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Stochastic Deadlines:

A Comparison of Parallel Multiple Auction Designs*

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May 18, 2009

Abstract

In online auction platforms, offers are listed side by side and may end at the same point in time. While theoretical studies predict efficient coordination across auctions, experimental and empirical studies observe efficiency losses, i.e. goods remain unsold. In order to mitigate this coordination failure, we contribute to the literature of auction design by introducing a stochastic deadline in parallel multiple auctions. In these parallel Candle Auctions, several auctions start at the same time but end (separately) due to a stochastic process. We think that the stochastic ending rule decreases the coordination failure because the threat of a sudden termination forces the bidders to coordinate across auctions early in the auction process. Indeed, we find that coordination is less pronounced in parallel Candle Auctions resulting in higher efficiency.

Keywords: Simultaneous Auctions, Internet, Auction Design, Experimental Economics

JEL classification: D44, C92

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1 Introduction

Online auction platforms simultaneously offer homogeneous goods in concurrent auctions. Due to the rising popularity of online auction platforms, these offers are listed side by side and may end at the same point in time. Theoretical studies predict efficient coordination among auctions. However, experimental and empirical studies observe efficiency losses in auctions with the same pre-specified deadline, i.e. in *hard close auctions*. The bidders engage in late bidding behavior, yielding low prices or even unsold goods.

With this study, we contribute to the literature of auction design by introducing a stochastic deadline rule in parallel multiple auctions with homogeneous goods. In this simultaneous multiple *candle auctions* setting, bidding starts at the same time but ends due to a stochastic process. Therefore, the bidders do not know the exact deadline(s) of the auctions and the next bid may be the last. We conduct an experiment to compare the hardclose auctions to the candle auctions. The baseline is the parallel multiple hard close auction, where bidding in any auction starts and ends at the same time. We further consider multiple candle auctions with a *separate* ending, i.e. auctions with different deadlines, and auctions with a *non separate* ending, i.e. auctions with the same deadline. We consider a four-bidder-three-sellers setting. At first, the sellers simultaneously choose a starting price in their auction. Thereafter, the bidding process starts.

We hypothesize that the threat of a sudden termination forces the bidders to coordinate among auctions earlier in time than in the baseline treatment. Hence, more goods are sold and efficiency increases.

Indeed, we found evidence that bidders submit bids earlier in the candle auction setting than in the baseline. Furthermore, the frequency of bidders who only concentrate on one single auction is lower in the candle auction settings. The results give reasons to believe that coordination failure is less pronounced in parallel multiple candle auctions than in parallel multiple hard close auctions. Hence, efficiency is higher if we compare separate ending candle auctions to the baseline. Besides, we found that sellers with a low starting price have a higher chance to sell an object than sellers with a high starting price.

In the next section, we discuss some related literature. Section 3 describes the experimental setting, while section 4 discusses the experimental results. Finally, we conclude.

2 Related Literature

Stryszowska (2005) introduces a model with two parallel second price hard close auctions in a private value environment. In the theoretical prediction the high value bidders divide the goods among themselves. This is due to a coordination mechanism early in the auction process where bidders receive information about the ordering of their private valuation. The high value bidders become the current holder and submit bids that equal their valuation at least in the last stage.[1] Finally, the price for all goods is the same, and equals the highest valuation of the remaining bidders. Stryszowska's model yields the efficient outcome in that the bidders with the highest valuations receive the objects. Peters and Severinov (2006) find similar results in their model, though they use parallel going-going-gone auctions where bidding is only allowed sequentially.

Both studies indicate that bidders need to cross bid, i.e. submit bids on different auctions in order to coordinate. Empirical results are inconclusive concerning cross bidding. While Anwar et al. (2006) find evidence in parallel auctions (considering Intel Pentium CPU's), Tung et al. (2003) find that the number of bidders participating in more than one auction is relatively small (considering VCR/DVD player and Mini DV Camcorder).

Hoppe (2008) experimentally analyzes the behavior and the performance of participants in a parallel multiple auction market with a homogeneous good. In the experiment there

[1]Notice that the number of stages has to be at least as high as the number of objects. Otherwise the coordination mechanism fails.

are three sellers, each offering one unit of a homogeneous good, and four bidders, each with one-unit demand. The market is organized in parallel hard close dynamic second price auctions. The study shows that bidders fail to coordinate among auctions by bidding late and concentrate on single auctions. This has a significantly negative impact on the efficiency in parallel multiple auctions. Both bidders and sellers receive a significantly lower profit than predicted by theory.

The candle auction is firstly studied by Füllbrunn and Sadrieh (2006). They theoretically and experimentally study a class of ending rules that are meant to influence the impact of the deadline effect. This sudden termination auctions are characterized by fixed bidding intervals and a probability distribution of termination times over the entire interval. A special subset is the candle auction that assigns a strictly positive and increasing termination probability to each point in the interval. Considering a proxy bidding mechanism (dynamic second price auction) and private values, the theory predicts serious bidding in the first hazard stage, i.e. in the first stage with a positive termination probability the bidders submit a bid that equals their valuation. Their experimental results mainly confirm the theoretical predictions.

3 Experimental Design

The experiment was conducted in Dezember 2008 at the Magdeburger Experimental Laboratory (MaXLab) at the University of Magdeburg. The programming and implementation was performed with the software z-Tree (Fischbacher, 2007). All subjects were undergraduates from the University of Magdeburg, recruited with the online recruitment system Orsee (Greiner, 2004). The subjects were paid according to their performance. Each subject was paid an average amount of 10 Euro per hour which is one and a half times the hourly wage rate of students. Every experiments session lasted nearly 1.5 hours. After the instructions were read aloud, the students were randomly assigned to the terminals.[2]

[2]Find the instruction in the appendix.

The benchmark settings of the market structures are given by Hoppe (2008). Four bidders participate in three auctions. In each auction a seller offers a single homogeneous object. The sellers' valuation of the object in any round is an independent random draw of a uniform distribution between [20; 80] ECU.[3] The sellers' only action is to choose a starting price for their own auction before the auction begins. The starting price is the lowest price a seller is willing to accept. [4] Every bidder has a one unit demand, and the according willingness to pay (private value) was independently drawn from a uniform distribution with domain [50,150] ECU. Notice, the valuation of every further object is zero. All traders receive an initial endowment of 300 ECU. The entire structure is common knowledge. The only private information is the realization of the valuations.

In Hoppe (2008) a dynamic second price auction format is used. The bidders may submit bids in subsequent bidding stages. Three auctions occur parallel, i.e. beginning with the first stage the bidders decide simultaneously in which auction to bid. The bidders submit sealed bids in any stage. After a stage the bids in any auction are sorted in descending order and the current price, i.e. the second highest bid, is publicly announced. Further on, the bidders privately receive their status as current holder. In the next stage the bidders may submit another bid that has to exceed the current price and the last submitted bid. After the final stage the bidder with the highest bid in an auction receives the object paying the current price. In the PAR, the parallel multiple Hard Close auction setting in Hoppe (2008), the common known number of stages was 6 in every auction, i.e. all auctions start simultaneously with stage 1 and end simultaneously in stage 6.

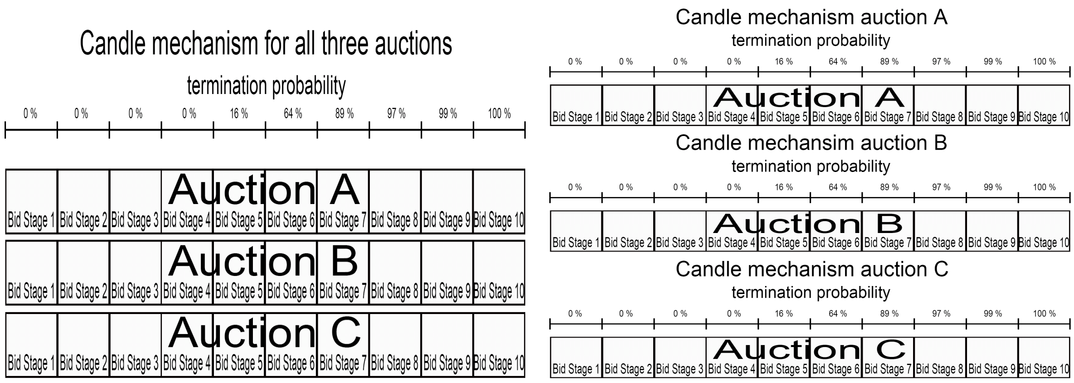
Our study implements the concave candle auction format into multi unit auctions (Füllbrunn and Sadrieh, 2006). In these treatments the auctions start simultaneously in stage 1 and the bidders may submit bids until the 5th stage for sure. In the 5th stage the candle auction mechanism starts, i.e. the occurrence of a 6th (or further) stage(s) depends on a random process with commonly known termination probabilities.[5] Stages with a positive

[3] The exchange rate was 1 Euro = 0.017 experimental currency unit (ECU).

[4] A screenshot of the decision screens is included in the instructions (see figure 10 and figure 11).

[5] The termination probability is the probability that the auction terminates after the current stage.

termination probability are called *hazard stages*. We conduct two candle auction mechanism treatments. In the non-separate parallel multiple candle auction treatment (NOSEP) all auctions end with the same stage. As in PAR, the bidders may submit a final bid with no chance for other bidders to react given the current stage is the final stage. However, the bidders do not know whether a current hazard stage is a final stage. In the separate parallel multiple candle auction (SEP) each auction has its own random process, i.e. any single auction could end after entering a hazard stage separately. The termination probability is increasing in every stage as stated in figure 1.[6]



(a) NOSEP **(b)** SEP

Figure 1: Structure of the treatments with a stochastic ending rule

The three sellers and the four bidders remain in their roles and the matching is the same for all fifteen auction rounds. We conducted five sessions with 28 subjects for every treatment (four independent groups each). Finally, we analyze 21 independent observations from PAR (Hoppe, 2008), 20 independent observations from SEP, and 19 independent observations from NOSEP.[7] Hence, a total of 420 subjects participate in this parallel multiple auction experiment.

[6]The concave course of the termination probability is given by, $q_5 = 1/6$, $q_t = \sqrt[4]{q_t - 1}$ for $5 < t < 10$ and $q_{10} = 1$. Füllbrunn (forthcoming) show that the market performance is better if the termination probability distribution is concave, rather than linear or convex.

[7]No-shows in NOSEP forced us to have only three independent groups in one session.

4 Results

4.1 The Sellers

Sellers' only choice is the individual starting price, i.e. the lowest bid a bidder has to submit to participate in an auction. When all sellers choose the same starting price, the bidders cannot differentiate across auctions and the starting price fails as coordination device (See Peter and Severinov, 2006). However, in most of the observations the starting prices differ and the bidders may use these prices to coordinate over the offered auctions. Figure 2 displays the average ratio of starting price to sellers private valuation.

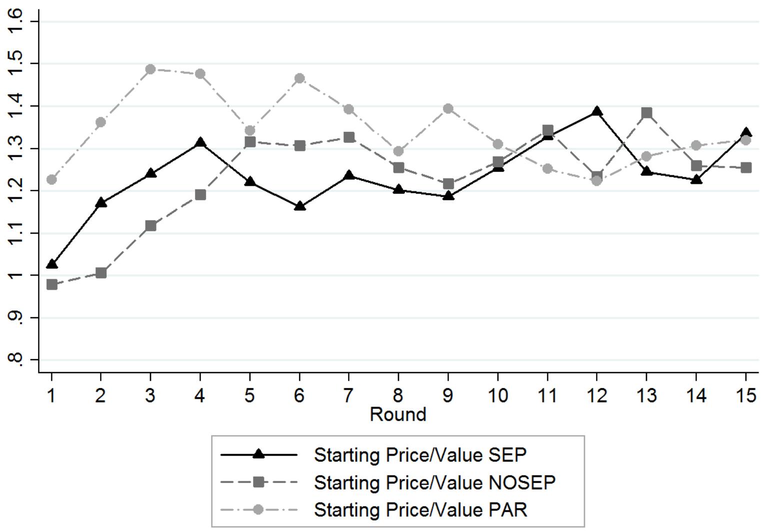
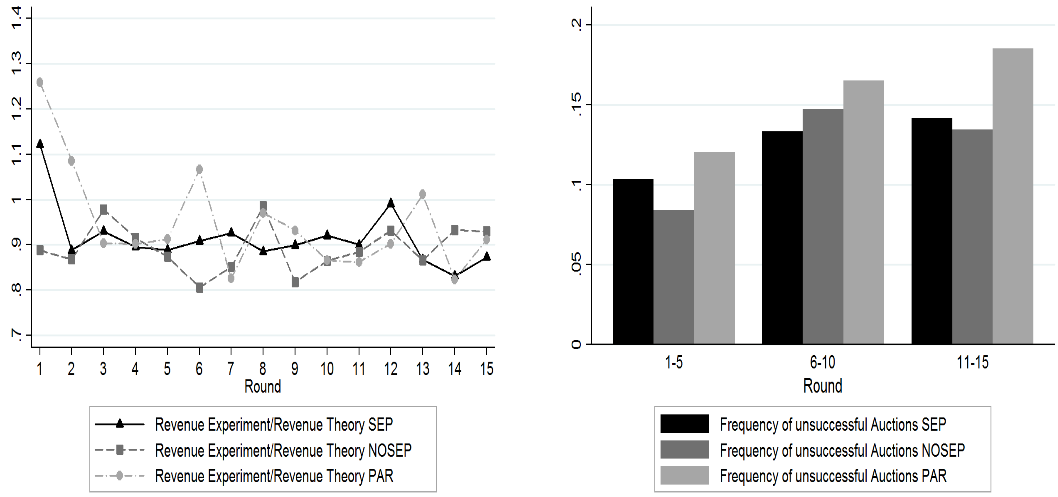


Figure 2: Average Ratio Starting Price to Private Value

The ratio almost exceeds 1.0 and thus, the starting price exceeds the sellers's value in most of the cases (Wilcoxon Test, two-tailed: $p < 0.05$ in any treatment) at least in the last section (round 11 - 15). Hence, the level of competition does not decrease the starting price to the valuation. Self-evident, the average ratio is higher for sellers with lower values than for sellers with higher values. But the absolute starting prices are lower for almost all sellers with low values (about 50 ECU) than for sellers with high values (about 70 ECU) in the last section. Although the ratio in PAR is higher than SEP or NOSEP in the first section (round 1 - 5), the difference disappears after the bidders gain experience. Finally, concerning the starting price no differences across treatments have been found, neither for the ratio nor the absolute starting prices.

From the sellers point of view the key issue is the revenue. Figure 3a compares the ratio of observed to predicted revenue (4th highest value of the bidders) across treatments. Moreover, the frequency of unsuccessful auctions, i.e. auctions where bids never exceed the starting price, is displayed in figure 3b. Hoppe (2008) has shown that in PAR the frequency of unsuccessful auctions has a substantial negative impact on sellers revenue in multiple parallel auctions.



(a) Ratio of observed to theoretically predicted revenues

(b) Frequency of unsuccessful auctions

Figure 3: Ratio of observed to theoretically predicted revenues and frequency of unsuccessful auctions

The curves in SEP and NOSEP settle at a level between 0.8 - 1.0. We find that the revenue of the sellers slightly undercuts the equilibrium revenue in all treatments (Wilcoxon Sign Rank Test, two-tailed, NOSEP: $p = 0.007$, PA: $p = 0.0017$, SEP: $p = 0.0057$). The ratio of the observed to predicted revenue remains indistinguishable across treatments in the last section. Furthermore, we find a higher ratio for sellers with the lowest starting price in contrast to sellers with the highest starting price in all treatments in the last section (Wilcoxon Sign Rank Test, two-tailed: $p < 0.01$).

The frequency of unsuccessful auctions is significantly positive in any section (Mann Whitney U Test, one-sided, $p < 0.01$). In SEP and NOSEP an (significant) increase over time has been found (Wilcoxon Sign Rank Test, two-tailed, SEP: $p = 0.0305$, NOSEP: $p = 0.0704$). In the last section, the frequency equals 17 percent in PAR, 15 percent in SEP and 13 percent in NOSEP. Although the figure suggests a higher frequency in PAR, we find no statistical differences in comparison to the other treatments in the last section.

The reason for the higher revenue by choosing a low starting price can been found in the frequency of unsuccessful auctions. Sellers who set the highest starting price are confronted with a frequency of unsuccessful auctions of about 40 percent, whereas the frequency for sellers with the lowest starting price is below 1 percent. In the majority of our observations the first bid in an auction has been placed on the auction with the lowest starting price. Hence, the results suggest that a low starting price increases the probability of selling the object for a higher revenue.

Summing up, we find no statistical differences comparing the outcome of the sellers across treatments. As one might expect, the candle auction mechanism treatments have no impact on the seller's choice. Although the frequency of unsuccessful auctions is lower in the candle auction treatments compared to PAR with a hard close ending rule, we find no differences in sellers' revenues.

4.2 The Buyers

Hoppe (2008) shows that the buyers' gain is below the equilibrium profits in parallel multiple auctions with a hard close ending rule, and even the market rent reaches merely 72 percent of the predicted rent. Several reasons concerning bidders behavior have been discussed. But mainly, the bidders do not coordinate among the offered auctions. Further, bidders submit serious bids very late in the auctions. From this follows that bidders either receive none or several objects, which both leaves the buyers worse off. A stochastic deadline ending rule in parallel multiple auctions could induce bidders to submit bids earlier in the auction process. This might reduce coordination failure on the demand side. In the following, we discuss these arguments comparing the hard close auctions to the candle auctions . We expect a lower failure of coordination in SEP and NOSEP due to serious bids earlier in the auction than in PAR.

Figure 4 displays the average ratio of the observed to predicted payoff according to Stryszowska (2005). Due to the results from Hoppe (2008) we do not expect the payoffs to be higher than theory predicts. However, we expect the payoffs to be higher in SEP and NOSEP than in PAR due to better coordination of the bidders.

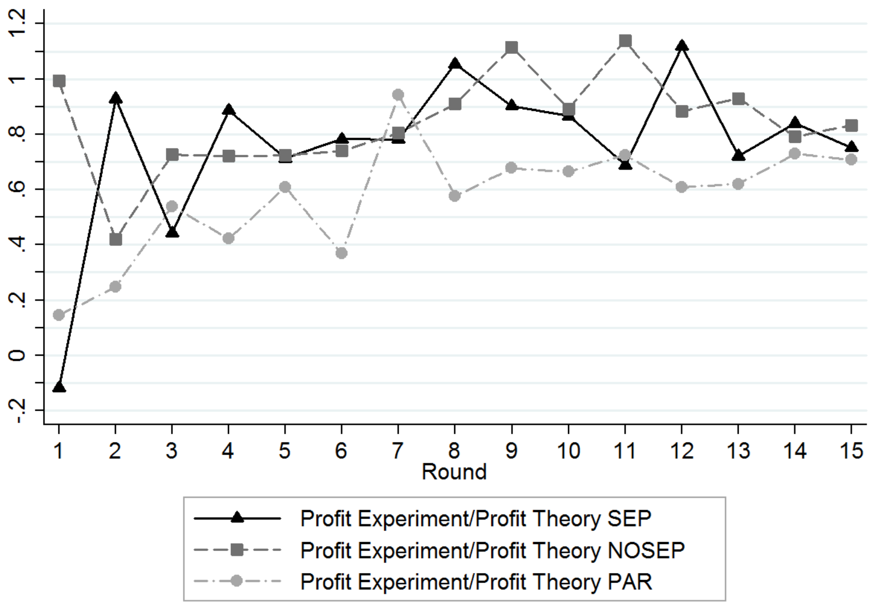


Figure 4: Ratio of the observed to theoretically predicted payoff

While in PAR the bidders have to gain experiences before reaching the last section payoff (Wilcoxon Sign Rank Test, two-tailed, $p = 0.025$), we find no significant differences comparing the payoffs of the first and the last section in SEP and NOSEP. Although the figure depicts a higher ratio in SEP (about 80 percent) and NOSEP (about 90 percent) than in PAR (about 70 percent), we found no statistical differences in the last section.[8] However,

[8]The negative ratio in the first round in SEP results from numerousness situations in which bidders win more than one object.

the results in all treatments remain below the theoretical benchmark (Mann Whitney U Test, two-tailed: $p < 0.01$ in all treatment).

4.2.1 Bid Levels

In PAR the last stage has a sealed-bid-character, i.e. bidders cannot react in a subsequent stage. Instead, the hazard stages in the candle auction allow bidders to react with a positive probability. They face a trade off between submitting a serious bid and revealing any information. Hence, we predict higher bids earlier in the auction in SEP and NOSEP than in PAR. Furthermore, bids above the private valuation could be the reason for lower observed profits compared to the prediction. Figure 5 reflects the stage wise willingness to pay as a fraction of the private value, i.e. the average ratio of bid to value. [9]

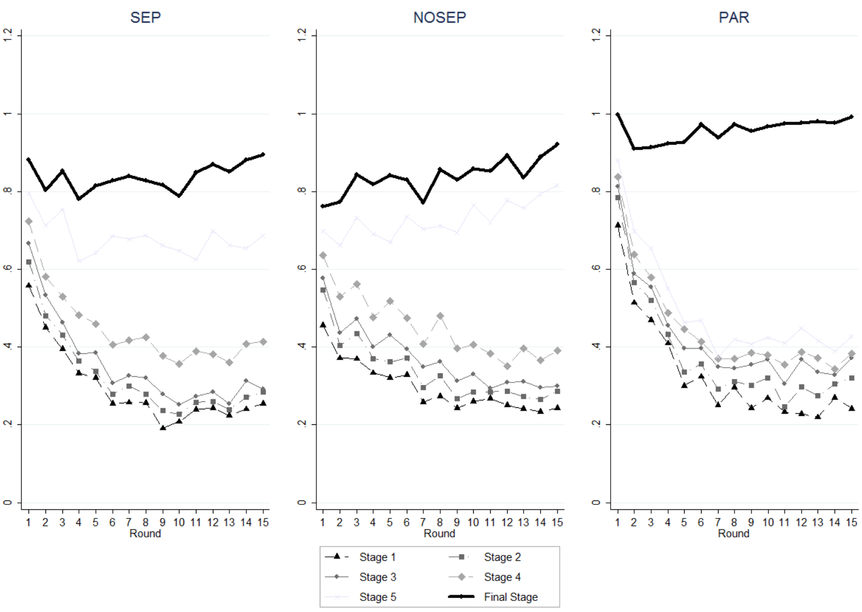


Figure 5: Ratio of bid to private valuation

In PAR the bidding pattern is seemingly analog to the bidding pattern in one object auctions (Ariely et al. 2005, Füllbrunn and Sadrieh, 2006). The average bidder ratio is relatively low between the stages 1 to 5 (0.4 in the 5th stage) and more serious in the final

[9]We discard all bids that undercut the lowest final price. This is due to the fact that these bidders under some circumstances could not submit value bids.

stage, though 1.0 is not reached. Although figure 5 is in line with the theoretical consideration from Stryszowska (2005), also a sniping behavior is conceivable.

The candle auction treatments show a different bidding pattern. While in the last section the ratio in the 5th stage is higher in SEP and NOSEP than in PAR (comparing 5th stage across treatments, Mann Whitney U Test, two-tailed, $p < 0.01$), the final ratio remains lower in SEP and NOSEP compared to PAR (Mann Whitney U Test, two-tailed, $p < 0.01$). We even found a different bidding pattern comparing SEP and NOSEP. In the last section, the first hazard stage ratio in NOSEP equals 0.78 and is significantly higher than 0.66 in SEP (Mann Whitney U Test, two-tailed, $p = 0.0083$). The bidders tend to understand that the probability of at least one further stage is higher in SEP than in NOSEP.[10] The probability of separate ending auctions in SEP, give the bidders the opportunity to switch between the auctions. Thus, they have more time to submit serious bids and consequently have a lower ratio in the 5th stage. However, in the final stage the ratios remain indistinguishable with an equal ratio of 0.88 in both treatments.

Nevertheless, the trend of the final stage ratio gives reason to believe that the experience process is not finished yet. The question remains, whether the bidders reach almost PAR ratios if a higher number of rounds has been chosen. Especially in NOSEP the performance of the 5^{th} stage ratio, that already exceeds 0.8 in the last round, would have been interesting.

4.2.2 Coordination

Stryszowska (2005) shows that the number of stages should be at least as high as the number of sellers in order to facilitate a coordination among bidders. Thus, the bidders need to enter the auction sufficiently early to allow for coordination. Figure 6 shows the development of the earliest and the latest entrance stage. For the earliest entrance stage, we recorded the stage in which the first bidder enters the auction, i.e. the stage in which

[10] In the last section in SEP in 1 of 100 cases all auctions end in the 5th period and in NOSEP in 11 of 95 cases.

the first bid has been placed. For the latest entrance stage we recorded the stages in which the last bidder enters the auction, i.e. the stage where the last bidder submits his first bid.

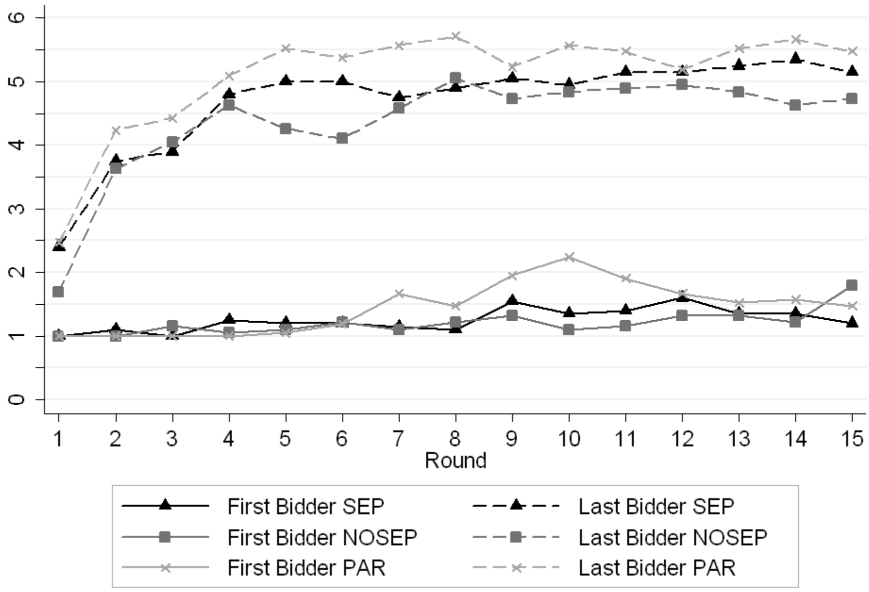


Figure 6: Average Entrance Stages

The figure shows that in the majority of cases the earliest bids have been placed in the 1st or the 2nd stage. Using Mann Whitney U Test we find no significant difference across treatments. However, the latest bids significantly differ across treatments in the last section. In NOSEP the last bidder enters almost before the 5th stage, while in SEP the last bidder enters significantly later (Mann Whitney U Test, two-tailed: $p = 0.0488$). The latest entrance stage is significantly higher in PAR comparing to SEP and NOSEP (Mann Whitney U Test, two-tailed: $p < 0.05$).

The order of the treatments concerning the latest entrance stage could be explained with the uncertainty of the number of stages. In PAR the bidders know the number of stages and accept the risk from bidding in the final stage. In SEP and NOSEP already the 5th stage could be the last. Hence, the bidders submit their first bid earlier in the auction process than in PAR. Due to the fact that in NOSEP the probability of ending all auctions simultaneously in the 5th stage is higher than in SEP, the propensity to act is more pronounced in NOSEP. The almost sequentially ending auctions in SEP enable the opportunity to switch between the auctions. Therefore, it could occur that some bidders enter their first bids in the last active auction. However, the bidders submit bids earlier in SEP and NOSEP and, therefore, increase the probability of coordination.

Hoppe (2008) categorized the bidders in three different types: the single object bidders, the multi object bidders and the cross bidders. In the first class the bidders submit bids only in one single auction, i.e. either in A, B, or C. The second class contains bidders, who submit their final bids on at least two different auctions, and accept the fact that they can win more then one object. Finally, the cross bidders jump from auction to auction.[11] Figure 7 displays the frequency of the different types in any treatment.

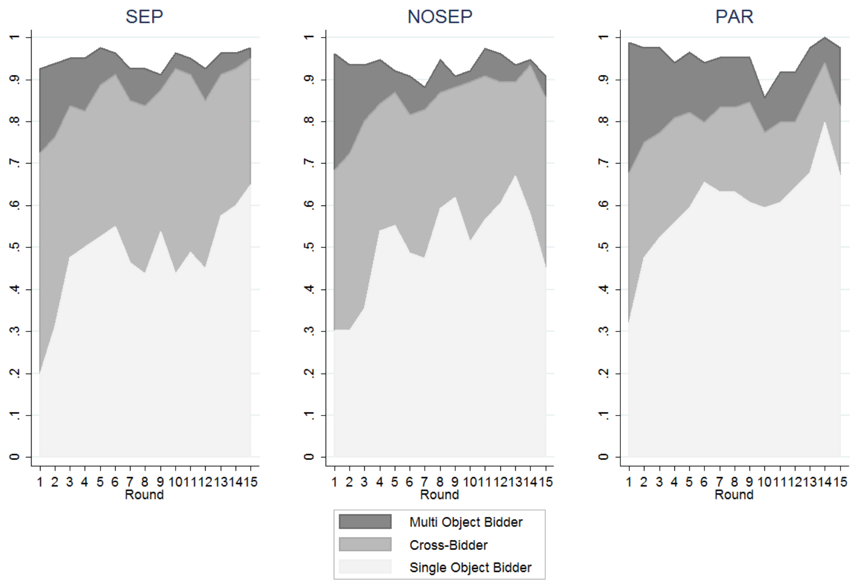


Figure 7: Bidder categorization

Concerning the time trend, we found that in all treatments the fraction of single object bidders increases, while the proportion of multi object bidders decreases (Wilcoxon Sign Rank Test, two-tailed, $p < 0.02$). The fraction of single object bidders is highest in PAR (68 percent) and also significantly different to SEP (55 percent) and NOSEP (57 percent) in the last section (Mann Whitney U Test, two-tailed, NOSEP: $p = 0.0453$, SEP: $p = 0.0234$). The lower fraction in SEP may occur due to the sequential ending of the offered

[11]The remaining fraction does not bid at all.

auction. For example, a bidder submits bids only in auction A until the first hazard stage and switches to B if only auction A closes in a following stage (unless she is the highest bidder in A). This reason does not hold for NOSEP, since all auctions end simultaneously. However, the fraction in NOSEP is statistically indistinguishable to SEP. The fraction of multi object bidders is highest in PAR (11 percent) and also (significantly) different to SEP (5 percent) and NOSEP (5 percent) in the last section (Mann Whitney U Test, two-tailed, NOSEP: $p = 0.0915$, SEP: $p = 0.0327$).

Cross bidding is essential to coordinate among auctions. PAR has the highest fraction of single object bidders and the highest fraction of multiple object bidders. Accordingly, the fraction of cross bidders is higher in the candle auction mechanism treatments. We conclude that the coordination failure is more pronounced in PAR than in SEP and NOSEP.

4.2.3 Exposure

A further reason for low profits in parallel multiple auctions is the frequency of exposure. Exposure is defined as the fact that a bidder receives more than one object although s/he values only one object. Hence, bidders are better off, if they only receive one object paying one price. Figure 8 depicts the frequency of exposure for the three treatments.

The three sections show a decreasing frequency over time in all treatments (Wilcoxon Sign Rank Test, two-tailed, $p < 0.02$). The bidders gain experience and observe the negative impact of multiple object bidding. Although the frequency of multi object bidder is significantly lower in PAR, the frequency of exposure is almost the same in any treatment in the last section. We find no significant difference across treatments.

4.3 Efficiency

Generally, a market is efficient if the maximal possible market rent is reached. This is the case, if the buyers with the highest values and the sellers with the lowest values match

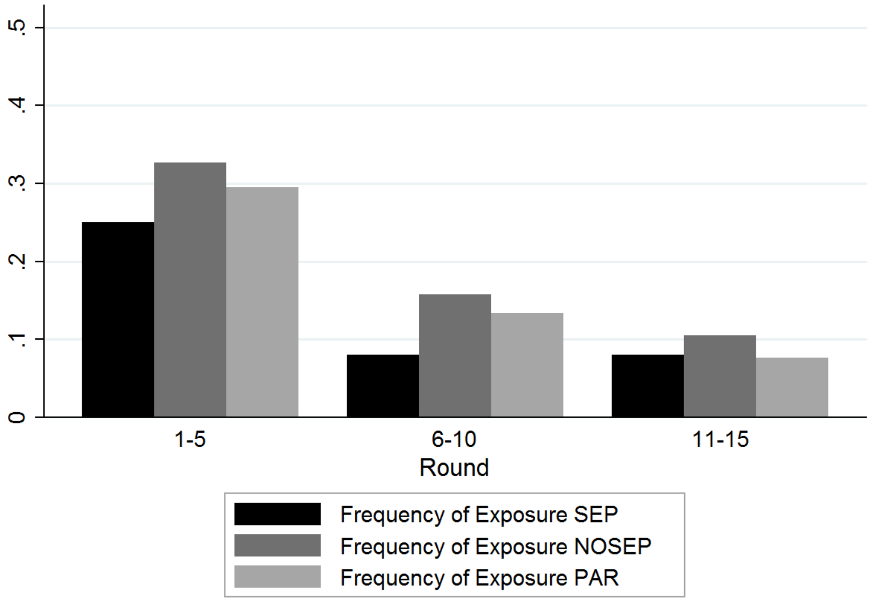


Figure 8: Frequency of Exposure

unless the value of the seller undercuts the value of the buyer. We consider the ratio of the observed market rent to the theoretically predicted market rent. The previous considerations give reason to believe that the coordination performance of the bidders is better in SEP and NOSEP in comparison to PAR. Hence, we have reason to believe that the efficiency is higher in SEP and NOSEP than in PAR. Figure 9 shows the efficiency for the tow candle auction mechanism treatments and the PAR.

The ratio increases over time in all treatments starting with above 70 percent in SEP, and quite below 70 percent in NOSEP and PAR in the first section. In PAR the last section frequency is 76 percent and no significant trend can be observed. In SEP and NOSEP the frequency significantly increases to above 80 percent in both treatments (Wilcoxon Sign Rank Test, two-sided, SEP: $p = 0.0169$, NOSEP: $p = 0.0048$). Furthermore, figure 9 shows a low efficiency in PAR in any section. We find a significantly higher efficiency in SEP compared to PAR (Mann Whintey U Test, two-tailed, $p = 0.0203$). The differences in the efficiency between NOSEP and SEP as well as PAR are statistically indistinguishable. Hence, we conclude that parallel multiple auctions with a candle auction mechanism

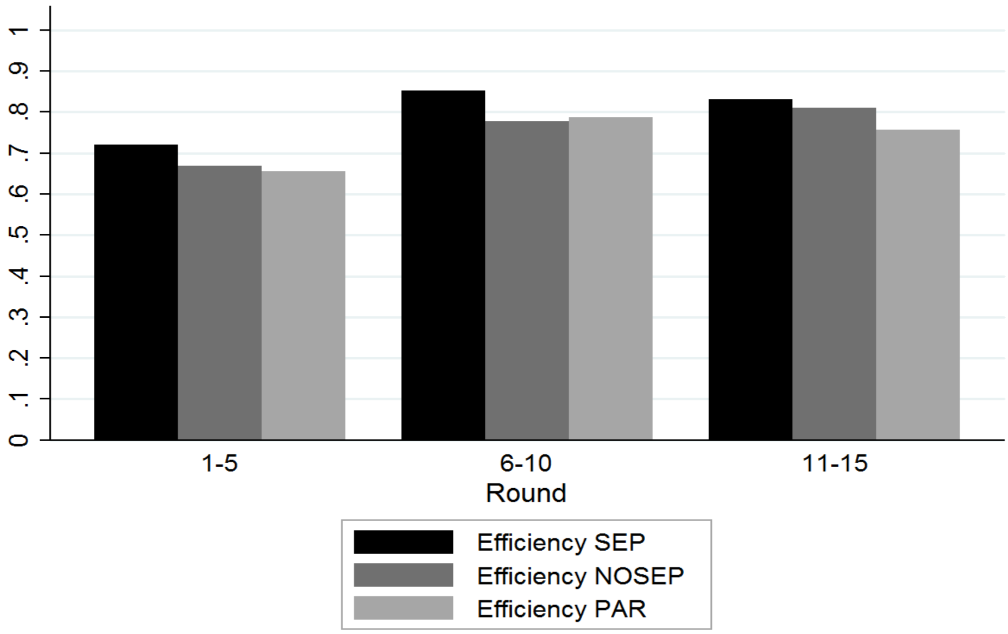


Figure 9: Efficiency

perform quite efficient. Especially, a candle auction mechanism with a separate deadline outperforms the standard parallel multiple hard close auction in terms of efficiency.

5 Conclusions

In parallel multiple auctions with fixed ending efficiency losses have been observed due to coordination failure. Bidders tend to bid late in the auction process. The side effect is bid concentration on single auctions rather than coordination across auctions. Hence, goods remain unsold.

The object of the paper is to introduce a mechanism that mitigates coordination failures in parallel multiple auctions. We think that an auction design with stochastic deadline rules solves the problem because the threat of a sudden termination forces the bidders to coordinate across auctions early in the auction process. In single object auctions this *candle auction* proves to be a fast and efficient auction design. We implement two different candle auction mechanisms. In one mechanism the auctions may end separate and in the other mechanism auctions end at the same time. However, the bidders were not aware of the exact duration of the auction process.

We found evidence that bidders submit bids earlier in the candle auction settings than in the hard close setting. Furthermore, the frequency of bidders who only concentrate on one single auction is lower in the candle auction settings. Therefore, this behavior yields more information on bidder activies in all auctions. These results give reasons to believe that coordination failure is less pronounced in parallel multiple candle auctions than in parallel multiple hard close auctions. Finally, the efficiency is highest in parallel multiple candle auction with separate endings.

In online auctions parallel endings occur. We conclude that online auction plattforms should give the sellers the opportunity to choose an advice that allows for stochastic deadline at least in the last few minutes.

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Appendix

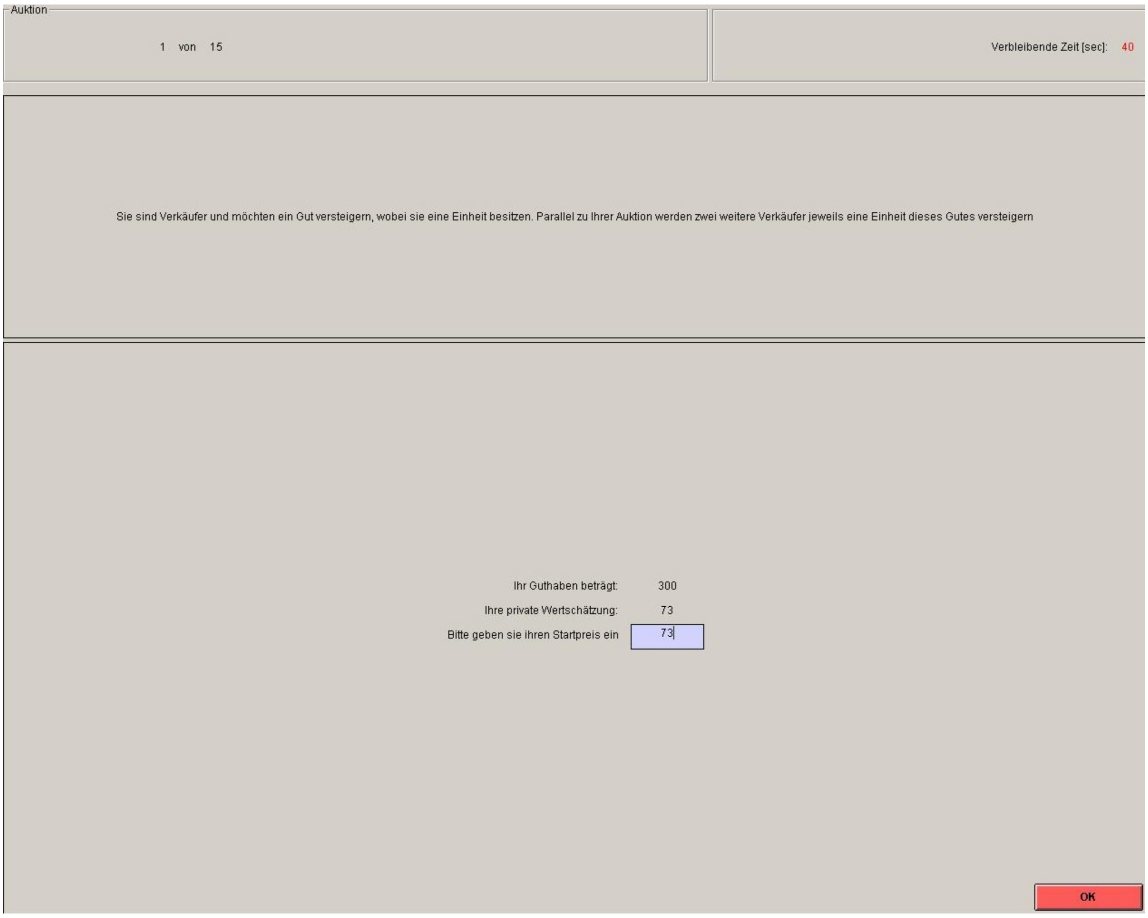

Figure 10: Seller Decision Screen

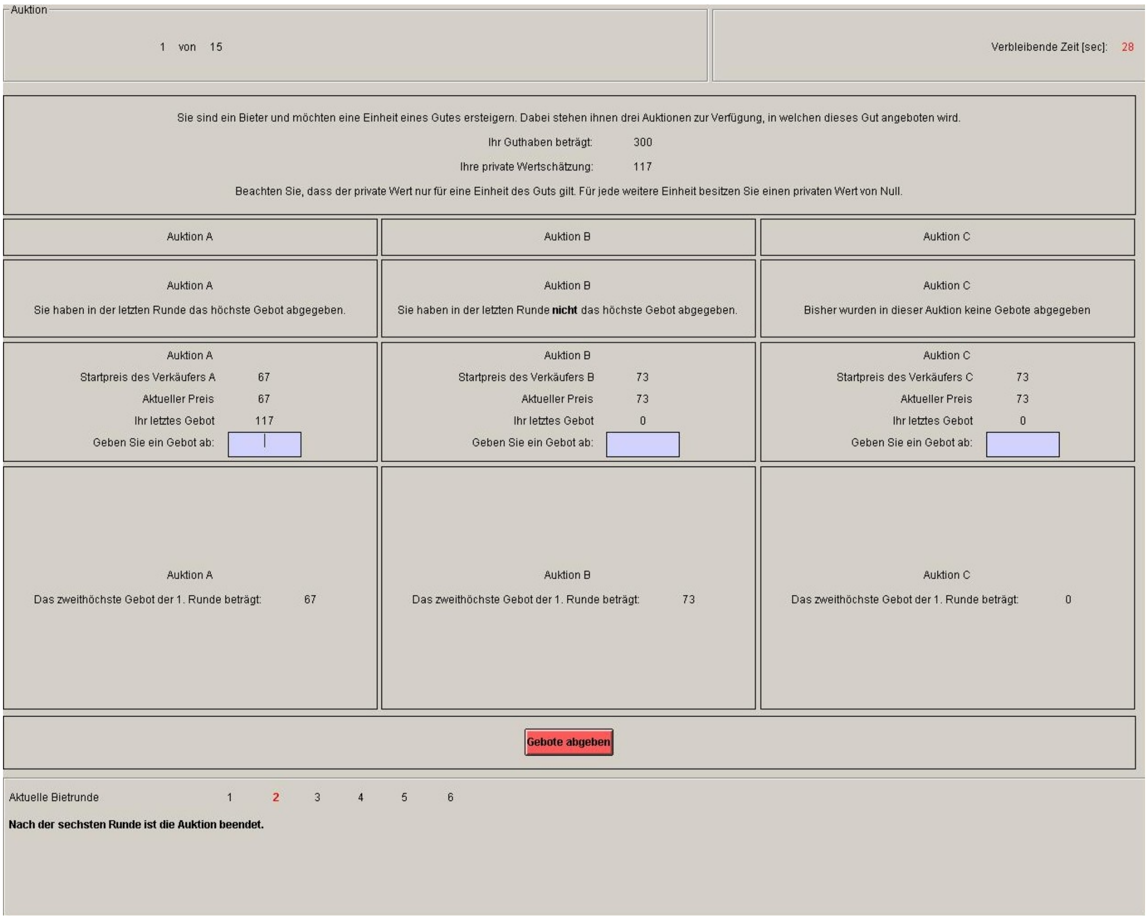

Figure 11: Buyer Decision Screen

Instructions for NOSEP (Translation)

Welcome to the Magdeburg experimental lab MAXLAB!

You are participating in a study in the context of experimental economic research concerning decision behaviour. During the experiment you will make a sequence of decisions. In doing so you will earn money. How much money it will be, on the one hand depends on your decisions and on the other hand on the decisions of the other players. Your entire profit will be paid to you in cash at the end of the experiment. Your decisions as well as your specific profit will be confidential, i.e. no other player will know about it.

The decision situation:

Your group consists of seven participants. All seven participants will only interact within the group. Just like you, the other six participants are currently located at a computer terminal. All participants have received the same instructions.

The group consists of three sellers and four bidders. After reading the instructions, but before the beginning of the experiment, you will be randomly assigned to a role. During the entire experiment you will be assigned to the same role.

<u>Sellers:</u>

You are in an auction setting. You will receive an endowment of 300 MU (Monetary Units). In 15 subsequent bidding periods you will face the following identical decision problem: You own a good, which you want to auction. At the beginning of each bidding stage you are randomly assigned to a private value of the good you want to sell. This private value results from a uniform distribution [20,80].

This means that each number between 20 and 80 can be assigned to you with the same probability. In each bidding stage you have to fix a starting price for the auction. This starting price has to amount to at least 1 MU . Parallel to your auction, the other sellers of your group auction one unit of the good. These two sellers also have an endowment of 300 MU and have also been assigned to a private value from the uniform distribution [20,80]. During the 15 bidding stages, each seller will offer his good five times in auction A, five times in auction B and five times in auction C. The random sequence of these auctions will be confidential. This means that bidders cannot identify which seller is selling his good in which auction. This auction is a second price auction, i.e. the highest bidder wins the bid but only has to pay the amount of the second highest bid.

The profit per bidding stage for the seller is: *profit = final price - private value*

After each bidding stage you will receive the following information. All starting prices, final prices and the course of bids of the second highest bid of all three auctions will be displayed to all sellers. Further, you will receive information at which auction you have sold your good, information on the bidding stage in which the auction ended, information on your private value, on your profit for the particular bidding stage and the total profit (see Screenshot 2). The total profit is the sum of all earned profits in all bidding stages.

Bidder:

You are in an auction setting. You receive an endowment of 300 MU. In 15 sequenced bidding stages you will face the following identical decision problem: Each bidding stage consists of three independent auctions with each ten bidding rounds at most. You have the possibility to buy one unit of a good in each auction. For the first unit you are randomly assigned to a private value. This value results from the uniform distribution [50,150]. This means that each number between 50 and 150 can be assigned to you with the same probability. For each further unit you have a private value of zero.

In each bidding stage you have the possibility to bid in three parallel auctions. In each auction you can make at most six bids. In which auction and in how many auctions you submit bids is up to you. If you do not want to submit a bid, leave the box blank.

This auction is a second price auction. This means that the highest bidder wins the bid but only has to pay the amount of the second highest bid.

Profit for the bidder per bidding period is: *profit = private value - sum of all final prices of the winning bids*

The other bidders in your group also have an endowment of 300 MU and a value from the uniform distribution [50,150].

For each auction you receive information concerning the starting price and the current price of the auction. From the second bidding stage on you will be informed whether you are the highest bidder or not, and if there has not been any bidding at all. Further, you are given the course of bids of the second highest bid of the previous bidding rounds.

How much time does an auction take? One auction consists of 10 bidding stages at most. From the fifth bidding stage on, there is a high probability that the auctions end. This so called "termination probability" is structured as follows:

Termination probabiltiy	0 %	0 %	0 %	0 %	17 %	64 %	90 %	97 %	99 %	100 %
Bidding stage	1	2	3	4	5	6	7	8	9	10

Example: You are in the sixth bidding stage. The breakdown probability is 64%, i.e. all three auctions will end after the sixth bidding stage with a probability of 64%.

After the end of each bidding stage you receive the following information: For each auction each bidder receives the information if he was the highest bidder and if he won the bid. In case two bidders equally hold the highest bid, chance decides who wins the bid. In addition to that each bidder receives information about his private value, the starting price, in which bidding stage the auction ended, and the final price of each auction. Further, you receive information about your profit in the particular bidding stage and your total profit. The total profit is the sum of all earned profits in all bidding stages.

Final Payment

After finishing the 15th bidding periods, your total profit and your endowment of 300 MU will be added up. The result will be multiplied by 0.017. The resulting amount will be rounded up and paid out to you in cash after completion of the experiment.

Notice: Your decisions are made anonymously from your computer terminal and your payment will be carried out confidentially.

Thank you very much for your participation!