Individuals and teams in UMTS-license auctions[#]

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Abstract: We examine bidding behavior of individuals and teams in an experimental auction which resembles UMTS-license auctions. Even though in reality teams – rather than individuals – were the bidding agents, experimental studies on bidding in auctions have so far relied on individual bidders. Our results show that teams stay on average longer in an (ascending sealed-bid English) auction and pay significantly higher prices than individuals. Consequently, teams make smaller profits and suffer more often from the winner's curse. The auction's efficiency is nevertheless higher with teams, since the bidders with the highest valuation are more likely to win the auction when teams bid rather than individuals.

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1 Introduction

In the years 2000 to 2002, many European countries conducted auctions to allocate licenses for operating UMTS mobile telephony (or more general 3G services). These auctions have caught considerable attention from the media, the public as well as the scientific community. Economists have been involved in designing the auctions and have also analyzed the influence of the design on outcomes, e.g. in terms of revenues for the auctioneer, bidding behavior or in terms of efficiency (see, e.g., Binmore and Klemperer, 2002; Börgers and Dustmann, 2005; Klemperer 2002a, 2002b; Milgrom, 2004).

In the wake of designing the auctions and when analyzing their outcomes, many researchers have relied on the method of experimental economics in order to study subjects' behavior under different auction designs (see, e.g. Abbink et al., 2005; Plott and Salmon, 2004; Seifert and Erhart, 2005). Surprisingly enough, all experimental studies on bidding behavior in UMTS-license auctions have used individual bidders, even though in reality bidders were actually teams.[1] In fact, bidding companies typically assembled a group of experts that was responsible for the company's bidding strategy (see, e.g. Börgers and Dustmann, 2002).[2] Given that individual and team decisions have been shown to differ in a broad range of economic situations (see Blinder and Morgan, 2005; Cooper and Kagel, 2005; Kocher and Sutter, 2005), it is an open question whether bidding behavior in UMTS-auctions has been adequately captured by relying on representative individual bidders in existing experimental studies. In view of the huge amount of money that was at stake at the UMTS-auctions and that are at stake in many other large-scale auctions potential differences between the two types of decision-makers may matter a lot in terms of final outcomes.

In this paper, we will present a systematic experimental test of differences in bidding behavior between individuals and teams. More precisely, we study individual and team bidding behavior in an experimental auction which captures important features of the British

[1] We are only aware of a single paper that deals with teams and individuals in auctions (however with a completely different auction design). Cox and Hayne (2002) have explored decision-making of teams and individuals in common value auctions. The paper yields rather inconclusive results since the existence of differences between individuals and teams seems to depend crucially on the amount of information available to bidders. When bidders have a rather good knowledge of the distribution of the values, teams suffer from a 'disadvantage' of information, i.e. they overbid more often and achieve smaller profits.

[2] UMTS-auctions are, however, not the only example for teams – instead of individuals – making bids. Oil companies, for instance, typically rely on groups of geologists and managers to formulate bidding strategies for bidding on offshore oil leases (Capen et al., 1971; Hoffman et al., 1991).

UMTS-auction[3] and which is based on a previous study by Abbink et al. (2005). We will compare individuals and teams as bidders according to (1) the number of bidding rounds, (2) the prices for the auctioned good and, hence, profits, as well as (3) the efficiency of the resulting allocations.

Abbink et al. (2005) have analyzed three different types of auctions (a uniform auction as well as a discriminatory auction of the Anglo-Dutch format and an ascending sealed-bid English auction) in an experimental study before the British UMTS-auction was conducted in March 2000. The main feature of their auction designs which is based on Klemperer (1998) is to combine a private and common value component in order to determine a bidder's valuation of the good.[4] The common value component captures the general profit prospects in an industry, whereas the private value component accounts for possible advantages of market incumbents over new market entrants. Since Abbink et al. (2005) have not found significant differences in bidding behavior across their three different designs, we will concentrate on a single design to focus on our main research question, i.e. whether individuals and teams bid differently in auctions.

Unfortunately, economic theory largely remains silent on the influence of the type of decision-maker on actual decisions and, therefore, offers no predictions on possible differences between individuals and teams. Thus, it seems reasonable to resort to stylized facts from experimental studies which have found that small unitary teams[5] act differently from individuals in games in which rationality and reasoning are the predominant task characteristics and social preferences are of minor importance. The general pattern emerging from these studies is that teams are more competitive, closer to standard game-theoretic predictions and better in anticipating other players' moves than individuals. Cooper and Kagel (2005) have shown that teams are better in exploiting the strategic opportunities in signalling games. Kocher and Sutter (2005), Kocher et al. (2005) and Sutter (2005) have found teams to be more successful than individuals in beauty-contest games. According to Bornstein et al. (2004) teams exit the centipede game considerably earlier than individuals, mainly because

[3] The British UMTS-auction was the first European UMTS-auction and is probably the best studied in terms of experiments conducted. For the sake of succinctness we do not go into the details of the actual British UMTS-auction, the experimental studies commissioned in its forefront and its result. Overviews are provided in Abbink et al. (2005), Binmore and Klemperer (2002) as well as Börgers and Dustmann (2005).

[4] For a theoretical treatment of auctions with private and common values see also Goeree and Offerman (2003).

[5] "Unitary" teams are teams that do not face an internal conflict in terms of payoffs and have to come up with a joint decision after a deliberation process.

they expect other teams to do the same. This leads to obvious efficiency losses in their team treatments as a consequence of the more competitive behavior among teams.[6]

Social psychology has offered several explanations for the higher competitiveness, respectively lower cooperation levels of teams in situations where there is a strategic conflict. The phenomenon is referred to as the "discontinuity effect" (see, e.g., Insko et al. 1987, 1988, 2001; Schopler et al. 2001). Three prominent hypotheses have been formulated in order to explain the discontinuity effect (Wildschut et al., 2001, 2003). First, the *identifiability hypothesis* proposes that in inter-*individual* interactions subjects assume that they are identifiable and thus can be held accountable if they make a competitive choice. In inter-*team* interactions it is less clear who is responsible for the competitive choice, because it is made by a team. Therefore, team membership provides a shield of anonymity that makes it easier for team members to propose and make a competitive choice, since they cannot be made responsible for it directly. Second, the *greed hypothesis* argues that inter-team behavior is more competitive than inter-individual behavior, because team members provide each other with social support for the competitive pursuit of immediate self-interest (Insko et al., 1990). This social support for self-interested behavior is unavailable for individuals and hence they are less competitive. Finally, the schema-based *distrust* or *fear hypothesis* proposes that group behavior is more competitive, because the anticipation of interacting with another team activates an out-group schema consisting of learned beliefs or expectations that inter-team interactions are competitive, deceitful and aggressive (Pemberton et al., 1996).

If we consider the evidence from experimental economics referred to above and the discontinuity effect from social psychology we might expect teams to behave more competitively in auctions than individuals. A more competitive behavior obviously implies higher bids in order to win the auction when teams interact with each other. This expectation is actually confirmed by our experimental results. Indeed, (1) teams stay on average longer in the auction than individuals; (2) they pay significantly higher prices and, thus, earn significantly lower profits than individuals; but (3) the allocation of the auctioned goods is more efficient with team bidders, since the bidders with the higher valuations actually get the licenses significantly more often when teams bid than when individuals bid.

[6] There is also some evidence that teams are more "rational" players – in the sense of making decisions closer to the standard game-theoretic predictions – in two-person bargaining games (see Bornstein and Yaniv, 1998, on the ultimatum game). However, the evidence is mixed (see Cason and Mui, 1997, who report teams to be more generous in dictator games). Hence, there is no consensus yet on whether and how team decisions differ from individual ones in situations where social preferences – like fairness or inequity aversion – play a major role. Note that social preferences are – at most – of only minor importance in auctions.

The rest of the paper is organized as follows. In section 2 we introduce the details of the experimental design. Section 3 presents the experimental results. Section 4 discusses our results and concludes the paper.

2 Experimental Design

2.1 The basic setup

In our experiment we let 4 bidders make bids in 15 consecutive and independent ascending sealed-bid English auctions. The set of 4 bidders will be referred to as a "market" in the following. The only experimental treatment variation is the type of bidders that we consider. In the INDIVIDUALS treatment, the 4 bidders in a market are individuals, whereas in the TEAMS treatment the 4 bidders are teams of three subjects each. In the latter case the three subjects have been seated together to discuss their bids and strategies before they had to enter a joint decision on a computer (using the software z-Tree by Fischbacher, 1999).[7] Neither individual bidders nor team bidders have been able to communicate with other bidders in their "market". In order to keep per-capita incentives constant across treatments, we paid each member of a team the amount that an individual would have won with the same decisions in its market.

Each bidder's valuation of a license is determined as the sum of a common and a private value component. The *common value component* (*cvc*) is identical for all bidders and is randomly drawn for each auction from the integers in the interval [*1000; 1500*]. Note, however, that bidders do not know the actual *cvc* nor the interval from which it is drawn when they submit their bids. Rather, each bidder receives a private signal on the common value component, the so-called *estimated common value component* (*ecvc*). Bidders know that this signal is randomly and independently drawn for all bidders from the integers in the interval [*cvc – 200; cvc + 200*].

The *private value component* (*pvc*) for each bidder is an integer number that is also randomly drawn from the interval [*-100; +100*]. Its realization depends on a bidder's type. In each market two of the four bidders are *type A* and two are *type B* bidders, which is common knowledge. The types are randomly assigned to bidders at the beginning of the experiment and remain fixed throughout the whole experiment. The *private value component* for type A bidders is randomly drawn from the interval [*0; +100*] with a probability of 80% and from the

[7] We did not set a time limit for submitting a bit.

interval [*-100; 0*] with a probability of 20%. For type B bidders the probabilities are reversed, i.e. they have an 80% chance that the *pvc* is drawn from the interval [*-100; 0*] and a 20% chance that it is drawn from the interval [*0; +100*]. The different probabilities should reflect the advantages of incumbents (type A bidders) over new market entrants (type B bidders).[8]

In order to keep the experimental conditions identical across our two treatments, we randomly drew the actual common value component (*cvc*), the estimates of the common value component (*ecvc*) and the actual private value component (*pvc*) for each single bidder in advance. Thus, we used a predetermined (yet randomly drawn) set of variables for the 15 auctions in each experimental session. To ensure that our results do not depend on a specific set of variables we drew 10 different sets of variables for the 15 auctions.[9] Each set was used for one market with 4 individual bidders and one market with 4 teams as bidders. The behavior of individuals and teams in a given set of variables therefore constitutes a matched observation that can be used to test for differences between individuals and teams in a highly controlled setting. In total we had 160 participants in our experimental sessions which lasted about 1.5 hours. The average payoff for subjects was 21.4 €.

2.2 Rules for bidding in an auction

2.2.1 Minimum bids

At the beginning of each auction bidders are informed about the estimates of the common value component (*ecvc*) and their private value component (*pvc*). Each auction can have several bidding rounds. A bidder can either quit an auction (without the possibility to re-enter in a later round of a given auction) or submit a bid to remain "active" in the auction. In each round a minimum bid has to be met (or exceeded) by any bidder who wants to stay in the auction.[10] In the very first round of an auction, the minimum bid is positively correlated with the actual *cvc*.[11] In all subsequent rounds the minimum bid is determined as the third highest

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[8] Incumbents might have a better knowledge of the market and a better reputation with future customers. Therefore, a UMTS-license might be more valuable for them than for new market entrants. Nevertheless, in our design type B bidders can also receive a positive *pvc*, which reflects the possibility that new entrants can make more efficient use of a license.

[9] A table with all values in the 10 sets as well as the raw data of the actual bids is included for referees' convenience at the end of the paper in a Supplement.

[10] In the experimental instructions (see Appendix) we informed participants that there is a maximum bid of 2000 which cannot be exceeded. This kind of liquidity constraint prevented bidders from submitting ruinously high bids, possibly made by error. It nevertheless allows overbidding since the maximum bid was well above bidders' valuations in each single case. In fact, we did not observe maximum bids.

[11] The minimum bid in the first round was determined by taking 80% of the *cvc* and adding a randomly drawn integer from the interval [-100, 100]. Subjects were not aware of this rule. All minimum bids for the first round

bid of the preceding round, plus an increment. The increment depends on the number of bidders still active in the auction and the difference between the current round's minimum bid and the previous round's minimum bid. Table 1 summarizes the rules for determining the increment. Note that the increment is larger when more bidders are still active and when the increase in the minimum bid from the previous to the current round is relatively smaller. This rule prevents an excessive number of bidding rounds when bidders would submit bids that are close or equal to the prevailing minimum bid.

Table 1: Bidding increments

Increment	**Condition**	**Number of bidders active in auction**
100	Minimum bid[†] in current round ≤ minimum bid in previous round + 150	4
50	Minimum bid in current round > minimum bid in previous round + 150	4
25	always	3

[†] The minimum bid in the current round is determined as the third highest bid of the preceding round, plus the increment.

2.2.2 End of an auction and determination of the price

At the beginning of each round bidders are informed about the number of active bidders and about the type of bidders that have already quit the auction. An auction continues until only two bidders are left who have made a valid bid in the current round. Each of these two bidders receives one of the two licenses and pays the third highest bid from the previous round as the price.[12]

If there are fewer than two bidders active in a given round, then the auction ends, and the active bidder (if any) receives a license. The second license (or both licenses in case all bidders have left the auction in the same round) is allocated randomly to one of the bidders who has submitted a valid bid in the previous round. The price for the license is then the minimum bid of the previous round. If there are fewer than two bidders active after the first round, the bidder with a valid bid gets a license and has to pay the minimum bid of the first round. All other bidders who quit the auction already in the first round receive nothing.[13]

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were also predetermined to make the starting conditions in a given set of variables completely identical in the treatments INDIVIDUALS and TEAMS.

[12] This price is equivalent to the minimum bid in the current round minus the increment.

[13] It never happened that no license was sold in an auction, i.e. that none of the four bidders submitted a bid in the first round, and there was only one case where only one license was auctioned.

2.2.3 Payoffs in the auction

Bidders who do not get a license receive no payoff for this auction. Bidders who get a license have the following payoff:

$$Payoff = cvc + pvc - price$$

In the instructions – that did not include any reference to spectrum license auctions – we have pointed out explicitly that negative payoffs are possible if the price of a license exceeds the sum of the private and the actual common value component of a bidder. Losses from one auction can be balanced with profits from other auctions. Bidders have received an initial endowment of 500 points (the experimental currency unit) at the beginning of the session in order to prevent overall losses. All points earned in the 15 auctions have been added up and converted into real money at a rate of 50 points for 1 €.

3 Results

3.1 Number of bidding rounds and bidding behavior

In Figure 1 we show the average number of bidding rounds in all 15 auctions. The overall average is 4.74 bidding rounds in INDIVIDUALS, and 5.12 bidding rounds in TEAMS. Hence, teams stay about 8% longer in an auction than individuals do. According to a Wilcoxon signed ranks test[14] the difference is not significant, though ($p > 0.1$; $N = 10$).

Result 1. On average, teams stay longer in an auction than individuals do, but not significantly so.

Figure 1 about here (Number of bidding rounds)

Before examining the prices resulting from bidding in the different treatments, we would like to analyze bidding behavior with respect to the minimum bid in a given round. For this purpose we define the *relative bid* as the ratio of a submitted bid to the minimum bid in a

[14] All tests in this paper rely on a two-sided, non-parametric Wilcoxon signed ranks test. Recall that we have 10 different sets of variables (*cvc*, *ecvc*, *pvc*) which yield 10 independent matched pairs of observations where one 'market' in the INDIVIDUALS treatment is matched with the corresponding 'market' (with the same set of variables) in the TEAMS treatment. For statistical testing, we only consider the overall average across all 15 auctions (concerning, for instance, the number of bidding rounds or the prices) in a given market and treatment and match it with the overall average in the matched market in the other treatment. Such a pair then constitutes one independent matched pair.

given round.[15] For the first two rounds of each auction we do not find any significant difference in the relative bids of individuals and teams. From the third to the sixth round[16], however, teams have significantly smaller relative bids than individuals ($p < 0.05$ in each round; Wilcoxon signed ranks test; $N = 10$). Teams obviously recognize faster that it does not make much sense to submit higher bids than the minimum bid (so-called "jump bids") because it suffices to submit the minimum bid to stay in the auction. Yet, in absolute terms the differences in relative bids are rather small, since relative bids of teams from round 3 on are in the range [1.003, 1.009], whereas individuals' relative bids are in the range [1.009, 1.021]. On average, teams submit a bid which is about one half percentage point above the minimum bid, and individuals submit a bid about 1.5 percentage points above the minimum bid.

3.2 Prices and profits

Figure 2 displays average prices in the 15 auctions. In each single auction teams pay higher prices for the licenses than individuals. The largest price difference is 15.3% in auction 6. Across all 15 auctions, the average price paid by teams is 1247 units of money, but for individuals it is only 1193 units, which is about 4.3% lower. Prices paid by teams are actually significantly higher than those paid by individuals ($p < 0.05$; Wilcoxon signed ranks test; $N = 10$).

Recall that we have perfect control over the common value and private value components for our matched observations of individual and team bidders. Hence, the difference in prices paid by individuals and teams cannot arise from differences in the underlying valuations of the good. It, therefore, indicates that teams are willing to pay more in order to succeed in the auction. It is interesting to note that the size of the effect does not decline in later auctions. Hence, the observed difference is not a transitory phenomenon that vanishes with experience, but seems to reflect a persistent behavioral pattern.

Result 2a. Teams pay significantly and persistently higher prices in our auctions than individuals.

Figure 2 about here (Average prices)

[15] Comparing absolute bids only makes sense in the first round of each auction, because after the first round absolute bids are obviously path-dependent.
[16] Due to the small number of auctions with 7 or more bidding rounds, we did not analyze differences in relative bids in these rounds.

Closely related to the finding of higher prices paid by teams are significantly lower average profits for teams when they win the auction ($p < 0.05$; Wilcoxon signed ranks test; $N = 10$).[17] Figure 3 displays average profits in single auctions. Profits for teams start out with an average of 130 units in the first auction and decline to an average *loss* of 6 units in the last auction. Hence, the aggressive bidding of teams strongly diminishes profits, in particular in the last four auctions. The average profits for individuals decline from 148 in the first auction to 83 units in the last auction. Sustaining positive profits even at the end of the experiment indicates that competition among individual bidders is not as strong as competition among team bidders.

Result 2b. Teams make significantly lower profits than individuals. In the course of the experiment average profits of teams go down to zero.

Figure 3 about here (Average profits)

Concerning the frequency of experiencing a loss after having received a license, we find that teams incur a loss in 28% of cases, and individuals in 19%. If losses were due to errors, the frequency of making losses should go down over time due to more experience. Yet, we observe the contrary. In INDIVIDUALS (TEAMS), the relative frequency of incurring a loss increases from 15% (28%) in auctions 1-5 to 22% (35%) in auctions 11-15.

Result 2c. On average, teams incur losses more often than individuals, but not significantly so.

3.3 Efficiency

The efficiency of an auction depends upon whether the bidders with the higher valuations actually get a license. Therefore, we measure efficiency by the relative frequency with which the two bidders with the highest actual valuation succeed in the auction. In TEAMS, 71% of the two highest bidders actually get a license, but in INDIVIDUALS only 64% ($p < 0.05$; Wilcoxon signed ranks test; $N = 10$). From this perspective, we may conclude

[17] Note that in both treatments type A-bidders (the incumbents) win the auction significantly more often than type B-bidders ($p < 0.05$ both in INDIVIDUALS and TEAMS; Wilcoxon signed ranks test; here we matched type A-bidders with type B-bidders in a respective treatment). Overall, 57% of type A-bidders win in INDIVIDUALS, and 59% in TEAMS.

that TEAMS is the better treatment in assigning licenses to the bidders which value them most.[18] The stronger competition in TEAMS – yielding higher prices and lower profits – therefore promotes a more efficient allocation of licenses.[19]

Result 3. The allocation of licenses is more efficient in the TEAMS treatment, because there the bidders with the highest valuations win the auction significantly more often than in the INDIVIDUALS treatment.

4 Discussion and conclusion

We have analyzed differences in bidding behavior of individuals and teams in an experimental ascending sealed-bid English auction. This type of auction resembles the British UMTS-auction in the year 2000, which has caught considerable interest in the scholarly economics literature. Even though in reality teams – rather than individuals – were the bidding agents, the experimental studies associated with the European UMTS-auctions have exclusively relied on representative individual bidders.

Our experiment provides conclusive evidence for several differences in the bidding behavior of individuals and small teams. Teams stay on average longer in an auction, but submit bids which are closer to the prescribed minimum bid in most bidding rounds. The latter behavior seems to support the hypothesis that teams act more "rationally" than individuals, because in our design it suffices to submit exactly the minimum bid in order to stay in an auction. However, due to staying on average longer in the auction, in the end teams pay significantly higher prices and, thus, make significantly smaller profits. This is a consequence of the stronger competition among teams. It even drives down average profits to zero by the end of the experiment in the TEAMS treatment. As a matter of fact, teams also incur losses more often than individuals. Put differently, the lack of precise knowledge of the

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[18] Recall from footnote 17 that the fraction of type A-bidders (the incumbents) who win the auction does not differ between our two treatments. However, type A-bidders who win an auction need not necessarily be the bidders with the highest valuation, because their actual private value component (*pvc*) might be lower than the one of a type B-bidder. If the latter constellation applies, the type B-bidders with the higher valuation get the license more often in TEAMS than in INDIVIDUALS, which causes the higher overall efficiency in TEAMS.

[19] There are several other ways of measuring efficiency. One alternative to our measure could be called *surplus extraction ratio* (SER) which is defined as $(SV_{act} - SV_{\min})/(SV_{\max} - SV_{\min})$, where SV_{act} denotes the sum of valuations of the two bidders who actually got the license; SV_{max} (SV_{min}) denotes the maximum (minimum) sum of valuations of two out of four bidders. TEAMS yields an SER of 76%, INDIVIDUALS one of 67% ($p < 0.05$; Wilcoxon signed-ranks test).

common value component leads to a more frequent occurrence of the winner's curse in TEAMS. Our results, therefore, reinforce the so-called discontinuity effect (Insko et al., 1987, 1988).[20] Finally, our experiment shows that the stronger competition among teams actually is associated with a more efficient allocation of the auctioned goods. The two bidders with the highest actual valuations receive the licenses significantly more often in the TEAMS treatment than in the INDIVIDUALS treatment.

Our results provide important implications both for real-world (license) auctions and for the analysis of general differences between individual and team decision making. We discuss both implications in turn.

Regarding real-world (license) auctions, our results suggest that the extraordinarily high prices for UMTS-licenses paid in the first auctions in Europe (in particular those in the U.K. and in Germany) might at least partly be due to teams rather than individuals submitting bids. Of course, most experimental studies commissioned for the UMTS-auctions were mainly interested in the proper auction design to yield the highest possible revenues for the treasury – which they obviously achieved. But these studies have nevertheless missed the differences in the bidding behavior of individuals and teams.

Given the amounts at stake at large-scale auctions like those on UMTS-spectrum licenses, even seemingly small relative differences in final prices caused by individual or team bidders (of about 4.3% in our design) yield substantial absolute differences in revenues from an auction. Even though the higher prices paid by teams may have been bad for them – in the experiments teams made losses in single auctions quite often, and in reality the winning contestants have not yet amortized their investments into UMTS-spectrum licenses – the allocation of licenses has been more efficient among teams than among individuals. This result shows that the stronger competition among teams actually has not only been beneficial for the auctioneers, but also for the overall efficiency of the auctions.

[20] In the context of our auction setting, the greed hypothesis and the distrust and fear hypothesis raised as possible behavioral explanation for the discontinuity effect seem to be most relevant for explaining the more aggressive and competitive bidding behavior of teams. From casual observation of team discussions, we realized that teams discussed much more often how to win an auction rather than which price to pay (or bid). Many teams seemed to prefer a rather small expected profit over making no profit at all in the case of quitting the auction. This casual evidence supports the greed hypothesis. The feedback on the remaining number of bidders after each round might have elicited behavior which is consistent with the distrust and fear hypothesis. If a bidding team sees that there are still two other teams active in the auction, this might be perceived as an indication of aggressive bidding of the other bidders, which in turn might induce the bidding team to bid aggressively itself – as the distrust and fear hypothesis would predict. Of course, the same line of reasoning can, in principle, be applied to the INDIVIDUALS treatment as well. But note that individuals drop out from the auction a little bit earlier than teams. Hence, individuals experience less often that two or three other bidders are still active. This might actually induce a relatively lower degree of competition among individuals.

In the light of these findings it is, of course, important to ask why companies usually delegate teams of experts rather than individual representatives to decide on bidding strategies in large-scale auctions. Recall here that we have simplified the decision making situation by giving all team members the same pieces of information, yet with some uncertainty regarding the real parameters of the auction. In the real-world, bidding teams are usually assembled in order to reflect different fields of expertise. Hence, teams without internal conflicts in terms of payoff may be viewed as units that aggregate valuable private information of the team members quickly and efficiently. Whether the advantage from information aggregation within teams outweighs the disadvantage from more aggressive bidding is beyond the scope of this paper and has to be left to future research. However, it also seems at least possible to supply a single representative with all the necessary information *before* the start of the auction in order to avoid adverse effects from team bidding. Companies probably refrain from this strategy either because they are not aware of the adverse effects of delegating teams to bid in auctions or because they believe that individuals are not able to respond adequately to all contingencies in the course of an auction.

An important complementary finding which suggests that teams are worse bidding agents than individuals in large-scale auctions from the viewpoint of companies comes from Cox and Hayne (2002). In this only other experimental study on the differences between individual and team bidding in auctions that we are aware of Cox and Hayne (2002) show that teams suffer more often from the winner's curse with more information. Hence, their findings for common value auctions surprisingly suggest that more information is even worse for teams than for individuals. Since the auction design of Cox and Hayne (2002) deviates considerably from ours and from license auctions, one has to be cautious in extrapolating their results to the real world. However, they are at least able to show that *more* information does not have to be an advantage in bidding from a behavioral point of view.

Regarding the growing literature on differences between individuals and small teams in economic decision making and behavior our results add an important piece of evidence to existing studies. The issue of team decision making and behavior has attracted increasing attention among economists recently[21] because many economic decisions are actually taken by small teams that share a joint goal rather than by individuals. Prime examples are families, boards of directors, juries and committees. Thus, a more profound knowledge of team decisions is clearly desirable in economics, especially in view of the mounting evidence for

[21] Camerer (2003) rates this issue even among the top ten open research questions in behavioral game theory.

the actual existence of systematic and persistent differences between individual and team decisions.

It can be considered a stylized fact in the literature that teams are generally closer to game-theoretic predictions than individuals in (interactive) games in which rationality and correct reasoning are the predominant task characteristics.[22] Since the first experiments with small teams in the prisoner's dilemma game we also know that we observe tougher competition when teams interact with teams than when individuals interact with individuals (Bornstein, 2003). Teams obviously strive to "win" in strategic interactions, and this motivation is stronger among teams than among individuals.

It is straightforward that the higher competitiveness of teams can be a two-edged sword for a team's profits, though, depending upon the task. As already mentioned, in signaling games teams are more successful in exploiting the strategic opportunities of signaling a specific type (Cooper and Kagel, 2005). Teams outperform individuals in direct interaction in a beauty-contest game, where teams win the contest almost twice as often as individuals (Kocher and Sutter, 2005; Kocher et al., 2005). In such types of games, teams earn more. In the centipede game, however, teams earn less, because they exit the game earlier than individuals (Bornstein et al., 2004). The same negative effect of team decision making on teams' profits has been found in our auction experiment. Therefore, our experiment clarifies the relative magnitude of the winning (or competitive) motive against the profit maximization motive among teams in auctions. Obviously, in our setup the higher competitiveness of teams drives up prices and leads to lower profits. Hence, the winning motive is more important in our auction than profit maximization considerations. Interestingly, the prevalence of the winning motive has been found to increase the auctions' efficiency in allocating licenses significantly. As a consequence, we conclude that team decision making is beneficial not only for auctioneers, but also for an auction's overall efficiency. These benefits come at the costs of teams paying higher prices and earning lower profits.

[22] We are referring to games with a strong "heureka"-component here, which means that once the correct solution is raised, it is easy to see for anybody (also called the "truth wins"-characteristic).

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Figures

Figure 1. Average number of bidding rounds

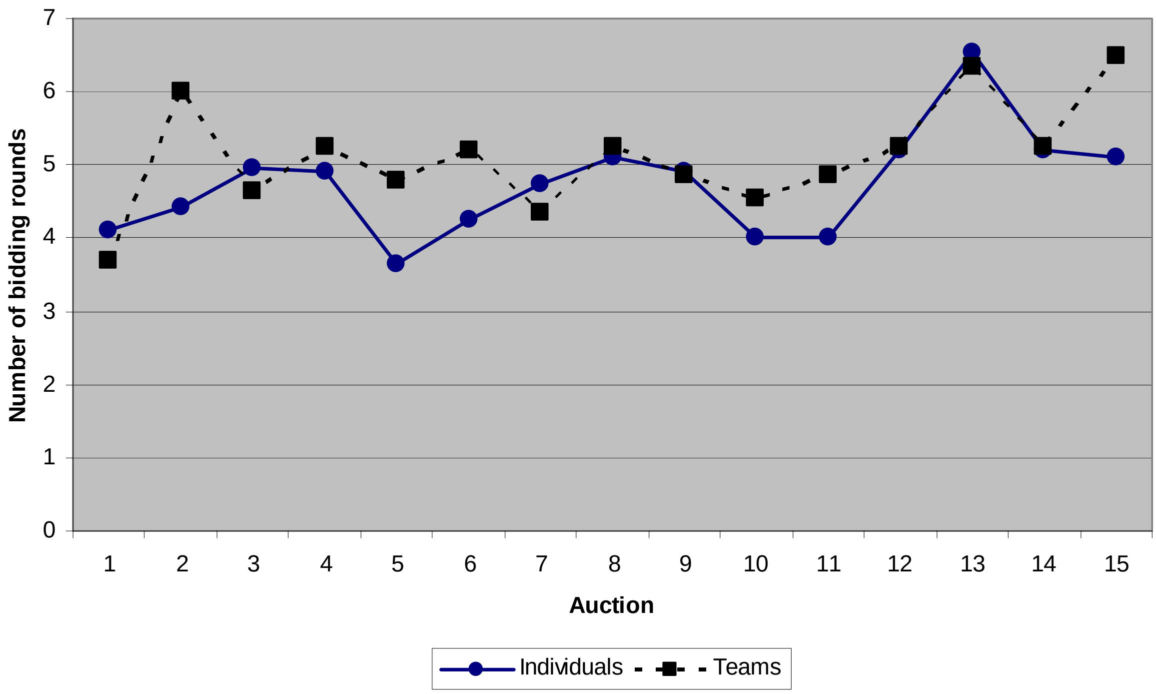


Figure 2. Average prices

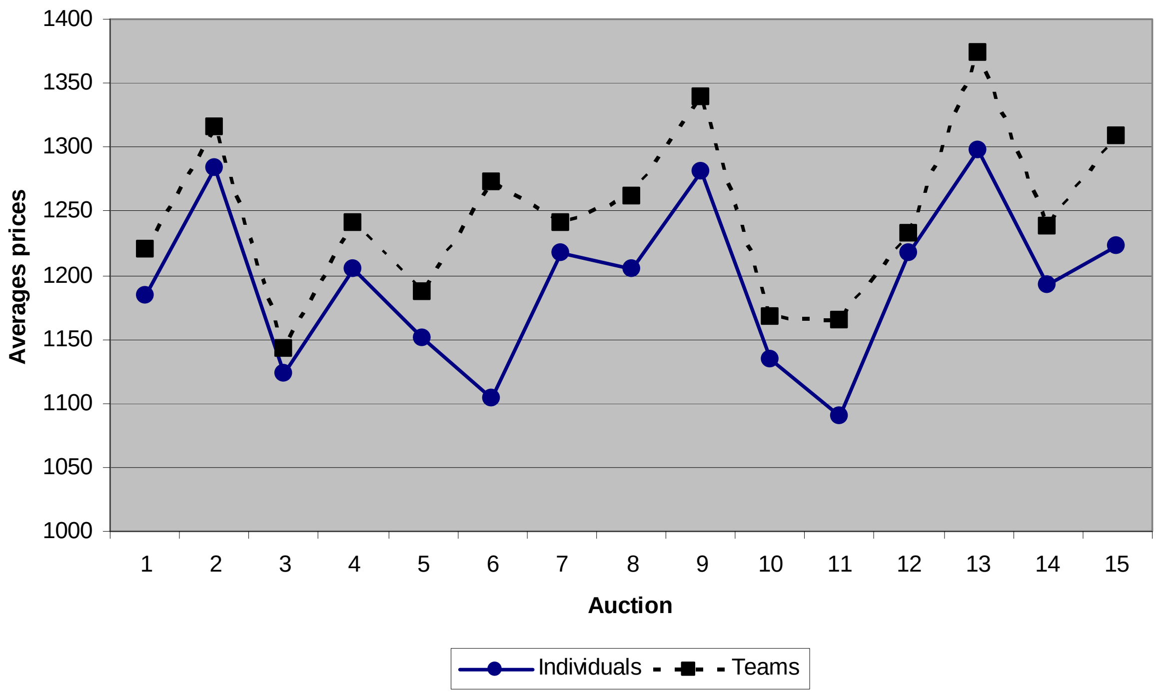
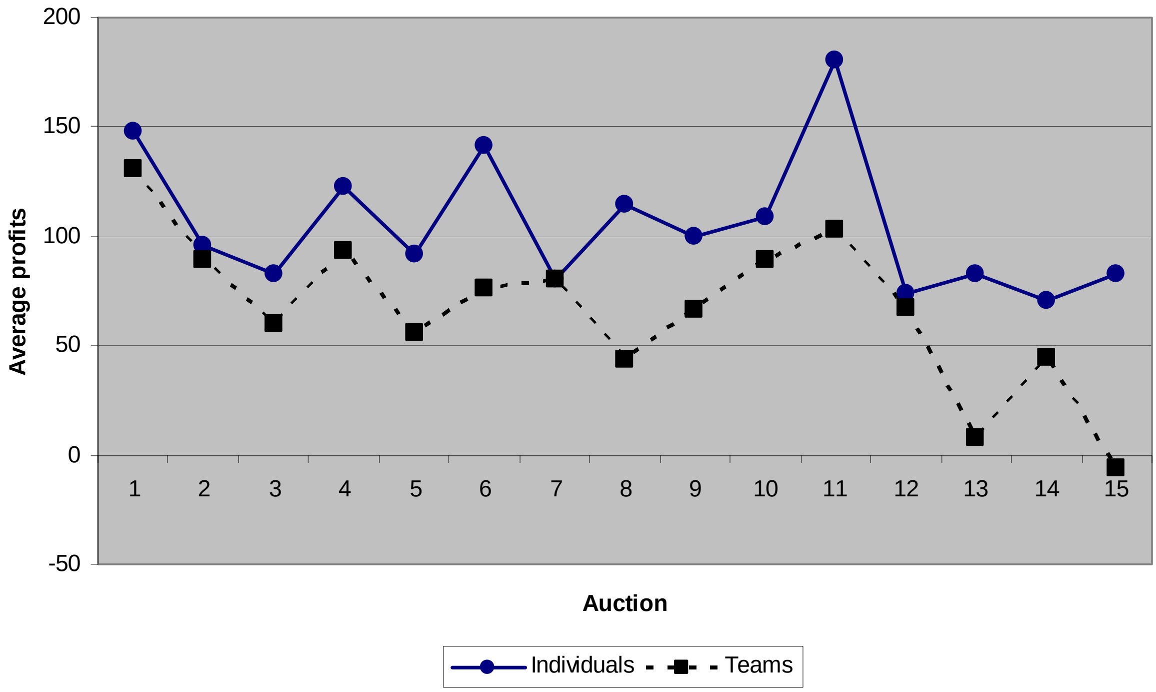


Figure 3. Average profits



Appendix – Instructions for TEAMS (not necessarily for publication)

(Instructions were the same for individual bidders and bidder teams; we only used the expression "bidder" instead of "bidder group" in the INDIVIDUALS instructions.)

Welcome to the experiment and thank you for your participation!

Please do not talk with other participants from now on!

Instructions
This experiment analyzes economic decision making. During the experiment you and the other participants will make decisions and you will earn money. The amount of money you earn depends on your own decisions as well as the decisions of the other participants and is determined by the rules of the game that will be explained in the following paragraphs. At the end of the experiment your total profit will be paid to you privately in cash.
The whole experiment will last about 2 hours. If you have any questions after reading the instructions please raise your hand. One of the experimenters will come to you and answer your questions privately. All participants receive the same instructions.

You are member of one of **4 bidder groups** who participate in an auction. Each bidder group consists of 3 members and has a bidder number that remains the same for the whole experiment. Each bidder group receives an endowment of € 10 (= 500 points) per member. We assign participants randomly to the groups.
In the auction **2 identical goods** are auctioned. The goods are not divisible. Each bidder group can only buy one of the goods in each auction. There will be **15 auctions.** Each auction consists of several rounds. You will make your decisions together with the same other two subjects in a bidder group in all 15 auctions. The composition of the other 3 bidder groups also remains the same during the experiment. Your bidder group is also linked with the same 3 bidder groups during the whole experiment.

There are **2 types of bidder groups,** type A and type B. Bidder groups with numbers 1 and 2 are of type A, bidder groups 3 and 4 of type B. You will be informed about your type and your bidder number at the beginning of the experiment in the heading line on the screen. Your bidder number and therefore your type remains the same for all 15 auctions.

Common value of the goods
Each good has a *common value*. This value is identical for both goods. The bidder groups do not know the common value of the goods during the auction. However, each bidder group receives an *estimation of the common value* that is determined by adding a integer randomly drawn from the interval [-200; + 200] to the real common value. That means that the estimation of the common value is at most 200 points higher or lower than the real common value. The estimation of the common value is different for the four bidder groups, but the real common value is the same for the 4 bidder groups. Each bidder group gets its estimation for the common value at the beginning of each auction.

Private value of the goods

Each bidder group will be informed about its private value of the goods at the beginning of each auction. This value is different for each bidder group. The private value for each bidder group is randomly drawn from the interval [-100; +100] in the following way.

For bidder groups of **type A** (bidder 1 and 2) the private value is randomly drawn from the interval [0; + 100] with a probability of 80 %. With a probability of 20 % the private value is from the interval [-100; 0]. That means that in 8 out of 10 cases the private value of bidder groups of type A is positive, in the remaining 2 cases it is negative.
For bidder groups of **type B** (bidder 3 and 4) the private value is randomly drawn from the interval [0; + 100] with a probability of 20 %. With a probability of 80 % the private value is from the interval [-100; 0]. That means that in 8 out of 10 cases the private value of bidder groups of type B is negative, in the remaining 2 cases it is positive.

Rounds in each auction

At the beginning of each auction you will be informed about your private value and your estimation of the common value.
At the beginning of each round you will additionally be informed about the *current price* in the auction and the status of the other bidder groups, i.e. if the particular group is still participating in the auction or if it has already quit the auction.
In the first round the current price equals the *minimum sales bid.* The minimum sales bid is randomly drawn. From the second round on the current price is the third highest bid from the preceding round. That means that for example in round 3 the current price is the third highest bid from round 2.
The *minimum bid* that is valid for this particular round is announced at the beginning of each round. In the first round the minimum bid equals the minimum sales bid. From round 2 on the minimum bid rises according to a fixed scheme:

Minimum bid = current price + increment

Increment	**Condition**	**Number of bidders left in auction**
100	Current price this round ≤ (current price preceding round + 150)	4
50	Current price this round > (current price preceding round + 150)	4
25	always	3

Each bidder group can decide to either make a bid that is at least as high as the minimum bid or to quit the auction. The maximum bid is 2000 points. If a group has quit the auction it can only participate again in the next auction but not at the remaining rounds of the current auction. Therefore, getting back into an auction after having quit once is not possible.

End of the auction

The auction ends if there are exactly 2 bidder groups left who make a valid bid. Each of these groups gets one of the goods and pays the current price for it.

If a group has quit the auction it usually cannot buy a good anymore. However, if there are less than 2 bidder groups left who have made a valid bid in a particular round this rule is not applied. In this case, a group gets one of the goods if it has made a valid bid. The remaining good (respectively goods if nobody has made a bid in this round) is randomly allocated to one

(two) group(s) who has (have) made a valid bid in the preceding round. All bidder groups who receive a good pay the current price of the last round for it.
Exception: If less than 2 bidder groups have made a valid bid already in round 1, the group who has made a valid bid gets a good and pays the minimum sales bid. Therefore, it is possible that in this case only one or even no good is sold.

Payoff
Common value, estimation of common value, private value, current price, increment, minimum sales bid and minimum bid are all given in points. Also bids have to be made in points. The conversion ratio is:

100 points = 2 Euro

Note that each group member receives the stated number of points earned during the whole experiment plus the initial endowment of € 10 (500 points) as final payoff.

A bidder group who buys one of the goods receives the following payoff in the respective auction:

Payoff = common value + private value – price for the good

Note that the private value may be negative.
A bidder group who did not buy a good in an auction does not get any payoff in the respective auction.

Attention!
Note that losses are possible in this auction! If you pay a higher amount for one of the goods in an auction than the sum of real common value and private value, your payoff will be negative in this auction!
Note especially that your estimation of the common value can be higher than the real common value. You will be informed about your private value at the beginning of each auction. If your private value is negative it will be subtracted from the common value if you buy a good.

Losses will be subtracted from profits you have made so far and the initial endowment of 500 points. If you have made a total loss at the end of the 15 auctions, this loss has to be paid to the experimenters!

The common value, your estimation of the common value and your private value are randomly and completely independent drawn at the beginning of each auction from the respective intervals. That means that these values usually differ between the auctions.
Bidder numbers and type remain the same for all auctions.

Summary of values

- Common value

Value of each of the goods. Is unknown during the auction, but you will be informed about it at the end of each auction. It is used to calculate the payoff.

- Estimation of the common value

Each bidder group is informed about it at the beginning of each auction and it is randomly taken from the interval [-200; + 200] around the common value.

- Private value

Each bidder group receives information about it at the beginning of each auction. It is added to (subtracted from) the common value when calculating payoffs. It lies in the interval [-100;

+100]. For bidder groups of type A it is positive with a probability of 80 %, for type B-bidders this probability is 20 %.

- Minimum sales bid

Minimum bid in the first round. It is randomly determined and will be announced at the beginning of each auction.

- Current price

Third highest bid from the preceding round (except round 1 where the minimum sales bid applies)

- Minimum bid

The minimum acceptable bid from round 2 on. Minimum bid = current price + increment (increments are calculated according to the table on page 3 of the instructions).

If you still have questions, please raise your hand. One of the experimenters will come to you and answer your question(s) privately.

Thank you for participating!