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Trust in Procurement Interactions

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Trust in procurement interactions^{*}

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Abstract

We investigate the claim that auctions in procurement are detrimental to the buyer-seller relationship, which is expressed by less trust by the buyer and more opportunistic behavior by the supplier after the sourcing. To do so, we compare experimentally a standard auction and a buyer-determined auction. It turns out that buyer-determined auctions result in higher prices but enable cooperation between the buyer and the selected supplier. In the buyer-determined auction it can be optimal for the buyer to choose the larger offer. The standard auctions, on the other hand, yield lower prices but reduce cooperation to a minimum. Interestingly the degree of trust reflected by a larger number of trades and efficiency in case of trade are significantly higher in the buyer-determined auction. Theoretical reasoning based on other-regarding preferences helps to organize the results.

Keywords: Trust, Procurement, Reverse Auctions, Behavioral Game Theory, Experimental Economics

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1 Introduction

Reverse auctions, and in particular non-binding reverse auctions are commonly used in procurement Elmaghraby (2007).¹ However, an often-heard argument against procurement auctions is that reverse auctions can have a negative impact on the relationship between the buyer and the supplier (Smeltzer and Carr 2003; Jap 2002; Jap 2003; Jap 2007). This relationship is particularly important if the exact specifications of the good cannot be verified by a third party and the buyer has to trust the supplier.²

In this paper we investigate the claim that the mechanism used for procurement has an influence on the degree of cooperation between the buyer and the seller once trade takes place and on trust that is necessary for trade to take place. For this purpose we compare a binding first-price auction and a non-binding buyer-determined auction in a framework, where after the sourcing the seller decides on the quality of the product she delivers. It is shown that the buyer-determined auction induces a significantly higher degree of trust and cooperation, but at the same time leads to higher prices. Interestingly, it can be worthwhile for the buyer in a buyer-determined auction to choose the higher offer instead of the lower one.

To organize our results, we discuss a model based on other-regarding preferences. While standard reasoning implies that both mechanisms should lead to the same allocation, allowing for other-regarding preferences helps to explain the results of the experiment.

In the experiment, both in the binding auction as well as in the buyer-determined auction potential suppliers place a sealed offer. In the binding auction, the buyer can only accept the lowest offer or refuse to trade, while he can also accept a larger offer in a buyer-determined auction. Once supplier and price are determined, the selected supplier decides on the quality of the good and delivers it. A higher quality is more valuable, but also more costly to the seller.

Now, with standard preferences, the seller will deliver lowest quality in all cases, as quality is not part of the contract. Since there is competition between suppliers, both mechanisms thus

¹In buyer-determined reverse auctions, bidders compete against each other like in a standard reverse auction, but the winner is not necessarily the supplier with the lowest bid. Rather, buyers decide based on the final quotes and further information on the suppliers, who will be awarded the contract. In a recent survey, Elmaghraby (2007) notes that "The exact manner in which the buyer makes her final selection still remains unclear. With either an on-line auction or a RFP, the buyer may still leave some terms of trade unspecified." (p. 411).

²Mayer et al. (1995) define trust as "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party".

lead to prices equal to costs of the lowest quality, which is assumed to be the same across suppliers. With other-regarding preferences both suppliers and buyers might care about the profit the others obtain. Then individuals have two objectives. On the one hand they still want to maximize their monetary payoff, but on the other hand they care about the gap between their own and others' monetary payoffs. Thus, when prices are high there can be a trade-off. Increasing quality decreases supplier's own monetary payoff but also results in more equitable outcomes. Therefore quality is no more independent of prices and high prices might induce high quality if the supplier has other-regarding preferences and gains from cooperation are high. As a consequence the equilibrium outcomes of auctions and buyer-determined auctions can differ strongly. While buyer-determined auctions can result in high-price and high-quality, the same suppliers will compete to lowest costs and provide minimum quality in auctions.

This paper contributes to the literature on buyer-determined auctions. Engelbrecht-Wiggans et al. (2007) compare a price-based and a buyer-determined mechanism in a setting where costs and qualities are correlated. They show theoretically that buyer-determined auctions are more profitable for the buyer if the correlation between costs and quality is high and the number of bidders is not too low. They also provide experimental evidence for their predictions. In contrast to our study, they assume that quality is exogenously given; in our setting, the supplier decides about quality after the selection. In Fugger et al. (2015) we analyze a setting where suppliers are uncertain about buyer's exact preferences during the competitive bidding and suppliers bid either in a dynamic buyer-determined or a binding reverse auction. In such a setting, there is a trade-off for the buyer between binding price-based auctions and buyer-determined auctions. Price-based auctions induce low prices but might force the buyer to select a non-preferred supplier. On the other hand, buyer-determined auctions allow the buyer to choose the best offer but can also enable tacit collusion which results in high prices especially when the number of bidders is small.

The work in the procurement literature closest to ours is Brosig-Koch and Heinrich (2012). In an experimental study, they find that price-based auctions are less profitable for buyers than buyer-determined mechanisms, when buyers can base their selection on suppliers' past performances. Like us, they also consider a setting with incomplete contracts. However their approach differs from ours in two major aspects. First, their explanation of differences between auctions and buyer-determined auctions is based on reputation building. In their setting reputation

building can only be profitable in the buyer-determined mechanism. While the buyer has to select the lowest bid in the auction, he is free to make his selection based on bids and suppliers' reputation in buyer-determined auctions. This gives suppliers an incentive to provide high quality and thus results in more efficient outcomes with higher prices but also higher profits for buyers in buyer-determined auctions. In contrast to their set-up, we rule out reputation building as a possible explanation. As a consequence of the anonymity in our setting, other-regarding preferences rather than reputation can explain differences between the price-based and the buyer-determined mechanisms. Second, all their procurement mechanisms are binding in the sense that trade always takes place. Furthermore, trade is guaranteed to be profitable for the buyer. In our approach buyers can be at risk of making losses and are free to refuse trade. This specification gives us the opportunity to analyze the influence of the procurement mechanism on buyers' trust.

The paper is structured as follows: In the next section we describe our experimental setup and analyze the basic model with standard preferences. The results of the experiments are shown in Section 3. In Section 4 we use a model with other-regarding preferences to organize the results. In Section 5 we conclude the paper.

2 Experimental Design and Theoretical Considerations

2.1 Experimental Design

In the laboratory experiment, we focus on a procurement interaction where one buyer faces two potential suppliers. All suppliers are pre-qualified and verified to meet the same minimum quality requirements. The buyer's valuation for the good depends on the quality $q_i \in \{q^1, q^2, \dots, q^7\}$ the selected supplier i provides. While the buyer benefits from higher quality, a higher level of quality is associated with higher costs $c(q_i)$ for the supplier. We further assume that the provision of quality is welfare increasing, i.e. $\forall q' > q : q' - c(q') > q - c(q)$.

In the procurement stage, participants take part either in a buyer-determined auction or a binding auction depending on the treatment. In the buyer-determined auction (BDRA) treatment, each supplier places a sealed offer. The buyer observes both offers and decides

whether to accept one of the offers or to reject both. If he accepts one offer, the selected supplier observes both offers and then chooses which quality level to provide. The binding auction treatment (Auction) is very similar to the buyer-determined auction. The only difference is that the buyer cannot choose between the two offers. He can only decide whether to accept or reject the lowest price in the Auction. After the buyer decided from which supplier to buy, this supplier chooses the quality she wants to provide.

In the experiment we had a total of 108 participants and used the between-subjects design. There were six independent cohorts for each treatment. Each cohort included nine participants. In each session two cohorts of the same treatment were in the lab at the same time. Two thirds of our participants were given the role of suppliers, one third the role of buyers. These roles were not changed during the experiment. Each subject participated only one time and was randomly assigned to one of the two treatments. All experimental sessions were conducted in the Cologne Laboratory for Economic Research at the University of Cologne. We recruited participants using the online recruitment system ORSEE Greiner (2004) and earning cash was the only incentive offered.

Upon arrival at the laboratory, the participants were seated at computer terminals. We handed out written instructions to them and they read the instructions on their own. When all participants finished reading, we read the instructions to them aloud, in order to ensure public knowledge about the rules of the game. After we finished reading the instructions to the participants, we started the actual game. In each session, each participant took part in a sequence of 30 procurement interactions. We used random matching and the participants had no possibility to identify each other. At the beginning of each round, the nine participants in a cohort were divided into three groups consisting of one buyer and two suppliers. We programmed the experimental interface using the zTree system (Fischbacher 2007). The first two lines of Table 1 were displayed on every screen.

Table 1: Parameter values

Costs	10	20	30	40	50	60	70
Quality	15	80	130	180	220	250	270
Welfare	5	60	100	140	170	190	200

For each interaction in each period, the selected supplier earned the difference between

the price and her costs and the buyer earned the difference between his valuation for the good and the price. The not selected supplier earned zero. If no trade took place, buyer and suppliers earned zero. We computed cash earnings for each participant by multiplying the total earnings from all rounds by a predetermined exchange rate of 50 ECU per Euro and adding it to an initial endowment of 7.50 Euro, the endowment was included to prevent losses for the buyer. Furthermore each participant received a show-up fee of 2.50 Euro. Participants were paid their earnings in private and cash at the end of the session. One treatment lasted about 60 minutes and participants made an average profit of 16.98 Euro.

2.2 Theoretical Considerations

In order to establish a benchmark for the further analysis, we will first derive the predictions for the different procurement mechanisms in the framework of standard economic theory. We consider two games with three players, one buyer and two potential suppliers. Each supplier places a bid $b_i \in \mathbb{R}^+$ and decides what quality $q_i \in \{q^1, q^2, \dots, q^n\}$ to provide in case of selection. The buyer observes suppliers' bids $\mathbf{b} = (b_1, b_2)$ and decides if he wants to trade. In the Auction he can take two actions, either accept the lowest bid a^1 or refuse to trade a^0 . In the BDRA he can take three actions, accept the lowest bid a^1 , accept the highest bid a^2 or refuse to trade a^0 .

Applying the concept of backward induction, the analysis starts in the last stage where the selected supplier i decides what quality to provide. At this stage, the price $p = b_i$ for the product is already decided. Since it is assumed that individuals only seek to maximize their own monetary payoff, the decision problem of the selected supplier is to maximize

$$U_i^{SP}(q_i|b_i) = b_i - c(q_i) \quad (1)$$

with regard to q_i . Hence, providing minimum quality $q_i = q^1$ maximizes this expression. Anticipating this the buyer maximizes his utility by selecting the lowest price or by refusing to trade if lowest bid is higher than his valuation, i.e. $\min\{b_1, b_2\} > q^1$. As a consequence equilibrium prices in the BDRA and the Auction will be the same according to standard economic theory, namely $c(q^1)$. Summing up, we expect minimum quality, small prices and no differences between the mechanisms when suppliers' costs are common knowledge.

Hypothesis 1 [*Standard Theory*]

Buyer-determined auctions and binding auctions both lead to low prices $p = c(q^1)$ and to minimum quality provision q^1 .

3 Experimental Results

Figure 1 shows the average accepted price, provided quality, and acceptance rate for each period. The dashed benchmark lines display the predictions of standard theory. In both treatments actual prices and qualities are substantially higher than predicted. The average accepted price in the Auction was 35.0 ECU and was 117.2 ECU in the BDRA. The average quality in the Auction was 43.7 ECU and in the BDRA 150.3 ECU. Furthermore two opposing time trends can be observed. While accepted prices decrease in the binding auction, they rather increase in the BDRA. Note that all accepted prices above 15 express that the buyer trusts the selected supplier since his valuation for the enforceable minimum quality level is only 15. The acceptance rates reflect that buyers were more likely to trade in the BDRA even though bids were higher in the BDRA. However, in both mechanisms the acceptance rate is decreasing over time.

Table 2: Averages and standard deviations based on session averages.

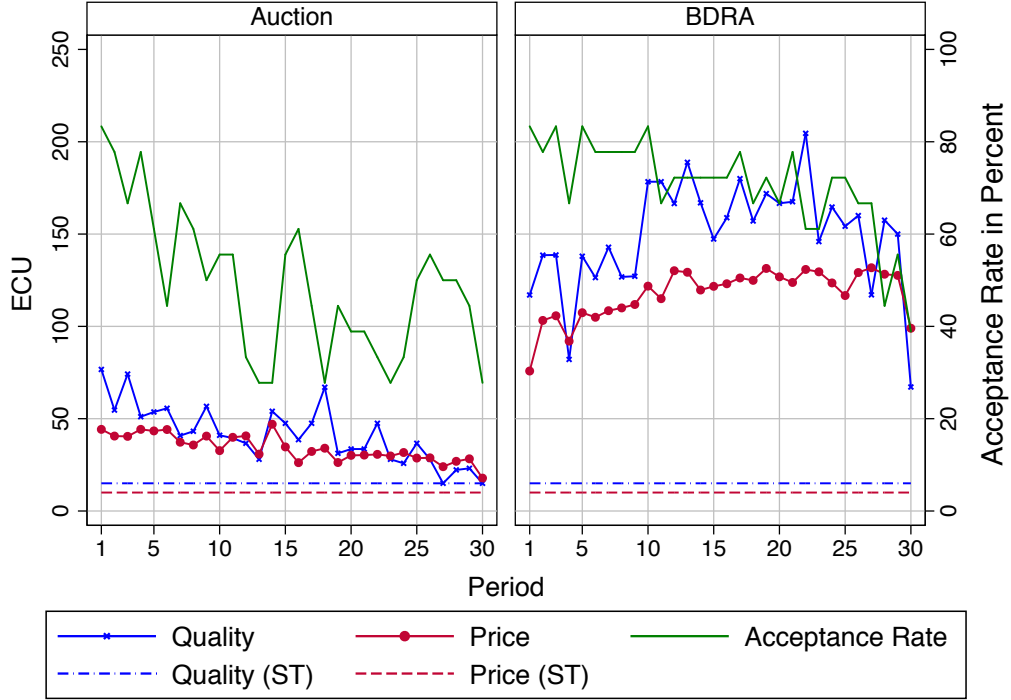
	Quality	Price	Costs	Buyer's Profit	Selected Supplier's Profit	Acceptance Rate
Auction	43.57 (12.06)	35.24 (4.31)	14.64 (2.09)	4.29 (6.04)	9.98 (1.62)	0.49 (0.07)
BDRA	141.20 (60.77)	114.23 (29.21)	34.76 (13.19)	23.41 (29.39)	28.37 (12.07)	0.71 (0.21)
<i>p</i> Value	0.0039	0.0039	0.0039	0.3367	0.0039	0.0538

Notes: Table 2 displays the averages of the key parameters for Auction and BDRA based on cohort averages. Furthermore it provides the *p* values based on the non-parametric Wilcoxon-Mann-Whitney test comparing the two treatments taking each cohort as one independent observation.

Table 2 shows that accepted prices and provided qualities were significantly higher in the BDRA than in the Auction. In this setting higher quality implies higher efficiency if trade takes place, in addition the BDRA had also a larger acceptance rate which increases its efficiency advantage further.

While standard theory predicts that the buyer extracts all the surplus, the profit of the

Figure 1: Average accepted prices and provided values.



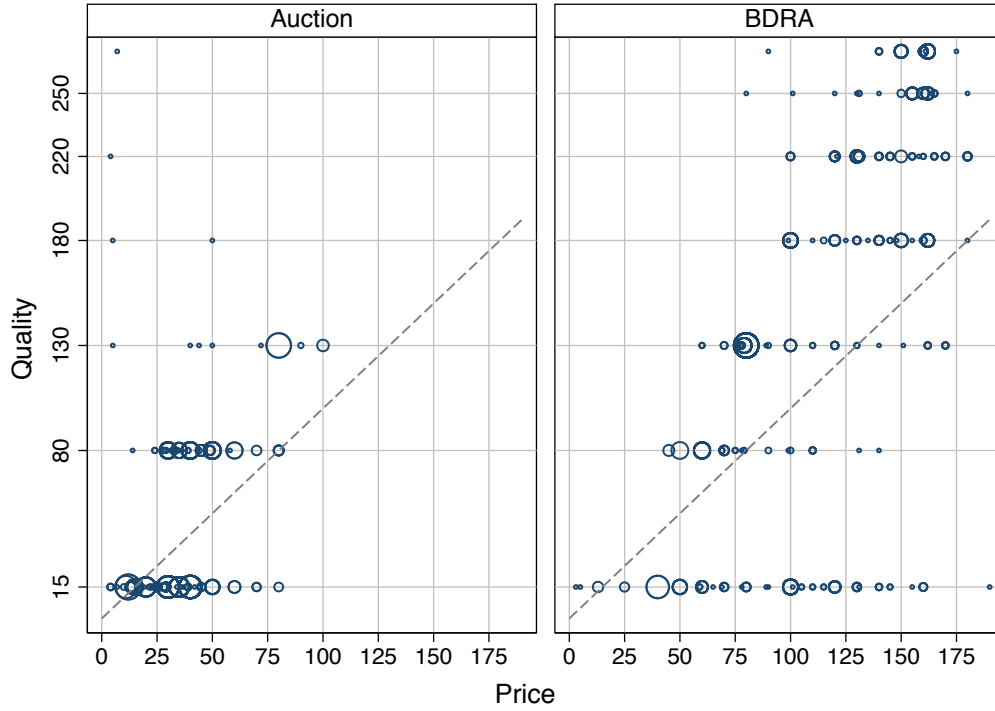
Notes: Figure 1 displays the average accepted price and average provided quality of all trades that took place in a period over time. Furthermore, it illustrates the evolution of the acceptance rate, i.e. the ratio between trades and possible trades in a period.

selected supplier was on average greater than the buyer's profit in both treatments. According to the non-parametric Wilcoxon matched-pairs signed-rank test the profit of the buyer and the selected supplier do not differ significantly ($p^{\text{Auction}} = 0.1159$ and $p^{\text{BDRA}} = 0.7532$). Suppliers were significantly better off in the BDRA compared to the Auction. Also the buyer earned on average higher profits in the BDRA. However, this difference was not significant and accepting the high bids in the BDRA was also a risky choice as the possible loss was substantial.³

Figure 2 provides us with price-quality doubles for each trade. Each point above the dashed line is associated with a positive profit for the buyer. In the Auction nearly all accepted prices were smaller than 60 ECU and in more than 61.5 percent of trades the provided quality was $q^1 = 15$. In another 33.6 percent of trades the quality was $q^2 = 80$, the number of trades

³The numbers reported in Table 2 differ slightly from those depicted in Figure 1. In Figure 1 we display the average over all trades that took place in a period, hence cohorts that traded more than other groups in the same treatment have more weight. In Table 2 we take the average of each cohort as one observation and thereby guarantee that each cohort has the same weight.

Figure 2: Observed price-quality doubles in Auction and BDRA.



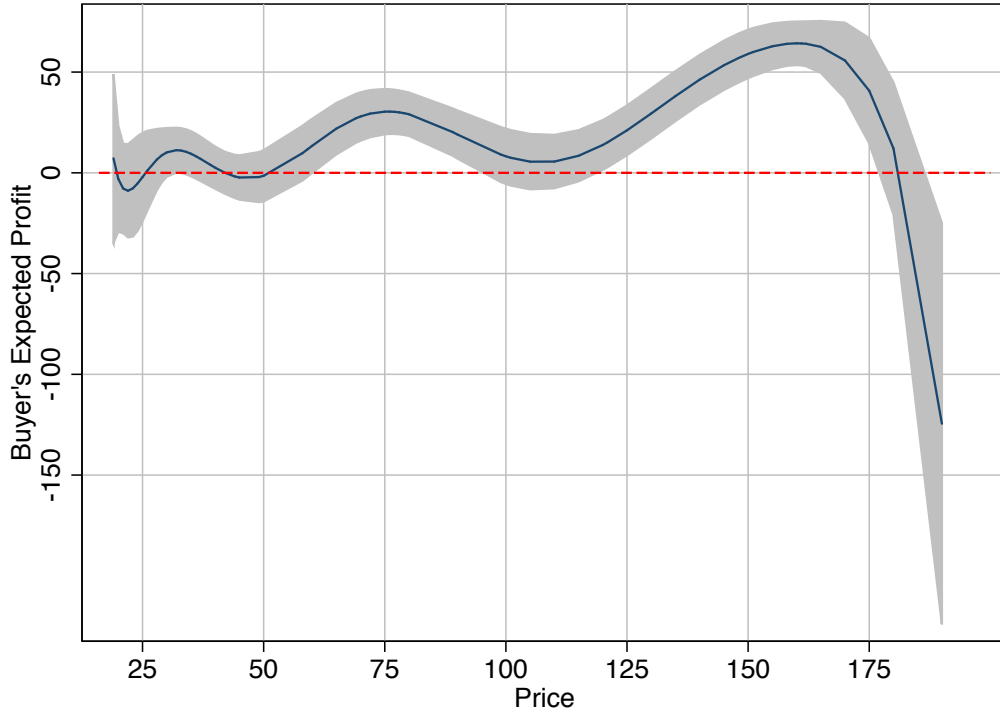
Notes: Figure 2 displays all price-quality doubles. Each double above the dashed line represents a trade that was profitable for the buyer. The size of a bubble corresponds to a doubles frequency of occurrence.

with even higher quality is neglectable. The share of trades that were profitable for the buyer was only 41.9 percent. The observations in the BDRA were very different. Only 5 percent of accepted prices were smaller than 60 ECU and most prices were between 80 and 155 ECU. Minimum quality was provided in less than 20 percent of trades. The share of trades that were profitable for the buyer was 75.8 percent. However, due to the higher prices realized losses were larger in the BDRA.

Figure 3 illustrates the expected profit of a buyer as a function of the accepted price considering all observations in the Auction and the BDRA treatment. It reflects the positive correlation between price and expected quality. This correlation was similar in both treatments and accepting a high bid was often profitable. Interestingly the expected profit is not monotonically increasing or decreasing in the price.

So far the description of results concentrated mainly on trades that took place. Table 3 displays the key determinants of a buyer's acceptance decision. In both treatments it is mainly

Figure 3: Expected buyer's profit depending on accepted price.



Notes: Figure 3 displays buyer's expected profit as a function of the price. The shaded area represents the 95 percent confidence interval. The estimate is the result of a fractional polynomial regression taking into account each trade in the Auction and BDRA.

driven by the quality level that the buyer received in the period before. Interestingly, buyers that accepted to trade selected the higher bid in 46 percent of the BDRAs. For that reason we ran the same regressions as in Table 3 also for the highest bid for the BDRA treatment but found no difference.

Table 4 shows how a supplier changes her bidding behavior over time. Her bid is influenced by the bids she and her former competitor placed in the last period. Interestingly, a supplier that traded in the last period does not change her bid in the Auction but increases it significantly in the BDRA.

Table 3: Logit panel regression of acceptance probability.

	Acceptance Probability			
	Auction	BDRA	Auction	BDRA
Lowest Bid	-0.00135 (-0.18)	-0.00113 (-0.20)	0.0232* (1.83)	-0.00690 (-0.80)
Period	-0.0540*** (-4.36)	-0.0875*** (-4.95)	-0.0000514 (-0.00)	-0.0389 (-1.61)
Quality _{t-1}			0.0297*** (5.54)	0.00788*** (2.82)
Price _{t-1}			-0.0241* (-1.90)	0.00955 (1.16)
Constant	0.841* (1.96)	2.848*** (3.49)	-0.827 (-1.22)	1.102 (1.25)
Observations	540	540	260	374

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Notes: Regressions reported in column one and two take all interactions into account, regressions in column three and four only consider interactions where the buyer traded in the period before, hence the number of observations is reduced.

Table 4: Panel regression of suppliers' bidding behavior.

	Bid	
	Auction	BDRA
Bid _{t-1}	0.414*** (6.71)	0.637*** (10.84)
Competitor's Bid _{t-1}	0.126*** (3.09)	0.193*** (3.93)
Trade _{t-1}	-1.406 (-0.91)	7.319*** (2.94)
Period	-0.339*** (-3.35)	0.0159 (0.15)
Constant	25.48*** (6.35)	15.16*** (2.97)
Observations	1044	1044

t statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Notes: Regressions illustrate how suppliers adjust their bidding behavior over time. Trade_{t-1} is a dummy variable that is 1 if the supplier traded in the last period and 0 else.

4 Behavioral Model

In this section, we intend to shed light on the results by using a model based on other-regarding preferences. In contrast to the assumptions of standard theory, many observations in experimental economics suggest that most individuals are not solely motivated by profit maximization but also affected by fairness considerations such as inequity aversion. To incorporate this idea into our model we assume that suppliers have utility functions as suggested by Fehr and Schmidt (1999).⁴

Again we consider an Auction and a BDRA with three players, one buyer and two potential suppliers. Inequity aversion implies that an individual is not only affected by her own monetary profit, but also by that of others. If the buyer refuses trade all players still have a utility of zero. If the buyer accepts a bid b_i the utility of the selected supplier is given by

$$\begin{aligned} U_i^{\text{selected}} = & b_i - c_i \\ & - \frac{1}{2} [\lambda \beta_i \cdot (q_i + c_i - 2b_i)^+ + \beta_i \cdot (2b_i - q_i - c_i)^+] \\ & - \frac{1}{2} [\lambda \beta_i \cdot (c_i - b_i)^+ + \beta_i \cdot (b_i - c_i)^+] . \end{aligned} \quad (2)$$

and that of supplier j by

$$\begin{aligned} U_j^{\text{not selected}} = & 0 \\ & - \frac{1}{2} [\lambda \beta_j \cdot (q_i - p)^+ + \beta_j \cdot (p - q_i)^+] \\ & - \frac{1}{2} [\lambda \beta_j \cdot (p - c_i)^+ + \beta_j \cdot (c_i - p)^+] \end{aligned} \quad (3)$$

with $(x)^+ = \max\{x, 0\}$. The first lines give the utility suppliers derive from their profits. The second lines express how much they suffer from the inequality compared to the buyer and the third line compared to the other supplier. The parameter $\beta_i \in [0, \bar{\beta}]$ reflects how much she suffers from advantageous inequality and $\lambda > 1$ how much more she suffers from disadvantageous inequality. The buyer's utility is given by $\Pi = q_i - b_i$.⁵ To account for heterogeneity among suppliers we assume that the β_i are continuously distributed according to a distribution function

⁴The model developed by Bolton and Ockenfels (2000) leads to similar predictions.

⁵We assume that the buyer is not affected by inequity aversion. For the buyer inequity aversion has the same consequences as loss aversion since losses are overweighted due to suffering from disadvantageous inequality, i.e. buyers that are inequity averse are less likely to accept (risky) high bids.

$F : [0, \bar{\beta}] \rightarrow [0, 1]$ and that her type is a supplier's private information. After defining the game we analyze it via backward induction. In the last stage the selected supplier maximizes her utility as defined in expression 2 by choosing the quality q_i of the provided good. Her decision depends on her inequity aversion β_i and the price b_i . The smaller β_i the higher is the price that makes supplier i prefer high quality. If the price is low no supplier will provide more than minimum quality.

In the second stage the buyer decides if he wants to trade or not. If he wants to trade he has to accept the lowest bid in the Auction and can choose between the offers in the BDRA. Note that quality provided by supplier i depends only on her (accepted) bid b_i . The buyer will only accept a bid where he expects a positive profit. Let $\mu^k(b_i)$ be the buyer's belief about receiving quality q^k if he accepts a bid b_i . Then his expected profit can be written as

$$E\Pi(b_i) = \sum_{k=1}^n \mu^k(b_i) \cdot q^k - b_i \quad (4)$$

If there is more than one profitable offer he will select the one with higher expected profit. Anticipating the buyer's selection suppliers place bids in the first stage. Expression 3 shows that a not selected supplier suffers when she observes a trade. As a consequence, the expected utility of a supplier can be negative even if she has a positive selection probability and placed a bid above costs. Which bid is optimal for a supplier depends both on the buyer's beliefs and the procurement mechanism. In the Auction a supplier can always reduce the competitor's probability of winning to zero by undercutting. Whereas this is not possible in a BDRA.

We focus on strategies where all suppliers pool in the first stage by placing the same bid \hat{p} and call $(\sigma^b, \sigma_1^s, \sigma_2^s) = [a^k, (\hat{p}, q_1), (\hat{p}, q_2)]$ an equilibrium strategy if there is a belief system, s.t.

$$\begin{cases} q_i = \arg \max U_i(q_i | \hat{p}) \quad \forall i \\ \hat{p} = \arg \max U_i [q_i(b_i), b_i] \quad \forall i \\ \sum_{k=1}^n \mu^k(\hat{p}) \cdot q^k - \hat{p} \geq 0 \end{cases} \quad (5)$$

Due to the leeway in specifying beliefs outside the equilibrium path, there can be a wide variety of perfect Bayesian equilibria. For example, many bids can be established as equilibrium bids given the following belief structure. All suppliers bid $b_i = b^*$ and the buyer's belief about receiving quality q^k given this bid is correct, i.e. $\mu^k(b^*) = \Pr\{q^k | b^*\}$. However, for any other

bid $b_j \neq b^*$, the buyer is sure to receive minimum quality q^1 , i.e. $\mu^1(b_j) = 1$. We now characterize two types of possible pooling equilibria. A low-price low-quality equilibrium and a high-price mixed-quality equilibrium.

In both procurement mechanisms exists a low-price low-quality equilibrium independent of suppliers' inequity aversion. Suppose that all suppliers place a low bid $\hat{p} = c^1$ and that the buyer believes that a supplier who placed a bid $p' \neq \hat{p}$ will never provide more than minimum quality, i.e. $\mu^1(p') = 1$. Then no supplier has an incentive to deviate since there is no offer a bidder can make that will positively influence the payoff distribution. Hence, $(\sigma^b, \sigma_1^s, \sigma_2^s) = [a^1, (c^1, q^1), (c^1, q^1)]$ is an equilibrium strategy independent of the distribution of β_i . Furthermore, there cannot be another low price equilibrium as suppliers then have an incentive to undercut. In the Auction suppliers' strategy as defined above constitutes an equilibrium strategy independent of the buyer's belief, in the BDRA it is only an equilibrium strategy for certain beliefs.

Depending on suppliers' types also a high-price mixed-quality equilibrium exists in the Auction and the BDRA. However, the exact conditions differ. Suppose that all suppliers place a high bid \hat{p} and that the share of suppliers that want to provide high quality given this price is sufficiently large.

In an auction the only reasonable way to deviate is to place a bid p' lower than \hat{p} that will be accepted, e.g. all bids smaller than q^1 fulfill this condition. A supplier that places such a bid is sure to win and can avoid to suffer from disadvantages inequality. Hence, a high-price mixed-quality equilibrium can only exist in an auction if no supplier suffers too much from disadvantageous inequality. In a sense each supplier can veto a high-price equilibrium by undercutting. This is important as the expected utility of supplier might be small.

Suppliers in a BDRA cannot easily prevent competitors from winning by placing a lower bid. They can only try to offer a bid that is more attractive for the buyer. As a consequence there can be high-price equilibria in the BDRA where suppliers have negative expected utility. Such equilibria are not possible in an auction.

Constant beliefs The last section showed that in both mechanisms a wide range of equilibria is possible. In this section we try to make a more precise prediction by imposing a restriction on beliefs. We assume that the buyer does not interpret a supplier's bid as an informative signal

about her type, i.e. the buyer's belief about supplier i 's type β_i is independent of her bid b_i . However, the buyer's expectation about the provided quality depends on the price.

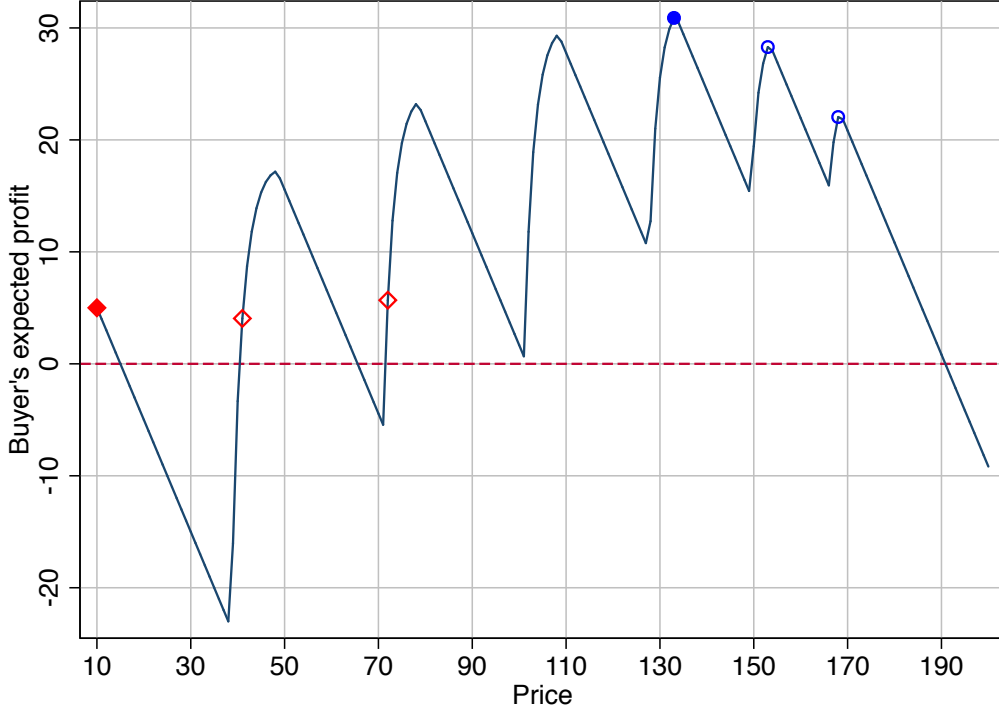
In the Auction all high-price equilibria with constant beliefs have the property that the buyer has an expected profit of zero. To see this suppose that there is equilibrium with \hat{p} and $E\Pi(\hat{p}) > 0$. Then a supplier can make herself strictly better off by placing a bid slightly below \hat{p} . The buyer will accept the bid and the deviating supplier is sure to win. Hence, there cannot be a high-price equilibrium where the buyer expects positive profits. Given a price p_A^* with $E\Pi(p_A^*) = 0$ and $\frac{\partial E\Pi(p)}{\partial p}|_{p=p_A^*} > 0$ a supplier that wants to deviate faces a trade-off. If she slightly undercuts the buyer will refuse to trade. Hence, she must lower her bid so that the buyer will accept, which decreases her profit. The commitment to select the lowest bid puts pressure on prices that need not be beneficial for the buyer.

In the BDRA all high-price equilibria with constant beliefs have the property that they are local maximizers of the buyer's expected profit, furthermore those prices must be at least as high as the price that maximizes the buyer's expected profit. Suppose there is a price smaller than the buyer's preferred price then a supplier is better off by placing a higher bid. If the price is higher than the buyer's preferred price then suppliers have an incentive to slightly undercut that price. Hence, all high equilibrium prices p_B^* of the BDRA have the following property $\frac{\partial E\Pi(p)}{\partial p}|_{p=p_B^*} = 0$. Furthermore, the low price equilibrium only exists if there exists no price \bar{p} with $E\Pi(\bar{p}) > E\Pi(c^l)$. As a consequence the deviation incentive given a high price is stronger in the Auction than in the BDRA.

Quantitative Predictions To get some appreciation for the size of the effects of inequity aversion, we have to make assumptions about the inequity aversion parameters and the characteristics of the supplier population. We consider a population where the β_i are uniformly distributed between 0 and $\frac{3}{5}$ as a benchmark. We also derived predictions for the estimates by Fehr and Schmidt (1999), Blanco et al. (2011), and Yang et al. (2012). Predictions are very similar only those based on the estimates of Yang et al. (2012) differ substantially as the share of inequity averse individuals is much smaller.⁶

⁶Estimates for the share of inequity averse individuals and the amplitude of inequity aversion differ quite a bit. Fehr and Schmidt (1999) assume that 30 percent of the suppliers are not affected by inequity aversion, another 30 percent have $\beta = \frac{1}{4}$, and 40 percent have $\beta = \frac{3}{5}$. Blanco et al. (2011) report that 29 percent of their subjects had a $\beta < 0.235$, 15 percent between 0.235 and 0.4, and 56 percent larger than 0.5. Yang et al. (2012) observed that about 70 percent of their subjects have a β smaller 0.125, 20 percent a between 0.125 and 0.375, and 10 percent larger than 0.375. Andreoni and Vesterlund (2001)

Figure 4: Buyer's expected profit.



Notes: Figure 4 displays the expected profit of a buyer as a function of the price. It is assumed that suppliers suffer twice as much from disadvantageous inequality than from advantageous inequality ($\lambda = 2$). Red diamonds mark equilibrium candidates in the Auction and blue circles equilibrium candidates in the BDRA.

Figure 4 displays buyer's expected profit as a function of the accepted bid and is similar to our observation in the experiment which is displayed in Figure 3. It illustrates that we have three candidates for equilibrium prices in the Auction and also three in the BDRA if we assume that the β_i are uniformly distributed and that individuals suffer twice as much from disadvantageous inequality compared to advantageous inequality, i.e. $\lambda = 2$.⁷ These candidates however differ substantially between the two mechanisms. In the auction the candidates are bids of 10, 41, and 72. In the BDRA these are bids of 133, 153, and 168. Since the associated expected profits are positive the buyer will accept, i.e. has no incentive to deviate.⁸

If suppliers want to deviate from high prices remains to be checked. As the deviation report that 44 percent of their subjects showed completely selfish behavior in a similar setting.

⁷The exact parametrization of λ only has little effect on the possible equilibrium outcomes, because the effects are mainly driven by suppliers' aversion towards advantageous inequality.

⁸The strictly positive expected profit for the high-price candidates in the Auction is due to discrete prices.

incentive is intensified by aversion towards disadvantageous inequality, it suffices to examine if a supplier with $\beta = \frac{3}{5}$ wants to deviate. We start with the Auction. Given that the other bidder placed a bid of 72 (41) optimal deviation is given by a price of 65 (15). By deviating the supplier can be sure to win, but has to accept a lower price. Because the price reduction is overcompensated by the increased probability of winning 72 (41) is no equilibrium price in the auction. Hence, there is only a low-price low-quality equilibrium with $p^{Auction} = 10$. In the BDRA optimal deviation from 168 is given by 159 and from 153 by 136. In both cases deviation is attractive. Hence, the only equilibrium price is given by $p^{BDRA} = 133$

To sum up, we got the following predictions:

- (i) Prices in the Auction are small. ($p^{Auction} = 10$)
- (ii) Buyer can extract all gains from trade in the Auction.
- (iii) Prices in the BDRA are high. ($p^{BDRA} \approx 130$)
- (iv) Selected supplier's profit is similar to that of the buyer in the BDRA.
- (v) The correlation between price and expected quality is positive.
- (vi) Buying in the BDRA is risky. High prices can be profitable but can also result in losses for buyers.

Our predictions for the BDRA are in line with our observations in the experiment. In the Auction prices and provided qualities were higher than predicted, furthermore the buyer did not extract all gains from trade. Under the assumption that buyers are homogeneous we cannot make reasonable predictions about acceptance rates. But if we assume that a small fraction of suppliers is risk averse, then it can make sense for suppliers to place bids such that risk neutral buyers accept and risk averse buyers reject. In that case we should observe positive rejection rates in the BDRA but not in the Auction.

Robustness So far we focused on a procurement interaction where one buyer faced two suppliers and assumed that both the selected and the not selected supplier compare their profit to the buyer's profit and to their competitor's profit. In this section we first discuss the effect of more competition, i.e. a larger number of potential suppliers, and then the effect of another reference group.

Given that a supplier compares her profit to both the buyer's profit and her competitor's profit increasing the number of competitors has two effects in the Auction. First, it strengthens the deviation incentive given a high price as the selection probability when pooling on the same price is decreased. Second, it reduces the selected supplier's incentive to provide high quality as increasing the quality becomes less efficient in reducing inequality. The second effect also occurs in the BDRA and reduces equilibrium prices indirectly. However, qualitatively the results remain unchanged if the number of potential suppliers becomes larger.

One might argue that suppliers compete anonymously in the bidding stage and that buyer's selection initiates a fundamental transformation in the sense of Williamson (1985). For example, Hart and Moore (2008) argue in this direction. In this case the selected supplier compares her profit to that of the buyer and the not selected supplier does not compare her profit neither to the buyer nor to the supplier. Under this assumption suppliers can guarantee themselves non-negative expected utility as they do not suffer if they are not selected. As a consequence low-price equilibria are affected as inequity averse suppliers prefer not to trade rather than selling at very low prices. Furthermore, high-price equilibria in the Auction become more likely as the incentive to undercut is reduced due to the higher expected utility when pooling on a price. Specifying the reference group differently does not change the results qualitatively, however, high-price equilibria become more likely in the Auction.

Interestingly, the comparison group has also an influence on the effect of a larger number of potential suppliers in the BDRA. If selected supplier compares her payoff to all other then an increasing number of potential suppliers reduces her incentives to provide high quality. If she only compares her profit to that of the buyer her incentives to provide high quality in case of selection and her bidding behavior are not affected.

5 Conclusion

In this paper we investigated in how far the mechanism being used to select the supplier has an influence on the degree of trust and cooperation between the supplier and the buyer. In contrast to the predictions of standard theory our data shows significant differences between the Auction and the BDRA treatment. Prices, qualities and acceptance rates were substantially lower in the Auction than in the BDRA. Furthermore, the experimental data shows a clear ranking

in terms of efficiency. With regard to profits, the BDRA was on average more profitable for buyers and suppliers. At the same time, the BDRA was more risky for buyers. Some buyers made losses while others made large profits. Also in the Auction prices were significantly higher than suppliers costs and higher than minimum quality, i.e. accepting trade in the Auction was risky, too. However, due to smaller prices possible losses were substantially smaller than in the BDRA. Interestingly, the acceptance rate was significantly higher in the BDRA even though prices and hence the necessary level of trust were substantially higher.

Most of the observations are in agreement with theory based on other-regarding preferences. It also predicts buyer's commitment to only consider the lowest bin in an Auction can hinder the implementation of the buyer's optimal price. Hence, the BDRA is on average more profitable for the buyer if the gains from cooperation are large.

References

- Andreoni, J. and L. Vesterlund (2001). Which is the fair sex? Gender differences in altruism. *Quarterly Journal of Economics* 116(1), 293–312.
- Blanco, M., D. Engelmann, and H. T. Normann (2011). A within-subject analysis of other-regarding preferences. *Games and Economic Behavior* 72(2), 321–338.
- Bolton, G. E. and A. Ockenfels (2000). ERC: A theory of equity, reciprocity, and competition. *American Economic Review* 90(1), 166–193.
- Brosig-Koch, J. and T. Heinrich (2012). Reputation and mechanism choice in procurement auctions: An experiment. *Production and Operations Management* 23(2), 210–220.
- Elmaghraby, W. J. (2007). Auctions within e-sourcing events. *Production and Operations Management* 16(4), 409–422.
- Engelbrecht-Wiggans, R., E. Haruvy, and E. Katok (2007). A comparison of buyer-determined and price-based multiattribute mechanisms. *Marketing Science* 26(5), 629–641.
- Fehr, E. and K. M. Schmidt (1999). A theory of fairness, competition, and cooperation. *Quarterly Journal of Economics* 114(3), 817–868.
- Fischbacher, U. (2007). z-tree: Zurich toolbox for ready-made economic experiments. *Experimental Economics* 10(2), 171–178.

- Fugger, N., E. Katok, and A. Wambach (2015). Collusion in dynamic buyer-determined reverse auctions. *Management Science*, forthcoming.
- Greiner, B. (2004). The online recruitment system orsee 2.0 - A guide for the organization of experiments in economics. *University of Cologne, Working Paper Series in Economics 10*.
- Hart, O. and J. Moore (2008). Contracts as reference points. *The Quarterly Journal of Economics 123*(1), 1–48.
- Jap, S. D. (2002). Online reverse auctions: Issues, themes, and prospects for the future. *Journal of the Academy of Marketing Science 30*(4), 506–525.
- Jap, S. D. (2003). An exploratory study of the introduction of online reverse auctions. *Journal of Marketing 67*(3), 96–107.
- Jap, S. D. (2007). The impact of online reverse auction design on buyer–supplier relationships. *Journal of Marketing 71*(1), 146–159.
- Mayer, R. C., J. H. Davis, and F. D. Schoorman (1995). An integrative model of organizational trust. *Academy of Management Review 20*(3), 709–734.
- Smeltzer, L. R. and A. S. Carr (2003). Electronic reverse auctions: Promises, risks and conditions for success. *Industrial Marketing Management 32*(6), 481–488.
- Williamson, O. E. (1985). *The economic institutions of capitalism*. Simon and Schuster.
- Yang, Y., S. Onderstal, and A. Schram (2012). Inequity aversion revisited. *Working Paper*.