

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 public reserve price, set a private reserve price or shill bid. We present results from a controlled experiment in which we auctioned identical \$20 Starbucks gift cards in order to test these 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.

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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 occurring 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 insuring 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 in a known common value setting. If reserve prices affect seller revenues in a known common value setting, where the item sold is a widely available product, one can expect that this result will intensify for private value items and items within thinner markets.

Our controlled experiment involves auctioning identical \$20 Starbucks gift cards on the eBay platform. We simultaneously auctioned four identical cards each session, one was a control in which the starting price was 1 cent without any other involvement, one had a public reserve price set at the treatment level, one had a private reserve price set at the treatment level and one was identical to the control group but a confederate bid was placed at the level of the reserve price. 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 treatments. 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 types of price floors, and second by showing that in order for a reserve price to have a real effect it must be affective, or binding.

We found that the existence of any price floor 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 increased. Generally, this was the case under all the different treatments

although it was most noticeable under the public reserve price treatment. The fact that the shill bidding treatment attracted fewer bidders and produced a lower number of bids than the control group might suggest that bidders responded to the possible existence of a shill bidder and reduced their participation in response.

We found that sale prices significantly increased with the treatment level. 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. At the \$10 and \$15 treatment levels there was no difference between the control group and the other treatments, possibly due to the short time effect of the reserve. At the low and medium treatment levels bidders reached the price floor threshold long before the auction ended. In contrast, at the high treatment level the reserve was active noticeably longer. At this high level, the control group's average sale price was significantly lower than both the private reserve treatment's average sale price and the shill bid treatment's average sale price. The latter yielded the highest average sale price. These averages suggest that high price floors discourage only non-serious bidder entry.

We attribute these results to selection effects and the anchoring effect. The average sale price of items sold using private reserve price and shill bid treatments only includes observations of \$18.50 and above, effectively cutting out the lower tail of the distribution and consequentially raising the average sale price. We motivate the remaining difference in average sale price with the high treatment price floors "anchoring" bidders' willingness to pay. We claim that auction fever cannot explain the higher average sale price of the high treatment items because of the reduction in bidding activity at this treatment level, as described above.

When placement costs and unsold item costs are taken into account; the advantage of price floors for the seller is wiped out. The control group 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 a greater advantage for reserve prices because the cost of placing reserve price or shill bidding would be comparatively lower. Second, our experimental design and the eBay format result in high comparability between our control group and our treatment groups. This

comparability may have raised the average sale price of our control groups due to spillover effects from the treatment groups such that the positive effect of reserve prices on sale prices we find is actually stronger in reality.

The paper is organized as follows. In the next section we survey the literature regarding the different tools available for an auction seller to have some control of the sale price. We contrast our findings with these of the other empirical and experimental studies and demonstrate that if there are differences in the findings they 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 price only when the treatment level was binding. Section 3 describes the data and performs empirical analysis. A final section offers some concluding remarks.

2. Literature Review

Theoretical Background

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' valuation of the item or their willingness to pay and affect the entry of certain bidders. These effects can work in both directions, and bidders' knowledge of behaviors 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 public reserve prices effect on sale prices are varied. Myerson (1981) and Riley and Samuelson (1981) claim 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 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. This could potentially cause additional bid shading by risk averse bidders who would value the item above the reserve price if there was full information disclosure. Also, 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, which could scare bidders away. Entry effects will be less prevalent in known common value item auctions, where it is easier for bidders to determine their willingness to pay, and also in auctions without monetary costs of entry, both of which characterize our experimental design.

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.² Shill bidding could raise an item's sale price by giving the seller more information (Graham et al (1990)). This effect is counteracted by the possible response of the buyers who may shade their bids if 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, leads to the possibility of shill bidding not being profitable (Chakraborty and Kosmopoulou (2004)). In addition, eBay buyers have the option of sniping (bidding on an item with only few seconds left). This practice insures that a shill bidder will not be able to react (Engelberg, J. and J. Williams 2005).

Empirical Background

Many empirical and experimental investigations of reserve prices and shill bidding have been carried out. These also show 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. Our data shows that this effect holds true even in known common value items, as well as providing more detail to the proposed effect. We show below that the minimum bid increases the sale price only when it is binding, and not when it is set at low levels.

² 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.

Ariely and Simonson (2003) observe the effect of both the minimum bid and the number of bidders by looking at 275 tickets sold on eBay for a special college football game (the Rose Bowl). Their analysis shows that both higher reserve prices and a higher number of bids increase the final sale price. These two variables are inversely related; as a lower reserve price allows more room for new bids. The authors conclude that the anchoring effect³ of high reserve prices outweighs the potential auction fever⁴ inspired by many bids. We confirm two of their observed effects in a controlled experimental setting. Our data shows the inverse relationships between reserve price levels and the number of bids. Also, when the reserve price level is affecting, it has a positive effect on final sale prices.

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, specifically those under \$25. Our data contradicts their findings, and provides further insight by adding a control group to each experimental session. In low, non-binding treatment levels, we see no difference in sale price or sale rate. In the high treatment level, which was binding, the private reserve price treatment ended in a sale only 10% less than the public reserve price, and both reserve prices ended in a sale over 20% less than the control group. Under the high treatment value, the private reserve price sample returned a higher average sale price than the public reserve sample, both of which were higher than the average sale price of the control group. The difference in our results may be explained by our use of a familiar known common value item, in contrast to Katkar and Reiley's use of a private value item, and also by the different levels of reserve price.

Bajari and Hortag̃su (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

³ 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.

⁴ 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.

deter bidding more than private reserve prices for high value items and that more experienced sellers were more likely to use private reserve prices. Our data supports their conclusion that optimal selling strategy varies with the value of the item. When the treatment level was non-binding, there was no significant difference between average sale price under public and private reserves and the control treatment. Under a binding treatment level, the private reserve price treatment produced a higher average sale price, but the public reserve treatment had a higher sale rate than the private reserve treatment. The difference in our results is most likely explained by our use of a known common value, cheaper item.

Dewally and Ederington's (2004) study of comic books 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. Below we demonstrate that this relationship holds true under non-binding reserve prices. However, binding reserve prices affects the average sale price of an item as well as bidder entry.

Despite the risk involved in shill bidding,⁵ 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, and could also underestimate the prevalence of the practice. Kauffman and Wood predict that shill bidding erodes trust in the marketplace, and could hurt 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

⁵ eBay policy prohibits shill bidding, and suspends or bans users who they catch.

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, but only at binding treatment levels. 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 confirms that from an individual perspective, shill bidding could raise seller revenue.

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 shill 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 treatments level was only 50% of the item's value. In contrast, our experiment uses higher reserve prices and shill bid levels. Indeed, we find that the treatment has an effect only under binding treatment levels, which were not present in their experiment.

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, number of bidders and 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 are an item 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 common, well known value

item, minimizing the effect of information on the auction outcome. We expect differences in price will not be due to incomplete information. A priori, we expected to see no differences between the average sale prices of any treatment level or treatment type.

Four auctions were run simultaneously each session. Each auction title, description and picture was identical, and all cards sold were new items to insure 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 level of the reserve price. During each individual session, one reserve price level was used, but throughout the experiment 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 at the same time as each session, creating an environment of very high comparability. We predict that any results seen from this experiment would intensify in a situation of low comparability.

The auctions ran for 3 days and they started and ended at the same time to insure that all four items faced exactly the same demand conditions and any differences in outcome were due to the treatment effect. In order to reduce the effects of seller ratings on auction outcome we rotated the four different sellers 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 dollar treatment level, 15 dollar treatment level and 18.5 dollar 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) as reported on the table columns.

To fix ideas, on the top left cell in Table 1, which is the intersection between the \$10 treatment level and the control group, we have the following numbers. There were eight different sessions in which the treatment level was 10 dollars. The mean sale price of the Starbucks gift cards that were in the control group was 18.54 dollars and the standard deviation was 0.426. We had 8 different sessions at the 10 dollar treatment level, 8 different sessions at the 15 dollar treatment level, and 13 different sessions at the 18.5 dollar level. Some cards went unsold. One card from the control group at the 15 dollar 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 dollars 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-ways analysis of variance to test for the effect of the different treatments and the different treatment levels.⁶ We include the treatment level, the different types of reserve prices and the interaction between these two categorical variables as explanatory variables.⁷ Although, the model was valid with an R-squared of 0.2719, based on this procedure, only the treatment value has a significant effect on the sale price. Namely, increasing in the treatment value positively and significantly affects the sale price. That is, the differences between the numbers on the right column of Table 1 (the Total column) 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 the proper level (p-value of 0.17) suggesting that generally under this model procedure we can not reject the null hypothesis that there is no difference in the sale price between the different treatments.

⁶ Qualitatively, similar results were obtained when we used the appropriate regression analysis.

⁷ Similar results were obtained without the interactions variables.

We can explain the two ways analysis of variance results using the following rational. 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. In particular, at the high level treatment the treatment effect should be the most observed. 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. If reserve prices have any effect, they will be more pronounced in the high treatment level because late in the auction only the high treatment level is visible to bidders.

The two-ways analysis of variance detected no differences between the average sale prices of different treatment types, which supports the conclusion that low level treatments are meaningless late in auctions. At the \$10 and \$15 treatment levels, the type of reserve price is unnoticed by bidders late in the auction, and therefore should have no effect on sale price. Our data reveals a difference between treatment types at the lower treatment levels for only one extraneous case not explained by the theory.⁸ At the high treatment level (\$18.50), the reserve price was visible to bidders later in the auction, and therefore could affect the final sale price. This theoretical possibility is confirmed empirically by our data. When we conduct separately a series of t-tests for the 18.5 dollar treatment level, 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 shill 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 treatment level can be explained possibly through selection bias and

⁸ When we separately conducted a series of t-tests we found that at the 10 dollars 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.

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 confederate bidder won the auction. The average 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 might also provides a theoretical motivation for why the high treatment level will 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 shill bid items. This anchoring effect might be observed by looking at the average sale price of the control group in the high treatment sessions and low treatment sessions. 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 account for only the high average sale price for the shill bid item at the high reserve level.⁹ Shill 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 can be verified by looking at the average number of bids at different treatment levels. Below we demonstrate that the differences in the sale prices cannot be explained by auction fever because the higher treatment level reduced both the number of bidders and bids. Our evidence shows that both the anchoring effect and selection effects possibly affect our

⁹ 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.

results. We believe that selection issues have a stronger effect on final sale price, and that 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 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 cents¹⁰, a private reserve price cost the seller \$2.65¹¹ 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.¹² Assuming these relative costs stay the same over time, we can estimate which treatment type produces the highest profit for the seller. First, if the seller uses any reserve price, she should only use a binding reserve price because non-binding reserve prices, such as the lower two treatment levels in our experiment, will have no effect on sale price, and they will incur costs. In that case we can use the high treatment level sale prices as our estimates for sale price. Conversely, the control group sale price will be best estimated by the average of the lower two treatment levels, because the third treatment level's higher average sale price was likely an effect of being sold alongside high treatment items.

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 produces an average sale price of \$19.19, with costs of \$2.65 and 4 unsold items, producing average revenues of \$15.36 per item sold after accounting for unsold items.¹³ The public reserve price

¹⁰ This is 25 cents of posting costs plus 40 cents for this type of reserve price.

¹¹ This is 25 cents of posting costs, plus 40 cents for a reserve price, plus an additional 2 dollars for a private reserve price.

¹² 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 ($18.17 * 0.0875$).

¹³ 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

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, after taking into account the unsold items.¹⁴ Shill bidding produced an average sale price of \$19.24 and 5 unsold items, resulting in average profits of \$17.84 per item sold.¹⁵ Therefore, taking into account the unsold items, our results suggest that average seller profits from the control treatment are higher than all price floor groups. As far as price floor treatments, the average public reserve treatment profits were higher than the average shill bid treatment profits, which were 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. In 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 the insurance that their item will not sell below a certain value.

[Table 2 here]

Table 2 provides the number of bidders' summary statistics results. 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 respectively. We report the results of all auctions that ended in a sale. To fix ideas, on the top left cell in Table 2, which is the intersection between the \$10 treatment level and the control group, we have the following numbers. There were eight different sessions in which the treatment level was 10 dollars. The mean number of bidders was 8.25 in the control group and the standard deviation was 2.604. The average number of bidders in the shill

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.

¹⁴For the public reserve, the costs are divided among the ten items sold. Average profit = average revenue – average cost. Therefore, average profit = $\$18.90 - (\$0.65 * 13) / 10 = \$18.05$.

¹⁵ 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 .

bid treatment includes the shill bidder in every case. Removing the shill bidder would have the solitary effect of reducing the average number of bidders in every treatment level of the shill bid column by 1. 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 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 and 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 reduced the number of bidders below all treatment types at all three treatment levels. 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 non-serious bidder 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 non-serious bidders.

[Table 3 Here]

Table 3 provides the number of bids submitted summary statistics results. 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. To fix ideas, on the top left cell in Table 3, which is the intersection between the \$10 treatment level and the control group, we have the following numbers. There were eight different sessions in which the treatment level was 10 dollars. The mean number of bids that were in the control group was 12.50 and the standard deviation was 5.682. The average number of bids in the shill bid treatment includes the shill bid in every case. As mentioned above, removing the shill bid would have the solitary effect of reducing the average number of bids in every treatment level of the shill bid column by 1.

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.¹⁶ The effect is most pronounced when there is little room to bid, namely at the high level public reserve. This is because under this treatment the fourth bid is at or above the card's face value.

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.¹⁷ 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.

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 Starbucks gift cards under the three treatment types against a control group at treatment levels of \$10, \$15 and \$18.5. Because a Starbucks gift card is a well known, widely available common value good, we minimize the effects of information on our auction outcomes. We predict that our findings will intensify in the situation of private value or unknown common value goods, as well as in thinner markets.

¹⁶ 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.

¹⁷ 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.

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 non-serious 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 treatment levels. Within our binding treatment level, both private reserve prices and shill bidding produced significantly higher average sale prices than the control group. We claim 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 will 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 private value items, unknown 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.