are statistically significant, we can refute the null hypothesis that increasing the treatment level has no effect on the sale price. In contrast, we cannot reject the null hypothesis that there are no differences, with respect to the sale price, between the different treatment groups based on the numbers in the last row (the Total row). The interaction coefficient was not significant at conventional levels (p-value of 0.17).

We can explain the two way analysis of variance results using the following rationale. At the low treatment level the difference between the control group and treatment group is substantially eliminated before the auction is over, and bidders can only observe that a reserve price was used in the case of private reserve prices. In these low level reserve price cases we would expect no differences in sale price between the treatment group and the control group. The treatment level is more effective the higher it is. At the \$18.50 treatment level, the presence of reserve prices is visible to bidders in the case of both public and private reserves. Namely, bidders will see that a public reserve exists and that the private reserve has not been met until bids are submitted that are higher than \$18.50. Late in the auction only the high treatment level is visible to bidders.

The two-way analysis of variance detected no differences between the average sale prices of different treatment types, which support the conclusion that low level treatments are meaningless late in auctions. This applies to both the \$10 and \$15 treatment levels. Our data reveals no difference between treatment types at the lower treatment levels except for one extraneous case not explained by the theory.⁹ When we conduct separately a series of t-tests for the \$18.5 treatment level, however, the difference between the mean sale price of the control group and the mean sale price of the private reserve price group was statistically significant at the 6% significance level. Also, the difference between the mean sale price of the control group and the mean sale price of the skill bidding group was statistically significant at the 5% significance level.

The differences in average sale price between the treatment groups and the control group at the \$18.50 reserve price level can be explained possibly through selection bias and the anchoring effect. At the high treatment level, there were some items that did not sell because the reserve price was not met or the skill bid won the auction. The average

⁹ When we separately conducted a series of t-tests we found that at the \$10 treatment level the difference between the control group's mean sale price and the private reserve price group's mean sale price is statistically significant at the 5% significance level.

sale price was calculated using only observations where a sale was actually made. For each treatment level and type there was a distribution of sale prices, and by not including the items that didn't meet a high reserve price, we are in effect cutting out the lower end of the sale price distribution for these treatment types at the \$18.50 level. The treatment level may not actually affect bidder action, and only affect the probability that an auction will end in a sale.

The anchoring effect provides another theoretical motivation for why higher reserve prices lead to higher sale prices. The anchoring effect is a psychological effect that, when applied to auctions, suggests that when a bidder sees a reserve price their willingness to pay will change as a result of the reserve price. In our experiment, four items were auctioned simultaneously, and the anchoring effect of reserve prices may have an externality effect on other treatment types auctioned off at the same time. In these situations of high comparability, bidders may see other items with price floors higher than their initial willingness to pay and therefore may bid higher on the control and skill bid items as well. If there is no anchoring effect, the average sale price for the control group should be the same under all treatment levels.

A third possible explanation for differences between sale prices at the high treatment level that we eventually reject is auction fever. This explanation could only account for the high average sale price for the skill bid item at the high reserve level.¹⁰ Skill bidding up to a high level could inspire competition among third party bidders, who may become attached to the item they are bidding on. Auction fever is rejected in our case, however, because the higher treatment level reduced both the number of bidders and bids. Although our evidence shows that both the anchoring effect and selection effects possibly affect our results, we believe that selection issues have a stronger effect on final sale price--while both effects allow sellers to increase their revenue through setting proper reserve prices.

The seller's goal is to maximize profits, taking into account both sale price and costs. Costs are different for each of the different treatments types used in our experiment. eBay charges a placement fee for both public and private reserve prices that

¹⁰ Public reserve prices will not promote auction fever, especially at high treatment levels, because they reduce the bid space, not allowing many bidders to submit multiple bids for an item. Private reserve prices and the control treatment neither encourage nor prohibit auction fever at different treatment levels.

increases along with the reserve. eBay also charges the seller a percentage of the final sale price if the auction ends in a sale. Shill bidding avoids reserve price fees, because it is unseen by the eBay platform, but the seller runs the risk of winning her own auction and paying the associated final sale fee.

For our experiment, placing the control item cost the seller 25 cents, a public reserve price cost the seller 65 cents¹¹, a private reserve price cost the seller \$2.65¹² and, similar to the control item, shill bidding cost 25 cents while running the risk of paying a \$1.59 sale fee if the auction was won by the confederate.¹³ Assuming these relative costs stay the same over time, we can estimate which treatment type produces the highest profit for the seller. Due to the high comparability of the eBay format, we didn't detect any differences of selling price at the low and medium treatment levels, although the price floors has positive effect on the selling price. On the other hand, setting a reserve price of \$18.5 caused a reduction in the sale rate. Apparently, the optimal reserve price should be somewhere between \$15 and \$18.5. Since the only statistically significant difference between the control group and the price floor cases was at the high treatment level we will use this group to conduct a cost benefit analysis.

We estimate that the control group returns a sale price of \$18.54 and costs of \$0.25 to produce revenues of \$18.29. The private reserve price of \$18.50 produces an average sale price of \$19.19, with costs of \$2.65 and 4 unsold items, producing overall average revenues of \$15.36 per item sold.¹⁴ The public reserve price produced an average sale price of \$18.90, costs of \$0.65 and 3 unsold items, producing average revenues of \$18.05 per item sold.¹⁵ Shill bidding produced an average sale price of \$19.24 and 5

¹¹ This is 25 cents of posting costs plus 40 cents for this type of reserve price.

¹² This is 25 cents of posting costs, plus 40 cents for a reserve price, plus an additional \$2 for a private reserve price.

¹³ eBay charges a sale fee of 8.75% of sale value up to \$25, 3.5% of the sale value up to \$1000, and 1.5% of the value above \$1000. In our experiment, the average price paid by a confederate bidder who won an auction was \$18.17, which incurred a \$1.59 fee ($18.17 * 0.0875$).

¹⁴ Recall that sellers on eBay have to pay posting fees (\$2.65 for our private reserve treatment) regardless of whether the item sells. For the private reserve, the costs are divided among the nine items sold. Average profit = average revenue – average cost. Therefore, average profit = $\$19.19 - (\$2.65 * 13) / 9 = \$15.36$. eBay offers free re-listing of items to large volume sellers permanently, and occasionally offers this option to low volume sellers, but this is not the norm.

¹⁵ For the public reserve, the costs are divided among the ten items sold. Average profit = average revenue – average cost. Therefore, average profit = $\$18.90 - (\$0.65 * 13) / 10 = \$18.05$.

unsold items, resulting in average profits of \$17.84 per item sold.¹⁶ Therefore, taking into account the unsold items, our results suggest that average seller profits from the control case are higher than all price floor groups. As for price floor treatments, the average public reserve treatment profits were higher than the average shill bid treatment profits, which were in turn higher than the average private reserve treatment profits. The private reserve profits are significantly lower in our experiment because there is a flat additional \$2 fee on eBay for using a private reserve price. Our experimental design minimized many possible sources of price floor effects on sale prices. For high value items, placement costs would be lower relative to the sale price, and price floors may become profitable. In settings of lower comparability, the price floor effects may also be more pronounced. In addition, risk-averse sellers may have incentives to set price floors because of utility maximization, produced not through a higher average sale price, but through ensuring that their item will not sell below a certain value.

[Table 2 here]

Table 2 provides summary statistics on the number of bidders. Each cell first reports the mean number of bidders in auctions within the category, then the standard deviation of the mean, and last the number of observations in that category. We report the results of all auctions that ended in a sale. The top left cell in Table 2 shows that, for the \$10 treatment level and the control group, the mean number of bidders was 8.25 in that group and the standard deviation was 2.604 across the eight sessions. The average number of bidders in the shill bid treatment includes the shill bidder in every case. Removing the shill bidder simply reduce the average number of bidders in every treatment level of the shill bid column by one. The standard deviation would remain the same because the shill bidder was constant and consistent in each trial.

Table 2 shows strong effects from both treatment type and treatment level on the number of bidders in an auction. All differences between treatment type, treatment level and the interactions between the two are statistically significant. Higher treatment levels attract fewer bidders, and the effect is statistically significant at the 5% level. The

¹⁶ This average cost is calculated by summing the total costs associated with selling all the cards, and dividing by the number of cards sold. Totals costs consist of placement fees for all 13 cards, and the cost of winning ones own auction for 5 of the cards (\$1.59). Total cost = $13 * \$0.25 + 5 * \$1.59 = \$11.20$. Average cost = $\$11.20 / 8 = \1.40 .

average number of bidders was 6.53, 5.90 and 5.37 for the low, medium and high treatment levels respectively. Unlike the sale price, there are significant differences in the number of bidders between the low and medium treatment levels as well as between the different treatment types within these levels.

The treatment type had a statistically significant effect on the number of bidders. The public reserve price reduced the number of bidders most significantly, with an average of 3.35 bidders per auction won. Although this result was driven by an average of 1.5 bidders per auction won at the \$18.50 public reserve, the public reserve always reduced the number of bidders relative to other treatment types. The private reserve price attracted the second lowest number of bidders, both on average and at each of the three treatment levels. The shill bidding produced an average number of bidders similar to the private reserve price and fewer bidders than the control group at all treatment levels. This suggests that bidder participation in the auction was influenced by the shill bidding.

Similar to Bajari and Hortaçsu (2003) we found that reserve prices, both public and private, discourage bidder entry. The public reserve price decreased the number of bidders because the reserve eliminated much of the bidding space available to bidders. This effect was most pronounced at the \$18.50 level, where there was only room for 4 bids (at 50 cent increments) before the bid reached the card's face value.

Despite reducing bidder entry into the auctions, sale prices in public and private reserve auctions, at the low and middle treatment levels, were not statistically significantly lower than the control group, as shown in Table 1. Similar to Dewally and Ederington (2004) it seems that only low-value bidders entry was reduced, which was not detrimental to auctioneer revenues.

Shill bidding could have reduced the number of bidders with or without bidder suspicions that shill bidding existed. Shill bidding might have a similar effect on entry as a public reserve price by taking away room for bidders to bid. In addition, the reduction in the number of bidders can be explained through bidders shading their bids and entrance to the auction when they suspect shill bidding is present in the auction (see Chakraborty and Kosmopoulou (2004)). Despite this reduction in the number of bidders, the shill bid treatment raised the sale price at the high (\$18.50) level. This suggests that

similar to the public and private reserve prices effect, shill bidding discouraged entry of only low-value bidders.

[Table 3 Here]

Table 3 provides summary statistics for the number of bids submitted. Each cell first reports the mean number of bids in auctions within the category, then the standard deviation of the mean, and last the number of observations in that category respectively.

The treatment level had a significant effect on the number of bids. All differences between treatment type, treatment level and the interactions between the two are statistically significant. The average number of bids were 10.0, 8.70 and 7.82 for the low, medium and high treatment levels, respectively. The higher the treatment level the lower the number of bids submitted in an auction. The treatment type also had significant effects, with the public reserve price reducing the number of bids at all treatment levels most significantly. Again we see that public and private reserve prices reduce bidding activity at the low and middle treatment levels.¹⁷ As before, the effect is most pronounced when there is little room to bid at the high level public reserve.

The average number of bids under the shill bid treatment is below the control group at all treatment levels. Again, we can explain this reduction through auction structure or bidder suspicions of shill bidding. Shill bidding prohibits bidders from entering the bidding at low levels because the shill bid speeds the process at which the auction's price rises. Both the reduction in the number of bidders and the speed of the price convergence reduce the overall number of bids.¹⁸ In addition, as stated above, bidders who suspect that shill bidding is taking place may either not enter the auction or bid more cautiously out of fear. This can lead to lower number of bids.

¹⁷ At the high treatment level, the average number of bids under the private reserve price was significantly higher than under the control group. We cannot motivate this result.

¹⁸ In the case of an exchange of low level bids involving a third party and a shill bidder, the shill bidder will automatically bid one increment higher than the third party until the third party submits a bid higher than the initial shill bid. The resulting number of bids after the third party surpasses the shill bid value is the number of third party bids plus one shill bid. In a low level bidding war with two third parties and no shill bidder, the two third parties can alternate bids up to the equivalent level of the first example, and the number of bids will be higher, because the second third party will have submitted multiple bids, as opposed to the single bid submitted by the shill bidder.

4. Conclusions

In this paper, we presented the results of a controlled experiment which examined the effect of all the different price floors available to auction sellers on sale prices and bidder participation. Namely, we analyzed the effect of private reserve prices, public reserve prices and shill bidding on the number of bids in an auction, the number of bidders in an auction and the sale price. We are able to do so because we simultaneously auctioned identical \$20 Starbucks gift cards under the three treatment types against a control group at reserve prices of \$10, \$15 and \$18.5. Because a Starbucks gift card is a well known, widely available good, we minimize the effects of imperfect information on our auction outcomes.

We found that relative to a control group, all price floor mechanisms decreased bidder participation, both in terms of the number of bids and the number of bidders. At non-binding treatment levels, we see that this reduction in bidder participation has no detrimental effect on the sale price, effectively deterring only low-value bidders. We found that increasing the treatment level increased the sale price; however we could not detect differences between treatment types at the low or middle reserve prices. Both private reserve prices and shill bidding produced significantly higher average sale prices than the control group at the high treatment level. We suspect that this distinction between binding and non-binding price floors is due to sampling effects and the anchoring effect. Taking placement costs into account, seller profit is maximized under no reserve price (our control group). We conjecture that the advantages of price floors over a control group with regards to profit do not exist in our experiment due to our use of a low value item and the nature of the eBay setup. We expect higher value items would show a higher payoff from reserve prices.

A natural and interesting extension of this research would be to use this methodology in a different environment and auction other types of goods. It would be insightful to check the effect of these floor prices on sale prices of common value items and more expensive items.

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Table 1: Sale Prices Summary Results (items sold)

Treatment	Control	Private Reserve Price	Public Reserve Price	Shill Bid	Total
\$10	18.543	18.018	18.213	18.167	18.235
	(0.426)	(0.386)	(0.798)	(0.588)	(0.578)
	8	8	8	8	32
\$15	18.544	18.395	18.845	18.802	18.650
	(0.759)	(0.583)	(0.862)	(1.009)	(0.801)
	7	8	8	8	31
\$18.5	18.693	19.191	18.901	19.247	18.968
	(0.638)	(0.499)	(0.460)	(0.376)	(0.552)
	13	9	10	8	40
Total	18.613	18.561	18.672	18.739	
	(0.601)	(0.694)	(0.748)	(0.814)	
	28	25	26	24	

Note: In each cell, the first number is the mean of the category, the standard deviations are in the parentheses, and the number of observations in the category is reported last.

Table 2: Number of Bidders Summary Results (items sold)

Treatment	Control	Private Reserve Price	Public Reserve Price	Shill Bid	Total
\$10	8.250	6.500	4.750	6.625	6.531
	(2.604)	(2.070)	(1.669)	(1.302)	(2.257)
	8	8	8	8	32
\$15	7.428	5.875	4.250	6.250	5.903
	(2.225)	(1.642)	(1.035)	(1.281)	(1.885)
	7	8	8	8	31
\$18.5	7.384	6.000	1.500	6.250	5.375
	(1.609)	(1.870)	(0.527)	(1.281)	(2.705)
	13	9	10	8	40
Total	7.642	6.120	3.346	6.375	
	(2.040)	(1.810)	(1.853)	(1.244)	
	28	25	26	24	

Note: In each cell, the first number is the mean of the category, the standard deviations are in the parentheses, and the number of observations in the category is reported last.

Table 3: Number of Bids Summary Results (items sold)

Treatment	Control	Private Reserve Price	Public Reserve Price	Shill Bid	Total
\$10	12.500	11.000	6.500	10.000	10.000
	(5.682)	(6.458)	(3.251)	(1.927)	(4.996)
	8	8	8	8	32
\$15	13.000	8.250	5.000	9.125	8.709
	(2.645)	(1.982)	(1.069)	(2.948)	(3.560)
	7	8	8	8	31
\$18.5	9.461	12.333	1.500	8.000	7.825
	(3.125)	(3.807)	(0.527)	(2.329)	(4.781)
	13	9	10	8	40
Total	11.214	10.600	4.115	9.041	
	(4.130)	(4.600)	(2.861)	(2.475)	
	28	25	26	24	

Note: In each cell, the first number is the mean of the category, the standard deviations are in the parentheses, and the number of observations in the category is reported last.