An Experimental Assessment of Confederate Reserve Price Bids in Online Auctions

Tim Hoppe ⬩ Abdolkarim Sadrieh

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Tim Hoppe and Abdolkarim Sadrieh*

University of Magdeburg

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Abstract

Confederate bids (i.e. bids placed by sellers' confederates) may be used to evade placement costs for a high reserve price, without increasing the risk of unacceptably low auction outcomes. We present three field experiments with parallel auctions of identical items, using five different reserve price and confederate bid settings. We find the prices to be highest with optimal reserve prices and optimal confederate bids. The expected net revenues, however, are highest with optimal confederate bids and minimum reserve prices. Finally, field data suggest that optimal confederate bids may be frequently used by sellers.

Keywords: internet auctions, reserve price, market design

JEL classification: D44, C93

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*Address: Chair in E-Business, Faculty of Economics and Management, University of Magdeburg, Postbox 4120, 39016 Magdeburg, Germany, Tel: +49 391 67-18492 (fax: -11355), E-Mail: tim.hoppe@ww.uni-magdeburg.de, sadrieh@ww.uni-magdeburg.de, http://www.ww.uni-magdeburg.de/e-business

1 Introduction

The growing flexibility of online auctions provides sellers with an increasing set of strategic design features. While many of these design features have been investigated empirically and theoretically,[1] there are hardly any studies that examine the effect of confederated bids in auctions. A confederated bid is a single bid placed by a confederate of the seller ensuring that the item is not sold below the seller's reservation price. Hence, confederate bids resemble reserve prices (or "starting prices") that are hidden from the other bidders.

We present three field experiments.[2] First, in the field experiments 1 and 2, we compare the auction outcomes with and without confederate reserve prices bids. The confederate bid in our first experiment is set to one increment below the sellers' estimated average willingness-to-accept (WTA). We furthermore compare these auctions to auctions with a public reserve price set at the level of the sellers' WTA. The difference between the two experiments is that in the first case we auction items that have a "thick" market (blockbuster DVDs), while in the second case we auction items that have a "thin" market (memorial coins in a coin booklet). In a third field experiment, we again auction blockbuster DVDs, but instead of using the estimated sellers' WTA, we use the optimal reserve price both in the treatment with the confederate bid and in the treatment with the public reserve price.[3] To derive the optimal reserve price we introduce a method of estimating the distribution of values from previous auction data.

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[1] See Ockenfels, Reiley, and Sadrieh (2006) for an overview.

[2] Field experiments are different from classical laboratory experiments, mainly because we cannot control for buyers' valuations. However, while we lose control concerning the valuations, we gain higher external validity than laboratory experiments generally have. Kagel (1995) surveys some of the classical auction experiments. Newer work is presented by Abbink, Brandts and Pezanis-Christou (2006), Goeree and Offerman (2003), Kirchkamp, Poen and Reiss (2009), Brosig and Reiss (2007).

[3] We never harm the buyers with our confederate bids. If the confederate bid affected the final price (i.e. the buyer had to pay our bid plus an increment), we contacted the buyer and sent him/her back the item and the entire amount paid. Hence, these buyers received the item basically for free.

Our main research question is how sellers' revenues are affected by confederate bids and public reserve prices. Should the revenue of both formats be equal, confederate bidding can be regarded as an effective cost reduction measure for sellers, who can save the auction fee that is charged for public reserve prices. However, it is possible that revenues from the auction formats differ, either because bidders behavior depends on the presence of public reserve prices or because the number of active bidders differs across the two auction formats. In the first case, it is possible that the existence of a public reserve price has a psychological effect on the bidders, e.g. boundedly rational bidders may anchor their bids on the reserve price (Kauffman and Wood (2003)). In the second case, in which we assume that the public reserve price reduces the number of active bidders, some authors conjecture that prices maybe lower due to a lower level of "auction fever" (Heymann, Orhun, and Ariely (2004)).

In our first two field experiments, parallel auctions of identical units of a popular DVD and a German memorial coin are used to compare revenues attained with the three different reserve price settings. We repeatedly run three parallel auctions of each object on an online auction platform, one with a WTA reserve price, one with the minimum reserve price and a WTA confederate bid, and finally one with the minimum reserve price and no further manipulation. Since the only difference between any three auctions running at the same time is the constellation of the public reserve price and the confederate bid, any observed difference presents a systematic effect of the seller's strategic choice.

We find that the sales prices in all three types of auctions are statistically indistinguishable. However, in the DVD experiment, the seller's payoff is significantly lower in the case with a WTA reserve price, due to the higher auction fee.[4] In our memorial coin experiment, we find no significant difference in the seller payoffs, even though the av-

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[4]While a substantial placement fee must be paid to place a public reserve price, the confederate bid incurs only low cost, especially when the submission is automated.

erages hint in the same direction. Hence, our study indicates that sellers may have a financial incentive to use minimum reserve prices or WTA confederate bidding in order to evade the auction fees for public reserve prices.

In the third field experiment, in which we use optimal reserve prices, we find significantly fewer successful auctions using the optimal reserve price (both as a public reserve price and as a confederate bid) compared to the case with a minimum reserve price. The successful auctions, however, result in significantly higher prices with optimal reserve price than without. Taking these two effects together and considering the auction fees, we find that the auctions with a public optimal reserve price yield significantly lower expected net revenues than the auctions with optimal confederate bids and the auctions without any manipulation. While we find no significant difference in the expected net revenues of the latter two treatments, a comparison of the prices that we achieve in our auctions with the prices of similar auctions conducted at the same time on the online auction platform indicates a widespread usage of confederate bidding.

2 Hypothesis and the Related Literature

In this section, we introduce a number of alternative hypotheses and relate them to the empirical and theoretical literature in the field. We restrict our attention mainly to empirical work on online auctions and the theoretical work on the corresponding independent private value model of open English auctions.[5] Both the theoretical and empirical results reported in this literature on public reserve prices and confederate bids are ambiguous. While some authors report a positive impact of higher public reserve prices on the auction revenues, others find the opposite results.

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[5]Clearly, one could argue that many of the empirical observed auctions may concern goods that have some common value element. However, like most papers in the field, we focus on the independent private value setting because the informational structure of most online auctions corresponds more closely to a standard private value model including a known minimum value that is common knowledge.

Hypothesis 1a: Higher prices with high public reserve prices than without.

Hypothesis 1b: Lower prices with high public reserve prices than without.

Ariely and Simonson (2003) examine data for the tickets of a sports event. They show that the starting price and the total number of bids received have strong positive effects on the auction prices, whereas auction duration had a negative effect. They also conduct a field experiment in which various items (i.e. DVD, VHS, webcams and keyboards) were auctioned online. The level of the starting price (public reserve price) is varied, where in some cases the two variants are run in sequence (low comparability) and in other cases the two variants are run insimultaneously (high comparability). They find a strong positive effect of the WTA reserve price on the final price, but only in the low comparability treatment. In a recent paper, Rosenkranz and Schmitz (2005) show theoretically that these results are in line with the model that incorporates a reference point effect in the bidders utilities.

In contrast, some authors seem to have evidence for a negative impact of the public reserve price on the number of active bidders. Bajari and Hortascu (2003), for example, examine 407 eBay coin auctions and show that auction entry is significantly reduced with a WTA reserve price. They conjecture that the lower number of bidders effects the sellers' revenues negatively. While it is clear that participation by low value bidders (i.e. bidders with a value below the sellers reserve price) should rationally have no effect on the auction outcome, a number of authors argue that high activity may create a competitive atmosphere, in which bidders are infected by auction fever, i.e. a psychological dynamic that induces higher bids from all bidders (Heymann, Orhun, and Ariely (2004) and Häubl and Popkowski (2003)). Ehrhart, Ott and Abele (2006) observe in their experiment that auction dynamics lead to higher bids. Furthermore, they find higher bids in these auctions when they allow for a psychologically induced feeling of ownership (pseudo-endowment effect) of the item. Auction fever would also explain

why prices paid in online auctions are frequently higher than the price quoted by online shops (Ariely and Simonson (2003)).

Hypothesis 2a: Higher prices with confederate bids than without.

Hypothesis 2b: Lower prices with confederate bids than without.

Some of the empirical literature on online auctions suggests that replacing WTA reserve prices by a minimum reserve price and a WTA confederate bid will increase final prices in the auction. Kauffman and Woods (2005) examine ca. 1000 coin auctions on ebay. They identify "Premium Bids" that are assumed to be placed by confederate. Controlling for a number of other parameters, e.g. number of bidders, weekend sale, presence of an object picture and sellers reputation, they report a significantly positive effect of the premium bid on the final sales price. This result supports their earlier finding (Kauffman and Woods (2003)) that coin auctions with "questionable bids" attain higher selling prices than those without.[6]

There is no empirical evidence to support the opposite hypothesis. This may be due to the fact that finding evidence would require knowledge on bidders' beliefs concerning the existence and extend of confederate bidding. A number of authors argue that both bidder participation and revenues are lower when bidders believe to face confederate bidding.[7]

Hypothesis 3a: Higher prices with confederate bids than with WTA reserve prices.

Hypothesis 3b: Lower prices with confederate bids than with WTA reserve prices.

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[6]Questionable bids that roughly correspond to early jump bids that are rarely successful and are placed by bidders who concentrated their bidding on specific sellers.

[7]Chakraborty and Kosmopoulou (2004) show theoretically that bidders activity is negatively correlated to confederate bidding because bidders discount the information context of observe bids. Although they use a common value setting to give a rational account, a similar effect can be easily shown in a private value setting based on psychological bidder reaction. Kosmopoulou and De Silva (2007) give experimental support for the negative effect of seller participation.

Once a seller has decided to set a reserve price, the question is whether it will be more beneficial to do so in public or behind the scenes. Izmalkov (2004) shows that the two alternatives are theoretically outcome equivalent in an independent private value English auction because there exists an equilibrium in which the seller can achieve the optimal mechanism outcome by using confederate bids instead of a public reserve price. Sinha and Greenleaf (2000) provide theoretical reasons that the effect may go either way in a richer model. Their results depend on numerous parameters that are extremely difficult to observe in the field, one crucial parameter is the "aggressiveness" of bidders' bidding strategies, which - depending on its value - can support either hypothesis above. While no field evidence has been provided yet, Katkar and Reiley (2005) have experimental evidence showing that auctions with secret reserve prices tend to raise less revenue than auctions with public reserve prices.

3   Experimental Design

The basic concept of the experiment is to auction identical items at the exact same time with the exact same description and to only vary the reserve price parameter. We compare an auction with a minimum reserve price (the lowest starting price allowed) to an auction with a WTA reserve price (not higher than 50 percent of the retail price) and to an auction with confederate bid at the level of the WTA reserve price.

We conducted multiple rounds of auctioning on an online auction platform. In each round, the auctions ran in parallel, starting and ending at exactly the same time. We auctioned two different types of items, 60 DVDs of the movie „The Lord of the Ring 3 - The Return of the King" and 30 memorial coins in a coin booklet. We chose these two items in order to check possible effects of the sales volume. At the time of experiment, the DVD represented a blockbuster item with high sales volume. In contrast, the coin is a collectors item that is sold infrequently. Since all the DVDs and the coins were new items, we have no reason to doubt the assumption that they were homogeneous goods.

To ensure an identical design for all auctions, we use the same item title, item description and picture for every transaction. We specified that the item will only be shipped to bidders in Germany. The only shipping option that we provided was insured shipping with the German shipping service DHL.

We started the first session at 8:00 a.m. and the next session at 8:00 p.m. This sequence was repeated throughout the experiment. The reason for this auction schedule was to check for possible effects, due to the starting time. Our 3 auction formats and the varied starting time constitute a 2x3 factorial design matrix for our field experiment. Table 1 shows that for every combination of the starting time and auction format we collected 10 observations for the DVD and 5 observations for the coin.

Table 1: The 2x3 factorial design matrix of the field experiment

	Starting time 08:00 a.m.	Starting time 08:00 p.m.
Minimum Reserve Price	10 DVDs / 5 Coins	10 DVDs / 5 Coins
WTA Reserve Price	10 DVDs / 5 Coins	10 DVDs / 5 Coins
WTA Confederate Bid	10 DVDs / 5 Coins	10 DVDs / 5 Coins

To avoid any confounding effects of reputation we used a unique new seller name for each of the rounds. Since the seller accounts were created specifically for the experiment, all feedback sheets were empty.[8] The confederate bidder account was specifically created for the experiment. In the treatments with WTA confederate bids, this account

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[8]The fact that seller reputation can have an effect on outcomes was shown empirically by Katkar and Reiley (2005) and experimentally by Bolton, Katok and Ockenfels (2003). Others however find these reputation effect negligible (Kaufmann and Wood (2004), Ariely and Simonson (2003))

was used to submit a bid at the level of the WTA reserve price. Both the bid submission of the confederate and the auction configuration were automatized in order to avoid errors and delays.

4 Results

4.1 The distribution of prices

Figure 1 shows the prices of all auctioned DVDs. The 20 sessions are presented in chronological order with a separate curve for each different treatment of the DVD auctions. While the price is volatile over time, it is immediately obvious that none of the treatment curves lie clearly above or below the others. In fact, applying the Wilcoxon Matched-Pairs Signed-Ranks Test to pairwise comparison, we find no significant differences between the prices.[9] In other words, the DVD prices neither react to the size of the public reserve price nor to the confederate bid. Hence, for the case of the DVDs, we must reject all six alternative hypotheses presented in section 2 in favor of the null hypotheses that there is no difference between prices across treatments. Even a closer look at the distribution of prices that takes the starting time of the auction into consideration reveals no differences between treatments. Perhaps it is the high trading volume in the market of the blockbuster DVD that overrides any possible effects of reserve prices.[10]
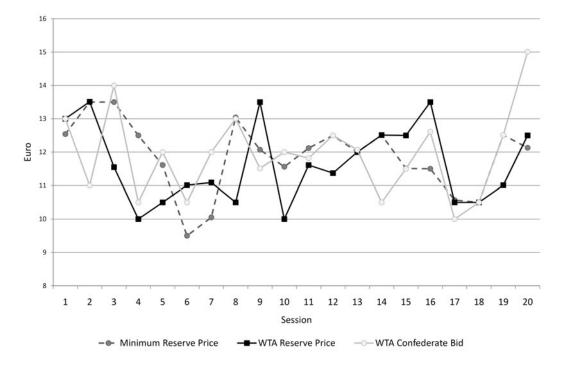
To check whether the results of the DVD sessions are only due to the high sales volume, we ran a second series of auctions using a unique collector's item. By bundling a collector's coin with the coin booklet[11], we created a unique item neither sold in an online

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[9]In the 17th session of the WTA confederate bid treatment, we had to buy the DVD because there was no higher bid than 10.00 Euro. The highest bid that was placed by a non-confederate bidder was also 10.00 Euro. Hence, we can conclude that the price in this auction would not have been above 10.00 Euro even without the confederate. This also means that there is no problem including the price in our treatment comparison, because the corresponding auctions in the other two treatments have higher prices anyway. Nevertheless, we tested all hypotheses excluding this bid and found no differences to the results reported.

[10]The average price (11.82) we achieved in the DVD auctions was well below the retail price (19.99 Euro) of the DVD, even if we add the shipping and handling costs for the auction buyers (3.50 Euro). Making losses in such field experiments is common (Ariely and Simonson (2003)).

[11]The coin booklet is a plastic envelope, in which the coin is placed together with brief description.
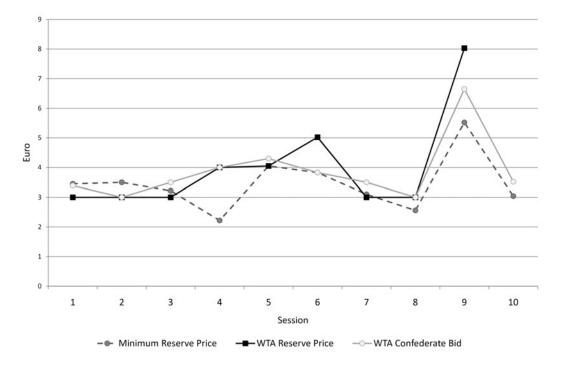
Figure 1: Prices in the 3 DVD treatments

shop nor auctioned online.[12] The experimental procedure we used was identical to the procedure used for the DVD auctions. Again, we ran all three treatments in parallel in each session.
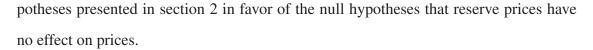
Figure 2 shows the prices we achieved for the coin bundles in each of the 10 sessions. Once again we find volatility in prices over time but no clear differences between the prices in the three treatments. The visual impression is supported by the fact that we cannot find any significant differences between the prices across treatments using the Wilcoxon Matched-Pairs Signed-Ranks Test.[13] In other words, the volume of sales, which is much lower with our unique collector's item than in the case of the DVD blockbuster item, does not effect our basic finding that prices are unaffected by the sellers reserve price policy. As in the case of the DVDs, we must reject all 6 alternative hy-

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[12]The coin for itself was traded online.

[13]In Session 10 of the WTA reserve price treatment, the coin bundle was not sold. We therefore exclude Session 10 from the treatment comparisons. In the sessions 1, 2, 3, 7 and 8 of this treatment, the coin bundles were sold at the reserve price of 3.00 Euro. In the confederate treatment, our confederate had to buy the coin bundle only in session 8. Therefore we exclude session 8 from the treatment comparisons.

Figure 2: Prices in the 3 coin treatments

potheses presented in section 2 in favor of the null hypotheses that reserve prices have no effect on prices.

We also checked for differences in prices due to the auction termination time of the day. We find no differences between morning and evening terminations for either good. Day of weeks effects are not easily detectable in our experiment, but even if they are present they would effect all three treatments in the same way and thus cancel out in our comparison.

4.2   Distribution of bids

Although we do not find any treatment effects when analyzing the prices, it could be that some of the prerequisites for the hypotheses in the literature are present in our data. One of these phenomena is that the number of bids submitted in the WTA reserve price treatment is lower than in other treatments. Table 2 shows the average number of bids in each treatment for both auctioned items. It is obvious that we observe less bids in auc-

Table 2: Average number of bids in the DVD and the coin treatments

	Minimum Reserve Price	WTA Reserve Price	WTA Confederate Bid
DVDs	7.45	2.75	5.30
Coin bundles	3.60	1.90	2.50

tions with a WTA reserve price and we can show this effect to be statistically significant (1 percent level, one-tailed, for the DVD experiment and 5 percent level, one-tailed, for the coin experiment).[14]

Together with the fact that we do not observe treatment differences in prices, this result seems to indicate that high bidding activity levels have not induced the type of bidding behavior that is related to auction fever. We seem to observe an unemotional environment in which the serious bidders remain unimpressed by the high volume of activity in the early phase of the auction.

4.3 Seller's Net Revenue

We established that prices are indistinguishable across treatments leaving sellers with the same expected amount of revenue, no matter which reserve price policy is chosen. However, a seller's net revenue does not only depend on the auction price, but also on the auction fees. Since the different reserve price policies incur different placement fees, a seller's decision on which policy to choose must incorporate these fees. Table 3 shows the average net revenue achieved by sellers in each treatment and for each item. Since placing a WTA reserve price incurs substantial auction fees, average net revenue in the treatments with WTA reserve prices are lower than in the other two treatments. Using the Wilcoxon Matched-Pairs Signed-Rank Test, however, we find this difference to be statistically significant only in the case of the DVDs and not in case of the coins.

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[14]To test the statistical significance we use the Wilcoxon Matched-Pairs Signed-Ranks Test.

Table 3: Average net revenues

	Minimum Reserve Price	WTA Reserve Price	WTA Confederate Bid
DVDs	11.93	11.63	11.89
Coin bundles	3.20	3.56	3.58

4.4 Dispersion of payoffs

So far we have seen that WTA reserve prices are empirically dominated by the other two setups, because the revenues are indistinguishable, but the fees are substantially higher in the former than in the latter. Comparing the other two treatments, the WTA confederate bid treatment may be preferred by sellers over the treatment with a minimum reserve price, if the risk of selling at a low price is diminished by engaging a WTA confederate bidder. To test this hypothesis, we compare the dispersion of payoffs across treatments. Table 4 displays the mean absolute deviation from the average payoffs.

Table 4: Mean absolute deviation from the average payoffs

	Minimum Reserve Price	WTA Reserve Price	WTA Confederate Bid
DVDs	0.8394	1.2378	0.9602
Coin bundles	0.551	0.7174	0.655

It is obvious that the dispersion of payoffs in the WTA confederate bid treatment is not substantially different than that in the minimum reserve price Treatment. Correspondingly, no significant differences can be found across the two treatments. Hence, we can conclude that empirically there is no advantage in using WTA confederate bidding to reduce the dispersion of payoffs. We additionally checked whether the payoff dispersion with a WTA reserve price is significantly greater than in the other two treatments. While the mean absolute deviation is slightly greater in that treatment than in the others, we

cannot identify significant differences. Interestingly the sales volume has no effect on these comparisons. Even in the coin auctions, in which higher dispersion could have been assumed due to the low sales volume, we cannot identify any significant dispersion effects.

5 Setting the optimal reserve price

Perhaps our WTA reserve prices and our WTA confederate bids did not have a direct impact on revenues, because they were only selected to guarantee a minimum transaction price. While securing the transaction in this way is a legitimate and frequently observed behavior, auction theory predicts that sellers will use the reserve price to maximize expected payoff (Riley and Samuelson 1981; Meyerson 1981). In this section, we present a follow-up experiment, in which we first estimate optimal reserve prices and then use these to compare WTA reserve price and the corresponding WTA confederate bid auctions to the baseline of minimum reserve price auctions. Using the same experimental setup as before (see section 3), we auction 4 triples of 5 blockbuster DVDs on on the online auction plattform.

Unlike the auctions in the previous experiment, we expect a high frequency of auctions without a transaction when using the optimal reserve price (or the corresponding optimal confederate bid). This is due to the fact that the optimal reserve price does not maximize sales, but the expected revenue for a risk-neutral seller. Riley and Samuelson (1981) show that the optimal reserve price in a standard private value auction with valuations drawn from the interval $[0, 1]$ is:

$$r^* = v_0 + \frac{1 - F(r)}{f(r)} \tag{1}$$

If valuations are drawn from a uniform distribution between $[a, b]$ the optimal reserve price is:

$$r^* = \frac{v_0 + b}{2} \tag{2}$$

Hence, if we assume a uniform distribution of valuations, we can compute the optimal reserve price, given we know the bounds of the interval of valuations, i.e. a and b. These bounds are generally not known to the sellers in the field. However, they can be estimated by assessing the number of bidders n as well as the expected value and variance of prices from past auctions. Assuming that the prices observed in the field will generally be a good estimate of the second highest valuation, we can use the following formulas for the expected value and the variance of the second-order statistic to calculate the bounds of the uniform distribution.[15]

$$E(a + (b - a)Beta((n - 1), 2)) = \frac{b(n - 1) + 2a}{(n + 1)} \tag{3}$$

$$Var(a + (b - a)Beta((n - 1), 2)) = (b - a)^2 \frac{(2n - 2)}{(n + 1)^2 (n + 2)} \tag{4}$$

To calculate the optimal reserve price we collected two weeks of data from the auctions on the platform offering our 5 blockbuster DVDs. From this data, we estimated the number of bidders n. On average, 4 bidders participated in the auctions we observed. Using the prices in the same data set, we estimated the expected value and the variance of the second highest private valuation. With $n = 4$ and the expected value and variance estimates, we computed the bounds a and b of the uniform distribution of valuations. Setting $v_0 = 0$, with n, a, and b we calculated the optimal reserve prices presented in table 5.[16] The optimal confederate bids were set one bid increment below the corresponding optimal reserve prices, in order to account for the fact that bidders can bid exactly on the reserve price, but must outbid the optimal confederate bid.

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[15]For more details see Appendix.

[16]We will come back to the discussion of the assumption $v_0 = 0$ at the end of this section.

Table 5: Optimal reserve prices

DVD Nr.	DVD	Optimal Reserve Price	Optimal Confederate Bid
1	Fool's Gold	7,00 Euro	6,50 Euro
2	Keinohrhasen	7,90 Euro	7,40 Euro
3	P.S. I love you	9,70 Euro	9,20 Euro
4	Shaun the Sheep	7,40 Euro	6,90 Euro
5	Step Up to the Streets	11,70 Euro	11,20 Euro

Figure 3 shows the optimal reserve prices, the optimal confederate bids, and the realized prices of the DVDs sold in our three treatments. Note that we have four realized prices for each DVD in the minimum reserve price treatment. In the other two treatments we rarely sold the items. DVD 1 was not at all sold in the optimal reserve price treatment and sold only one out of four times in the optimal confederate bid treatment. DVD 2 and DVD 3 were each sold twice in the optimal confederate bid treatment and only once in the optimal reserve price treatment. DVD 4 was sold twice in the optimal reserve price treatment and only once in the optimal confederate bid treatment. DVD 5 was sold only once in each of the two treatments. However, each time a DVD was sold in the optimal reserve price or optimal confederate bid treatment the achieved price was higher than the average price in the minimum reserve price treatment. Taking the five DVDs together we can show that average price in the minimum reserve price treatments are significantly lower than in each of the other two treatments (two-tailed Wilcoxon Matched-Pairs Sign Rank Test, $p < 0.05$).

Achieving higher prices seems desirable on first sight but must be traded off against the lower expected sales and - in the case of the optimal reserve price treatment - against the higher auction fees. Let us assume that the seller owns a single DVD and can choose between the three auction setups. If he uses the minimum reserve price setup he will
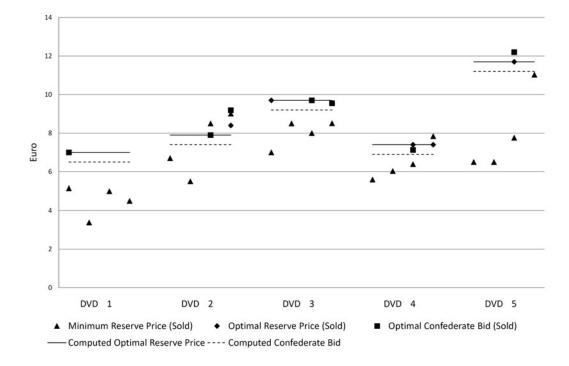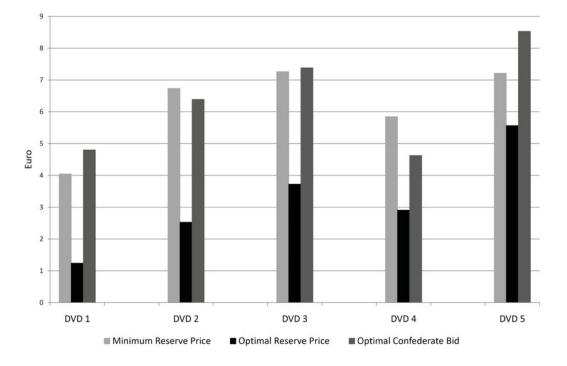
Figure 3: Prices in the optimal reserve price experiment

sell his DVD for sure at the first auction and only pay a small auction fee. If he uses the optimal reserve price, he can expect to sell his DVD only one fourth of the time. Hence, in expectations the seller pays four times the auction fee for selling a unit. Remember that the auction fee in this case is relatively high because the optimal reserve price is much greater than the minimum reserve price. Taking these fees into consideration the expected net revenue in the optimal reserve price treatment is significantly lower than in the minimum reserve price treatment (two-tailed Wilcoxon Matched-Pairs Sign Rank Test, $p < 0.05$). Figure 4 displays the expected net revenue per unit in each of our three treatments.

Interestingly the expected net revenue in the optimal confederate bid treatment is also significantly higher than in the optimal reserve price treatment. This is due to the fact that higher sales prices are achieved without additional auction fees. Comparing the expected net revenue in the optimal confederate bid setting to the minimum reserve price setting we do not find a significant difference. While the auctions with an optimal confederate bid achieve higher prices, they also incur higher auction fees due to the cases

Figure 4: Expected net revenue per unit

in which the confederate is forced to buy the item. In conclusion, the question whether minimum reserve price auctions with or without optimal confederate bidding are more profitable depends on the distribution of values and the comparison of auction fees.

There are two caveats in the theoretic treatment of the optimal reserve prices that we have presented here. On the one hand, we assume that the seller's value of the item is zero, i.e. $v_0 = 0$. If sellers actually have higher valuations than we have assumed, the optimal reserve prices would be even higher, leading to even lower sales probabilities.[17] One possible reason why the theoretically optimal reservation prices seem to high in the field is that optimal auction theory does not take the competition amongst auctions into account.[18]

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[17]Using the lowest observed market price as rough estimate of the sellers WTA we calculated optimal reserve prices that were basically outside the scope of observed prices. We decided to use the optimal reserve price based on a WTA of zero, instead.

[18]There have been several studies analyzing multiple auctions both theoretically (Peters and Severinov (2006) Stryszowska (2005)) and experimentally (Hoppe (2008)). None of the papers we know of has attempted to derive the optimal reservation price in such an environment.

On the other hand, we do not take the fee of setting a WTA reserve price into consideration when calculating the optimal reserve price. If we would consider the fees, the optimal reserve price would most probably be lower than we assume. Note that no theoretical approach has been introduced so far that would enable us to calculate the optimal reserve price under the condition that auction fees vary with the size of the reserve price. This obviously is outside the scope of this empirical paper and remains a challenge for auction theory.

6 Do other sellers achieve higher prices?

In the follow-up experiment with the optimal reserve price, we find that auctions with optimal confederate bids result in significantly higher prices than auctions with the minimum reserve price (two-tailed Wilcoxon Matched-Pairs Sign Rank Test, $p < 0.05$). In this section, we compare the prices that we achieve in our auctions with the prices achieved in "naturally" occurring auctions during the same time period. If we find that the prices in our minimum reserve price auctions are below the other market prices in similar auctions, then we can conjecture that confederate bids may have been employed in the market. We run a regression using all prices from our minimum reserve price auctions and from all other auctions on the platform selling the same items during the time the follow-up experiment was conducted.[19] To control the effect of reputations we run the regression both with the reputation score or the number of negative ratings as parameters. We also include the shipping fee and the cost of delivery insurance in the regressions. Furthermore, we control for the effect of each specific movie using dummy variables. Table 6 shows the results of our regressions.

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[19]The market data consists of all auctions of the corresponding items that ended on any of the 6 days during which our follow-up experiment was conducted. We collected only the data for new unused DVDs from our list. Only auctions with the minimum reserve price were considered.

Table 6: Regression

VARIABLES	(1) Price	(2) Price	(3) Price
Our auction	-1.635***	-1.580**	-1.622**
	(0.622)	(0.622)	(0.627)
Shaun	0.345	0.295	0.360
	(0.930)	(0.929)	(0.931)
Keinohr	1.491**	1.466**	1.534**
	(0.652)	(0.652)	(0.656)
P.S.	2.180***	2.120***	2.132***
	(0.716)	(0.716)	(0.718)
Step up	3.650***	3.582***	3.667***
	(0.839)	(0.840)	(0.841)
Shipping fee	-0.621	-0.498	-0.601
	(0.387)	(0.398)	(0.388)
Insurance	-0.571	-0.663	-0.580
	(0.640)	(0.643)	(0.644)
Num. ratings			-2.86e-05
			(6.01e-05)
Score			-0.000229
			(0.000213)
Negative ratings		-0.0260	
		(0.0202)	
Constant	10.14***	9.972***	12.38***
	(1.325)	(1.330)	(2.447)
Observations	221	221	221
R^2	0.160	0.166	0.166
Adj. R^2	0.132	0.135	0.130

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In column (1), the coefficients and standard errors are shown for a model in which no reputation score is included. We see that some specific DVD dummies are highly significant reflecting the fact that the DVDs had different market demand. For our analysis, however, the only fact to notice is that the price in our auctions with minimum reserve

price is significantly lower than the price achieved in the other auctions with a minimum reserve price. As columns (2) and (3) show the result is robust even if we include the number of negative ratings or the number total ratings and the reputation score, correspondingly.[20] Note that the shipping fee and the insurance cost exhibit negative but not significant coefficients. In other words, the price differences that we observe between our auctions and those of others are neither due to additional costs (shipping fees and insurance cost) nor due to differences in the reputation score. Hence, we conjecture that at least some fraction of the other sellers is using confederate bids as an alternative to optimal reserve prices.

7 Conclusions

The literature on online auctions is rich but relatively young. While numerous different hypotheses have been presented concerning the optimal reserve price policy in online auctions, the empirical evidence has been ambiguous. With our field experiment we provide some insight into the effect of alternate reserve price policies. To our surprise we find that neither a seller's WTA reserve price nor a WTA confederate bid have an effect on the auction revenue. We neither find evidence for auction fever nor for the reluctance to bid in the treatments with minimum reserve prices and confederate bids. We also do not find that serious bidders are deterred by WTA reserve prices. It seems that bidders are more rational and less emotional than often assumed in the literature.

The fact that neither reserve prices nor confederate bids at WTA level have a negative effect on the auction outcome is in line with optimal auction theory. To test the implications of that theory we present a novel approach to estimate the optimal reserve price from field data and report a follow-up experiment. The result of the experiment with

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[20]On first sight, it seems surprising that the coefficients for the reputation scores are non significant in regressions. But the literature on reputation in online auctions generally shows either no effects or very small effects of reputation on prices (Dellarocas 2007). Especially, low price items such as coins seem to be less affected by seller reputation (Kauffman and Wood (2003)).

optimal reserve prices and optimal confederate bids is striking. We find that the number of successful auctions drops dramatically, but the prices achieved when an auction is successful are significantly higher than in the case with the minimum reserve price. This indicates that if sellers of unsuccessful auctions can return for a "second try" with the same item, the expected revenue can be increased as long as the cost of auction re-runs is low. This is true in the case of optimal confederate bids, but not in the case of optimal reserve prices, due to the relatively high fee for setting reserve prices. Hence, for non-perishable goods it seems that the expected revenue of a seller on some auction platforms is maximized by using the minimum reserve price in combination with a confederate bid at the level of the optimal reserve price. Our regression in section 6 indicates that this strategy is perhaps already being employed by some sellers.

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A   Appendix

For a uniform distribution between $[0,1]$ the kth the second highest value is beta distributed: Beta $((n-1), n+1-(n-1))$ = Beta $((n-1), 2)$.[21] The expected value is Beta$(p,q) = \frac{p}{(p+q)}$, the variance is Beta$(p,q) = \frac{pq}{(p+q)^2(p+q+1)}$.

$$E(Beta((n-1), 2) = \frac{(n-1)}{(n+1)} \tag{5}$$

$$Var(Beta((n-1), 2) = \frac{(2n-2))}{(n+1)^2((n+2)} \tag{6}$$

Due to the fact that our values are drawn from a uniform distribution between $[a,b]$ we need a linear transformed beta distribution: $a + (b-a)Beta(p,q)$. Since $E(u + vX) = u + vE(X)$ and $Var(u + v(X)) = v^2 * Var(X)$,

$$E(a + (b-a)Beta((n-1), 2)) = \frac{b(n-1) + 2a}{(n+1)} \tag{7}$$

$$Var(a + (b-a)Beta((n-1), 2)) = (b-a)^2 \frac{(2n-2)}{(n+1)^2(n+2)} \tag{8}$$

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[21]In auction theory the second highest value is often referred to as second order statistic (see Krishna (2001)). In contrast statisticians refer to the distribution of the second highest value as the $(n-1)$ order statistic (see David and Nagaraja (2003)).