Teams and Individuals in Standard Auction Formats: Decisions and Emotions

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Teams and Individuals in Standard Auction Formats: Decisions and Emotions*

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Abstract

Our study compares individual and team bidding in standard auction formats: first-price, second-price and ascending-price (English) auctions with independent private values. In a laboratory experiment, we find that individuals overbid more than teams in first-price auctions and deviate more from bidding their own value in second-price auctions. However we observe no difference in bidding behavior in English auctions. Based on control variables, we claim that the observed difference can be explained by better reasoning abilities of teams. Emotions play a role in determining bids, but the effect of emotions on bidding does not differ between individuals and teams.

JEL classifications: C91, C92, D44

Keywords: auctions, team decision-making, experiment, overbidding

1 Introduction

Auctions are a very important allocation mechanism. In the theoretical and empirical literature, bidders in auctions are usually assumed to be (representative) individuals. However, often, small groups or teams (henceforth used interchangeably) determine bids or bidding strategies together

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(see, e.g., Börgers and Dustmann, 2005). Teams may be organized formally, potentially including a hierarchy, or informally such as it is usually the case with families or teams of experts without a formal structure.

Examples of bidding in teams readily come to mind. Think of a family that decides about their bid in an online auction. However, also on the level of corporate auctions, teams play a crucial role. In spectrum auctions (Abbink et al., 2005) or auctions for offshore oil leases, teams of managers or experts (geologists) formulate strategies for bidding (Capen et al., 1971, Hoffman et al., 1991). Interestingly, we know very little about the extent to which existing knowledge from bidding behavior of individuals can be transferred to auctions that involve team bidders. One reason is that the existing evidence, mostly from laboratory experiments, is not fully conclusive. We discuss the relevant literature in greater detail below.

This paper, therefore, compares individual and team bidding in a systematic design. We implement three commonly used auction formats: a first-price auction, a second-price auction, and an ascending English auction. Using a laboratory experiment, we systematically vary the type of decision maker by having either individuals or small unitary teams deciding about the bids. Our focus is on unitary teams, i.e. teams that do not face an internal conflict in terms of monetary outcomes and that have to come up with a joint decision after some deliberation. Obviously, team decision settings are quite diverse outside the laboratory. However, unitary teams seem to provide a good first impression of potential differences between individual decision makers and teams, and more involved teams settings follow immediately as potential extensions.

It is well-known that individuals and small unitary teams differ in several respects (Charness and Sutter, 2012, Kugler et al., 2012). First, individuals and teams differ in their ability to avoid mistakes (Bornstein et al., 2004, Blinder and Morgan, 2005, Cooper and Kagel, 2005, Sutter, 2005, Gillet et al., 2009, Feri et al., 2010) or in their learning ability and pace (Kocher and Sutter, 2005, Kocher et al., 2006, Maciejovsky et al., 2013). According to the economists' definition, teams are thus usually more rational decision makers than individuals. Applying results from existing studies using different decision making games would lead to the expectation of fewer instances of overbidding in first-price auctions and of fewer deviations from the dominant strategy of bidding one's own valuation in second-price auctions.

Second, individuals and teams might potentially differ in the risks they take. There is a long discussion starting in the early psychological literature about whether there is a "risky shift" from

individuals to teams (Stoner, 1961) or whether the shift is actually "cautious" (Moscovici and Zavalloni, 1969). Recent evidence from controlled laboratory experiments in economics provide inconclusive results (Baker et al., 2008, Shupp and Williams, 2008, Masclet et al., 2009, Zhang and Casari, 2012). Obviously, a difference in revealed risk attitudes from individuals and teams would affect equilibrium bids in first-price auctions, not in second-price auctions.

Third, there could be a difference in the emotional reactions to events during an auction or between auctions.[1] Auction fever describes a non-rational immersion into an auction that might lead to overbidding. There is large literature in social psychology showing that team decision making might go out of hand and lead to even disastrous consequences. This literature that is often summarized under the heading "groupthink" (Janis, 1972, 1982, 1989) has looked at (often spectacular) misjudgments or failures that followed deliberation within teams. Usually, groupthink goes hand in hand with some deficiencies in the group decision making process such as the existence of a strong group leader together with the suppression of deviant opinions. While there is no evidence yet, it is conceivable that groupthink could be related to emotional reactions or over-competitive attitudes in auctions. Does auction fever perhaps affect individuals and teams differently? Potential differential effects of auctions fever should be observable in ascending English auctions.

Our list of potential influences on bidding in auctions that lead to differences between individual bids and team bids is not exhaustive. There might be additional relevant aspects, but those mentioned above are probably the most important ones. So far, the existing experimental literature on bidding in auctions has almost exclusively focused on individual bidders. To the best of our knowledge, there are only a few exceptions. Cox and Hayne (2006), the first paper on the difference between individuals and teams in auctions, focus on the effect of information on team bidding and less on a controlled comparison between individual and team bidders. They find that more information in a common value auction environment makes teams less rational bidders than individuals – an effect that they call "curse of information". Indeed, such a curse could be related to groupthink or over-competitiveness. Interestingly, Sutter et al. (2009) find a similar result in a different framework. Their focus is on an ascending sealed-bid English auction with a private and a common value component (with some resemblance to spectrum auction designs). They show that teams stay significantly longer in the auction and that they also pay higher prices. As a

[1]See, for instance, Breaban and Noussair (2018) for an application of emotion measurement in experimental asset markets.

consequence, they make smaller profits and fall prey to the winner's curse more often.[2]

We are not aware of any study on the differences between individual and team bids in the most straightforward auction designs: sealed-bid first- and second-price auctions. We also implement an ascending English auction. An important feature of our design is that we keep all aspects equal across the individual treatments and the team treatments – hence, the bids in the auctions formats can be compared directly. Our teams consist of three members that remain anonymous and can only interact through a real-time chat in order to reach a joint decision. We elicit cognitive abilities and risk attitudes on the individual and on the team levels, alongside a set of other background measures. We also analyze the emotions of our decision makers as an additional control. Individuals always bid against individuals on a market consisting of three bidders, and team always bid against teams on a market consisting of three bidder teams, and this is common knowledge among participants of the experiment.

We find that individuals are more prone to overbidding in first-price auctions and less likely to bid their own valuation in second-price auctions. This is in line with our first expectation that teams are more rational decision makers than individuals. Indeed, we can show that the significant treatment effects vanish, as soon as we control for both cognitive ability and risk attitudes, in line with our second expectation. Taken together, in these simple formats, teams are the better decision makers in maximizing profits, which is in contrast to the existing results for more complex formats (Cox and Hayne, 2006, Sutter et al., 2009). Our results provide a rationale for reconciliation of the existing evidence for team decision making in auctions with the general picture that is painted regarding team decision making. Teams are more rational decision makers, but there might be forces such as increased complexity or strongly competitive environments in which teams fare worse than individuals, potentially due to inherent problems of teams as decision makers such as groupthink. Interestingly, we do not find any difference between individuals and teams in the ascending English auction. However, our design is such that it was slightly tilted against auction fever and groupthink, because we use a private value setup and a relatively slow-paced decision making environment.

The rest of the paper is organized as follows. In section 2, we describe the details of the experimental design. Section 3 reports the results of our experiment. Section 4 discusses our findings, and section 5 concludes the paper.

[2]Casari et al. (2016) look at a company takeover experiment that reports less overbidding by teams than by individuals. Similarly, Sheremeta and Zhang (2010) study Tullock-contests, finding again less overbidding by teams.

2 Experiment design

2.1 General structure and treatment variation

The experiment consisted of four parts. In the first part subjects participated in a series of auctions (either first-price sealed-bid auctions or English auctions). In the second part they bid in one round of a second-price sealed-bid auction. In the third part of the experiment subjects completed a risk elicitation task, where they had to make an investment into a risky asset. It was followed by a Raven's matrices test in the fourth part to measure cognitive ability. Finally, we concluded the experiment with a short questionnaire.

We varied our treatments in two aspects in a 2×2 factorial design. The first treatment difference concerned the type of the auction in the first part of the experiment. In part 1 of the *FPA* treatments, subjects participated in repeated first-price sealed-bid auctions. In part 1 of the *EA* treatments, participants bid in repeated English auctions. The detailes of the rules of both auction formats are explained in detail below.

The second treatment variation was the type of the decision-making entity. In *IND* treatments, all subjects made their choices individually. In *TEAM* treatments, subjects made decisions in teams of three. These teams stayed the same throughout all four parts of the experiment, but subjects did not know the identity of the other team members. The decision making process within teams was the same throughout all parts of the experiment: first, all three members of a team made an individual proposal for their team's bid in an auction (or an investment in part 3, or a test answer in the Raven's test in part 4). Afterward, if the individual proposals did not coincide within a team, its members had to agree on a joint decision within a limited time. During this time, team members could discuss their choices in a real-time chat. Once an agreement was reached within each team, the experiment proceeded. If some team failed to agree on a joint decision within the specified time frame, its members did not earn anything in the respective auction (or the respective task in part 3 or part 4). To make the treatments more comparable in terms of deliberation, we asked subjects in *IND* treatments to write a short explanation of their choice after they had made it. While writing the explanation, individuals could also change their decision if they wanted so.

2.2 The rules of the experiment

2.2.1 Part 1: repeated first-price and English auctions

In the first part of the experiment, bidders participated in a finite number of repeated auctions. We use the term "bidder" with respect to both individual bidders in *IND* treatments and team bidders consisting of three subjects in *TEAM* treatments. In the beginning of each auction, bidders were randomly matched into markets of three to bid for a virtual good. Bidders had independent private values for the good, drawn from a uniform distribution on $[0, 100]$ experimental currency points.[3] After learning their private values, bidders submitted their bids for the good. As described above, the bid submission process corresponded to individual bid proposals followed by a discussion in *TEAM* treatments, and an individual bid choice followed by an explanation in *IND* treatments. In the following, different auction rules in the *FPA* and *EA* treatments applied:

(1) In *FPA* treatments, bidders submitted their bids only once per auction. After all three bidders on a market submitted a bid, the auction ended. The bidder with the highest bid on the market won the auction and paid his own bid for the good. The payoff for the winner was thus the difference between her own value and her bid. For teams it means that each member of a team received the same payoff equal to the difference between the team's value and the bid, thereby facing exactly the same monetary incentives as bidders in *IND* treatments. Bidders who did not win the auction got 0 points.

(2) In *EA* treatments, each auction consisted of several bidding rounds. In each round bidders could either submit a bid higher or equal to the minimum bid in the respective round or quit the auction (equivalent to submitting a bid of zero). The minimum bid in each round amounted to the highest bid on the market in the previous round, referred to as current price, plus an increment. The increment decreased with the current price level as laid out in Table 1. The auction ended when only one bidder was left on the market. This bidder won the auction and received a payoff equivalent to the difference between her valuation and her own bid from the last round. In *TEAM* treatments this payoff was received by each member of the winning team. As for the first-price auction, bidders who did not win the auction got 0 points.

[3]The members of the same team in *TEAM* treatments had the same values for the good so that teams did not have more information than individual bidders in *IND* treatments.

Table 1: Increment rule in *EA* treatments

Conditions	Increment	Minimum bid
current price ≤ 30	10	current price + 10
$30 <$ current price ≤ 45	5	current price + 5
$45 <$ current price ≤ 90	3	current price + 3
current price > 90	2	current price + 2

When an auction ended, the participants received feedback about winning or not winning the auction and the price at which the good was sold. Then, the next auction started with exactly the same rules as before. The markets were randomly re-matched, and the new valuations were drawn (note that in *TEAM* treatments the composition of the teams remained the same). There were 12 auctions in *FPA* treatments and 8 auctions in *EA* treatments.[4] Only one auction was selected as relevant for payment at the end of the entire experiment. In the instructions we explicitly hinted at the possibility of making losses if the winning bid exceeds the winner's private value. The highest possible bid in all treatments was 110 points.

2.2.2 Part 2: second-price auction

After finishing the first part, subjects participated in a one-shot second-price sealed-bid auction. Since the optimal bidding strategy in the second-price auction is relatively straightforward and boils down to bidding own private value, we consider bidding behavior in this part of the experiment as a potential proxy for a bidder's rationality.

Like in the first part of the experiment, bidders were matched into markets of three to bid for a virtual good. In *TEAM* treatments subjects were bidding in the same teams as before. The values were private, independent and uniformly distributed over $[0, 100]$. After all bidders submitted their bids, the auction ended. The bidder with the highest bid on the market won the auction and received her private value net of the second highest bid on the market. To avoid potential income effects, we gave the participants feedback about the outcome of part 2 only at the end of the experiment. We also explicitly hinted at the possibility of making losses if the second highest bid on the market exceeds the winner's private value.

[4]We conducted a different number of auctions in *FPA* and *EA* treatments merely due to time considerations. English auctions on average took longer than first-price auctions.

2.2.3 Part 3: risk elicitation task

In this part of the experiment subjects made a decision about an investment into a risky asset, based on the approach of Gneezy and Potters (1997). As before, in *IND* treatments participants made their choices individually, while in *TEAM* treatments they agreed on a common investment within the teams.

Each decision-maker - individual or team - received an endowment of 100 experimental currency points and could invest any amount $r \in [0, 100]$ into a risky asset and keep the rest $100 - r$. The return from the investment was either $2.5r$ or 0 with equal probabilities. When the decision makers chose their investment r, the outcome was randomized and participants learned how much they earned. As before, subjects in teams shared the same payoff, having exactly the same incentives as subjects in *IND* treatments.

2.2.4 Part 4: Raven's matrices test

The last part of the experiment was a short version of Raven's progressive matrices test, aimed at obtaining a measure of decision makers' reasoning abilities. The test consisted of eight tasks to identify a symbol that fits the given pattern (see Appendix B). The time for solving each problem was limited to 90 seconds. If a decision maker managed to solve a problem correctly within this time frame, she got 50 euro-cents for the solution (also implying 50 cents per team member in *TEAM* treatments). If she submitted no answer or the answer was wrong, she did not earn anything for the respective problem. Once the subjects went through all eight problems, they learned how many of their answers were correct and how much they earned.

Finally, the participants filled out a short questionnaire and received feedback about their earnings from the four parts of the experiment.

2.3 Laboratory protocol

The experiment was conducted in the experimental laboratory MELESSA at the University of Munich, Germany, using the experimental software zTree (Fischbacher, 2007) and the organizational software ORSEE (Greiner, 2015). A total of 252 subjects, mostly undergraduate students, participated in 14 sessions with 18 subjects each. Sessions in *FPA* treatments lasted about 90 minutes, sessions in *EA* treatments took about two hours. Average earnings in the experiment amounted to 21.10 euros, including the show-up fee of 4 euros. Subjects received written instructions (see the

Appendix) for each part of the experiment, after the previous part was finished. They knew that there would be four parts from the beginning. We videotaped the subjects during the experiment and used FaceReader emotion recognition software. All participants had to sign an extra consent form for the video; there were no dropouts.

Since in *TEAM* treatments subjects were matched into teams of three, in part 1 and 2 there were two markets with three team bidders each. In each round, six team bidders in one session were randomly rematched into two markets, leaving us with one independent observation per session. In *IND* treatment sessions there were six markets with three individual bidders. We reshuffled the markets after each period within matching groups of six to keep the probability of facing the same people on a market equal across treatments. Thus, in *IND* treatments we had three independent observations per session. The subjects were aware of the matching protocol. We conducted two sessions each in *IND FPA* and *IND EA* treatments, and five sessions each in *TEAM FPA* and *TEAM EA* treatments.

3 Results

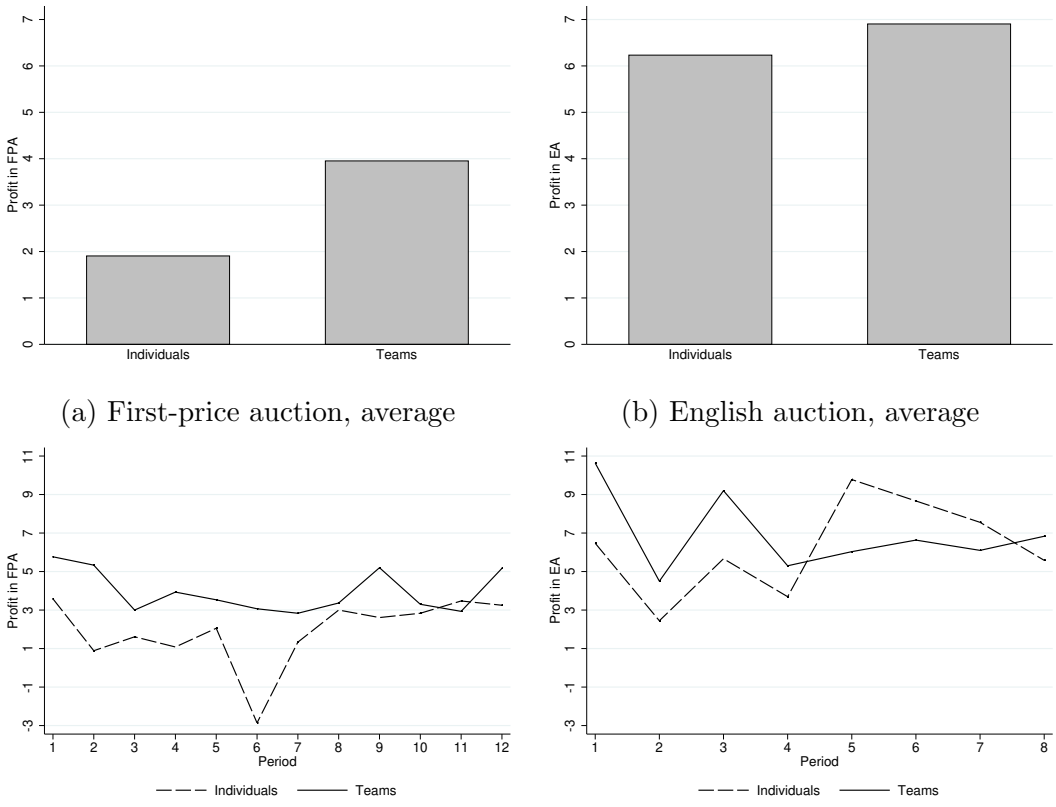
In this section we analyze the profits earned by bidders, different characteristics of bidding behavior specific to first-price and English auctions, and market outcomes such as prices and the efficiency of the auctions.

3.1 Realized profits

We start with analyzing actual profit that bidders earned in the auctions. By design, winner's profits in the first-price auction amount to the difference between their private values and their bids. If a bidder did not win an auction, the profit was zero. Our data show that in first-price auctions teams earned on average twice as much as individuals: 3.95 and 1.91 experimental currency points, respectively ($p = 0.0446$; two-sided Wilcoxon rank sum test; $N = 11$). Figures 1a and 1c show the average profit in first-price auctions and its dynamics over the twelve periods for individuals and teams. What could be a possible explanation for this difference? We attempt to answer this question by analyzing the effect of team membership on profits in first-price auctions using panel regressions with random effects, with robust standard errors clustered on the matching group level. We use the bidding behavior in the second-price auction, the amount invested into

the risky asset, the Raven's test score and several demographic characteristics as control variables. It can be seen in Table 2 in the Appendix that being an individual bidder reduces the profit by more than 2 points on average compared to team bidders. However, profit increases over time for individuals, implying that individual bidders might learn and start to close the gap. Profit is highly correlated with the performance in the second-price auction: if an average bidder bids closer to the optimal strategy in the second-price auction, she earns significantly more in the first-price auction as well. Bear in mind that the second-price auction takes place after experiencing the first-price auctions; hence, causality cannot be established for this statement. There is a weakly significant correlation of profits with risk attitudes (relatively less risk averse subjects earn more) and, interestingly, gender also has a strong effect on profits: female participants on average earned 2.6 points less then male participants, controlling for everything else.

In contrast, in the English auction we find no difference between the profits earned by individuals and teams. An average individual bidder in the English auction earned 6.23 points compared to 6.90 points in the *TEAM EA* treatment. This difference is clearly not statistically significant



(a) First-price auction, average

(b) English auction, average

(c) First-price auction, by period

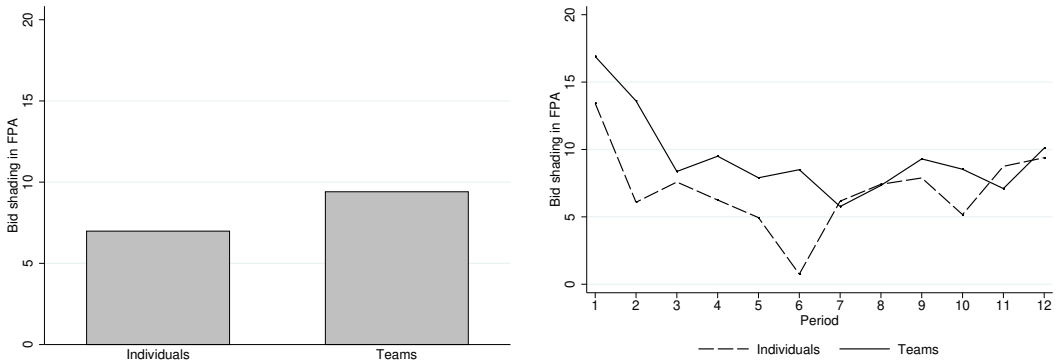
(d) English auction, by period

Figure 1: Profits earned by bidders

(see Figures 1b and 1d). Regression analyses in Table 5 also show that there is no significant treatment effect on profits in our English auctions. However, like in first-price auctions, there is weak evidence of individual learning and a strong correlation between profits earned in the English auction with bidding behavior in the second-price auction. In addition, profit is positively correlated with the self-reported high school math grade.

3.2 Bidding behavior

Bid shading is an important characteristic of bidding behavior in first-price auctions. We define bid shading in *FPA* treatments as the difference between the private value and the submitted bid. Thus, for the winners of the auction, bid shading is equivalent to the realized profit, while it also provides information about the behavior of the bidders who did not win the auction. Figure 2a shows that individuals on average bid 6.98 points below their valuation, and teams shade their bids more – by 9.41 points. Using the most conservative test – a two-sided Wilcoxon rank sum test on the level of independent observations – the difference is not significant due to the small number of strictly statistically independent observations.



(a) Average (b) By period

Figure 2: Bid shading in first-price auctions

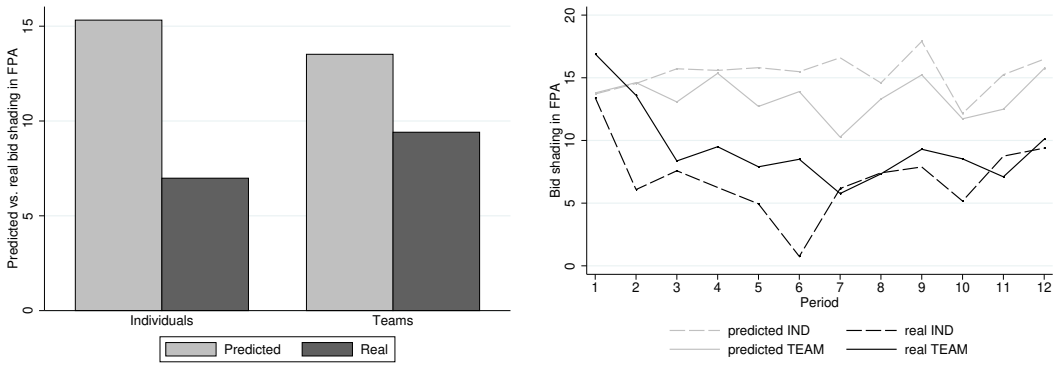
This changes when we look at parametric results. We estimate regression models of bid shading in Table 3, where the actual bid in the first-price auction is the dependent variable, regressed on the private value of the good. The coefficient associated with the value of the good can be interpreted as bid shading, which turns out to be slightly below 18% of the value in all specifications. The regression specifications (1)-(3) show that there is a difference between bidding behavior of individuals and teams, that vanishes when we control for variables from other parts of the experiment

in specifications (4)-(8). In line with the results from subsection 3.1, bid shading is negatively correlated with the deviation from rational behavior in the second-price auction. Moreover, bidders with higher Raven's test scores and better math grades submit lower bids, suggesting that general intelligence matters for bidding strategy. Subjects with longer past experience of participating in economic experiments also submitted lower bids in the first place. Risk aversion is associated with slightly higher bids: more risk-tolerant bidders submit lower bids, thereby increasing potential profit, but lowering the chance of winning. Finally, specifications (6)-(8) reveal that bids increase over time in *TEAM* treatments, suggesting that teams might become more competitive over time. Figure 2b shows that until period 7, average bid shading was higher in teams, but from period 7 on, there is little difference.

We have seen how bid shading differs across treatments, but how far away are the actual bids from the optimal strategy in the first-price auctions? To answer this question, we predict optimal bids using a simple parametric model with risk averse bidders. In this model, we assume that bidders have a constant relative risk aversion utility function $u(x) = x^{1-r}/(1-r)$, where x is the monetary payoff and r is the risk aversion parameter ranging from 0 to 1 (a higher r corresponds to higher levels of risk aversion). We get a proxy for this parameter from the choices in the risk elicitation task in part 3 of the experiment. The estimated average levels of risk aversion are $r = .07321$ for individuals and $r = .1721$ for teams: teams were more risk averse than individuals, but the difference is not significant.[5] Using these estimates and the realized values for the good, we predict optimal bid shading (value minus bid) for every bidder in every single auction. The optimal bid shading is presented together with the actual bid shading in Figure 3. We observe that both individuals and teams shade their valuations less, i.e. overbid compared to the prediction. This is a common finding in the auction literature. However,the deviation from the rational bidding strategy is more pronounced for the individuals ($p = 0.1003$; two-sided Wilcoxon rank sum test; $N = 11$). A regression with individual bid shading as the dependent variable gives very similar results as those in Table 3. Again, bidding in the second-price auction and Raven's test scores matter.

In contrast to the *FPA* treatments, we find no difference in bidding behavior of individuals and teams in English auctions. One characteristic of bidding behavior specific to English auctions is

[5]In fact, this difference was purely due to a higher number of teams that chose to invest zero points into the risky asset. We assumed $r = 1$ for those who did so, creating discontinuity in the parameter. Four out of 30 teams invested nothing in this task, compared to one out of 36 individuals. If we exclude these observations, the difference in risk preferences goes away.



(a) Average (b) By period

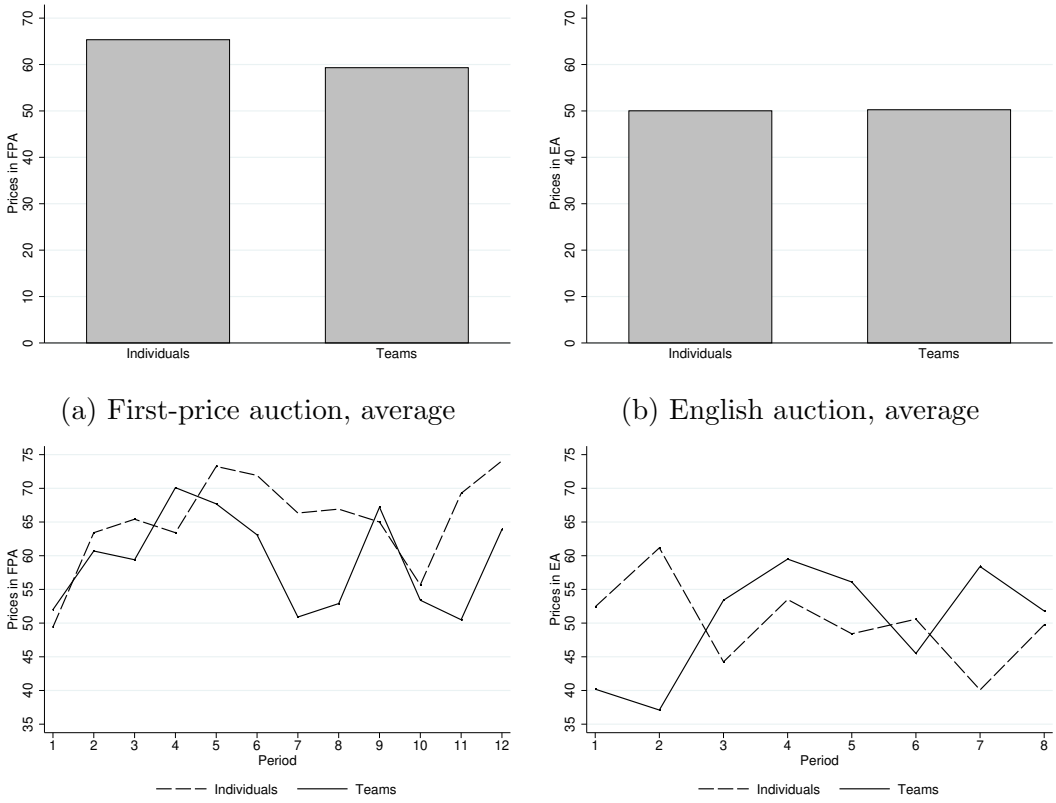
Figure 3: Deviation from the estimated optimal bid shading in first-price auctions

the average number of rounds that bidders spend in an auction before they drop out. We observe that teams stay slightly longer in English auctions: team bidders were on average active in 4.06 rounds per auction compared to 3.27 rounds for individual bidders. However, this difference is not significant on conventional levels. Another characteristic of bidding behavior in the *EA* format is the relative bid in each round. We define it as the ratio of the actual bid to the minimum bid in the respective round. The average relative bids were not significantly different: they are 1.48 for individuals versus 1.29 for teams.

3.3 Market outcomes: prices and efficiency

Given that the valuations were assigned randomly and independently, lower profits observed among the individuals in *FPA* treatments implies that individuals paid higher prices than teams. Indeed, in first-price auctions the average price for the good amounted to 65.34 points in *IND* treatments compared to 59.32 points in *TEAM* treatments ($p = 0.0679$; two-sided Wilcoxon rank sum test; $N = 11$). Average prices and their dynamics are depicted in Figures 4a and 4c. The regression analysis (Table 4) lacks power to capture the treatment effect since the data have to be collapsed on the market level; however, we still find the correlations between prices and control variables. In line with the observed bidding behavior described above, prices are positively correlated with the deviation from rational bidding in the second-price auction and risk aversion, and negatively correlated with the score in the Raven's test, high school math grade and previous experience of participating in experiments.

In English auctions, individuals and teams paid almost exactly the same price, slightly above 50



(a) First-price auction, average

(b) English auction, average

(c) First-price auction, by period

(d) English auction, by period

Figure 4: Realized prices

points (see Figure 4b). Although there is no difference on average over all periods, the development of the prices was different in *IND* and *TEAM* treatments. As one can see in specifications (5)-(7) in Table 6, prices paid by teams increased over time, while prices paid by individuals decreased. This pattern is also reflected in Figure 4d.

Finally, we look at efficiency, which is an important variable for auction design. An auction is defined as efficient if the bidder with the highest private valuation obtains the good. In *FPA* treatments with individual bidders 78% of all auctions were efficient, while in *TEAM FPA* treatments this share was 89%, the difference being not significant on conventional levels. Efficiency in English auctions was almost the same in the two treatments and almost the same as in the *IND FPA* treatment – slightly above 78%.

3.4 Emotions

Our experiment was recorded on camera and the facial expressions of the subjects were analyzed using the facial recognition software FaceReader. We focus here on investigating the role of emotions

in *FPA* treatments because of the relatively simple structure of first-price auctions. In particular, we were interested in the emotions experienced when the subjects saw their feedback screens at the end of each period, on which they learned whether they won the current auction or not and how much they earned. We expected the expressed emotions to have an effect on the future decisions of the bidders in subsequent auctions.

Apart from a neutral facial expression, the software detects six basic emotions: anger, happiness, surprise, disgust, sadness, and fear. Their magnitude was measured as a number between 0 and 1, captured multiple times per second. For each subject in each period, we took an average over those measurements within the first ten seconds that the subjects saw their feedback screen and used these measures for our analysis (synchronization between zTree and FaceReader was achieved by employing the software μCap by Doyle and Schindler, 2019). An additional composite variable "valence" amounts to the difference between measured happiness and the strongest negative emotion (anger, disgust, sadness, and fear). It reflects how positive or negative the overall emotional state is and ranges from –1 to 1.

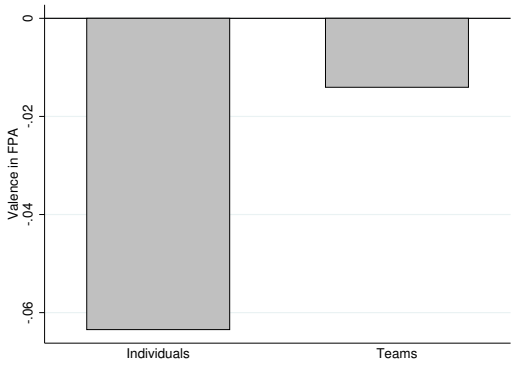


Figure 5: Valence of the emotions experienced by the subjects seeing their feedback screens in *FPA* treatments

Our first interesting observation suggests that subjects in *TEAM* treatments experienced on average more positive emotions than subjects in *IND* treatments (see Figure 5; $p = 0.1003$; two-sided Wilcoxon rank sum test; $N = 11$). This could possibly be explained by the fact that teams earned more on average and thus were more positive about the outcomes of the auctions. Another potential reason could be an inherent preference for interaction in teams (Kocher et al., 2006). Our *TEAM* treatments were likely to be more interesting for subjects due to the interaction through the chat messages and the challenge of agreeing on a joint bid. This experience could have influenced the overall satisfaction with the experiment.

To test whether the measured emotions reflect plausible reactions to the outcome of an auction, we checked whether different emotional states are correlated with winning or losing an auction in the *current* period. Table 7 shows that winning an auction is associated with more happiness and less anger, and respectively, a greater valence. Thus, we may conclude that facial recognition of emotions worked properly in our experiment. Interestingly, individuals seem to experience a bit more sadness than team members when not winning the auction.

The most interesting question lies in the potential impact of emotions on *future* bidding behavior. We evaluate this effect by estimating our regression models of bid shading with emotions experienced in the previous period as control variables. The results are reported in Table 8. We observe that two emotions are significantly correlated with bidding behavior in the next period. First, if subjects experienced sadness, it had a negative impact on their next bid, i.e. they bid, on average, closer to the rational prediction. One channel could be that winners were sad about the small profit they made despite winning the auction; in the next round, they would adjust their bids downwards to increase the expected profit. Second, the feeling of fear was positively correlated with the bids in the next period. If a subject was afraid of losing the next auction and ending up with zero profit, she might have overbid even more to increase the chances of winning at least something. This logic is similar to risk aversion, supporting the literature that claims an association between fear and risk-taking (Nguyen and Noussair, 2014). While the effect of sadness would become weakly significant when controlling for the number of emotions covered (multiple hypotheses testing), the effect of fear is robust. Interestingly, sadness and fear are emotions that one would not associate with auction fever. Bear in mind, however, that a seal-bid first-price auction is *ex ante* much less prone to auction fever than a fast-paced ascending English auction or a descending Dutch auction.

4 Further analyses and discussion

The results of the experiment have shown that teams bid closer to the rational prediction in first-price auctions, paying lower prices and earning larger profits than individuals, but we observe no difference between team and individual bidding behavior in ascending English auctions. Why do teams perform better in only one of the auction types? Although both auctions in our experiment were implemented in the simplest setting with independent private values, there seems to be a

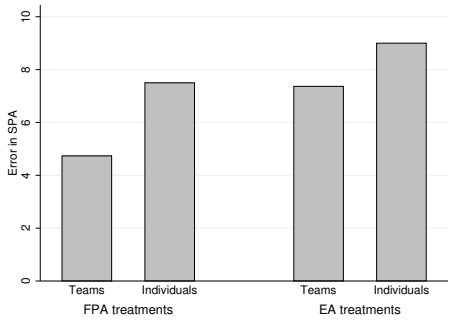


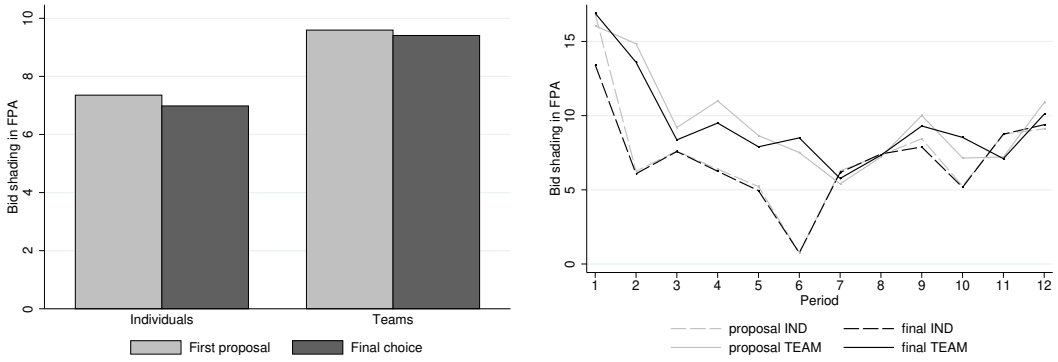
Figure 6: Absolute deviation from rational strategy (value minus bid) in SPA

difference in the complexity of the optimal bidding strategies. In the English auction, the dominant strategy is rather straightforward: a bidder should stay in the auction, as long as the minimum bid does not exceed her private value, and drop out otherwise. In first-price auctions, however, a bidder needs to figure out the best level of bid shading, taking into account the distribution of the values, her own risk attitude, and risk attitudes of the competitors on the market.

We see that teams outperform individuals in this relatively complex decision-making environment. Our analysis suggests that this effect can be explained by differences in reasoning abilities of teams and individuals: the performance in first-price auctions is correlated with the choices in a second-price auction, i.e. smaller deviations from the dominant strategy in the latter lead to less overbidding in the former. We consider the choices in the second-prices auction a measure of reasoning ability, but we get similar results for the scores in a Raven's test, the high school math grade, and the previous exposure to laboratory economic experiments. Among those, the deviation from rational bidding in the second-price auction is the most robust predictor of overbidding in first price auction. Indeed, average second-price auction bids in *TEAM* treatments are closer to the values than in *IND* treatments, see Figure 6. Non-parametric tests lack power to render this difference significant, but the discrepancy in this proxy for rationality can predict the treatment difference in *FPA* treatments, while it does not play a role in the relatively simple decision-making environment of *EA* treatments.

One could ask whether the observed difference in first-price auctions could be partly attributed to the fact that team members adapt their choices when they agree on a common strategy. In that case we would see a difference between final bids and initial bid proposals that were submitted individually before entering the discussion in *TEAM* treatments. Figure 7 depicts initially proposed bid shading along with actual bid shading (as mentioned in section 2, individual bidders also had

the possibility to change their first choices). We see that the initial proposals are not different from the final choice of both individuals and teams, suggesting that communication and agreeing on a common strategy cannot fully account for the observed difference in behavior. Obviously, there seems to be a component in team decision making that make individuals change their revealed preferred decision already prior to the team interaction. Perhaps anticipated peer observation makes them think harder about the optimal strategy in first-price auctions.



(a) Average (b) By period

Figure 7: Proposed and final bid shading in first-price auctions

Since auction experiments are inherently complex, we want to make sure that our results are not driven by lack of understanding of the experimental setup. To tackle this issue, we check whether there are bidders that consistently bid above their valuations, despite a clear statement in the instructions that losses are possible in this case. Remarkably, in both *TEAM* treatments we do not observe a single bid above the private values. Only in the *IND FPA* treatment there are two subjects who always overbid and do not learn throughout the course of the experiment. If we exclude those observations from the analysis, it does not qualitatively change our results. However, the fact that we observe these outliers only in *IND FPA* treatment is interesting itself, supporting our claim that individual bidders have a harder time to cope with complex auction environments.

Apart from observing the realized profits and prices, unfortunately, there is not much more to say about the bidding behavior in *EA* treatments. Typically, in a setting with independent private values, both relative bids and the number of active rounds could be considered as a proxy for rational behavior. The more subjects bid relative to the minimum possible bid, and the longer they stay in an auction, the more competitive and the less rational their behavior often is. We observe no significant difference between teams and individuals with respect to relative bids and

the number of active rounds, but in our experiment these potential measures of rationality turned out to be very noisy. Our *EA* treatments lasted about two hours, on average, and subjects might have become a bit tired during the experiment, making this clear in the discussion stage. Thus, there was a potentially perfectly rational motivation for both teams and individuals to bid higher than the minimum bid and drop out faster in order to finish the experiment more quickly. This property of our experimental setup might partly account for the absence of evidence for auction fever on the side of the teams, contrary to the previous findings.

If a seller had the possibility to choose between the two auction types in our setting, first-price auctions would be more profitable than English auctions, and vice versa for the bidders. The revenue equivalence principle holds neither in *IND* nor in *TEAM* treatments, and realized prices in first-price auction are significantly higher than in English auctions, as once can see on Figure 4 ($p = 0.0014$; two-sided Wilcoxon rank sum test; $N = 22$). This is partly explained by bidders' risk aversion that makes them bid higher in first-price auctions. However, as mentioned above, both individuals and teams overbid in comparison to the theoretical prediction that takes risk aversion into account, boosting the difference in profitability between *FPA* and *EA* treatments.

Finally, some specifications of the regression models allow us to draw inferences on the dynamics of bidding behavior and auction outcomes. On the one hand, in both auction types we find that the performance of individuals improves over time: for instance, individual profits increase in both first-price and English auctions. We interpret this as learning, which is more pronounced among individuals, since their average performance is poorer, than in teams and, therefore, there is more room for improving the bidding strategy over time. On the other hand, in contrast to this pattern, the bidding behavior of teams became less rational over the course of the experiment: team bids in first-price auction and prices in English auction increased with the time. This deterioration in performance supports the strand of the literature that shows that teams tend to behave more competitively than individuals (as in Cox and Hayne, 2006, Sutter et al., 2009).

5 Conclusion

We have conducted an experimental study that systematically compares the bidding behavior of individuals and unitary teams in different auction formats. Our results show that individuals deviate more from the optimal strategy in first-price and second-price auctions than teams, while

there is no difference between individual and team bidders in English auctions. The difference in overbidding in first-price auctions between individuals and teams is strongly correlated with bidders' ability to make rational decisions, which we consider to be reflected in their bids in second-price auctions and in their Raven's cognitive ability test scores. In other words, teams outperform individuals in first-price auctions, because they are more rational decision makers. This finding challenges the results from the existing literature that showed that teams perform worse than individuals in auctions (Cox and Hayne, 2006, Sutter et al., 2009) and it is in line with the studies where teams outperform individuals in other decision-making environments (e.g., Casari et al., 2016, Sheremeta and Zhang, 2010, Sutter, 2005). We argue that the complexity of the decision making environment matters for the observed difference in individual and team behavior: since the optimal bidding strategy in first-price auction is more complex relative to our English auction format, better reasoning abilities of the teams play a role in determining the difference in first-price auctions, but not in our simple version of the English auction. Also contrary to our expectations, we find no evidence for auction fever among teams in English auction, with this result possibly being an artifact of our experimental setup with independent private values and without time pressure.

Our paper is the first that systematically analyzes different auction formats with individual and team bidders. Obviously, there are choices to make, when it comes to the experimental design, and thus there is room and need for more research. First, one could investigate whether more systematically varying the complexity of an auction affects the performance of individuals and teams in a different manner. In our setting we found that teams outperformed individuals in more complex auctions; however, the previous studies that observed teams performing worse than individuals had even more complicated auction rules. How team and individual bidders respond to exogenous variations in complexity of an auction, keeping everything else constant, and whether the difference in bidding behavior is monotone in complexity, remains an open question. Second, it would be interesting to learn about which auction features could potentially lead to groupthink and over-competitiveness among teams, which were documented in some of the previous studies. Our setup was clearly tilted away from groupthink phenomena. Introducing some (natural) hierarchy could be an interesting avenue for future research. Our experiment also shows that an ascending price is not enough for teams to exhibiting anything close to auction fever. Finding the characteristics of an auction (potentially time pressure, face-to-face interaction, etc.) that

trigger those reactions in teams and, hence, potentially deteriorate their performance, would be an important aspect for auction design that we think requires more attention.

Appendix A Regression tables

A.1 First-Price Auction

Table 2: Profits in FPA

	(1)	(2)	(3)	(4)
Individual	-2.048**	-3.486**	-2.937**	-2.559*
	(0.875)	(1.509)	(1.303)	(1.345)
Period		-0.0717	-0.0717	-0.0717
		(0.0467)	(0.0468)	(0.0469)
Individual*Period		0.221**	0.221**	0.221**
		(0.110)	(0.111)	(0.111)
SPA error			-0.171***	-0.168***
			(0.0580)	(0.0558)
Risk			0.0255*	0.0181*
			(0.0150)	(0.0110)
Cognitive			0.270	0.398
			(0.432)	(0.248)
Female				-2.437***
				(0.902)
Math grade				0.417
				(0.647)
Experience				0.389
				(0.578)
Constant	3.953***	4.419***	2.110	0.676
	(0.197)	(0.297)	(2.547)	(3.449)
Observations	792	792	792	792
R^2	0.0152	0.0177	0.0892	0.106

GLS random effects regression. Robust standard errors in parentheses (clustered on matching group level). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: Bids in FPA

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Individual	2.663*	2.719**	2.848**	2.164	1.237	4.584	3.693	2.781
	(1.573)	(1.382)	(1.364)	(1.439)	(1.316)	(3.453)	(3.385)	(3.255)
Value	0.824***	0.824***	0.826***	0.828***	0.828***	0.825***	0.824***	0.824***
	(0.0137)	(0.0135)	(0.0127)	(0.0126)	(0.0126)	(0.0136)	(0.0138)	(0.0139)
Individual*Value		-0.00117	-0.00384	-0.00819	-0.00780			
		(0.0260)	(0.0258)	(0.0260)	(0.0264)			
Period			0.242	0.242	0.242	0.402***	0.402***	0.402***
			(0.185)	(0.185)	(0.186)	(0.123)	(0.123)	(0.124)
SPA error				0.130***	0.160***		0.130***	0.159***
				(0.0476)	(0.0531)		(0.0473)	(0.0529)
Risk				-0.0497*	-0.0575*		-0.0497*	-0.0575*
				(0.0281)	(0.0317)		(0.0280)	(0.0316)
Cognitive				-1.600**	-2.252***		-1.590**	-2.240***
				(0.653)	(0.704)		(0.658)	(0.696)
Female					0.339			0.357
					(2.220)			(2.208)
Math grade					-2.417*			-2.410*
					(1.371)			(1.371)
Experience					-2.418***			-2.426***
					(0.733)			(0.729)
Individual*Period						-0.296	-0.296	-0.295
						(0.337)	(0.338)	(0.338)
Constant	-1.020	-1.051**	-2.700**	9.291*	27.33***	-3.682***	8.369*	26.38**
	(0.705)	(0.418)	(1.321)	(4.997)	(10.03)	(1.022)	(4.831)	(10.25)
Observations	792	792	792	792	792	792	792	792
R^2	0.836	0.836	0.837	0.852	0.860	0.838	0.852	0.861

GLS random effects regression. Robust standard errors in parentheses (clustered on matching group level).
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Prices in FPA

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Individual	4.842	5.422	6.717	4.613	1.743	0.191	-1.576
	(3.521)	(3.539)	(4.376)	(4.111)	(4.438)	(4.315)	(4.238)
Value	0.831***	0.838***	0.870***	0.855***	0.828***	0.831***	0.820***
	(0.0548)	(0.0536)	(0.0595)	(0.0583)	(0.0392)	(0.0412)	(0.0400)
Individual*Value	0.00120	-0.0108	-0.0709	-0.0628			
	(0.0774)	(0.0787)	(0.0737)	(0.0780)			
Period		0.380	0.391	0.389	0.113	0.114	0.109
		(0.292)	(0.289)	(0.290)	(0.156)	(0.156)	(0.157)
SPA error			0.237	0.249**		0.232	0.242**
			(0.146)	(0.116)		(0.148)	(0.119)
Risk			-0.102*	-0.108**		-0.100*	-0.106**
			(0.0576)	(0.0462)		(0.0570)	(0.0457)
Cognitive			-2.872*	-4.358***		-2.791*	-4.279***
			(1.672)	(1.568)		(1.683)	(1.578)
Female				0.684			0.677
				(4.882)			(4.864)
Math grade				-4.427***			-4.470***
				(1.594)			(1.575)
Experience				-4.704*			-4.745*
				(2.676)			(2.672)
Individual*Period					0.486	0.484	0.492
					(0.524)	(0.525)	(0.521)
Constant	19.76***	16.97***	37.74***	73.94***	19.15***	40.84***	77.11***
	(2.982)	(3.343)	(7.135)	(16.71)	(1.746)	(7.634)	(15.56)
Observations	264	264	264	264	264	264	264
R^2	0.481	0.486	0.517	0.530	0.487	0.518	0.531

GLS random effects regression, data collapsed on market level. Robust standard errors in parentheses (clustered on matching group level). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

A.2 English Auction

Table 5: Profits in EA

	(1)	(2)	(3)	(4)
Individual	-0.672	-3.885	-3.590	-4.134
	(1.243)	(2.399)	(2.662)	(2.700)
Period		-0.304	-0.304	-0.304
		(0.248)	(0.248)	(0.249)
Individual*Period		0.714*	0.714*	0.714*
		(0.380)	(0.382)	(0.383)
SPA error			-0.0532***	-0.0677***
			(0.0142)	(0.0215)
Risk			0.00351	0.00143
			(0.0130)	(0.0232)
Cognitive			1.027	1.104*
			(0.728)	(0.659)
Female				0.447
				(2.317)
Math grade				1.498**
				(0.671)
Experience				-0.0667
				(1.284)
Constant	6.904***	8.274***	2.059	-1.333
	(0.656)	(1.565)	(5.432)	(7.501)
Observations	528	528	528	528
R^2	0.000511	0.00372	0.0148	0.0208

GLS random effects regression. Robust standard errors in parentheses (clustered on matching group level). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Prices in EA

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Individual	-7.120	-7.226	-6.389	-6.843	15.98*	16.19*	15.43*
	(7.853)	(8.024)	(7.890)	(7.777)	(8.495)	(8.555)	(8.840)
Value	0.772***	0.780***	0.786***	0.781***	0.875***	0.875***	0.867***
	(0.155)	(0.151)	(0.155)	(0.160)	(0.0839)	(0.0830)	(0.0897)
Individual*Value	0.180	0.182	0.170	0.166			
	(0.170)	(0.175)	(0.182)	(0.180)			
Period		0.712	0.712	0.706	2.394**	2.393**	2.389**
		(0.745)	(0.753)	(0.759)	(1.103)	(1.114)	(1.123)
SPA error			-0.118	-0.137		-0.135	-0.152
			(0.148)	(0.155)		(0.145)	(0.152)
Risk			0.000663	0.0197		-0.00280	0.0158
			(0.0857)	(0.0929)		(0.0838)	(0.0897)
Cognitive			0.193	0.562		0.0950	0.491
			(1.383)	(1.707)		(1.302)	(1.677)
Female				5.495			5.706
				(9.408)			(9.634)
Math grade				1.336			1.330
				(4.206)			(4.112)
Experience				0.0544			-0.206
				(3.411)			(3.238)
Individual*Period					-3.099**	-3.099**	-3.101**
					(1.244)	(1.255)	(1.264)
Constant	10.02	6.413	5.713	-3.047	-6.110	-5.499	-13.41
	(6.587)	(6.736)	(7.511)	(23.46)	(6.163)	(9.997)	(26.19)
Observations	176	176	176	176	176	176	176
R^2	0.432	0.437	0.444	0.444	0.459	0.467	0.467

GLS random effects regression, data collapsed on market level. Robust standard errors in parentheses (clustered on matching group level). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

A.3 Emotions

Table 7: Emotions associated with winning an auction

	Dependent variable			
	Neutrality	Happiness	Sadness	Anger
Individual	-0.0351	-0.0272	0.0144**	0.00985
	(0.0271)	(0.0176)	(0.00709)	(0.0125)
Winner	-0.00843	0.0112**	-0.00479	-0.00317
	(0.00609)	(0.00468)	(0.00605)	(0.00408)
Individual*Winner	-0.00805	-0.00656	-0.000756	-0.0120**
	(0.0242)	(0.0107)	(0.0112)	(0.00554)
Constant	0.650***	0.105***	0.0795***	0.0600***
	(0.0119)	(0.00678)	(0.00300)	(0.00863)
Observations	1500	1500	1500	1500
R^2	0.00519	0.00765	0.00508	0.00102

	Dependent variable			
	Surprise	Fear	Disgust	Valence
Individual	0.00633	-0.000877	0.00546	-0.0471**
	(0.00543)	(0.000807)	(0.00511)	(0.0215)
Winner	-0.00415*	0.000377	0.000776	0.0177***
	(0.00248)	(0.00135)	(0.00252)	(0.00475)
Individual*Winner	0.00505	-0.000942	0.00661	0.000616
	(0.00523)	(0.00137)	(0.00492)	(0.0175)
Constant	0.0213***	0.00170**	0.00755**	-0.0225**
	(0.00417)	(0.000762)	(0.00300)	(0.0109)
Observations	1500	1500	1500	1500
R^2	0.00485	0.00123	0.0111	0.0103

GLS random effects regression. Robust standard errors in parentheses (clustered on matching group level).
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: The effect of emotions on future bids

	Bid in FPA		
	(1)	(2)	(3)
Individual	2.884**	2.819	2.345
	(1.391)	(1.931)	(1.810)
Value	0.827***	0.834***	0.835***
	(0.0124)	(0.0135)	(0.0136)
Individual*Value	-0.00461	-0.00240	-0.00561
	(0.0252)	(0.0222)	(0.0225)
Period	0.319**	0.0421	0.0420
	(0.132)	(0.166)	(0.166)
Neutrality_{-1}		0.797	0.776
		(1.093)	(1.151)
Happiness_{-1}		1.375	1.657
		(1.930)	(2.040)
Sadness_{-1}		-4.246**	-3.859**
		(1.686)	(1.668)
Anger_{-1}		2.783	2.763
		(2.003)	(2.022)
Surprise_{-1}		11.36	11.87
		(10.93)	(10.80)
Fear_{-1}		18.67***	18.01***
		(4.736)	(4.585)
Disgust_{-1}		-1.078	-2.112
Constant	-3.229***	-1.898	6.479
	(0.971)	(1.468)	(4.780)
Controls	No	No	Yes
Observations	1512	1375	1375
R^2	0.887	0.902	0.908

GLS random effects regression. Robust standard errors in parentheses (clustered on matching group level). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Appendix B Instructions

Below we provide the instructions in *TEAM FPA* treatment (translated from German).

Welcome to the experiment and thank you for your participation!

From now on, please do not talk to other participants of the experiment.

General Information

This experiment analyzes economic decision-making. You can earn money in the experiment. The earnings will be paid to you privately in cash after the experiment ends.

The whole experiment takes approximately two hours and consists of 4 parts. At the beginning of each part, you will receive detailed instructions. The parts are independent of each other; decisions made in one part will not affect your earnings in another part. The sum of your earnings from the 4 parts will constitute your total payoff from the experiment. You will be informed about your total payoff after completion of the fourth part, and it will be paid out to you in cash at the end of the experiment.

If you have any questions after the instructions or during the experiment, please raise your hand. One of the experimenters will come to you and answer your questions in private. For the sake of linguistic simplicity, we only use masculine terms.

During the experiment, you and the other participants will be asked to make decisions. Sometimes you will interact with other participants. This means that your own decisions as well as the decisions of other participants can affect your total payoff. This will be determined according to the rules explained below.

A clock will run down in the top right corner of the screen while you make your decisions. This informs you of how much time you still have to make your decision. Sometimes this time restriction is binding and sometimes it is not. The details are explained below. The information screens, on which you do not need to make any decisions, will disappear when the clock runs out.

Payments

In parts 1-3 of the experiment, the payoffs are expressed in points, not Euros. The points will be converted into Euros at the end of the experiment. At the beginning of each part you will be informed of the exchange rate for the conversion. In part 4, the payoffs are expressed in Euros.

For having shown up on time, you will receive €4 in addition to the money that you can earn during the experiment.

Anonymity

We only evaluate aggregated data from the experiment and never link names to the data from the experiment. At the end of the experiment, you will be asked to sign a receipt regarding your earnings, which serves only for accounting purposes and cannot be linked to your behavior in the experiment. This experiment will be videotaped. The video records serve the research purpose of the experiment. Just act natural.

Tools

You will find a pen on your table. Please leave it there when the experiment ends.

Groups

In the experiment, you will be a member of one out of six groups. Each group consists of three members. The allocation to the groups is random. The groups remain unchanged throughout the experiment.

Part 1

Exchange Rate

The exchange rate in part 1 is: **3 Points = 1 Euro**

Auctions

Part 1 consists of twelve independent auctions. In each auction, you bid in your group for a good, which has a certain value for you and your group. For each auction, three groups are randomly matched to bid for a good. We will call this a market (consisting of three groups with three members each).

Each group member receives a one-time initial endowment of 10 points.

Value of the Good

Each group receives information about the value of the good at the beginning of each auction. This value is determined independently for each group on a market; it means it is very likely that

it will be different for different groups in the same auction. The value for each group is drawn randomly between 0 and 100 points. Every value between 0 and 100 is equally likely (where 0 and 100 are also possible). Each bidder group knows its own value for the good but not the values of the other two groups on the market.

Decision Making

In this part, each group will place a bid. Each group decides on a bid simultaneously. The decision within the group is made in two stages:

In the first stage, you will be asked individually for a suggestion for the group bid. You have 30 seconds to enter a suggestion in the middle of the screen and click on "Next" button. After all group members in your group have entered their suggestions, the second stage starts.

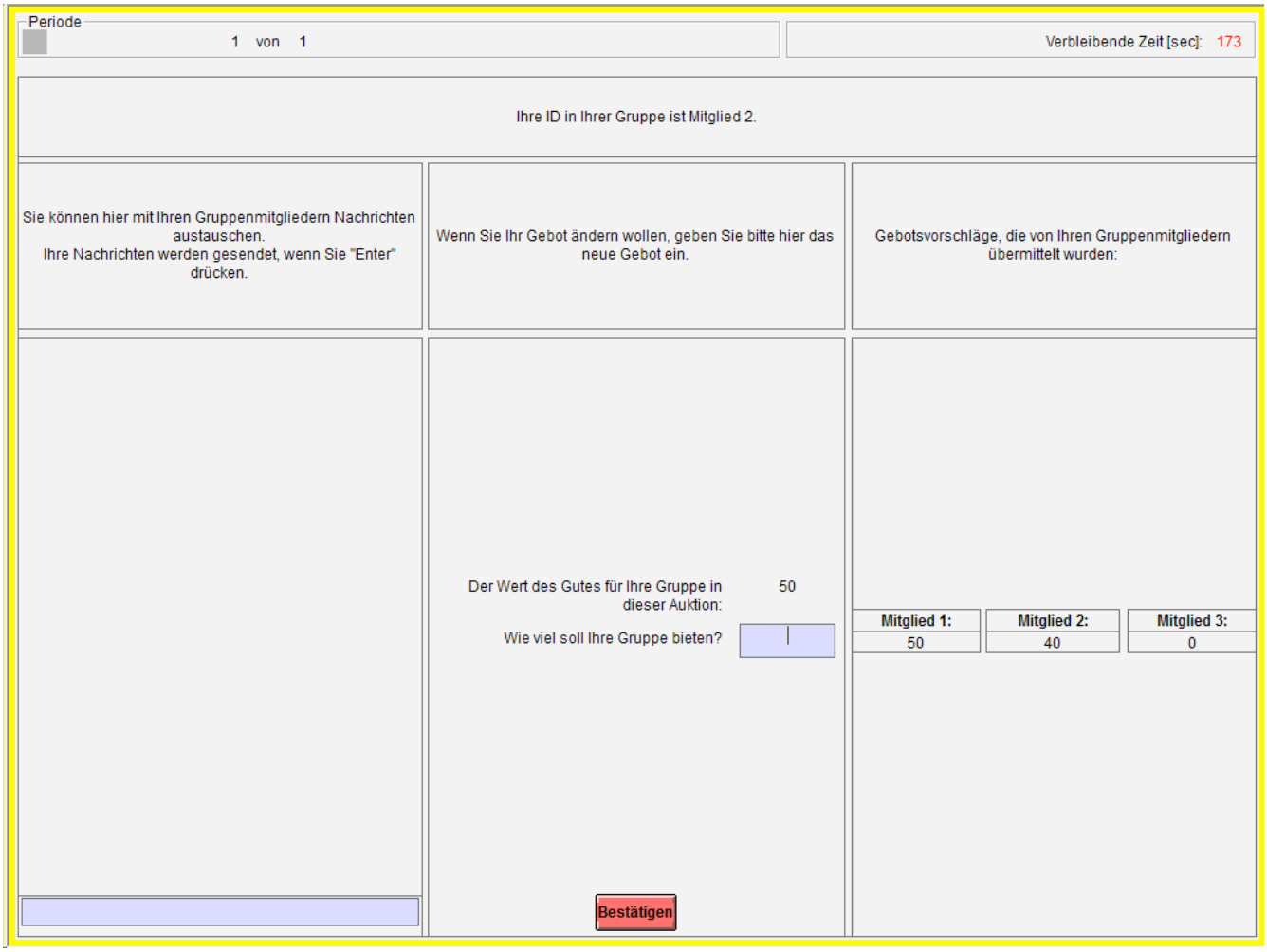
In the second stage, the group has 180 seconds to agree on a common decision. A decision is considered valid only if exactly the same decision is entered by all three group members (you can see the decisions of your group members in the right part of your screen). Within the 180 seconds, all group members can modify their decisions as often as they want. You can also discuss your decisions with the other group members – this discussion takes place in a chat window in the left part of the screen.

The following rules apply for the chat: (i) conversation in German; (ii) no insults, threats or similar violations of etiquette; (iii) no information that would allow to identify you (e.g. seat number, name, gender, field of study etc.). If you break these rules, you will be excluded from the experiment.

The chat should help you to coordinate within the group. If a group fails to reach a common decision within 180 seconds, a bid of 0 will be assumed.

Bids must always be integer numbers. The highest possible bid is 110 points.

All information can also be found on the screen, which will look like this:



In the upper area of the screen, you can see your identification number (ID) in your group (e.g. "Your ID in your group is member 2"). Your ID will be retained for the entire experiment.

On the left side of the screen, you will see a chat window where you can exchange messages with the other members of the group. To do so, enter your message in the purple field at the bottom left and then press the enter key (Return/Enter). Your entry will be transmitted to the computer and appear in the grey area of the window. The other participants in your group will see your message and you will also see the messages of the other group members above the purple input field. Important: If you want to send a message, press the enter key (Return/Enter) so that the text you have written will appear in the grey area.

On the right side of the screen, you will see your group members' suggestions for the bid. If you choose to change your bid, you can do it in the center of the screen. Your bid will be changed

when you enter a new bid in the input field in the middle and click on "Confirm" button. Then your new bid will replace your previous bid on the right side of the screen.

Payoffs

The group with the highest bid among the three groups wins the auction. This group pays their bid as the price for the good. Hence, each member in this group earns the following amount in this auction:

Payoff for each group member = Value of the good – Bid of the group

For example: The three group bids are 80, 60, 40. The group which has bid 80 wins the auction. Each member of the winning group receives the value of the good and pays 80 points.

If all three groups bid 0, the good will not be sold. If two or three groups have submitted the same highest bid (greater than 0), it is determined randomly which group wins the auction and pays for the good.

If a group does not receive the good in an auction, it does not earn anything in this auction.

However, each group member retains the initial endowment of 10 points (with one exception: see below).

Feedback and Further Auctions

Once an auction ends, a new auction starts with exactly the same rules. There are in total 12 auctions in this part of the experiment. In each auction, the six bidder groups in the room are randomly re-matched to form two markets. The three members of a group remain unchanged.

At the end of the experiment, one auction is randomly drawn as relevant for your payoff. Your payoff from Part 1 is based on the points you have earned in this auction (it means: the value minus the bid if your group won the auction; or zero if your group did not win the auction) plus the initial endowment of 10 points.

Attention!

You can also lose money in an auction. If your group wins an auction with a bid that is above the value of the good, you are going to make losses! Losses are deducted from your initial endowment (and if it is not enough: from your earnings from the other parts of the experiment).

If you have any questions, please raise your hand. An experimenter will come to you and answer your questions.

Part 2

Exchange Rate

The exchange rate in part 2 is: **3 Points = 1 Euro**

Auctions

Part 2 contains only one auction. In this auction, you bid in your group for a good, which has a certain value for you and your group. Three groups are randomly matched again for the auction and form a market to bid for a good.

Each group member receives a one-time initial endowment of 10 points.

Value of the Good

Each group receives information about the value of the good at the beginning of the auction. This value is determined independently for each group on a market; it means it is very likely that it will be different for different groups. The value for each group is drawn randomly between 0 and 100 points. Every value between 0 and 100 is equally likely (where 0 and 100 are also possible). Each bidder group knows its own value for the good but not the values of the other two groups on the market.

Decision Making

In this part, each group will place a bid. Each group decides on a bid simultaneously; there is no repetition. The decision within the group is made in two stages:

In the first stage, you will be asked individually for a suggestion for the group bid. You have

30 seconds to enter a suggestion in the middle of the screen and click on "Next" button. After all group members in your group have entered their suggestions, the second stage starts.

In the second stage, the group has 180 seconds to agree on a common decision. A decision is considered valid only if exactly the same decision is entered by all three group members (you can see the decisions of your group members in the right part of your screen). Within the 180 seconds, all group members can modify their decisions as often as they want. You can also discuss your decisions with the other group members – this discussion takes place in a chat window in the left part of the screen.

The following rules apply for the chat: (i) conversation in German; (ii) no insults, threats or similar violations of etiquette; (iii) no information that would allow to identify you (e.g. seat number, name, gender, field of study etc.). If you break these rules, you will be excluded from the experiment.

The chat should help you to coordinate within the group. If a group fails to reach a common decision within 180 seconds, a bid of 0 will be assumed.

Bids must always be integer numbers. The highest possible bid is 110 points.

End of the Auction

The group with the highest bid among the three groups wins the auction. The group pays the second highest bid as the price for the good. Hence, each member in this group earns the following amount in the auction:

Payoff for each group member = Value of the good – The second highest bid on the market

Example: The three group bids are 80, 60, 40; the group which has bid 80 wins the auction. Each member of the winning group receives the value of the good and pays 60 points.

If all three groups bid 0, the good will not be sold. If two or three groups have submitted the same highest bid (greater than 0), it is determined randomly, which group wins the auction and

pays for the good.

If a group does not receive the good in an auction, it does not earn anything in this auction.

However, each group member retains the initial endowment of 10 points (with one exception: see below).

Attention!

You can also lose money in this auction. If your group pays a price above the value of the good (=when the second highest bid is higher than the value of the good and you win the auction), you are going to make losses! Losses are deducted from your initial endowment (and if it is not enough: from your earnings from the other parts of the experiment).

There is only one auction in Part 2.

Summary

Only two things change in comparison to Part 1:

- There is only one auction.
- The winner of the auction pays the second highest bid on the market for the good.

If you have any questions, please raise your hand. An experimenter will come to you and answer your questions.

Part 3

Exchange Rate

The exchange rate in part 3 is: **40 Points = 1 Euro**

Each group member receives 100 points. Your group can invest any amount between 0 and 100 points (0 and 100 are also possible) in a risky asset and keep the rest. We denote the amount of points that your group invests in the risky asset as R. With a probability of 50%, the amount R is multiplied by 2.5; with a probability of 50%, the amount R is lost. Each group member receives

from their investment either $2.5 \times R$ or nothing with the same probability. Each group member keeps the amount $100 - R$ that was not invested.

Decision Making

The decision within the group is again made in two stages, with the group being the same as in parts 1 and 2.

In the first stage, you will be asked individually for a suggestion for the amount R to be invested. You have 30 seconds to enter a suggestion in the middle of the screen and click "Next" button. If you do not make a suggestion before the time is up, you will be automatically taken to the second stage without a suggestion.

In the second stage, the group has 120 seconds to agree on a decision on the amount R to be invested. A decision is considered valid only if exactly the same decision is entered by all three group members (you can see the decisions of your group members in the right part of your screen). Within the 180 seconds, all group members can modify their decisions as often as they want. You can also discuss your decisions with the other group members – this discussion takes place in a chat window in the left part of the screen.

The following rules apply for the chat: (i) conversation in German; (ii) no insults, threats or similar violations of etiquette; (iii) no information that would allow to identify you (e.g. seat number, name, gender, field of study etc.). If you break these rules, you will be excluded from the experiment.

The chat should help you to coordinate within the group. If your group fails to reach a common decision in 120 seconds, you will not earn any money in part 3.

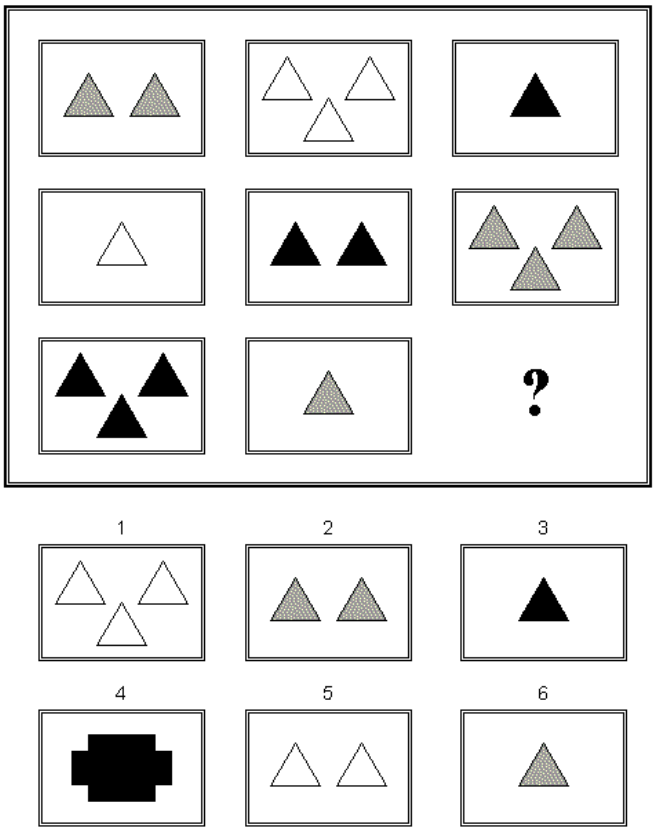
After a valid decision, the computer will simulate the investment and you will find out how much you have earned.

Part 4

In this part, we ask your group to solve 8 problems. All of them have the same structure.

You see a box with a matrix, i.e. a rectangular pattern of different symbols. Each matrix has 3 rows and 3 columns. The symbol in the lower right corner is missing. Below the matrix, there

are 6 symbols to choose from. Only one of them fits into the pattern and should replace the empty field. Here is an example.



The correct solution is "Number 5". The task for your group is to identify the correct symbol. Once you are done with one problem, the next problem will appear on the screen. You cannot go back to the previous answers once you have submitted a solution. For each correct solution, each group member receives 50 Cents. If the answer is wrong, you will not get anything.

The decision within the group is again made in two stages:

In the first stage you will be asked individually for a suggestion for the correct symbol. You have 30 seconds to enter a suggestion in the middle of the screen and click "Next" Button. If you do not make a suggestion before the time is up, you will be automatically taken to the second stage without a suggestion.

In the second stage, the group has 60 seconds to agree on the correct symbol. A decision is considered valid only if exactly the same decision is entered by all three group members (you can see the decisions of your group members in the right part of your screen). Within the 60 seconds, all group members can modify their decisions as often as they want. You can also discuss your

decisions with the other group members – this discussion takes place in a chat window in the left part of the screen.

The following rules apply for the chat: (i) conversation in German; (ii) no insults, threats or similar violations of etiquette; (iii) no information that would allow to identify you (e.g. seat number, name, gender, field of study etc.). If you break these rules, you will be excluded from the experiment.

The chat should help you to coordinate within the group. If your group fails to reach a common decision in 60 seconds, you will not earn any money for the respective problem.

At the end of part 4, you will learn how many problems your group has solved correctly.

Before we pay out your earnings to you in cash, we ask you to fill out a short questionnaire. Then the experiment ends.

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