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Do economic agents act rationally? Empirical evidence from internet auctions

As a rule, economic models assume that economic agents are rational and maximise their utility. Experimental economic research in particular attempts to verify this assumption under artificial conditions using laboratory tests. Experiment results must be carefully interpreted, as laboratory conditions often fail to fully represent reality.

Internet auctions on the other hand present the possibility of observing the actual behaviour of economic agents and comparing it with theoretical expectations. The analysis of market leader eBay's auctions shows that participants behave differently not only in individual cases, as would at first be expected theoretically. Herd behaviour among the auction participants would appear to be an important explanatory factor. Closer examination reveals, however, that at least a portion of the supposed irrationality can in fact be explained by rational behaviour.

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Do economic agents act rationally? Empirical evidence from internet auctions

1. Introduction

The starting point of economic theory is “homo oeconomicus”, the utility-maximising, rational being. The assumption of utility maximisation dominates all important areas of theoretical economic science, such as household and consumer economics, the theory of the firm and new political economy. Individuals everywhere strive to maximise their personal utility, and behave rationally to this end.

Rationality means that, given preferences, an individual will choose the option that best suits his aims (see *Frank*, p. 15ff.).

However, the abstract assumption of utility maximisation says nothing about what the individual actually strives for, as the preferences of the individual under consideration are generally not known. The preferences are only disclosed when, for example, a willingness to pay is made known in an anonymous market. Under certain conditions, this can lead via the pricing mechanism to an optimum allocation of scarce resources, in other words to optimum prosperity. By acting in their own self-interest, the players not only achieve the best possible results for themselves, but also aid the common good with the help of the “invisible hand” (Adam Smith). For this reason the majority of economists recommend laying greater emphasis on market mechanisms to solve economic problems.

At present, however, the existence of “homo oeconomicus” is increasingly being questioned. Experimental economic research has come to the conclusion that actual human behaviour — as tested in the “laboratory” — can deviate considerably from the theory of utility maximisation assumed by models. Experiments repeatedly show motives of altruism, fairness, reciprocity or envy alongside egoism (see *Falk*, 2001a, *Falk* 2001b, *Bohnet/Frey*, 1997, *Gächter*, 2001). The 2002 Nobel Prize for Economics was won by *Vernon Smith* and *Daniel Kahnemann*, two researchers who tested the existence of “homo oeconomicus” with laboratory experiments and psychological methods.

Two distinctions must be made at this point: a large proportion of the (supposed) contradictions can only be explained if the hypothesis of utility maximisation is not simply interpreted as pure egoism. There is a difference between pure egoism and individual utility maximisation. The egoist orients himself exclusively to his — narrowly defined — utilities, monetary or otherwise (“exclusive self-interest”, see *Erlei*, 2002, p. 2f.). In contrast, the individual devoted to his own utility maximisation takes into account that he does not live alone in an isolated microcosm. Social contact, fairness, empathy, reciprocity etc. are important considerations in human society. Non-

egoistic behaviour is compatible with utility maximisation: individual profit can come as a result of charitableness, empathy etc. An example is the “warm-glow effect”, or the feeling of having done something good (“enlightened self-interest”, see *Erlei*, 2002, p. 2f.). The fact that humans do not just behave egoistically should surprise nobody outside the economic school of thought. In this respect, I believe that few conclusions of experimental economic research can be assessed as innovative insights – rather that a new method proves previous economic instruments to be insufficient.

This is distinct from modes of behaviour which even a generous interpretation of the hypothesis of utility maximisation would not predict. As shown by *Frey* (1997 and 2002), economic incentives can have effects other than those expected theoretically. Experiments can deliver better insights in many cases, despite the above-mentioned criticism, and allow the observation of actual behaviour which previously had to be accepted a priori in the absence of alternatives for the theory model.

Nevertheless, the results of experimental economic research must be interpreted carefully. Artificial laboratory conditions differ considerably from reality, and in some cases can even be manipulated purposely. *Smith* (2001) warns against transferring behaviour observed in small groups to the anonymous market. Human behaviour differs considerably in each (see *Erlei*, 2002, p. 15ff.).

Online auctions offer a new way to analyse human (strategic) behaviour in real conditions. Internet auctions are a rich source of statistical data about human behaviour in the economic context. Consequently, they are increasingly becoming the subject of economic research. Existing literature focuses mainly on the analysis of buyer and seller strategies (see *Albers/Schäfers*, 2002, *Katkar/Lucking-Reiley*, 2001, *Ockenfels/Roth*, 2001a and 2001b, and *Bajari/Hortacsu*, 2000).

Determining whether the behaviour of the auction participants is rational has, to my knowledge, until now been only an incidental or implicit part of this research. This article is devoted therefore to the question of whether the behaviour of the buyer/seller in internet auctions is rational or irrational. For this purpose, I analysed 80 auctions at eBay, the internet auction market leader.

To start off, the auction process is outlined and characteristics relevant to the investigation are explained. Some (supposed) irrationalities of the market participants are then presented, and one analysed in detail. The empirical data from the 80 online auctions is presented, followed by possible explanations. The article concludes with an evaluation of the findings.

2. The auction process

The auction process used by eBay is a modified version of the Vickrey auction (see *Vickrey*, 1961). In a Vickrey auction, the participants submit their bids secretly. The winner is the bidder with the highest bid, but he only pays the amount offered by the second-highest bidder, plus an incremental supplement. The maximum amount that participants are willing to pay is not revealed until the end of the auction, so each participant has an incentive to submit their true preference in the sealed

bid: there is no danger that strategic moves by the other participants will raise the price higher than the additional increment.

eBay modifies the Vickrey auction in that the second-highest bid does not remain secret until the end of the auction. The current price increases to the value of the second-highest bid as soon as that is submitted. However, the value of the highest bid remains secret up to and after the end of the auction.

This is illustrated by the following example: A seller sets a minimum bid (reserve price) of USD 10. Bidder 1 makes an opening bid of USD 20; the current price stays at the reserve price of USD 10; the value of the bid is hidden from the seller and other potential auction participants. Only the bidder himself (bidder 1) and a virtual eBay "bidding agent" know the value of the bid. The virtual bidding agent ensures that as bids are made by other participants, the price rises to the maximum bid by bidder 1 without him having to remain active in the bidding process. When a further bidder (bidder 2) enters the process and bids USD 50, the current price rises to USD 20 – the value of the maximum bid of bidder 1 (now second-highest). When a further bid of USD 27 is made by bidder 3, the current price rises to this value, because the virtual bidding agent immediately marks it up to the second-highest bid. If no further bids are made, the auction closes at USD 27. Strictly speaking, the price increases by exactly one increment above the second-highest bid, and goes to bidder 2.

At the end of the auction, the values of the highest individual bids are revealed in the bid history. The winner's maximum bid is declared as the final price of the auction, but his actual willingness to pay remains secret. The bid history also contains the number of bids submitted throughout the auction process, as well as the starting, or reserve, price. If the two highest bidders submitted an identical bid during the course of the auction, the bid that was placed earlier is accepted. The length of the auction, determined by the seller, may be five, seven or ten days.

Because a large proportion of the products sold on eBay are used goods, information asymmetry between buyer and seller is obviously of major significance. The seller has an important information advantage which, unless provisions are made, can lead to a market failure. eBay's feedback forum comes close to eliminating this problem. At the end of the auction, buyers and sellers have the opportunity to give a positive, neutral or negative rating of the other eBay members. This is normally carried out when the transaction is fully concluded and each party can make a final appraisal of the other. The total score of the feedback ratings is entered beside the user ID of every eBay member. In this way, the potential buyer is able to gauge the seriousness, authenticity and experience of the potential trading partner. The feedback forum also includes detailed comments on the respective members. Every member can in fact give a rating for any number of concluded transactions with another member, but in order to prevent bias against individual members, only one rating is counted for the score mentioned above.

Two additional options further reduce information asymmetry: the seller can post a detailed description and in some cases photographs of the item being sold. Along with the rigorous feedback forum, this ensures that the seller cannot create a seriously misleading impression. At every auction, the seller can also be emailed questions about the product on offer in advance.

3. Behaviour at eBay auctions

3.1 Rational bidder behaviour

It can be deduced from the auction process described above how rational participants in eBay auctions would place their bids. As mentioned previously, rational behaviour means that, given the choice, an individual will behave as best suits his aims. In the context of the auction mentioned here, this means that potential buyers with a given willingness to pay must submit their maximum bid during the course of the auction, as long as the current price remains below this value. Because the final buyer only has to pay the amount of the second-highest bid, and the highest bid stays hidden from all the participants throughout the auction, there is a priori no reason to hold this bid back. Registering one's own preferences is of no particular advantage. Observing the auction process and then bidding late only costs time and money, as this makes it necessary to remain online.

Furthermore, it is rational to make only one bid expressing the maximum willingness to pay per auction; the design of this auction means that no advantage lies in making an initial bid that is less than the maximum willingness to pay. Any further bids will only cost time and money. If a low bid is made initially, there is an increased risk of being outbid as the auction proceeds and being unable to react in time.

3.2 Deviations from expected behaviour

Even a preliminary analysis shows that actual behaviour differs in several regards from that which would be expected from a rational economic agent. A cross-comparison of auctions of a similar product demonstrates, for example, that the bidding level depends on the current price or the design of the auction (see *Katkar/Lucking-Riley*, 2001). This corresponds to several observations made in experimental economic research that the willingness to pay depends occasionally on factors which should not be relevant assuming consumer preferences are stable (see *Ariely et al.*, 2003, and *Strahilevitz/Loewenstein*, 1998). The deviation from expected behaviour regarding the timing of bid submission is even more serious. It emerges that participant activity increases considerably towards the end of the auction. *Ockenfels/Roth* demonstrate, for example, that in 40% of the eBay computer auctions and 59% of the antique auctions they examined, the last bid was made within the last five minutes (the length of the auction generally being seven days) (see *Ockenfels/Roth*, 2001a, p. 9ff. and *Ockenfels/Roth*, 2001b, p. 3ff.). This type of behaviour is not anticipated, as the auction design means that concealing preferences does not pay off and submitting a bid late entails the risk that due to technical difficulties it may not be received in time.

According to *Ockenfels/Roth* (2001b, p. 3), two percent of the participants submitted their bid only in the last ten seconds. Besides, it involves extra expense to remain online until the auction ends.

But *Ockenfels/Roth* give a convincing rationale for this late bidding: inexperienced buyers who are unsure of a product's "true" value, especially in the case of antiques, can use the bids of more experienced eBay members as a guide. Their user IDs have cachet and their bids can thus act as price signals. Experienced buyers have an incentive to wait until the end of the auction to place their bids as this means keeping valuable information to themselves. In fact, buyers with a high feedback score tend to be late bidders (see *Ockenfels/Roth*, 2001a).

Finally, contrary to theoretical expectations, many buyers bid numerous times in the same auction, i.e. they successively raise their bids. At least at first glance, this behaviour is irrational, as there would seem to be no advantage in making a bid lower than the maximum willingness to spend. Multiple bidding increases the cost of the transaction in terms of time and money, and like late bidding can also mean that the bidder misses the boat. The following analysis centres on multiple bidding.

3.3 Data

The analysis focuses on the bid histories of 80 auctions in total on the US eBay site. The auctioned goods consisted of rare vinyl records from the 1970s, unavailable in commercial retail stores and thus comparable to antiques. Random tests in other product categories showed similar bidder behaviour, which rules out a certain category of buyers having specific behaviour. The advantage of using antiques as test objects is that due to the slim chance of being able to buy an item again, its price is almost unlimited. If an analysis was conducted on the auctions of goods such as used CDs still available in stores, the upper price limit would in principle be determined by the retail price.

The auctions selected were held in the period between October 14 and 21, 2001. Only auctions in which at least three bids were submitted were selected, because less than three bids would indicate that there was no multiple bidding. For the purpose of this examination such auctions were not of interest.

3.4 Results

A total of 285 bidders took part in the 80 auctions, submitting 550 bids in all. Of the 285 bidders, 128 (44.9%) made multiple bids during an auction. *Ockenfels/Roth* (2001b, p. 13) also confirm from their data that 38% of bidders made multiple bids. In only eight of the 80 auctions did all the participants behave according to expectations, not making multiple bids. This means that in 90% of the auctions examined, at least one auction participant made a multiple bid. The number of multiple bids made by individual bidders reached as many as 10 per auction. In other words, individual participants raised their original bid nine times successively.

The fluctuation margins of the different bid levels of the multiple bidders were of varying width, but in most cases they were considerable. In absolute terms, the maximum difference between the first (lowest) bid and the last (highest) bid amounted to USD 140, the first bid in this case being USD 40 and the last bid USD 180. In relative terms the greatest variation of the last bid from the first bid was 510% (USD 10 to USD 61).

The results show that actual deviation from theoretically expected behaviour — a one-off bid with the “true” willingness to pay — is considerable in terms of both quality and quantity. It will be examined subsequently whether there is a rational motivation for the behaviour of the auction participants, or whether irrationality is the only possible explanation.

3.5 Interpretation

3.5.1 Inexperience of the auction participants

One obvious interpretation is founded on the auction process. It may be that inexperienced auction participants presume that they are taking part in an English auction, where the highest bid is the final price. Those to whom the process is unclear and who thus make multiple bids are acting rationally. But even naïve economic agents soon notice that their bid is not accepted according to the English system. Through “learning by doing”, they soon understand the process better. This is generally realised at one of the first auctions, if an eBay “newbie” pays a lower price than his maximum bid, or even before this if the going price jumps to the level of the second-highest bid and not his own maximum bid.

To quantify the significance of inexperienced participants, the bidders were differentiated in terms of their personal feedback score. It can be assumed that a participant with a positive feedback score of at least 6 points has participated successfully in at least 6 auctions and would no longer display naïve behaviour. There were a mere 16 “newbies” with a feedback score lower than 6 among the 285 bidders. These inexperienced bidders were not responsible for the high level of multiple bidding or the maximum margin of fluctuation. Only a very small proportion of the multiple bids can be attributed to the participants’ inexperience.

3.5.2 Changes in wealth

Another theoretical interpretation would be changes in the wealth of the multiple bidders during the course of the auction. If their income or wealth situation improves, this can have a positive effect on the willingness to pay and lead to higher bids. Admittedly, the limited length of the auction — 10 days maximum — means that wealth effects have only a marginal impact on bidder behaviour. Often bids are placed in quick succession (within a few minutes; “incremental bidding”) so wealth effects, even in theory, hardly come into question. The final sale prices at the auctions examined here were relatively low, which would also mean that changes in wealth should play no part.

3.5.3 Changes in preference

Changes in preference can be attributed to an alteration in taste, or to an improvement in information.

3.5.3.1 Changes in taste

In theory it is possible that taste may change during an auction. In practice, however, the same arguments as those against changes in wealth can be made: the auction is too short and the chronology of bids often too rapid. This explanation is thus of negligible value.

3.5.3.2 Changes in the level of information

Generally speaking, changes in the level of information can have a marked influence on the consumer's willingness to pay and thus on the market price. eBay auctions contain at least two possible ways for new information to be gained and have an effect on the (potential) customer's willingness to pay: after spotting a particular auction, the bidder can go on an active information search if he does not possess sufficient information about the product on offer. Multiple bidding can then arise if the bidder makes a bid of low value to be on the safe side before beginning an information search. An improved level of information can conceivably lead to successive raising of the initial bid. New information gained during the auction would seem to explain a proportion of the multiple bids. However, the quantitative significance here is also somewhat low, as it cannot explain multiple bids made within minutes or seconds of each other.

The bidder can also gain new information passively during the auction, as the bids of experienced participants can send out information signals about the product. eBay users who have proved themselves knowledgeable about particular goods can, as previously mentioned, unintentionally incite less-experienced bidders to increase their valuation. This is not a conclusive explanation, however, for "incremental bidding", i.e. the successive raising of the bid by small amounts. "Incremental bidding" can only be viewed as prudent strategy when the bidder assumes that the other participants are unsure of the actual value; otherwise it can lead to "bid hiking". Even if this motive were valid, the dominant strategy would still be to make a first bid just before closing in order to avoid bidding wars.

3.5.4 Transaction costs

As the product is usually delivered by post, the shipping or transaction costs should be taken into account when submitting a bid. The maximum willingness to pay for a product is divided between the actual value of the good and the shipping costs. The maximum bid can be calculated as follows:

$$B_{\max} = W_{\max} - CT \quad (1)$$

B_{\max} indicates the maximum bid, W_{\max} the maximum willingness to pay and CT the transaction costs.

The shipping costs for the second and any additional vinyl record are very low, sometimes zero, so the average transaction costs sink accordingly. Let us assume that bidder Y submits a bid to seller A for product 1. His maximum bid can be calculated according to formula 1. Bidder Y is subsequently interested in product 2 offered by seller A and submits another bid according to formula 1. If bidder 1 wins the auction, CT for the second auction falls to zero, because the shipping costs are covered by the product already purchased. As a result, Bmax for the auction still running increases. It would be absolutely rational to subsequently increase the bid for the second product. However, this would only explain increases of an amount up to that of the shipping costs.

3.5.5 Uncertainties regarding valuation and herd behaviour

A proportion of the multiple bids can be explained by the factors mentioned hitherto. However, it remains unclear why the bids can differ from each other by up to several hundred percent. For this reason, the assumption of the fundamental proper price value should be more closely examined. If buyers were only aware of the relative price of a product and not its true value, successive adjustment of their willingness to pay would be comprehensible. This is particularly the case when there are no equivalent market prices to use as a guideline. Goods for everyday use can be easily priced by comparing different offers. Antiques are a different matter, and an independent fundamental valuation is also necessary in the case of capital and foreign-exchange markets. The current prices merely signal the future expectations of the market average, which may deviate from the fundamental valuation.

In relation to the auction market, this means that the value assessments need not remain stable over time and can also be influenced by the market participants. As opposed to the additionally gained information described in 3.5.3.2, it is also conceivable that the auction participants would behave emotionally rather than rationally. Herd behaviour can occur if the individual bidder has to make a quick decision under time pressure, for example just before the end of an auction, and overreacts for fear of missing out on a bargain. Consequently, the final price can deviate considerably from a fundamental valuation made outside this environment. Analysis of the bid history shows that especially towards the end of an auction, two or more bidders may force each other to raise their bids, suggesting that in the heat of the bidding war the participants will make bids exceeding their fundamental valuation. In conclusion, the significance of herd behaviour should not be underestimated.

3.5.6 Envy and spite

Finally, envy and spite may push bid levels above fundamental valuation. Multiple bidding could be a bidder's attempt to push the price up as high as possible when he has been outbid. The danger of this strategy is that if it goes too far, the "envious bidder" ends up winning with a bid that exceeds his willingness to pay. The difference between willingness to pay and the actual bid can be termed "envy premium" or "spite premium". It is of no significance to the "envious bidder" that the higher final price benefits the seller. He would feel emotionally closer to the seller rather than

his competitors, because the seller would have been willing to sell his product at a lower price. The enemy in this case is the competing bidder who has spoiled the game.

Though envy and spite may be theoretical incentives for supposed irrational behaviour, they can probably only explain individual cases.

3.5.7 The fun of bidding wars

There is also the possibility that the multiple bidder enjoys the bidding process and gets a certain kick from bidding wars. In this case it would be rational to bid a number of times, since this would increase his enjoyment. The fun of bidding is relevant as well as the acquisition of the good.

But while this phenomenon is theoretically conceivable, it is not of great significance. There are also factors accompanying the purchase outside of the auction sphere which, despite their relevance, are hardly mentioned in microeconomic analysis. For example, there are consumers who go shopping as much for the atmosphere as for the actual shopping, and who base their purchases on this. But the decision to purchase is essentially determined by the classic parameters of consumer theory such as product quality, income and price.

While the fun of bidding wars may have a limited value as explanation, its effect is by no means a mass phenomenon.

4. Conclusion

Internet auctions lend themselves well to the empirical testing of theoretical model assumptions. They have the advantages of field rather than laboratory experiments, since the auction participants are in a real-life situation. The analysis of auction participant behaviour confirms many of the results of experimental economic research, in particular the realisation that humans do not always behave according to exclusive self-interest and therefore not always rationally.

Not everything in internet auctions is as irrational as it first appears, however. The rational mind-set of the players underlies much of the action. But not all, and this poses the question of whether the assumption of strict rationality, widespread among economists, is not too narrow an interpretation.

A more precise analysis of herd behaviour using internet auctions would be of interest. The next step could be to question the motives of participants in bidding wars. This could possibly quantify the variation between the actual bid submitted and the fundamental willingness to pay, and thus lead to insights into how financial markets function.

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