Common Value Auctions with Voluntary and Qualified Entry

Marco Casari*
Timothy N. Cason**

We study auctions under different entry rules. In the field, individuals self-select into auctions and regulations often require them to meet specific qualifications. In this experiment we assess the role of voluntary entry and financial requirements on the incidence of severe overbidding and bankruptcies, which are widespread in common value auctions. We show that voluntary entry amplifies overbidding and increases bankruptcy rates. Qualified entry has only modest impacts on overbidding. This study adds new insights to existing experiments where all subjects are usually placed exogenously into auctions.

ENCHÈRES À VALEUR COMMUNE AVEC ENTRÉE VOLONTAIRE ET PAR QUALIFICATION

Nous étudions les enchères sous différentes règles d'entrée. En pratique, les individus choisissent eux-mêmes de participer aux enchères et les réglementations exigent souvent qu'ils remplissent certains critères de qualification. Notre expérience évalue le rôle joué par l'entrée volontaire et par les exigences financières dans la fréquence des offres excessives et des faillites, qui sont très répandues dans les enchères à valeur commune. Nous montrons que l'entrée volontaire amplifie les offres excessives et accroît les taux de faillite. L'entrée par qualification n'a qu'un impact modeste sur les offres excessives. Cette étude apporte de nouveaux enseignements par rapport aux expériences existantes puisque dans ces dernières, les sujets sont en général placés dans les enchères de manière exogène.

JEL Codes: D44, D03, C92.

* University of Bologna. *Correspondence:* Università di Bologna, Department of Economics, Piazza Scaravilli 2, 40126 Bologna, Italy. *Email:* marco.casari@unibo.it

** Purdue University. *Correspondence:* Krannert School of Management, Purdue University, West Lafayette, IN 47907-2076, U.S.A. *Email:* cason@purdue.edu

Funding for subject payments was provided by the Krannert School of Management at Purdue University. We thank Justin Krieg and Kory Garner for excellent research assistance, and audiences at the Universities of Queensland, Sydney, Monash, Otago, Canterbury and the ESA European meetings and Florence Workshop on Behavioral and Experimental Economics for valuable feedback.

INTRODUCTION

In common value auctions, bidders compete for an item that has the same value for everyone. Typically the item value is uncertain and bidders base their decisions on estimates of the true value, which is generally observed only after the auction is over. Canonical examples of this type of auction include procurement of public construction and public works projects, and leases and sales of government assets such as mineral extraction rights and the radio spectrum. Reverse auctions for private procurement of inputs or services also have a strong common value component. Persistent overbidding is a robust empirical finding for these types of auctions, both in naturally-occurring data and in data from controlled experiments (Wilson [1992]; Kagel and Levin [2002]). The winning bidder often incurs systematic losses, a phenomenon known as the "Winner's Curse."

This study investigates the implications of sampling biases due to self-selection and restricted entry on the winner's curse using laboratory common value auctions. Our main research question is whether selecting bidders in different ways leads to an improvement in auction performance and bidding behavior. This could occur, for example, through additional opportunities for individual learning, since previous experimental research on the winner's curse shows that bidding performance improves over time. To vary learning opportunities, we consider a benchmark situation where bidders are randomly assigned to a given auction and compare it with two other situations where entry into auctions occurs either through the self-selection of bidders or through qualification—in which only the better-earning bidders can bid in the more risky and higher-stake auctions. One key measure of performance is bankruptcy rates, as bankruptcy generally implies a lack of completion of the transaction or task, generating a cost for society and the termination of (possibly long-term) supply relationships. We also compare behavior with the theoretical predictions for equilibrium bidding in these treatments, and seek to identify the characteristics of bidders who self-select into bidding in common value auctions. This study joins a wave of experimental investigations of specific auction rules that are of interest for field applications (Armantier, Holt and Plott [2013]; Merlob, Plott and Zhang [2012]).

This paper focuses on a comparison of different mechanisms through which the sample of participants is selected into bidding. In the field, auction participants self-select into bidding and are not a random sample of the population. We know little about the bidding behavior of those who seek to enter these auctions compared to the population at large. Moreover, the pool of potential bidders presents an additional selection bias because entry in many auctions is restricted by the auctioneer. This is particularly relevant for public procurement auctions, although it is present also in auctions with indicative bidding.[1]

1. In auctions with indicative bidding, bidders are short-listed after a first round of non-binding bids. The short list is established based on the level of the bid and on considerations about bidders' qualifications. This procedure has been employed in privatization, takeover, and acquisition auctions (Kagel, Pevnitskaya and Ye [2008]). Examples include the acquisition of Ireland's cable television provider Cablelink Ltd., the privatization of the Ente Nazionale Idrocarburi of Italy, the takeover auction for Daewoo Motors of South Korea and some real estate markets (Foley [2003]).

Revue économique – vol. 67, n° 5, septembre 2016, p. 953-976

Almost all auction experiments, by contrast, do not disclose the nature of the experiment when recruiting subjects and require everyone to participate in auction bidding.[2] The only selection that takes place in the laboratory is generally through an eventual bankruptcy, which leads the subject to drop out of the auction, or low earnings that discourage subjects from returning to "experienced" sessions (Casari, Ham and Kagel [2007]). Moreover, very few auction experiments have considered endogenous entry. Nearly all of those consider the independent private values setting (Ivanova-Stenzel and Salmon [2004]; Palfrey and Pevnitskaya [2008]; Ertaç, Hortaçsu and Roberts [2011]), where the winner's curse does not occur since bidders know their own value with certainty. In these experiments bidders tend to enter the auction too often. Cox, Dinkin and Swarthout [2001] is the only previous experiment that studies endogenous entry in common value auctions. Subjects' alternative to auction bidding was the collection of a known "safe haven" payment. Cox, Dinkin and Swarthout [2001] study market size given that entry is endogenous. In our paper market size is fixed and we study the selection of bidders in markets. We allow subjects to choose between different bidding activities, and also compare different selection procedures for entry and not only voluntary self-selection.

It is important to study self-selection or "qualification" requirements to enter common value auctions because they could affect the extent and origins of the winner's curse, which is a severe departure from the predictions of the risk neutral Nash equilibrium whose source is still unknown. One leading interpretation is that bidders' reasoning fails to account for the adverse selection implicit in the winning event. Even if ex-ante estimates were unbiased for everyone, the winner is expected to have the highest estimate among all bidders. Hence, when conditioning on the event of winning, the winner's estimate will be (ex-post) biased upward (Charness and Levin [2009]). Regardless of the source of the winner's curse, substantial evidence exists that it fades away only very slowly and when bidders are allowed enough exposure to the task. Such convergence toward the equilibrium predictions is achieved through a combination of individual learning and harsh selection through the survival of the smartest (Casari, Ham and Kagel [2007]). Our design allows participants to gain some experience through low-stake tasks with a similar underlying logic, which sets up a more favorable situation for learning and sorting the most able bidders into the high-stake task. Moreover, we include an alternative task that is simpler than an auction and expectations about others' information or rationality levels play no role. It is possible that selection at entry also reduces or eliminates the winner's curse in common value auctions. In particular, there may be important welfare implications depending on whether the adjustment takes place through learning, survival, or selection at entry.

Policy measures that prevent bankruptcies, such as in public procurement, are intended to improve social welfare. As noted above, government auctions for public works and reverse auctions for private procurement have a strong common value component. Participation in such auctions is often highly regulated and limited to qualified bidders in order to prevent the bankruptcy of winning contractors. Such bankruptcies are in practice very costly due to the social cost of the consequent delay in the completion of public infrastructure, delivery of

2. Theoretical models considering endogenous entry include Harstad [1990], Hausch and Li [1993], Levin and Smith [1994], and McAfee and McMillan [1987].

Revue économique – vol. 67, n° 5, septembre 2016, p. 953-976

needed inputs or services, and the disappearance of the organizational capital embedded in a firm (goodwill). Our experimental design manipulates access to the auction markets in some ways analogous to these qualification regulations and assesses the impact on bankruptcy.

We report two main results. First, voluntary entry into common value actions does not reduce the winner's curse, as the fraction of overbidders is higher when participants self-select into auctions than in the case of random assignment. Second, a simple version of the qualification procedure based on cumulative earnings does not eliminate winner's curse bidding but only marginally reduces it. Thus, voluntary entry does not improve auction performance or reduced the winner's curse in our experiment, both when compared to random assignment and to a simple qualified entry mechanism.

SELECTION IN FIELD AUCTIONS

A well-known example of the costly impact of overbidding and bankruptcies is the 1996 FCC auction for the C-block radio spectrum, which received winning bids of $10.2 billion. The FCC established that auction receipts would be collected through an installment plan that permitted the winning bidders to pay their debt obligations over a ten-year period. At the time, the C-block auction was viewed as a huge success. Several licensees later declared bankruptcy, however, and many others returned the bandwidth originally assigned to them. As a result, less than 10% of spectrum issued in the C-block auction was allocated as bid, with the remainder either tied up in lengthy bankruptcy court proceedings or returned to the FCC for re-auction (Committee on Commerce [1998]; Plott [2000]). This case shows the welfare cost of bankruptcy, both in terms of lost organizational capital for the winning entities and in terms of unused assets.

In order to avoid a socially undesirable outcome of bankruptcy by the selected contractor, it is common to require that bidders pre-qualify. For example, European law restricts participation to public work auctions through a certification system. To be certified a firm must meet several criteria regarding financial soundness and technical capabilities. In the European Union there are criteria concerning the *current* ability to successfully complete the project and others about the recent *experience* in projects of similar type and amount (Directives 93/37/EEC, 97/52/EC, and 2001/78/EC).

In particular, a contractor can be excluded as unsuitable in accordance with criteria of economic and financial standing and of technical knowledge or ability. First, a bidder must not have already asked for bankruptcy protection. Second, each bidder is required to supply proof of good financial and economic standing in terms of guarantees by banks, balance sheets, or in other forms.[3] This provision helps ensure that the bidder will be able to absorb

3. National legislations that implemented the European Directives provide additional details. For instance, the Italian legislation (Law 109/94 and Ordinance DPR 34/2000) requires a deposit in a locked bank account. Higher discounts on the baseline budget of the procurement auction require a greater deposit. Deposit requirements range from a minimum of 2% for no bid discount to 12% for a 20% bid discount, to 32% for a 30% bid discount. Legislation about qualifying

Revue économique – vol. 67, n° 5, septembre 2016, p. 953-976

an eventual loss originating from a miscalculated bid without going bankrupt. In our experimental design, we adopt similar criteria to restrict participation in the auctions.[4] Third, a bidder must possess the technical capability to complete the project, including evidence about management's skills, equipment availability and current workforce. Fourth, the firms must have already had substantial experience in carrying out projects of the same type and scale. This experience refers to the proper completion of projects according to the rules of the trade in the last five years, Interestingly, Dyer and Kagel [1996] mention specialization as a *voluntary* strategy of contractors in order to avoid the worst effect of the winner's curse. Within an economic model of auction bidding, specialization could provide a restriction in the support of the distribution of the private estimate of the object, or a reduction in the variance, which would reduce the common value component of the object. This aspect does not play a direct role in our experimental design.

Some national legislation requires bidders to have experience on how to handle projects of comparable size of the one currently bid. When a firm is in the official list of recognized contractors, it is generally authorized to bid in government auctions within a maximum baseline budget.[5] A newly established firm will have to acquire experience in small projects before being able to bid in large projects. This regulated progression from small to large value auctions could provide an effective solution to the high rate of bankruptcies of inexperienced bidders.

Some auctioneers may not care about bidder bankruptcies, of course, and could view the overbidding and bidder losses as profitable outcomes to encourage. In private procurement settings, for example, buyers could benefit when suppliers suffer from the winner's curse. In other cases the auctioneer has long-term objectives and may have concerns for bidders' long-term viability. Consider for instance auction houses that may want to discourage overbidding as a way to maintain a good reputation among the public, or buyers of services or material inputs that will be delivered frequently over a long-term contract or are completed with a long horizon. The entry restrictions in public procurement and privatization settings indicate that some auctioneers place a value on avoiding bankruptcies.

bidding is common also in other nations; for instance, see the registration requirements for the Singapore Building Construction Authority [2014].

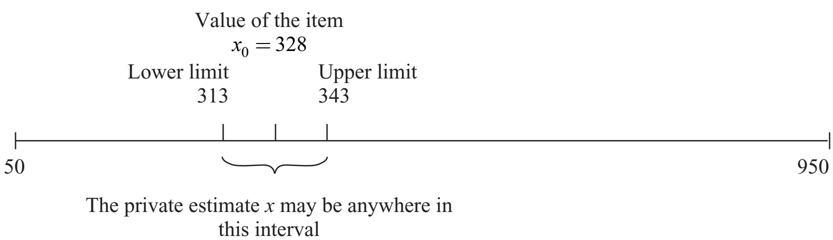
4. According to canonical theory, the rationale for the second criterion may be to avoid the problem of rational "overbidding" when there is little to lose, which increases the risk of bankruptcy. Moreover, even in equilibrium, ex-post profits of the winner may be negative. The criterion on technical capability is not relevant in the abstract experimental design.

5. Italian law lists 47 distinct types of projects (art. 18 DPR 34/2000), where experience in a different type of project is irrelevant for pre-qualification. For instance, experience in building power plants does not help to qualify for maintenance works of the power grid, and experience in providing lighted road signs for highways does not help to qualify for bidding to supply non-lighted road signs. Moreover, a firm is placed in one of eight budget categories, each one characterized by a maximum budget ranging from a quarter of a million euros to fifteen million euros and above. In the recent past the firm must have successfully completed at least one project of the same type with a budget of at least forty percent the maximum ceiling of the category (art. 3 DPR 34/2000). This condition could be met both with projects for the government or for the private sector.

THEORETICAL CONSIDERATIONS

All subjects placed bids in three activities: a high-stake, a medium-stake and a low-stake activity, which differed in the level of equilibrium earnings as well as in the level and type of risk.

The high- and medium-stake activities were common value auctions with identical rules, except for the level of the equilibrium earnings in dollars. In each period the item value x_0 was randomly drawn from a uniform distribution with upper and lower bounds $[50, 950]$. In each auction each bidder received a private information estimate, *x*, drawn from a uniform distribution on an interval centered on the actual item value $[x_0 - 15, x_0 + 15]$. The instructions illustrate this situation with the following example:



We implemented a first price sealed-bid auction procedure: the high bidder paid her bid amount b_1 and earned profits equal to $x_0 - b_1$. For risk neutral bidders the symmetric risk neutral Nash equilibrium (RNNE) bid function $f(x)$ is given by Kagel and Richard [2001]:[6]

$$f(x) = x - 15 + h(x), \tag{1}$$

where

$$h(x) = [30/(n+1)]\exp\{(-n/30)(x-65)\} \tag{2}$$

and *n* is the number of active bidders in the auction. This equilibrium bid function combines strategic considerations similar to those involved in first-price private value auctions, and item valuation considerations resulting from the bias in the estimate value conditional on the event of winning. We deal with the latter first.

In common value auctions bidders usually win the item when they have the highest, or one of the highest estimates of value. Define $\mathrm{E}[x_0 \mid \mathrm{X} = x_{1n}]$ to be the expected value of the item conditional on having x_{1n}, the highest among *n* estimate values, then

6. The Nash equilibrium solution and other theoretical aspects of common value auctions will be discussed only in reference to estimates in the interval $65 \leq x \leq 935$ (called region 2), where by design about 97% of the observations lie (Wilson [1977]; Milgrom and Weber [1982]). Within region 2, bidders have no end point information to help in calculating the expected value of the item.

Revue économique – vol. 67, n° 5, septembre 2016, p. 953-976

$$\mathrm{E}\left[x_0 \mid \mathrm{X} = x_{1n}\right] = x_{1n} - \left[\left(n-1\right)/\left(n+1\right)\right]15 . \tag{3}$$

This provides a convenient measure of the extent to which bidders suffer from the winner's curse since in auctions in which the high estimate holder always wins the item, bidding above $\mathrm{E}\left[x_0 \mid \mathrm{X} = x_{1n}\right]$ results in negative expected profit.[7]

In each activity there were $n = 5$ subjects, which previous studies suggest being sufficient for the winner's curse to emerge. With $n = 5$ the bid factor—defined as the signal minus the bid—that generates zero expected profits is 10.00, or approximately 67% of the total bid factor in the RNNE.[8]

The low-stake activity was a company takeover game where there was a buyer and a seller who moved sequentially (e.g., Samuelson [1984]; Casari, Zhang and Jackson [2016]). For this activity there is no competition with other subjects and no strategic risk. We used this auction environment to provide a bidding activity for bankrupt subjects and those who wished to avoid bidding in the interactive common value auctions. Similar to the common value auction, subjects who fail to condition on the event of winning may suffer from the winner's curse. This bidding activity thus allows us to assess subjects' general and initial propensities to overbid but in a simplified environment that eliminates strategic uncertainty and has smaller opportunities to gain and lower risk to lose money. In this auction the buyer made a take-it-or-leave-it offer $b \in \left[0, 36\right]$ to a computer seller whose company's value was s. The seller either rejected or accepted the bid. The payoff for the seller was s if she rejected and b if she accepted. The payoffs for the buyer were 0 if the seller rejected and $\left(1.5s - b\right)$ if she accepted. The company could have all possible values s between 6 and 24. When making a decision, the seller had private information about s, while the buyer only knew that each realization of s had equal probability. The computer seller accepted all bids greater or equal to the seller's company value.

Hence, the task was a bilateral bargaining problem against a computer with asymmetric information and valuations. The informational disadvantage of the buyer was offset by an assumption that the buyer's value was 1.5 times the seller value, s. A rational buyer had the following objective function (Holt and Sherman [1994]):

$$\text{Rational objective:} \quad \left(\frac{b-6}{24-6}\right)\left[1.5 \cdot \left(6 + \frac{b-6}{2}\right) - b\right] \tag{4}$$

A bid of 12 is optimal for the risk-neutral rational buyer who accounts for the selection effect arising from the fact that sellers only accept bids that exceed their valuation s. This bid yields an expected profit of 0.5.

7. This design mostly followed Casari, Ham and Kagel [2007]. Even with zero correlation between bids and estimate values, if everyone else bids above $\mathrm{E}\left[x_0 \mid X = x_{1n}\right]$, bidding above $\mathrm{E}\left[x_0 \mid X = x_{1n}\right]$ results in negative expected profit as well. As such, if the high estimate holder frequently wins the auction, or a reasonably large number of rivals are bidding above $\mathrm{E}\left[x_0 \mid X = x_{1n}\right]$, bidding above $\mathrm{E}\left[x_0 \mid X = x_{1n}\right]$ is likely to earn negative expected profit.

8. This approximation is based on the fact that within region 2 the RNNE bid function is essentially $f\left(x\right) = x - 15$, because the negative exponential term $h\left(x\right)$ in equation (1), approaches zero rapidly as x moves beyond 65.

EXPERIMENTAL PROCEDURES

Overview

The activities in each session are outlined in Table 1. Each session had 15 subjects who underwent an investment part, a training part, and a main part.

Table 1. *Session chart*

PART	REPETITIONS (Periods)	GROUP A	GROUP B	GROUP C
INVESTMENT	1	Risky task	Risky task	Risky task
TRAINING	1 + 3	Low	Low	Low
same for all	1 + 3	Medium	Medium	Medium
treatments	1 + 3	High	High	High
MAIN	5	Low	Medium	High
assignment of	5	Low	Medium	High
subjects to	5	Low	Medium	High
activities varies	5	Low	Medium	High
by treatment	5	Low	Medium	High

Note: Group composition could change after every block. Every line of the table is a block. Groups A + B + C = 15 participants, with 5 in each group.

Each session opened with a simple task to measure subjects' preferences toward risk, along the lines of Gneezy and Potters [1997]. Everyone chose an amount up to \$5 to place into a risky investment that yielded 0 or three times the invested amount with equal probability. The outcome of this risky investment decision was determined at the end of the session.

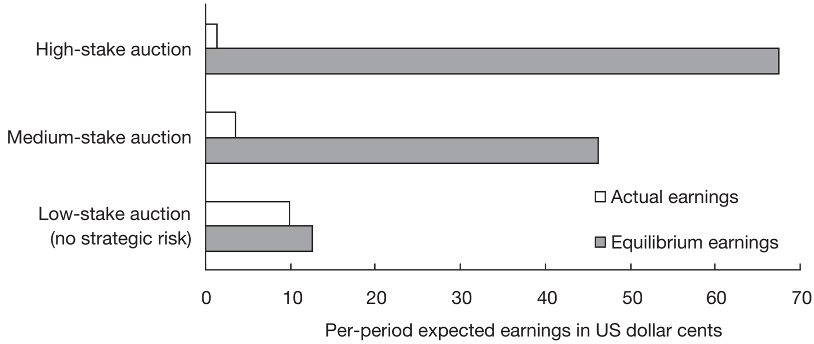
The training part was identical across treatments and aimed at familiarizing subjects with the various activities: low-stake, medium-stake and high-stake auctions. For each activity there was a sequence of one dry run (unpaid) period followed by three periods for profit. After each sequence, the participants were randomly divided into three independent markets with five bidders each. Subjects received full feedback at the end of each auction.[9]

The starting balance was \$10. In the low- and medium-stake activities, additional earnings in points were converted into dollars at a rate of \$1 for every 4 points. In the high-stake activity, the conversion rate was \$1 for every 2 points and each subject also received \$0.25 in every period. As a result, the high-stake activity yielded equilibrium earnings more than five times as large as the low-stake activity (Figure 1).[10]

9. In the medium- and high-stake auctions an admissible bid was any number between 0.00 and $x + 22.50$. This upper restriction on allowable bids was intended to prevent bankruptcies resulting from typing errors, while still permitting substantial overbidding. Bids could be specified in up to two decimal places. The instructions informed the subjects about the underlying distribution of s, x_0 and x. A copy of the instructions are included in the appendix.

10. This participation bonus does not change the optimal bidding strategy. It was necessary to make these auctions financially more attractive, since overbidding (documented below and throughout this common value auction literature) typically led to negative trading profits for the winning

Figure 1. *Equilibrium and actual earnings of the three possible activities*



Note: Average per-period earnings when placing a RNNE bid. The large and medium-stake auctions consider only region 2 and are based on the average gain of 4.25 points when winning plus the fixed bonus of 25 US dollar cents. Actual earnings are computed pooling all treatments (Table 2).

Treatments

The experiment involved three treatments, which differed in the way subjects were allocated into activities: random assignment, qualified entry, and voluntary entry. Five subjects bid in low-stake auctions, five in the medium-stake auction, and five in the high-stake auction. The allocation of participants into activities remained fixed for a block of five periods. At the start of every block subjects observed the list of all individual U.S. dollar profits earned in the previous block sorted by activity and without identities.[11] The rule to allocate subjects to activities varied by treatment and was explained after the training phase.

Under the Random Assignment treatment, subjects were reassigned to activities through independent *random draws* at the start of every five-period block.[12]

Under the Qualified Entry treatment, we assigned subjects to an activity according to a noisy measure of bidder ability based on past performance. All subjects in a session were ranked according to their *accumulated point earnings* at the start of every five-period block. This earnings ranking excluded the extra points assigned for merely participating in the common value auctions. The top five earners entered the high-stake auction, the bottom five earners entered the low-stake auction, and subjects ranked 6 to 10 were placed in the medium-stake auction. Any ties were broken randomly. The selection procedure was intended to place the more successful bidders (based on past performance) in the high

---

bidder. Before each activity of the training phase, an experimenter read aloud the instructions while subjects followed along on their own copy. At the conclusion of these initial instructions subjects answered five computerized quiz questions to test their instruction comprehension for that activity, and were paid $1 for each correct answer. Besides providing incentives for subjects to consider the instructions carefully, this quiz also provided explanations for any wrong answers.

11. In one of the 12 sessions, more than five bidders were bankrupt during six of the final periods. In that case, we reduced the market size of the medium-stake auction to four bidders, with the number of bidders always posted on subjects' computer screens.

12. In principle it was possible for a subject to be assigned to the same activity in all periods. In practice this never occurred, except for one subject who was bankrupt in all periods due to large losses during the training periods. This subject thus always bid in the low-stake auction.

value auction, similar to the good financial standing and successful bidding experience included in the qualification procedure for auctions in the field discussed in the section on selection in field auctions. Of course, the technical capability required for qualification is not a criterion relevant for a laboratory experiment. Past performance is partly due to luck, namely the randomness of the signals received. Past performance is also due in part to skill, such as the ability to avoid negative earnings and the winner's curse.

Under the Voluntary Entry treatment, subjects chose the activity for which they wanted to bid in for the upcoming five-period block. They stated their first, second and third choice, and the allocation algorithm provided subjects with the incentive to truthfully reveal their preferences over activities without interference from strategic considerations about over- or under-subscription of activities. The algorithm first placed five subjects into the high-stake auction. Subjects obtained their first choice whenever possible. Since the capacity was five bidders in each auction activity, sometimes an activity was over-subscribed. In such cases the assignment to the high-demand activities was randomly determined among those who ranked that activity highest. When an activity was under-subscribed, we next allocated those subjects who ranked that activity as second choice. Subjects who did not get their first choice were placed into their second choice whenever possible. If there were still slots available, we then considered also those who ranked it third choice. The algorithm then placed five subjects into the medium-stake auction following the same rules as above.[13]

Details

In all treatments, the number of bidders per high- and medium-stake auctions was held constant at $n = 5$ to preserve comparability of results.[14] We provide full feedback each period about the activity outcome. In the low-stake activity, after every period a subject observed the realized company value for the buyer, their period earnings in points, and their cumulative balance in dollars. In the medium- and high-stake activities, each auction involved new random draws for the true item value (x_0) and for item private estimates (x). All bids were posted from highest to lowest along with the corresponding estimate values as well as all individual profits (or losses) (bidder identification numbers were suppressed) and the value of x_0 .

13. Before proceeding to assign subjects to the medium-stake auction, the algorithm removed their preferences for the high-stake auction from their rankings since this auction was already filled. Bidders were placed into a common value auction that they least preferred in only two times (out of 261 non-bankrupt activity rankings). If a subject who could not get their first choice specified a common value auction as their second choice, then they were assigned this second choice when space was available. If a subject who could not receive their first choice instead indicated that the low-stake auction was their second choice, then they were placed in the low-stake auction unless the common value auctions did not yet have five bidders each.

14. For brief periods following bidder bankruptcies the bidder numbers fell below five. A subject is bankrupt if she had a negative US dollar cumulative balance. Because they are no longer liable for losses, bankrupt bidders may engage in irresponsibly high bidding. For this reason they were automatically assigned to the low-stake auction in all treatments. Cox, Dinkin and Swarthout [2001] find no evidence that limited liability increases the winner's curse. Since in our experiment some markets occasionally had fewer than five bidders, the number of bidders in the subject's market was always posted at the top of bidders' computer screens.

Revue économique – vol. 67, n° 5, septembre 2016, p. 953-976

We recruited 180 subjects by email using ORSEE (Greiner [2015]), drawn from the diverse student population at Purdue University. Each treatment involved 60 subjects divided into four sessions. The experiment was programmed and conducted with the software z-Tree (Fischbacher [2007]). No eye contact was possible among subjects during the experiment due to visual dividers between computer stations. Average earnings were $20.08 per subject (standard deviation $7.20). Sessions lasted less than two hours, including instruction reading, quizzes, and a post-experiment questionnaire.

RESULTS

Here we report five main results. The focus is on the voluntary and qualified entry into auctions with different stakes, and the random assignment serves as a baseline that replicates the standard procedure in auction experiments. This section is articulated into subsections that focus on the main treatment effects (Results 1-3), the impact of self-selection (Result 4), and the types of individual bidders (Result 5). Before presenting the main results, it is useful to comment on the patterns of bidder turn-over across the auctions. If the group composition is determined largely because of stable preferences for a specific auction, then there may be in little turn-over. A similar outcome may occur if the group composition depends on individual cumulative earnings, given that the high-stake auction generates higher potential profit. In the experiment, instead, the turn-over rates were generally high. In the Qualified Entry treatment only 20% of the bidders remained in the high-stake auction for the entire session, which is an average of one out of five bidders. This fraction was just 8% in the Voluntary Entry and 0% in Random Allocation treatment. Bidder selection was more effective in keeping subjects out of the high-stake auction. About 53% never entered it in the Qualified Entry treatment, 32% in Voluntary Entry, and 15% in Random Allocation treatment.

Main treatment effects

Self-selecting into their preferred activity is generally credited for improving agents' welfare. Our first result indicates, however, that assigning people to activities according to their revealed preferences made them worse off on average, despite preferences being elicited in an incentive-compatible way.

Result 1: The pooled profits from all activities were lower when subjects could voluntarily choose where to bid than in the other treatments.

Support: Table 2 reports the total profits earned by bidders. Subjects in the Voluntary Entry treatment on average earned over 20% lower profit compared to the other two treatments, and cross-sectional regressions shown in the appendix (with robust variance estimates clustering to account for intra-session correlation) indicate that these profits are significantly lower than the Qualified Entry treatment (p-value = 0.039) and marginally significantly lower than the Random Assignment control treatment (p-value = 0.075).

Table 2. *Mean period earnings (US dollars)*

Treatment	Low-stake auction	Medium-stake auction	High-stake auction	Sum of earnings
Random Assignment	0.148 (0.856)	0.033 (0.998)	0.055 (1.694)	+ 0.236
Qualified Entry	0.090 (0.818)	0.087 (0.936)	0.043 (1.482)	+ 0.220
Voluntary Entry	0.052 (0.844)	– 0.017 (1.021)	– 0.061 (1.796)	– 0.026
Treatments Pooled	0.099 (0.840)	0.035 (0.985)	0.014 (1.657)	+ 0.148

Note: Standard deviations shown in parentheses.

Many participants randomly assigned to a common value auction often placed bids with negative expected profits. The data are thus consistent with the literature documenting the winner's curse (Kagel and Levin [2002]). Our novel finding is that the frequency of these winner's curse bids increased in the Voluntary Entry treatment.

Result 2: When bidders voluntarily enter into the common value auctions, they suffered from the winner's curse more frequently than in the other treatments.

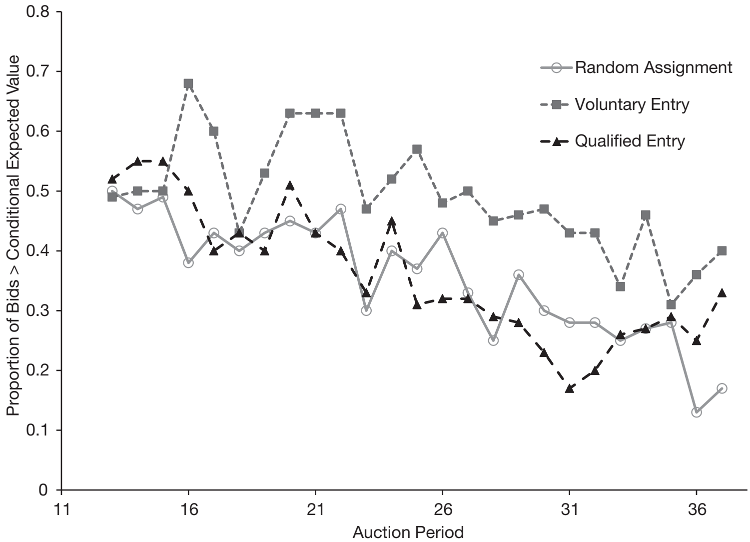
Support: Table 3 and Figure 2 provide support for Result 2. Table 3 summarizes the profits and frequency of winner's curse bids in the common value auctions for the three treatments (col. 1, 2 and 4, 5, respectively) based on the 25 periods following the initial training periods.

Table 3. *Summary statistics for common value auction by treatment*

	(1) Average profits (in tokens)	(2) RNNE Bid average profits (in tokens)	(3) Auctions won by bidder with x_{1n} (percent)	Percent of winner's curse bids, $b > \mathrm{E}[x_0 \mid X = x_{1n}]$	
				(4) All bidders	(5) High bidders
Random Assignment	– 1.64 (0.51)	4.91 (0.31)	57.8	35.8	66.5
Qualified Entry	– 1.54 (0.47)	4.91 (0.31)	67.5	36.6	55.3
Voluntary Entry	– 2.61 (0.58)	5.27 (0.36)	61.9	48.8	75.6

Note: b = bid, x_0 = item value, x_{1n} = highest private estimate, RNNE = Risk Neutral Nash Equilibrium. Only periods with five bidders, pooling medium-stake and high-stake auctions, and value draws in region 2 are included. (1) reports the average period profits of the winner in each treatment (including relevant participation points), with standard errors in parentheses; (2) displays the average profits that would be earned at the RNNE for the realized value and estimate draws, with standard errors in parentheses; (3) indicates the percentage of auctions in which the bidder with the highest estimate won the auction; (4) and (5) show the percentage of bids that are winner's curse bids, which are defined as bids that exceed the item's expected value conditional on being the highest estimate.

Figure 2. *Frequency of winner's curse bids*



The winner's curse frequency in the Voluntary Entry treatment is nearly one-half of the bids, compared to about one-third of the bids in the other two treatments (Table 3). In order to compare the bidding performance of the auctions across treatments, we focus on the propensity to submit winner's curse bids using standard panel data econometrics. In particular, we estimate Probit models to compare overbidding across treatments, using robust variance estimates that allow for intra-subject and intra-session correlation. Treatment differences are assessed through dummy variables. These estimates are reported in the appendix, and they indicate that the winner's curse frequency is marginally significantly higher in the Voluntary Entry treatment compared to the Random Assignment control treatment (p-value = 0.056) and compared to the Qualified Entry treatment (p-value = 0.081).[15]

The above comparisons refer to all bidders, but of course the directly payoff-relevant bids in a given period are the highest, winning bids. Here we consider winning bidders who bid above the conditional expected value and therefore suffered from the winner's curse (col. 5 of Table 3). Based on panel regression estimates shown in the appendix (with robust variance estimates for session clustering), we conclude that in the Qualified Entry treatment the 55 percent rate is significantly lower (p-value < 0.001) than the 76% rate in the Voluntary Entry treatment.

With experience, subjects learn to avoid in part the winner's curse but learning appears retarded in the Voluntary Entry treatment. Figure 2 shows that

15. Small differences across treatments exist in the training periods, but these bids occur before any treatment manipulations are introduced. The same statistical tests applied to these training periods never reveal any significant differences across treatments. This indicates that the random assignment of subjects to treatments worked properly.

the frequency of winner's curse bids starts at approximately one-half and then declines over time in all treatments. The decline starts earlier in the Qualified Entry and Random Assignment treatments, compared to the Voluntary Entry treatment where this frequency fluctuates upward in many early periods and remains near or above one-half of the bids until the final third of the session.

We now turn to performance under Qualifying Entry.

Result 3: In the Qualified Entry treatment, pooled profits were indistinguishable from Random Assignment. Only with respect to severe overbidding, in the Qualified Entry treatment bidders were marginally better.

Support: Tables 2, 3, and 4 provide support for Result 3. The difference in terms of pooled profits between the Qualified Entry and Random Assignment treatments was not significant (p-value = 0.367). In terms of overbidding frequency, the Qualified Entry treatment is marginally significantly lower than the 67% rate in the Random Assignment treatment (p-value = 0.084, Table 3). In addition to profits and overbidding, another measure of performance is the rate of bankruptcies. By the end of the session, 5% of bidders go bankrupt in the Qualified Entry treatment, which was significantly lower than the 13% in the Random Assignment treatment (p-value = 0.005) and the 18% in the Voluntary Entry treatment (p-value = 0.003).[16]

Table 4. *Accumulated profits and bankruptcy rates*

Treatment	Average cumulative profit in the final period	Percent of subjects bankrupt in the final period
Random Assignment	\$12.30 (\$1.20)	13.3 (8 of 60 subjects)
Qualified Entry	\$12.25 (\$1.05)	5.0 (3 of 60 subjects)
Voluntary Entry	\$9.70 (\$1.15)	18.3 (11 of 60 subjects)

Note: Standard error of the mean shown in parentheses. Subjects began session with \$10 endowment.

SELF SELECTION: WHO CHOOSES TO ENTER THE HIGH-STAKE AUCTIONS?

Recall that in the Voluntary Entry treatment, every five periods the non-bankrupt subjects ranked the three activities and entered into their most preferred activity whenever possible. When ranking activities, subjects' decision screens displayed the historical profit performance of individual bidders (shown anonymously) in each activity during the preceding block of periods. This information revealed that the high-stake auction exhibited the lowest average profit and the highest (variance) risk (Table 2), and therefore a subject who believes he would

16. These statistics are based on cross-sectional Probit models shown in the appendix, which cluster robust variance estimates that account for intra-session correlation.

achieve typical earnings should avoid it. Nevertheless, the high-stake auction was the first choice in 40% of bidders' rankings, the medium-stake auction was first choice in 32%, and the low-stake auction was the first choice the remaining 27%. This suggests that subjects focused on factors other than the mean and variance returns of the alternative bidding activities when choosing which auction to enter.

There exist several reasons to expect better performance of bidders in the Voluntary Entry compared to the Random Assignment treatment but also reasons to expect worse performance, depending on the type of bidders who voluntarily enter the auctions. For this exploratory study we offer for consideration the following six factors through which entry might affect the frequency of bankruptcies and winner's curse bids. Factors 1, 2, and 3 point toward improved performance and factors 4, 5 and 6 point toward detrimental effects.

First, confused subjects may avoid the high-stake common value auctions. Those subjects who did not understand the rules of the common value auction and are forced to participate in the Random Assignment treatment may opt to stay out in the Voluntary Entry treatment. Second, subjects with no prior auction experience may stay out. In the field, bidders in highly complex auctions are generally professionals who specialize and self-select into that activity. These factors are conjectures based on a notion of ambiguity aversion (e.g., Chen, Katuscák and Ozdenoren [2007]).

Third, subjects who plan to place "passive" bids may enter in greater numbers in common value auctions. A bid is passive when the aim is not to be competitive and win but instead to obtain the $0.25 participation payment awarded each period to bidders in the common value auction markets. This factor is specific for our experimental design and biases the experiment toward finding a better performance under the Voluntary Entry treatment. The experiment was calibrated to include this participation payment to maintain the attractiveness of the common value auctions in light of the large and systematic winner's curse. With the current design, this provides the opportunity for a small but risk-free payment each period for a bidder willing to bid passively. Thus, the average earnings by other aggressive bidders may be irrelevant for a subject who is considering a passive bidding strategy.

Fourth, subjects with greater tolerance for risk may enter in larger numbers into common value auctions and bid aggressively. This factor is also a conjecture as there is no theoretical result providing unambiguous impacts of risk attitude on bidding in common value auctions, but in some circumstances more risk seeking agents place higher bids (Kagel and Richard [2001]). Fifth, subjects who prefer contests and competition the most may enter more frequently into common value auctions. This factor is based on behavioral results that show how subjects' "joy of winning" is a component of the utility function in bidding activities (Cooper and Fang [2008]), even when it leads to negative earnings (Sheremeta [2010]). We posit that its influence is weakest in the low-stake auction because it does not involve a direct competition with other bidders. Sixth, overconfidence may also play role (Camerer and Lovallo [1999]). It is not the presence of overconfidence per se that can damage the performance of self-selection into activities but its correlation with abilities. If the degree of overconfidence is negatively correlated with the ability to bid, self-selection into the activities can make session participants worse off than random assignment.

To provide some initial evidence regarding these factors in mind, we next explore systematically what characteristics influenced subjects' decision on whether to enter the high-stake auction.

Result 4: Subjects who seek to enter the high-stake auction are more frequently male, have no previous experience in field auctions, have high cumulative earnings, and have avoided losses more frequently in previous common value auctions. Subjects who display a greater tolerance for risk are less likely to enter.

Support: Support for Result 4 comes from Table 5, which presents two Probit models of bidders' choice to rank the high-stake auction as their top choice. Model (1) includes as regressors the frequency of experienced losses and highest private estimates in earlier periods, and model (2) employs instead the subject's accumulated earning balance up to the period of entry choice. Since these earnings are endogenous, we use an instrumental variable approach that employs the frequency of receiving the high estimate in previous common value auctions and the period number as instruments for this variable. The results are consistent across both specifications.[17]

The increased entry likelihood for male subjects is consistent with research documenting men's greater willingness to enter competitions (e.g., Croson and Gneezy [2009]). The estimates also show that factors 2, 4, and 5 discussed above are significant in influencing voluntary entry, although not always in the expected direction. Consider first the evidence on factors expected to improve the performance of the Voluntary Entry treatment (1, 2, and 3). Confusion does not appear to play a significant role. Table 5 includes variables to capture subject comprehension and confidence, but none of these variables are significantly associated with high-stake auction entry.[18] The high-stake auction does not attract bidders that have more auction experience in the field; in fact, it is more likely to attract naïve bidders (i.e., those who report no auction experience in the field), which may be an important reason for the high rates of the winner's curse and bankruptcy in this Voluntary Entry treatment. Our initial conjecture goes in the opposite direction to the empirical evidence. A possible interpretation is that high risk aversion is associated to low cognitive ability (Dohmen et al. [2010]), which is relevant for bidding in a complex setting such as common value auctions.

Passive bidders exist but are few in number. A risk-free bid for the current parameters is one that is 15 experimental points or more below a subject's value estimate. Such bids are certain to lie at or below the true common value, but they won only 2 of the 300 high-stake auctions after the training periods. Such bids represent only 5.8% of all high-stake auction bids after training. This rate of risk-free bidding was much higher in the Voluntary Entry treatment (12.2%), however, compared to the Qualified Entry (1.8%) and Random Assignment (3.5%) treatments. This provides evidence that bidding in the common value auctions varied depending on how bidders selected into the alternative bidding activities.

17. These models exclude some other factors that are never correlated with auction preference, such as self-reported grade point average, class standing, and major field of study. We also include a dummy for only the final block of periods, since all other period block dummy variables were never statistically significant. Estimates of similar models for preference of the medium-stake auction do not reveal any significant explanatory variables, so we do not report them here.

18. To measure confidence, after reading the instructions for the allocation rules after the training periods were over, we asked subjects "How do you think you will rank in terms of earnings among all participants?" There were five possible options, ranging from being among the three highest earners to be among the lowest three earners out of group of fifteen. This "confidence" question was not incentivized.

Revue économique – vol. 67, n° 5, septembre 2016, p. 953-976

Table 5. *Probit models of preference for high-stake auction (Voluntary Entry treatment only)*

Dependent variable 1 = top preference for high-stake auction 0 = otherwise	Model (1)	Model (2)
Frequency of losses in previous common value auctions	– 1.00** (0.311)	
Frequency received highest value estimate in previous common value auctions	– 0.32 (0.215)	
USD earnings balance at time of ranking (instrumental variable)		0.17* (0.074)
High tolerance for risk (investing $4 or more out of $5 in risk task)	– 0.90** (0.349)	– 1.01** (0.329)
Perfect score on instructions comprehension quiz	– 0.17 (0.320)	– 0.22 (0.324)
Poor score on instructions comprehension quiz (below 80%)	– 0.54 (0.388)	– 0.04 (0.560)
Confident to be high earner in session (top 40%)	0.38 (0.416)	0.67 (0.534)
Confident to be low earner in session (bottom 20%)	0.25 (0.592)	0.71 (0.538)
Male	0.63* (0.286)	0.56* (0.278)
No field auction experience reported (e.g., eBay)	0.70* (0.315)	0.88** (0.304)
Final block of periods	0.38* (0.151)	0.06 (0.226)
Constant	0.32 (0.437)	– 2.30** (0.775)
Observations	261	261
Number of subjects included	57	57
Pseudo R-squared	0.154	

Note: Standard errors robust to clustering on subjects are shown in parentheses. ** $p < 0.01$, * $p < 0.05$ (two-tailed tests).

Consider now the evidence on factors expected to make the performance of the Voluntary Entry treatment worse (factors 4, 5, and 6). Subjects who are most willing to take on risk according to our separate risk assessment task, investing at least $4 out of their $5 stake in an attractive but risky investment, are significantly *less* likely to want to enter the high-stake auction. This is opposite to what was conjectured, but is consistent with the substantially greater frequency of passive and risk-free bids submitted in the Voluntary Entry treatment mentioned above, indicating that these are submitted by the more risk averse bidders who entered this auction. These passive bidders were not the cursed winners who suffered losses and sometimes went bankrupt.[19] The frequency of both winner's

19. We attempted to estimate similar models using only the subset of bidders who chose risk-free bids in a majority of the five periods in the block following their entry choice. Unfortunately, too few bidders satisfy this criterion for meaningful analysis.

cursed bids and risk-free bids is higher in the Voluntary Entry than in other treatments, which suggests that the high-stake auction attracts different types of bidders. Some cautious bidders enter but seek mostly to collect the high-stake auction participation payment rather than bid competitively, while some other aggressive bidders frequently suffer from the winner's curse perhaps due to lower cognitive ability. On balance the latter group tends to dominate since aggregate profits are lower and bankruptcies are higher in this treatment.

Types of individual bidders

The overall treatment comparisons reported above obscure substantial variation across individual subjects. Some subjects bid much higher than others and often go bankrupt, some overbid but do not always bid above the conditional expected item value, others bid closer to Nash equilibrium levels and avoid losses (but rarely win auctions), and a few subjects are passive and bid low, effectively withdrawing from the auction. In order to classify subjects into different types, we employ their median bid factor, where the bid factor equals to the bid minus the private estimate. This median is calculated considering all post-training common value auction bids submitted by each individual.

Table 6. *Classification of bidders into types*

	Average of median bid factor for type	Total in classification	*Classification* Random Assignment	*by* Qualified Entry	*Treatment* Voluntary Entry
(a) Conservative or withdraw	– 282.7	4	1	0	3
(b) About Nash: median bid within 1 of Nash	– 14.8	22	8	7	7
(c) Small overbid: median bid ≤ $\mathrm{E}\left[x_0 \mid \mathrm{X}=x_{1n}\right]$	– 11.7	70	27	26	17
(d) Winner's curse: $\mathrm{E}\left[x_0 \mid \mathrm{X}=x_{1n}\right] <$ median bid < own estimate X	– 6.0	62	19	17	26
(e) Strong winner's curse: median bid > own estimate X	3.1	9	4	1	4
(f) Percent of subjects classified in (d) and (e) (winner's curse bidders) in post-training periods			39.0	35.3	52.6
(g) Percent of bids submitted in post-training periods in common value auction by subjects in (d) and (e)			30.8	27.9	47.8

Note: Classification based on median bid factors in post-training periods when pooling medium and high-stake auction bids. Total number of classified subjects is 167, which submitted common value auction bids in the post-training periods. Of the 180 subjects who participated in the experiment, 13 always bid in the low-stake auction, often because they were already bankrupt during the training periods. Category b includes 21 subjects who fit the definition plus a 22nd subject who had a median bid factor of – 17.9. This individual could have also been included in the withdrawal group, and this reclassification would have no influence on the conclusions drawn here.

Based on median bid factors, we classified 167 subjects into five categories, which are shown in Table 6. A small group of bidders had median bid factors of less than – 28 and thus effectively withdrew from bidding. The risk neutral Nash equilibrium bid factor was around – 15, except for the infrequent cases of item values near the boundary of the value domain (outside of "region 2"). Bidders in category b had median bid factors within one unit of this level. The vast majority of bidders overbid compared to this benchmark, and our classification procedure divides them into those with a bid factor that implies typical expected winner's curse bids (bid factor > – 10; category d) and those who overbid by a smaller amount (bid factor ≤ – 10; category c).[20] A small number of subjects (category e) had positive median bid factors indicating bids that often exceeded their estimate. The lowest two classes d and e contain the subjects whose median overbid was large enough to exceed the conditional expected value, so they can be considered winner's curse bidders. The next result indicates that Voluntary Entry leads to more winner's curse bidders in the common value auction than does Qualified Entry.

Result 5: Bidders prone to winner's curse bids participate more frequently in common value auctions in the Voluntary Entry treatment than the Qualified Entry treatment.

Support: In the Voluntary Entry treatment about 52.6% of subjects are winner's curse bidders (row (f) in Table 6), which is not significantly different from the Random Assignment baseline (p-value = 0.285)[21], and is on the threshold of marginal significance compared to the 35.3% in the Qualified Entry treatment (p-value = 0.106). In the Voluntary Entry treatment nearly one-half of the bids submitted in the common value auctions were placed by individuals who were classified as winner's curse bidders (row (g) in Table 6); by contrast, only about 30% of the common value auction bids were submitted by such bidders in the other two treatments. The difference in these frequencies between Voluntary Entry and Random Assignment is not quite statistically significant (p-value = 0.158), but the difference between Voluntary Entry and Qualified Entry is significant (p-value = 0.034).

CONCLUSIONS

Bankruptcies and winner's curse are widespread and robust phenomena in common value auction experiments. Implications of these results for the field can be questioned because in naturally-occurring settings firms and individuals voluntarily enter when deciding to bid in auctions, and in many cases the auctioneer screens potential bidders in order to have only qualified participants. Qualifying bidding is especially important in procurement auctions, such as in public works projects. We report the first laboratory experiment on common value auctions

20. Individual median bid factors are highly correlated between the training periods and the post-training treatment periods (correlation coefficient = 0.85). Consequently, the bidder classification is similar in the training and the post-training periods. Individual subjects typically either remain in their same class or improve by one class, due to the general reduction in overbidding over time (illustrated in Figure 2).

21. The statistical tests reported in this paragraph are all based on Probit models shown in the appendix that employ robust variance estimates that allow for intra-session correlation.

that incorporates simplified versions of these entry mechanisms and study their impact on bidding behavior, profits, the winner's curse, and bankruptcies.

To date, there is no shared theoretical explanation for the observed winner's curse phenomenon, although it is likely linked to cognitive limitations in statistical reasoning (Kagel and Levin [2002]; Casari, Ham and Kagel [2007]). Here we study whether self-selection and individual learning are behavioral mechanisms that can lessen the winner's curse and the bankruptcy rate. The design is motivated by the rules observed in the field, not by theory.

We report two main findings. First, letting auction participants self-select into the activities without barriers to entry has null or negative consequences on performance. Voluntary entry actually increases the fraction of overbidders in common value auctions compared to the benchmark of random allocation of subjects to auctions and does not lower bankruptcy rates. This result is not due to more people entering into the auction, as we kept market size constant. Thus, voluntary entry does not improve auction performance over random allocation of bidders.

Second, qualifying entry—using simplified criterion similar to those that restrict participation in large field auctions—reduces winner's curse bidding only marginally in comparison to random assignment of subjects to auctions. This small behavioral difference arises even though some of the past performance in winning and profits earned is due to luck (i.e., the particular signal draws) rather than just skill at avoiding overbidding and the winner's curse. Qualification also reduces the frequency of bankruptcies, as expected, but without fully eliminating it.

Some general considerations are in order. Previous experiments under random assignment report the importance of aggregate improvements in bidding over time. Such improvements may originate from a combination of individual learning and survival of the smartest through avoided bankruptcies. One main conclusion of this study is that individual learning does not substantially differ under three different entry rules. Allowing participants to learn the logic of common value auctions with low-stakes and then eventually opting for a high-stake task does not seem to reduce the winner's curse. We also find that entry rules impact bankruptcy rates but not pooled profits. While qualified entry almost mechanically reduces bankruptcies, the level of "ecological" rationality of the market does not improve once a degree of freedom is added in terms of voluntary entry. Ex-ante one could postulate some about arguments to expect an improvement and others to expect a deterioration of performance. This study provides empirical evidence showing a net detrimental effect of self-selection in common value auctions. A larger sample of participants might have identified more precisely the type of self-selection at work. These arguments and explanations, though, remain exploratory since the topic of entry rules has largely been neglected by the theoretical literature on auctions.

In the field, qualifications for entry are both financial (as in the experiment) and technical. This study shows that purely financial criteria help in reducing bankruptcy rates but fail to select the most competent bidders. Whenever there is a common value component in auctions, regulations about technical and experiential requirements should also be a key element in restricting entry to bidders.

Experiments can complement field data in the study of common value auctions because they overcome the unobservability of the individual private estimate and, to a lesser extent, the true value of the object for each bidder. Consider for instance that most field auctions are hybrid with both a private and a common value components. The ideal field dataset to study the questions in this paper would be a pure common value good that is auctioned through a mechanism that undergoes an exogenous and unanticipated change in entry rules, while bidders remain constant in numbers and the underlying process generating estimates is unaffected. Although difficult to find, such a setting would help strengthen the external validity of this study.

REFERENCES

Armantier, O., Holt, C. and Plott, C. [2013]. "A Procurement Auction for Toxic Assets with Asymmetric Information," *American Economic Journal: Microeconomics*, 5 (4): 142–162.

Camerer, C., and Lovallo, D. [1999]. "Overconfidence and Excess Entry: An Experimental Approach," *The American Economic Review*, 89 (1): 306–318.

Casari, M., Ham, J. and Kagel, J. [2007]. "Selection Bias, Demographic Effects, and Ability Effects in Common Value Auction Experiments," *The American Economic Review*, 97 (4): 1278–1304.

Casari, M., Zhang, J. and Jackson, C. [2016]. "Same Process, Different Outcomes: Group Performance in an Acquiring a Company Experiment," *Experimental Economics*, 19, forthcoming.

Charness, G. and Levin, D. [2009]. "The Origins of the Winner's Curse: A Laboratory Study," *American Economic Journal: Microeconomics*, 1: 207–236.

Chen, Y., Katuscák, P. and Ozdenoren, E. [2007]. "Sealed Bid Auctions with Ambiguity: Theory and Experiments," *Journal of Economic Theory*, 136: 513–535.

Committee on Commerce [1998]. *Telecommunications Competition and Consumer Protection Act of 1998*, 105th Congress Report to the House of Representatives, 105–801, 2d Session, October 8. http://www.gpo.gov/fdsys/pkg/CRPT-105hrpt801/pdf/CRPT-105hrpt801.pdf.

Cooper, D. and Fang, H. [2008]. "Understanding Overbidding in Second Price Auctions: An Experimental Study," *The Economic Journal*, 118 (532): 1572–1595.

Cox, J., Dinkin, S. and Swarthout, J. [2001]. "Endogenous Entry and Exit in Common Value Auctions," *Experimental Economics*, 4 (2): 163–181.

Croson, R. and Gneezy, U. [2009]. "Gender Differences in Preferences," *Journal of Economic Literature*, 47 (2): 448–474.

Dohmen, T., Falk, A., Huffman, D. and Sunde, U. [2010]. "Are Risk Aversion and Impatience Related to Cognitive Ability?," *The American Economic Review*, 120 (54): 256–271.

Dyer, D. and Kagel, J. [1996]. "Bidding in Common Value Auctions: How the Commercial Construction Industry Corrects for the Winner's Curse," *Management Science*, 42 (10): 1463–1475.

Ertaç, S., Hortaçsu, A. and Roberts, J. [2011]. "Entry into Auctions: An Experimental Analysis," *International Journal of Industrial Organization*, 29 (2): 168–178.

Fischbacher, U. [2007]. "z-Tree: Zurich Toolbox for Ready-Made Economic Experiments," *Experimental Economics*, 10 (2): 171–178.

Foley, A. [2003]. *Multi-round Auctions for Institutional Real Estate Assets: Theory and Practice*. M.S. Thesis in Real Estate Development, Massachusetts Institute of Technology.

Gneezy, U. and Potters, J. [1997]. "An Experiment on Risk Taking and Evaluation Periods," *Quarterly Journal of Economics*, 112 (2): 631–645.

Greiner, B. [2015]. "Subject Pool Recruitment Procedures: Organizing Experiments with ORSEE," *Journal of the Economic Science Association*, 1 (1): 114–125.

Harstad, R. [1990]. "Alternative Common-Value Auction Procedures: Revenue Comparisons with Free Entry," *Journal of Political Economy*, 98 (2): 421–429.

Hausch, D. and Li, L. [1993]. "A Common Value Auction Model with Endogenous Entry and Information Acquisition," *Economic Theory*, 3 (2): 315–334.

Holt, C. and Sherman, R. [1994]. "The Loser's Curse," *The American Economic Review*, 84 (3): 642–652.

Ivanova-Stenzel, R. and Salmon, T. C. [2004]. "Bidder Preferences Among Auction Institutions," *Economic Inquiry*, 42 (2): 223–236.

Kagel, J. and Levin, D. [2002]. *Common Value Auctions and the Winner's Curse*. Princeton: Princeton University Press.

Kagel, J., Pevnitskaya, S. and Ye, L. [2008]. "Indicative Bidding: An Experimental Analysis," *Games and Economic Behavior*, 62: 697–721.

Kagel, J. and Richard, J. [2001]. "Super-Experienced Bidders in the First-Price Common-Value Auctions: Rules of Thumb, Nash Equilibrium Bidding, and the Winner's Curse," *Review of Economics and Statistics*, 83 (3): 408–419.

Levin, D. and Smith, J. [1994]. "Equilibrium in Auctions with Entry," *The American Economic Review*, 84 (3): 585–599.

McAfee, P. and McMillan, J. [1987]. "Auctions with Entry," *Economics Letters*, 23 (4): 343–347.

Merlob, B., Plott, C. and Zhang, Y. [2012]. "The CMS Auction: Experimental Studies of a Median-Bid Procurement Auction with Non-Binding Bids," *The Quarterly Journal of Economics*, 127 (2): 793–828.

Milgrom, P. and Weber, R. [1982]. "A Theory of Auctions and Competitive Bidding," *Econometrica*, 50 (5): 1089–1122.

Palfrey, T. and Pevnitskaya, S. [2008]. "Endogenous Entry and Self-Selection in Private Value Auctions: An Experimental Study," *Journal of Economic Behavior and Organization*, 66 (3-4): 731–747.

Plott, C. [2000]. "The FCC Rules for the 700 MHz Auction: A Potential Disaster," *Social Science Working Paper*, 1107, California Institute of Technology.

Samuelson, W. [1984]. "Bargaining Under Asymmetric Information," *Econometrica*, 52 (4): 995–1005.

Sheremeta, R. [2010]. "Experimental Comparison of Multi-Stage and One-Stage Contests," *Games and Economic Behavior*, 94: 731–747.

Singapore Building Construction Authority [2014]. BCA Contractors Registry, Registration Requirements, http://www.bca.gov.sg/ContractorsRegistry/contractors_registration_requirements.html.

Wilson, R. [1977]. "A Bidding Model of Perfect Competition," *Review of Economic Studies*, 44 (3): 511–518.

Wilson, R. [1992]. "Strategic Analysis of Auctions." In Aumann, R. and Hart, S. (eds). *Handbook of Game Theory with Economic Applications*, Vol. 1. Amsterdam: Elsevier Science, p. 227–279.

APPENDIX
PAIRWISE TREATMENT COMPARISONS FOR RESULTS SUMMARIZED IN TEXT

Treatment comparisons of per-bidder profits earned (Result 1)
Dependent variable = subject earnings

	Model (1)	Model (2)
Random Assignment treatment dummy	2.60^{+} (1.25)	
Qualified Entry treatment dummy		2.56* (1.01)
Constant	9.70** (0.67)	9.70** (0.67)
Observations	120	120
R-squared	0.021	0.023

Note: Omitted treatment is the Voluntary Entry treatment. Standard errors robust to clustering on sessions are shown in parentheses. ** $p < 0.01$, * $p < 0.05$, $^{+}$ $p < 0.10$.

Probit models of winner's curse bid frequency (Result 2)
Models 1 and 2: Dependent variable = 1 iff submitted bid is a winner's curse bid
Models 3 and 4: Dependent variable = 1 iff winning bid is a winner's curse bid

	Model (1)	Model (2)	Model (3)	Model (4)
Random Assignment treatment dummy	$– 0.33^{+}$ (0.17)		– 0.24 (0.22)	
Qualified Entry treatment dummy		$– 0.31^{+}$ (0.18)		– 0.55** (0.15)
Constant	– 0.03 (0.12)	– 0.03 (0.12)	0.68** (0.14)	0.68** (0.14)
Observations	1595	1670	319	334
Pseudo R-squared	0.013	0.011	0.007	0.033

Note: Omitted treatment is the Voluntary Entry treatment. Standard errors robust to clustering on subjects are shown in parentheses. ** $p < 0.01$, * $p < 0.05$, $^{+}$ $p < 0.10$.

Probit Models of Subject Bankruptcy (Result 3)
Dependent variable = 1 iff subject ends session bankrupt

	Model (1)	Model (2)
Random Assignment Treatment Dummy	0.53** (0.19)	
Voluntary Entry Treatment Dummy		0.74** (0.25)
Constant	– 1.64** (0.15)	– 1.64** (0.15)
Observations	120	120
Pseudo R-squared	0.035	0.063

Note: Omitted treatment is the Qualified Entry treatment. Standard errors robust to clustering on sessions are shown in parentheses. ** $p < 0.01$, * $p < 0.05$.

Probit Models of Bidder Type (Result 5)
Models 1 and 2: Dependent variable = 1 iff subject is classified as a winner's curse bidder (row f of Table 6)
Models 3 and 4: Dependent variable = 1 iff the bid is submitted in common value auction by a subject classified as a winner's curse bidder (row g of Table 6)

	Model (1)	Model (2)	Model (3)	Model (4)
Random Assignment treatment dummy	– 0.35 (0.32)		– 0.44 (0.32)	
Qualified Entry treatment dummy		– 0.44 (0.27)		– 0.53* (0.25)
Constant	0.07 (0.26)	0.07 (0.26)	– 0.05 (0.23)	– 0.05 (0.23)
Observations	116	108	1944	1966
Pseudo R-squared	0.014	0.022	0.022	0.032

Note: Omitted treatment is the Voluntary Entry treatment. Standard errors robust to clustering on sessions are shown in parentheses. ** $p < 0.01$, * $p < 0.05$

Revue économique – vol. 67, n° 5, septembre 2016, p. 953-976