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Short communication. Bid affiliation in repeated random nth price auction

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Abstract

In most experimental auctions, it is a common practice to carry out several bidding rounds for the same product and to post the winning price at the end of each round. This practice can lead to an affiliation of participants' bids and biased value estimates if bids between subjects are inter-dependent. In this paper, the effect of posted prices on bidders' willingness to pay for a good using a random nth price auction is examined. The auctioned good was one kilogram of the Protected Designation Origin (PDO) 'Mongeta del Ganxet Vallés Maresme' white bean, stored in a cloth bag. In general, results indicate that bid affiliation is not an issue in the random nth price mechanism. However, consumers' experience of the auctioned product matters. Experienced subjects are positively influenced by high posted prices while inexperienced subjects tend to decrease their bids when the posted price is low. Interestingly, low posted prices do not influence bids of experienced subjects and high posted prices do not influence bids of inexperienced subjects.

Additional key words: consumer experience; posted prices.

Resumen

Comunicación corta. Afiliación de las pujas en la subasta de enésimo precio aleatorio

En la mayoría de las subastas experimentales, es una práctica común subastar el mismo producto en varias rondas y revelar el precio que el ganador tiene que pagar (precio de referencia) al final de cada ronda. Esta práctica puede conducir a una afiliación de las pujas de los participantes y a estimaciones sesgadas si las pujas son interdependientes. En este trabajo examinamos el efecto de los precios de referencia en la disposición a pagar de los pujadores utilizando la subasta de enésimo precio aleatorio. El objeto de la subasta fue un kilogramo de la judía blanca 'Mongeta del Ganxet Vallés Maresme', producto recientemente amparado bajo una Denominación de Origen Protegido (DOP). En general, los resultados indican que la afiliación no es un problema en el mecanismo de subasta de enésimo precio aleatorio. Sin embargo, la experiencia en el consumo del producto subastado es importante. Los participantes con mayor experiencia tienden a aumentar sus pujas cuando los precios de referencia son altos, mientras que los participantes con menor experiencia tienden a disminuir sus pujas cuando el precio de referencia es bajo. Curiosamente, los precios de referencia bajos no influyen en las pujas de los participantes más experimentados y los precios de referencia altos no afectan a las pujas de los participantes menos experimentados.

Palabras clave adicionales: experiencia del consumidor; precios de referencia.

During the last decades the use of experimental auctions (EA) has gained recognition among economists as a tool for valuation of private and public goods. In fact, Vickrey, random nth price, BDM (Becker, DeGroot and Marschak) and English auctions are mechanisms largely used today by economists, psychologists and marketers interested in valuing new products. The use of the auction procedure in experiments is substantially based on results derived from pioneering theoretical works of Vickrey (1961), Riley and Samuelson (1981) and McAfee and McMillan (1987). One of the most important results of this auction lite-

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Abbreviations used: BDM (Becker-DeGroot-Marschak), EA (experimental auction), GM (genetically modified).

rature is the incentive compatibility of the four mechanisms mentioned above. An auction is said to be incentive compatible when it induces each bidder to submit a bid that sincerely reflects his or her value for the good.

The incentive compatibility of an auction takes place under strong assumptions such as the independence of bidders' values (not affiliated), the risk neutrality of bidders, the absence of budget constraints, and the symmetry of bidders (Krishna, 2002). Therefore, when bidders' values are affiliated in the sense that one subject's value depends on another subject's value, the auction is neither incentive compatible nor efficient, and the implementation of the auction as a pricing method leads to biased valuations (McAfee and McMillan, 1987).

In earlier empirical studies using experimental auctions, it is a common practice to carry out several bidding trials for the same product and to post the winning price at the end of each round. Repeated trial auctions are normally used for the purpose of market learning[1] and to enhance equilibrium behavior[2]. However, as mentioned by Harrison *et al*. (2004), bidders who are unfamiliar with the auctioned product or uncertain about the price of the good that can be purchased outside of the experimental auctions take the posted prices as signals of what the good should be worth to them. The debate on the use of repeated rounds with price feedback has not been settled. In fact, a literature review of several empirical studies that have been carried out to examine the presence of bid affiliation in experiments with repeated rounds reflected conflicting results and conclusions. Some authors defended the use of multiple rounds with price feedback as an important approach in learning the auction market and in improving understanding of the auction mechanism. However, others authors suggested the use of single-round auction since their results showed an affiliation of participants' bids when the auction market price is posted after each round.

Kagel *et al*. (1987) auctioned a single indivisible good among six bidders with positively affiliated private value under a first price, a second price and an English auction and found no evidence of bid affiliation in induced value auction. List and Shogren (1999) also conducted a second price auction where subjects bid to obtain one of two sandwiches that varied in safety. They concluded that the general effect of repeated rounds was to improve learning about the auction mechanism. Also in a Vickrey auction, Alfnes and Rickertsen (2003) analysed European consumers' willingness to pay for four types of beef meat. They found that posting of the clearing prices heavily increased the bids for all the auctioned products and concluded that market learning is responsible for this bidding behaviour.

Harrison *et al*. (2004) reanalysed the data in Hoffman *et al.* (1993) who carried out a field experiment (Vickrey auction) where participants bid for beef steaks in two alternative retail packages. They found significant effects of the lagged prices and argued that such effects were due to affiliation. To test the hypothesis that bidders' values become affiliated when the auction product is unfamiliar, Bernard (2005) conducted a Vickrey auction to determine consumer willingness to pay for non-genetically modified (non-GM) and organic milk chocolate bars over conventional chocolate bars, and organic over non-GM chocolate bars. The results showed that participants' values seem to be interdependent. They concluded that «this led to affiliation of values, which resulted in loss of potentially valuable information in terms of the initial formulation of their values». More recently, Corrigan and Rousu (2006) used confederate bidders to control the effect of posted prices over the course of multiple rounds in a Vickrey auction. They showed that posted prices have a statistically and economically significant effect on subjects' bids in subsequent rounds for both familiar and unfamiliar products. As in Harrison *et al*. (2004) and Bernard (2005), they suggested abandoning the use of repeated-trial auctions and suggested the use of single-trial Vickrey auctions that are preceded by a learning period where the researcher can clearly explain the auction mechanism and carry out a practical example with an unrelated product to the subjects.

Some studies have also evaluated the issue of bid affiliation using different mechanisms. For instance, Rustrom (1998) and Lusk *et al*. (2004) compared results from BDM and English auctions of five types of meat steak and a box of gourmet chocolate and concluded that bid affiliation is not responsible for the changes in bids across bidding rounds. However, Shogren *et al*. (2001b) found that subjects' willingness to pay for both

[1] Authors such as Hayes *et al*. (1995), List and Shogren (1999); Shogren *et al*. (2001b), Alfness and Rickertsen (2003) and Lusk and Shogren (2007) argue that using repeated bidding rounds allow bidders to learn and gain experience with the mechanism.

[2] In several experiments, induced value studies showed the necessity to carry out multiple bidding rounds for behavior to conform to the predictions of economic theory (Lusk and Shogren, 2007).

coffee mug and candy bar increases in a repeated second-price auction but not in a BDM auction. They concluded that affiliation of bids could be an explanation for this difference in bidding behaviour between the two mechanisms, but no formal test was carried out.

No other study, however, has examined the bid affiliation issue in random nth price auction. Shogren *et al*. (2001a), Parkhurst *et al.* (2004) and Lusk and Rousu (2006) used the random nth price auction as a demand-revealing mechanism that can potentially substitute for the second price auction. In this paper, the bid affiliation issue in the random nth price auction was assessed, mainly, for two reasons. First, this mechanism has the desirable property that its pricing rule allows participants to be exposed to high and low posted prices. So we expect that bidders will be able to judge better his or her value when he or she knows the boundaries of other bidders' valuations. Second, no known studies have addressed the effect of posted price (high and low) on participant's bidding behaviour in random nth price auction. Therefore, this paper aims to empirically test the influence of high and low posted prices on bidding behaviour in random nth price auction and also show if results change when consumers' experience with the auctioned good is taken into account.

To examine the issue of bid affiliation in random nth price auction, an experiment that elicits subjects' willingness to pay for a traditional variety of white beans has been conducted in July 2006. Ninety subjects were randomly selected from a list of people from Barcelona and its metropolitan area who were responsible for food shopping in their household, using a quota system to guarantee that the sample represented the appropriate population age distribution (the socio-demographic and economic characteristics of participants are reported in Table 1). The people who participated did not have previous information regarding the goal of the study, the type of product to be auctioned or the conditions of the research. The experiment consisted of nine sessions with eigth rounds per session.

The experiment was conducted in three stages. In stage 1, recruited participants were randomly assigned a specific day and hour to come to the laboratory for the experiments. During the experiment, each participant received an envelope that contained €15 as compensation for their participation, his or her identification number, ten bidding cards and a questionnaire. In stage 2, the working of the random nth price auction mechanism was explained to subjects. Specifically, subjects were informed that in the random nth price auction each one of the participants offers a bid for the auctioned product. Then the auctioneer orders the bids from highest to lowest and selects randomly a number n from a uniform distribution between 2 and k (k participants). The n-1 highest bidders are declared winners of the auction and the auctioneer sells them one unit of the auctioned good at the nth price. For example if $n = 4$, the three highest bidders each will buy one unit of the auctioned good priced at the fourth highest bid (Shogren *et al.*, 2001a). After informing the subjects about how the random nth auction works, a practical example was then carried out with the auction of a 330 mL bottle of water. This practice session was conducted in three rounds. After the practice session, the

Table 1. Socio-demographic and economic characteristics of participants

Variables	Categories	Sample (%)	Population (%)
Gender	Male	21	47.3
	Female	79	52.7
Age	18-34 years	39.4	35.5
	35-49 years	32.3	35.1
	50-66 years	28.3	29.3
Education level	No formal education	2.3	11.5
	Primary school	17.7	19.5
	Secondary school	51.1	47.7
	University degree	28.9	21.3
Income (in €)	< 1,000	13.7	
	1,000-2,000	46.2	Not available
	2,001-3,000	21.3	
	3,001-4,000	13.8	
	> 4,000	5.0	

participants were then given the opportunity to ask any question about the experiment or the auction mechanism.

In stage 3, after the training/practice session, participants were provided an opportunity to closely examine the product to be auctioned. Once all the participants had finished inspecting the product, the auction began. In each round, the subjects had to write on bidding cards how much he or she was willing-to-pay for one unit of the product. After each round, the bidding cards were collected and numerically ordered based on the bids. The number *n* was then randomly selected from a uniform distribution, and the winner(s) was (were) announced after each round. The winning price was posted after each round. After all the rounds in each session were performed, one round per session was randomly chosen as the binding round to determine the winner(s). Once the results were announced, the product was then handed out to the winner(s) who then had to pay the corresponding market price.

As previously discussed, the objective of this study is to assess the effect of high and low posted prices on bidders' bidding behaviour in a random nth price auction. To achieve this objective, first high and low posted price variables were constructed as follows. In the experiment, the winning price is drawn from the following uniform distribution {2, 3, 4, 5, 6, 7, 8, 9, 10} since each session consisted of 10 subjects. Posted prices equal to the second, the third or the fourth price were classified as «high» while posted prices equal to the eighth, the ninth or the tenth price were classified as «low». Finally, the posted price was considered «medium» if the drawn price was the fifth, the sixth or the seventh price. In this study, 30%, 38% and 32% of drawn prices were classified as high, medium and low prices, respectively. To examine the issue of bid affiliation and account for the panel nature of the data, a three random-effects Tobit models were estimated.

$$WTP_{it} = \alpha_i + \beta_1 Trend + \beta_2 High_{t-1} + \beta_3 Low_{t-1} + \\ + \beta_4 Freqwb_i + \beta_5 Knowlege + \beta_6 Gender + \\ + \beta_7 Age + \beta_8 Income + \varepsilon_{it} \quad [1]$$

where WTP_{it} is the ith participant's willingness to pay at round t; α_i is a random-effect intercept term; is a time trend; $High_{t-1}$ (Low_{t-1}) is equal to one when the posted price in round t–1 is high (low), and 0 otherwise; $Freqwb_i$ is equal to one if the participant is an experienced subject of white beans (*i.e.,* regular buyers of white bean product), and 0 otherwise; *Knowledge* is equal to 1 if the participant has a high knowledge level about characteristics of the auctioned product, and 0 otherwise; *Gender* is equal to 1 if the participant is male, and 0 otherwise; *Age* is equal to 1 if the participant's age ranges between 50 and 60 years, and 0 otherwise; *Income* is equal 1 if the participant's income is higher than €3,000 mont^{-1}, and 0 otherwise; ε_{it} represents the contemporaneous error term. Equation [1] was estimated by maximum likelihood.

Results from the regression are reported in Table 2. As can be observed in the first column, when the overall sample is considered, the effect of posted prices is statically insignificant. This result suggests that the posting of high and low prices through rounds in random nth price auction seems to mitigate bid affiliation. Since the order statistic nature of the selling price changes from one round to another, this perhaps makes

Table 2. Results from random effect Tobit model estimation

Variable	Overall sample	Experienced subjects	Inexperienced subjects
CONSTANT	2.128***	2.782***	2.314***
TREND	–0.029***	–0.017	–0.039***
HIGH_1	0.067	0.151***	0.008
LOW_1	–0.069	0.017	–0.130**
FREQ	1.013***	—	—
KNOWLEDGE	0.430	0.727	0.150
GENDER	–0.339	0.114	–0.548
AGE	0.226	0.383	0.138
INCOME	–0.030	0.006	–0.076
LogL	–540.41	–170.74	–360.05
Waldchi2	32.12	10.38	17.71
Prob>chi2	0.00	0.16	0.01

***,** Statistically significant at 1% or 5% level.

it very difficult for a bidder to learn about the other bidders' preferences and hence is likely to dampen bid affiliation. If so, this finding can then be considered one of the main advantages of using the random nth price mechanism. However, since in the overall sample, buyers of white beans ($Freqwb_i = 1$) are willing to pay a higher premium for the product, the sample has been segmented between experienced and inexperienced subjects. Columns 2 and 3 of Table 2 show the estimates for each segment. As can be seen, experienced subjects [*i.e.,* those who are regular or occasional buyers of the product (37%)] are positively and significantly affected by high posted prices while inexperienced subjects [*i.e.,* those who do not regularly/occasionally buy the product (63%)] are negatively and significantly influenced by low posted prices. Hence, when the winning price in round *t*-1 is high, experienced subjects move up their bid to have a better chance of being in the winners group in round t. These results seem to suggest that experience matters. Experienced subjects are more likely to purchase the product and are more interested in becoming the winners. On the other hand, inexperienced subjects seem less interested in purchasing the product and hence, move down their bids when the posted price is low. This finding suggests that experience or familiarity of the good can have an influence on bidding behaviour and the nature of bid affiliation.

No other known study has evaluated the issue of bid affiliation in random nth price auctions. As discussed above, bids using repeated random nth auction do not generally seem to be affiliated to the extent present in previous studies using repeated Vickrey 2nd price or nth price/uniform price auctions (*e.g.* Kagel *et al.,* 1987; List and Shogren, 1999; Alfnes and Rickertsen, 2003). Interestingly, however, bid affiliation seems to be more of an issue when subjects are separately analyzed by their degree of experience with the good. A key contribution of this study is the finding that bid affiliation does not seem to be prevalent in random nth price auction when the whole sample is considered in the analysis. This finding is no longer valid, however, when the analysis is disaggregated by degree of subjects' experience with the product being auctioned. As can be expected in experimental work, findings can create more questions important for future work. For instance, while challenging, future studies should try to design experiments that would definitively determine the reasons behind this study's findings. Possible reasons might be related to the competitive environment of experiments, role of psychological factors like regret, etc.

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