Impact of the auction size in conservation auctions

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Abstract

Conservation auctions are a competitive mechanism to allocate contracts for environmental services to voluntary farmers. In this study, I rely on an online experiment to evaluate whether, to allocate a given number of conservation contracts, a buyer of environmental services should preferably conduct many small-scale auctions, or whether it is better to organize a single large-scale auction. We present three treatments with varying auction sizes ($N = 4, 8, 20$), but keeping the number of contracts awarded per bidder i.e., the level of competition (not all bidders can win a contract), identical in order to isolate only the effect of an auction's size on its performance. Our analysis was based on three performance measures: unit cost (that reflects cost-effectiveness), information rents rate, and allocative efficiency (that reflects the total cost of conservation measures to the society). The results show that as the size of the auction increases, its cost-effectiveness tends to improve, but there is a trade-off with allocative efficiency, which tends to decrease.

Keywords— Conservation auctions, Procurement auctions, Target constraint auctions, Auction size.

1 Introduction

Conservation auctions are procurement auctions designed to allocate contracts of payments for environmental services to voluntary farmers. The principle is that farmers who are ready to change their practices bid for agri-environmental contracts that offer payments in exchange for adopting environmentally friendly agricultural practices. The procurer, for example an environmental agency, aims to purchase the lowest cost (i.e., the lowest payment) contracts or those that provide the highest amount of environmental services relative to the payment. Conservation auctions are usually sealed-bid multi-unit reverse auctions with discriminatory payment (winners are paid their price), such as in the ecoTender in Australia (Stoneham et al., 2012; Rolfe et al., 2017) or Conservation Reserve Program (Hellerstein, 2017; Wallander et al., 2023). It has been highlighted in the literature that conservation auctions are more cost-effective than a fixed payment-scheme, i.e., the competitive auction mechanism allows purchasing more environmental services from a given budget than a fixed payment scheme would (Whitten et al., 2017). Indeed, there is an information asymmetry regarding contract implementation costs between the buyer and farmers (Ferraro, 2008). Putting farmers in competition with each other during conservation auctions decreases their informational rents. Nonetheless, the implementation of conservation auctions brings various challenges (Whitten et al., 2017; Bingham et al., 2021). For example, farmers' participation needs to be high enough to guarantee the cost-effectiveness of conservation auctions (Depiper, 2015), while it has often been observed to be quite limited in practice (Rolfe et al., 2021). The level and the nature of information revealed to bidders, including the budget size (Messer et al., 2017) or the targeted environmental benefits (Glebe, 2013), and pricing rules (Duke et al., 2017; Iftekhar and Latacz-Lohmann, 2017; Liu, 2021) are also found to be key factors that influence the cost-effectiveness of conservation auctions.

Empirical studies conducted on observational data from conservation programs often consider large scale programs, such as the Conservation reserve program or ecoTender. However, many auctions are also conducted at a much smaller scale (Rolfe et al., 2017; Whitten et al., 2017). The current paper aims to determine whether returns to scale can be achieved by increasing the size of an auction while keeping the proportion of bids accepted, i.e., the level of competition, constant. The study's objective isn't simply to examine the effect of participation on auction performance. Increasing the number of bidders obviously improves performance, all else being equal, partly because there's a greater chance that the lowest cost for the targeted number of units will be smaller, but also because it increases competition among bidders and should theoretically make them bid more aggressively (closer to their cost). Instead, we aim to observe the auction performance as N and M increase in proportion. This aspect has been largely overlooked in the literature, yet it holds significant relevance. The idea is that multiple small-scale programs may have comparable or shared environmental objectives, making it possible to combine them into larger programs. So we want to test the impact on the overall performance when combining several small-scale auctions into one larger.

In this paper we ask the following question: Does increasing the size of the auction, holding the level of competition constant, improve the performance of the auction? We employ three commonly used criteria to assess auction performance, as set out in the literature (e.g. Schilizzi and Latacz-Lohmann, 2007). The first criteria, which measure the cost-effectiveness, is the unit cost. This is the average cost to the buyer for each unit purchased. The second criteria is the information rent rate, which here stands for the share of program expenditures allocated to information rents payment. Finally, the allocative efficiency criteria determines whether the payment of winning bids is close to the lowest possible provision cost, so that the total cost of the program to society would be minimal.

To address our research question, this study relies on an online experiment with subjects from the general population, i.e., not exclusively farmers or students. The experimental protocol is decontextualized in order not to introduce a context to the subjects that they are not familiar with and therefore avoid introducing any bias. To keep the protocol as simple as possible, subjects are told that they have a single unit (of a virtual good) to sell and that they only compete on the payment they ask for their unit. However, in reality the payment is usually per hectare, and not all farmers are willing to commit the same area. In addition, it is assumed that units are all homogeneous, i.e., that they all provide the same amount of environmental benefit, which is another strong assumption that is not realistic in most agri-environmental programs. Here, we study target constraint auctions, where the procurer intends to purchase a predetermined number of units at the lowest possible cost and announces this target number to the bidders. We use the strategy method to collect subjects' bidding strategies over a range of induced cost values (see Coiffard et al., 2023). In this paper, the data from Coiffard et al. study is used for one treatment (4 bidders and 2 units), and 2 new treatments are proposed. This is a well-introduced method in experimental economics Mitzkewitz and Nagel (1993); Brandts and Charness (2011) and specifically in experiments on auctions (Rapoport and Fuller, 1995; Selten and Buchta, 1999; Güth et al., 2002, 2003; Kirchkamp et al., 2009; Katuščák et al., 2015; Mill and Morgan, 2022). The strategy method in experimental auctions involves asking subjects about their bidding strategy (for multiple cost levels) in a single round. In our experiment, every subject receives the same set of induced costs, and submits a bid price for each cost in a single round, i.e., each bidder must define his entire bidding strategy. To encourage subjects to make thoughtful decisions, this experiment is monetarily incentivized, so a cost will be randomly drawn for each subject at the end of the experiment to determine his payoff according to the bid submitted for that cost and that of the other bidders. For the analysis of this experiment, several groups of bidders are formed ex post in order to generate numerous observations of the auction results. Then, using the participants' bidding strategies I simulate, in each group, the possible outcomes of the auction for every arrangement of one cost drawn per subject. One of the key benefits of this method is that participants do not need to be connected at the same time.

Three treatments are presented here with three different group sizes, whereas the announced target constraint is adapted to keep the proportion of accepted bids (i.e., competition level) constant across treatments. The auction game and equilibrium bidding strategy are presented in section 2. Then in section 3, more details are given regarding the experimental protocol, and the performance criteria that are used to compare the auction's performance across treatments. Predictions are made using simulations in section 4 and results from the experiment are presented in section 5. Finally, we discuss results in section 6 and conclude in section 7.

2 Auction game and equilibrium bidding strategy

We consider a sealed-bid multi-unit reverse auction with N risk-neutral bidders, each with a single unit to sell. Each bidder i faces a private value of c_i to offer his unit. We assume that bidders are symmetric, their costs are drawn from the same probability distribution $F(.)$ on the interval $[\underline{c}, \overline{c}]$. Bidders submit bids b_i that are ranked by the auctioneer in ascending order of price with rank $(r), r = 1, ..., N$. In target constraint auctions, the procurer purchases units starting from the lowest rank value to the highest, until the desired number of units, i.e., the target constraint M, is obtained.

We apply a discriminatory (pay-as-bid) payment rule so that each winning bidder receives the bid he submitted as payment. Hailu et al. (2005) demonstrated that without any discretization of costs or bids, and assuming risk-neutral symmetric bidders, there exists a unique equilibrium bidding strategy. This bidding function taken from Hailu et al. (2005) is

$$b^*(c) = \frac{\int_c^{\overline{c}} uF(u)^{M-1}(1-F(u))^{N-M-1}f(u)du}{\int_c^{\overline{c}} F(u)^{M-1}(1-F(u))^{N-M-1}f(u)du}. \quad (1)$$

Figure 1 represents the equilibrium bidding strategies with costs ranging from 0 to 100, when $N = 4, 8, 20$ and $M = N/2$. Here, we observe that equilibrium bids decrease as the auction size (and the number of units purchased) increases, except for bids corresponding to extreme costs (0 and 100).

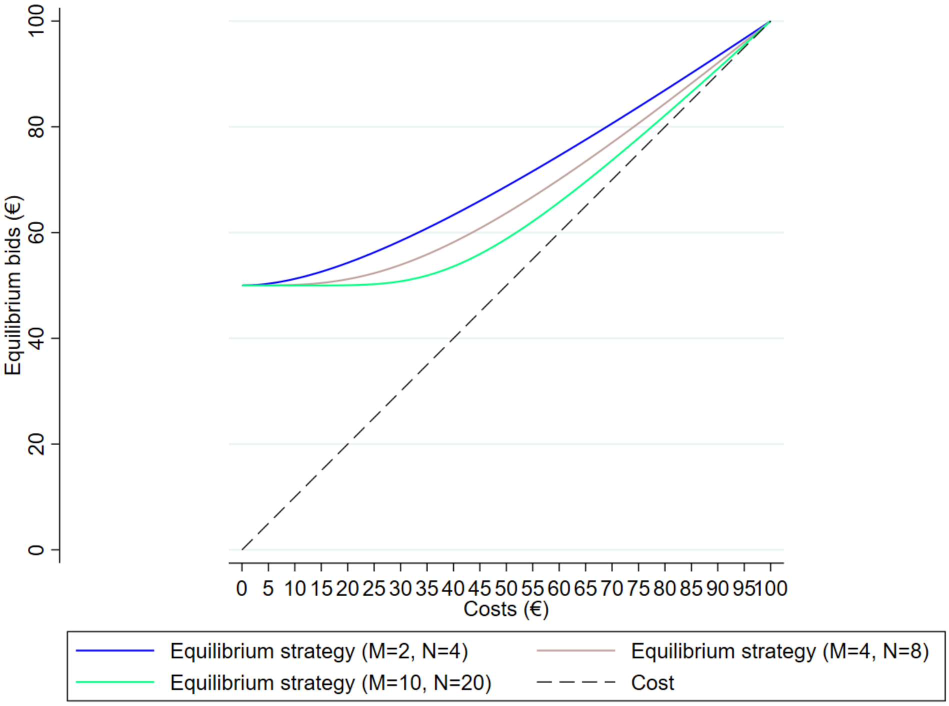


Figure 1: Equilibrium bidding strategies

3 Methods

In this article, I build on the work of Coiffard et al. (2023) to propose new treatments using the same experimental protocol, but investigating a different research question.

3.1 The strategy method

As in Coiffard et al. (2023), I use the strategy method to collect subjects' bidding strategies in a single experimental round. The approach involves participants stating their bids for multiple cost values induced at one time. In this study, we use discrete costs ranging from 0 to €100 in multiples of five. Therefore, each subject submits 21 bids corresponding to the 21 possible cost values (see figure 2). The cost distribution is chosen to be uniform in order to make it easier for subjects to understand the game as compared to the normal distribution. Finally, after each subject has completed the online experiment, groups of N bidders are randomly formed.

Your cost	Your selling price
0 €	€
5 €	€
10 €	€
15 €	€
20 €	€
25 €	€
30 €	€
35 €	€
40 €	€
45 €	€
50 €	€
55 €	€
60 €	€
65 €	€
70 €	€
75 €	€
80 €	€
85 €	€
90 €	€
95 €	€
100 €	€

Figure 2: Decision table

3.2 Experimental design

The experiment is based on a between-subject design with 371 subjects recruited on the FouleFactory plateform.[1] We conduct three treatments that are presented in Table 1. In accordance with our research question, we maintain a constant level of competition across treatments ($N/M = 2$). This enables us to exclusively examine the influence of auction size on auction performance. The auction groups are randomly constituted and independent so that each subject only appear in a single auction group. To this end, some subjects had to be randomly removed in each treatment to get multiples of N. Subjects receive a €2 base payment that is standard for completing a standard 15-minute survey. To encourage thoughtful responses, a cost value is assigned to each subject after the experiment to calculate potential extra earnings. If a subject's bid corresponding to his assigned cost value is among the lowest M bids in his group, this means that he succeeds in selling his unit and receives the difference between his bid and his cost as an additional payment.

Table 1: Presentation of treatments

Format	**N**	**M**	**Nb. subjects**	**Nb. groups**
N4	4	2	131	32
N8	8	4	126	15
N20	20	10	114	5

The instructions for the N4 treatment are shown in appendix A.1. Subjects were asked three comprehension questions (see appendix A.2) after watching the instructional video to check their comprehension and to highlight key points they needed to understand before completing the experiment. At the end of the experiment, we asked them some follow-up questions, including some sociodemographic questions (see appendix A.3). Finally, a sample description is provided in appendix B.

3.3 Evaluating auction performance

From the subjects' bidding strategies, it is virtually possible to simulate the auction outcomes for any group $g = 1, ..., G$ of N subjects and for any costs arrangement $k = 1, ..., K$. In practice, we are only able to run exhaustive simulations in the case of $N = 4$, since there are 194481 different possible costs arrangements. The two other cases were too demanding to be simulated exhaustively (21^8 and 21^{20}

[1] See https://www.wirk.io/en/50k-freelancers-in-france/ (former web address: https://www.foulefactory.com/en/)

possible costs arrangements without repetition) so we conducted simulations on 500,000 randomly drawn costs arrangements in each case.

We use three performance criteria to measure auction performance: the unit cost, the information rents rate and the allocative efficiency. The unit cost is the average price paid by the procurer by unit purchased. It is defined at one auction level (group g and set of costs k) by

$$UC_{gk} = \frac{B_{gk}}{M}. \tag{2}$$

where $B_{gk} = \sum_{r=1}^{M} b_{(r)gk}$ is the budget spent in that auction and M is the number of units purchased (i.e., the announced constraint). The unit cost is then averaged across all costs arrangements k within each group g, resulting in one mean value for each of the G independent groups.[2] Finally, these means are averaged across all groups to yield a single mean value at the treatment level such as

$$UC = \frac{\sum_{g=1}^{G} \frac{\sum_{k=1}^{K} UC_{gk}}{K}}{G}. \tag{3}$$

Let C_{gk} denote the total cost of winning bids, consisting of the individual winning bids, such as

$$C_{gk} = \sum_{r=1}^{M} c_{(r)}. \tag{4}$$

The share of the budget spent dedicated to the payment of information rents in group g and auction k is:

$$R_{gk} = \frac{B_{gk} - C_{gk}}{B_{gk}}. \tag{5}$$

The information rent rate, averaged at the group level and then at the treatment level, is :

$$R = \frac{\sum_{g=1}^{G} \frac{\sum_{k=1}^{K} R_{gk}}{K}}{G}. \tag{6}$$

Now we define C'_{gk} as the minimum total cost achievable with the given quantity of units purchased, such as

$$C'_{gk} = \sum_{i=1}^{M} c_{(i)} \tag{7}$$

with $c_{(i)}$ the cost corresponding to the i^{th}unit in ascending order of cost.

[2]For the three performance criteria, these group-level means are used as observations to perform the statistical tests.

To measure the allocative efficiency at the auction level (for group g and costs arrangement k), we define AE_{gk} as the ratio of the lowest possible total cost to the actual total cost, such as

$$AE_{gk} = \frac{C'_{gk}}{C_{gk}} \tag{8}$$

At the treatment level, the allocative efficiency is thus expressed as:

$$AE = \frac{\sum_{g=1}^{G} \frac{\sum_{k=1}^{K} AE_{gk}}{K}}{G}. \tag{9}$$

4 Theoretical predictions

We predict outcomes through numerical simulations, using exactly the same parameters as in our experimental protocol for auction group sizes of $N = 4, 8, 20$.[3] The only exception is that, to be consistent with theory, the cost distribution is continuous, i.e., costs can take any value between 0 and €100. This requires us to define a limited number of cost draws, which we set at 500,000 after verifying that this number is sufficient to ensure that the value of the results is stable at the rounding we choose for each criteria. The central assumption we make for the current simulations is that all bidders adopt the equilibrium bidding strategy corresponding to the given auction format. Those equilibrium bidding strategies are presented in section 2.

Table 2: Outcomes predicted using equilibrium bidding strategies in N4, N8 and N20 (500,000 draws in each case)

Format	**Unit cost**	**Rent rate**	**Allocative efficiency**
N4	59.98	0.525	1
N8	55.56	0.512	1
N20	52.38	0.504	1

Average values of simulated outcomes can be found in Table 2. We notice that as N (and M) increases the unit cost decreases, the rent rate decreases as well and the allocative efficiency stay constant to one, its maximum possible value.[4] From these predictions, we formulate the following three hypotheses:

[3]In the simulations, only one auction group per treatment is necessary as all bidders are assumed to have the same bidding strategy and to be cost symmetric.

[4]Indeed, since all bidders are assumed to bid the same, the auction winners will be those with the lowest costs.

H1: The higher the auction size, the lower the unit cost.

H2: The higher the auction size, the lower the rent rate.

H3: The auction size in treatments has no impact on the allocative efficiency.

5 Results

As a first result, we observe that the subjects' average bidding strategies (Figure 3) are very different from the theoretical equilibrium strategies (Figure 1). Examining the average bids from the experiment, the basic properties of equilibrium bidding strategies are also violated: convexity of the bidding functions and negative derivative of the bidding function with respect to N. Indeed, according to the theory, the difference between the bid and the cost (informational rents) is expected to be most significant when costs are at their lowest and then decline, initially rapidly and then gradually, until it reaches zero, i.e., the bidding functions should be convex. In fact, as shown in Figure 3, the average bidding strategies are nearly linear rather than convex, and the slope of the average bidding strategies exceeds one, indicating that in the experiment bidders demand lower information rents at the lowest cost values. Additionally, Figure 3 shows that bidders bid less aggressively on average in the N20 treatment than in the other treatments, while the average bidding strategies of N4 and N8 appear to be very similar.

The values for the three performance criteria in the experimental treatments are provided in Table 3, including the differences between treatments and their level of significance. The Wilcoxon Rank Sum Test was systematically used in this paper, with a continuity correction for ties, to perform statistical tests. First, we find that as N increases, UC decreases, which is consistent with our hypothesis H1. The only exception is for the comparison between N8 and N20, where this difference is not significant. Second, the rent rate (R) is found to be not significantly different across treatments, which contradicts H2. Third, we find that the allocative efficiency (AE) decreases as N increases, but only by a 10% significance level. However, this difference is not significant when comparing N8 and N20. This was not predicted by the theory, which suggests that allocative efficiency should not be affected by auction size (H3).

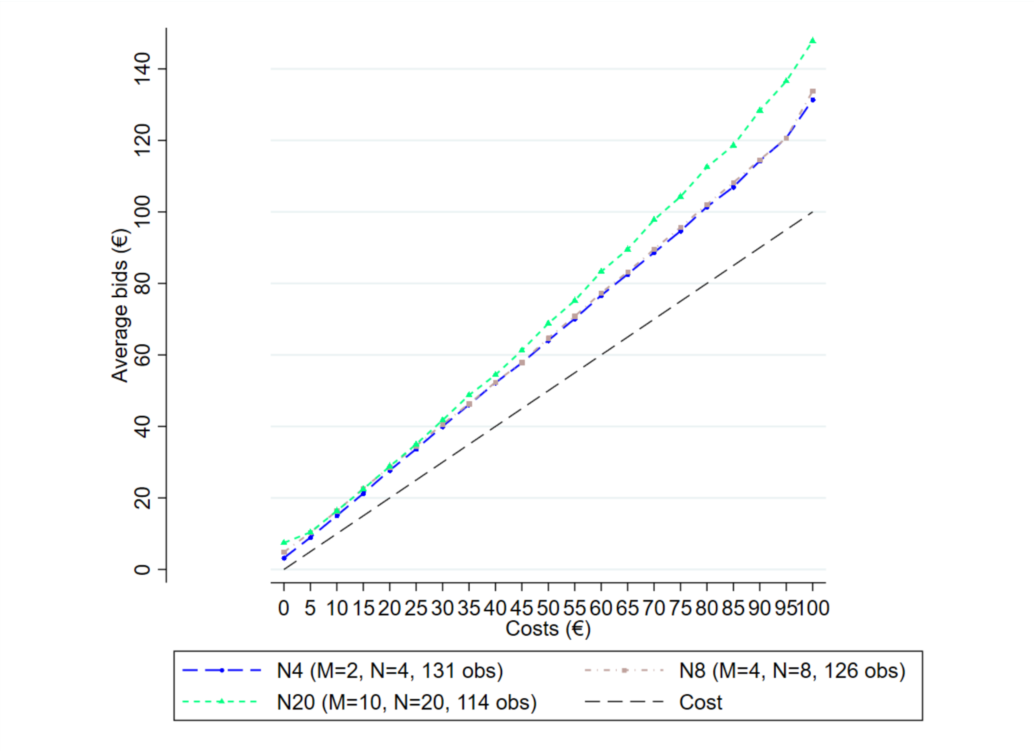


Figure 3: Average bids from the experiment in N4, N8 and N20

Table 3: Outcomes from the three treatments (N4, N8 and N20)

Outcome	**N4** (Nb.obs = 32)	**N8** (Nb.obs = 15)	**N20** (Nb.obs = 5)	***Diff.*** *N4 vs N8*	*N8 vs N20*	*N4 vs N20*
Unit cost	36.16 (3.28)	33.82 (2.45)	31.47 (1.21)	-3.336***	-1.35	-4.69***
Rent rate	0.197 (0.051)	0.185 (0.034)	0.192 (0.019)	-0.012	-0.007	-0.005
Allocative efficiency	0.973 (0.031)	0.956 (0.038)	0.943 (0.034)	-0.017*	-0.013	-0.030*

Standard deviations in parentheses.
Wilcoxon rank sum tests.
* p<0.1, ** p<0.05, *** p<0.01

6 Discussion

The vast literature on conservation auctions show that they can be more cost-effective than fixed payment schemes in allocating contracts for environmental services. However, this is context dependent (Whitten et al., 2017) and many aspects have been found to be critical for this better performance (Bingham et al., 2021). In this paper, we are interested in the case where similar environmental objectives are pursued in several locations, which may lead to the organization of either one large scale or several smaller scale auctions. It is also implicitly assumed that the distribution of costs is the same or at least similar in all these regions.

Our results show that, in line with H1, increasing the auction size tends to improve its cost-effectiveness when the auction size is increased from $N = 4$ to $N = 8$ (N4 and N8 treatments) or from $N = 4$ to $N = 20$ (N4 and N20 treatments). However, contrary to the simulated predictions, we do not find a significant difference between N8 and N20. A possible explanation for this is that, contrary to what theory predicts, subjects bid higher on average in the larger group size treatment, which tends to reduce cost-effectiveness. It is also likely that our study is underpowered, especially for the N20 treatment. The reason for this is that, in N20, it takes 20 subjects to increase the number of observations by 1, which would make it very costly to achieve similar sample sizes as in the N4 and N8 treatments. Another result is that the rent rate is not significantly different across treatments, which contradicts H2, whereas the allocative efficiency is found to decrease with the auction size (N4 vs N8 and N4 vs N20) at a 10% significance level, which is not consistent with H3. This suggests that there is a trade-off between cost-effectiveness and allocative efficiency. The present study yields two noteworthy observations. Firstly, it was observed that subjects tend not to behave as the theory predicts. In fact, average bidding strategies are close to linear rather than convex, and bids tend to stay at the same level or even higher on average as the auction size increases, even though the theory predicts that they would decrease. This is not surprising, as several experimental studies have found that subjects in experiments do not behave as the theory predicts (Cason and Gangadharan, 2005; Liu, 2021). One possible explanation could be that subjects are not risk-neutral, as the auction theory assumes. Secondly, the findings of the experiment indicate that although the average bidding strategies in N4 and N8 are similar, the unit costs decrease as the auction size increases. This could potentially be attributed to a mechanical effect of the auction format, i.e., the difference between the two treatments may not be driven by the bids, but by the format itself. A similar mechanical effect was found by Coiffard et al. (2023) when comparing target constraint ($N = 4$) and budget constraint ($N = 4$) reverse auction formats.

Next, most induced value auction experiments involve conducting several rounds to increase the number of observations, with one cost draw for each subject at each round (Schilizzi and Latacz-Lohmann, 2007; Boxall et al., 2017). This leads to two types of limitations. First, if the number of repetitions is low, the results may depend on randomly drawn costs. Second, there may be learning and wealth effects, leading to potential bias or noise in the data if auction results are communicated to the subjects after each round. In this online experiment, we used the strategy method instead to collect a discrete function of 21 bids for each subject in a one-shot setting (no repetitions). Next, we proceeded to simulate auction outcomes for each auction group using either all possible costs arrangements or a very large subsample of these arrangements, so that the results are no longer (or much less) dependent on cost draws.[5]

The agri-environmental context was not mentioned in this experiment to avoid introducing any bias, as the subjects were not farmers. In addition, we made a number of simplifying assumptions. For instance, bidders are assumed to be symmetric on costs and units are assumed to provide the same environmental benefits, whereas in practice both the provision costs and the environmental benefits are subject to heterogeneity. The range of costs and their uniform distribution were intended to simplify subjects' understanding, but may not be realistic. Finally, we must qualify our finding that a larger auction size, with a proportionally increased target constraint, leads to better cost-effectiveness. This assumption operates on the premise of zero transaction costs but, in reality, they may be higher for one large auction than for several smaller ones.

7 Conclusion

Conservation auctions have the potential to allocate payments for environmental services more efficiently than fixed payment schemes. Auctions are an attractive mechanism because, contrary to fixed payments, the regulator doesn't have to set the payment level. The auction mechanism presented here allows him to better deal with uncertainty about farmers' costs as well as heterogeneity in costs by putting them into competition and differentiating payment levels among farmers. Although conservation auctions present a vast and dynamic area of research, some of the parameters that influence their effectiveness remain to be studied. This work uses theoretical predictions and an online experiment to assess the effectiveness of implementing a single large-scale program versus multiple small-scale programs in achieving a given environmental objective. Results obtained suggest that expanding the scale of auctions enhances their cost-effectiveness (lower unit cost obtained for a given global environmental target). As such, it is recommended that conservation auctions be conducted at the largest feasible scale and that agri-environmental programs pursuing similar objectives pool their resources to organize a single auction whenever possible. However, it is crucial to take into account the transaction costs associated with organizing any large-scale program, which we have not considered in this paper.

[5]The computation time grows exponentially as the group size increases. This is why we had to use a subset of 500,000 costs arrangements for treatments N8 and N20.

A Content of the experiment

A.1 Instructional video for Target treatment (Translated slides from French to English)

Welcome !

This **experiment** is being conducted by researchers as part of a public research project to study decision making.

In this experiment you will have the **opportunity to earn money** in addition to the fixed participation payment.

1

The additional ***gain*** will depend on your decisions, as well as the decisions of other participants involved in this experiment.

We ask you to pay close attention to the instructions provided.
They should allow you to understand your role in the experiment.

2

This survey is entirely **anonymous**.

The researchers will not be able to link your identity to your decisions.

In this experiment, **groups of 4** participants will be randomly formed.

Other participants will not be able to identify you and you will not be able to identify them.

You are a seller and we (the researchers) are the buyer.

3

We are forced to use a neutral and abstract context in order not to influence your answers.

Each participant is invited to sell **1 unit** of a good.

1 unit =

The 4 units offered in each group (1 unit for each seller) are perfectly identical.

= = =

4

Your task is to propose selling **prices** (in euros) for your unit based on its **production cost**.

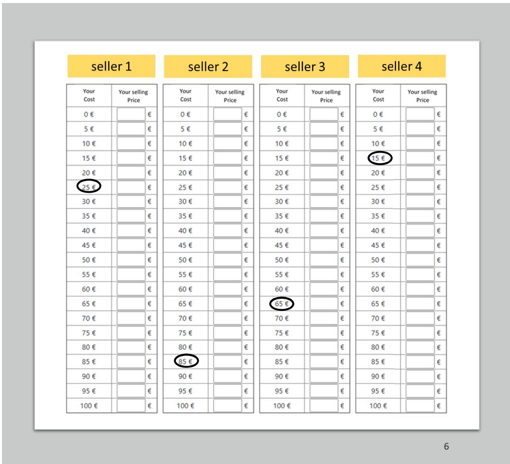
To this end, you must complete this table which contains all the possible production ***costs*** for your unit.

These ***costs*** range from 0€ to 100€ in 5€ increments.

Your Cost	Your selling Price
0 €	€
5 €	€
10 €	€
15 €	€
20 €	€
25 €	€
30 €	€
35 €	€
40 €	€
45 €	€
50 €	€
55 €	€
60 €	€
65 €	€
70 €	€
75 €	€
80 €	€
85 €	€
90 €	€
95 €	€
100 €	€

5

Once all sellers have completed their table,

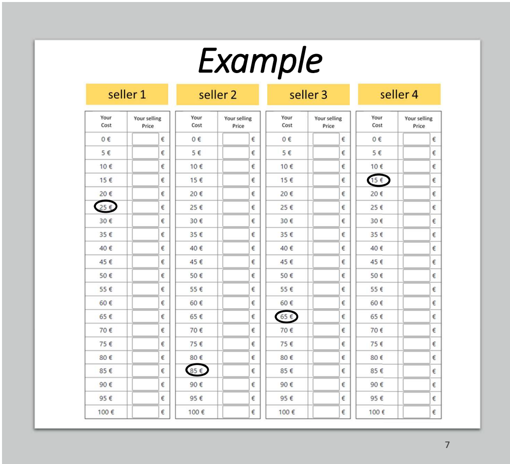


seller 1		seller 2		seller 3		seller 4	
Your Cost	Your selling Price	Your Cost	Your selling Price	Your Cost	Your selling Price	Your Cost	Your selling Price
0 €	€	0 €	€	0 €	€	0 €	€
5 €	€	5 €	€	5 €	€	5 €	€
10 €	€	10 €	€	10 €	€	10 €	€
15 €	€	15 €	€	15 €	€	15 €	€
20 €	€	20 €	€	20 €	€	20 €	€
25 €	€	25 €	€	25 €	€	25 €	€
30 €	€	30 €	€	30 €	€	30 €	€
35 €	€	35 €	€	35 €	€	35 €	€
40 €	€	40 €	€	40 €	€	40 €	€
45 €	€	45 €	€	45 €	€	45 €	€
50 €	€	50 €	€	50 €	€	50 €	€
55 €	€	55 €	€	55 €	€	55 €	€
60 €	€	60 €	€	60 €	€	60 €	€
65 €	€	65 €	€	65 €	€	65 €	€
70 €	€	70 €	€	70 €	€	70 €	€
75 €	€	75 €	€	75 €	€	75 €	€
80 €	€	80 €	€	80 €	€	80 €	€
85 €	€	85 €	€	85 €	€	85 €	€
90 €	€	90 €	€	90 €	€	90 €	€
95 €	€	95 €	€	95 €	€	95 €	€
100 €	€	100 €	€	100 €	€	100 €	€

6

Once all sellers have completed their table,

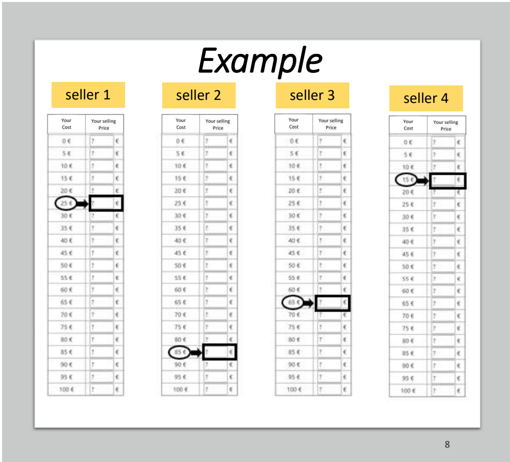
a production ***cost*** will be drawn randomly for each seller.



Once all sellers have completed their table,

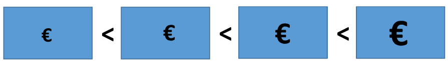
a production ***cost*** will be drawn randomly for each seller.

Then each seller's corresponding bid ***price*** for this ***cost*** will be looked up in their table.

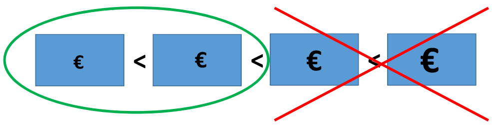


Game rules

The buyer will rank the 4 units offered in your group in ascending order of ***price*** (from lowest to highest).



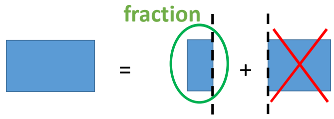
In each group, the buyer will buy the **2 least expensive units**.



9

In case of a tie

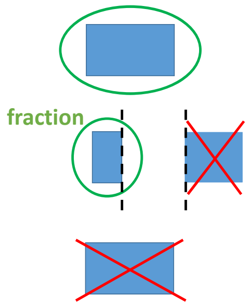
between several sales ***prices*** in the same group, these units will be divided by the buyer.



In this case, he will buy the same fraction of a unit from each of the ties.

10

Calculating your earnings



- If your entire unit is purchased:
  gain = price - cost

- If a fraction of your unit is purchased:
  gain = fraction × (price - cost)

- If your unit is not purchased:
  ***gain* = 0€**

You don't need to pay the cost of producing your unit if you can't sell it.

11

Remarks

- The ***cost*** that will be drawn at the end of the experiment to calculate your earnings does not depend on the ***cost*** of the other sellers.

- Each production ***cost*** in the table has the same chance of being drawn.

12

For each possible production ***cost,*** you should ask yourself :

*« For this production **cost**, what is my selling **price**? »*

At this point, you do not know the production costs or the prices that the other 3 sellers will offer.

Each ***price*** should be rounded to the nearest euro and be greater than or equal to the ***cost*** of production.

Your Cost	Your selling Price
0 €	€
5 €	€
10 €	€
15 €	€
20 €	€
25 €	? €
30 €	€
35 €	€
40 €	€
45 €	€
50 €	€
55 €	€
60 €	€
65 €	€
70 €	€
75 €	€
80 €	€
85 €	€
90 €	€
95 €	€
100 €	€

13

Only those who succeed in selling their unit (or fraction of a unit) will receive their ***earnings***.

Before filling in the table,

please answer 3 questions in order to better understand the experiment.

Your answers to these questions will have no impact on your earnings!

After completing the table, you will be asked to answer a short final questionnaire.

During the experiment you can review the instructions at any time by clicking on this button:

See the instructions

14

A.2 Comprehension questions

True/False about the experiment

1. The production cost drawn at random will necessarily be the same for all 4 vendors in your group.

The answer is **"False"** because the production costs are randomly drawn independently for each vendor. It is therefore highly unlikely that the 4 costs drawn within a group are identical.

2. When you must set a bid for each row in the table, you know the cost of producing your unit. However, you do not know the cost that will be used to calculate your profit.

The answer is **"True"** because when you set a selling price this price is necessarily associated with a production cost. However, only one cost (one row in the table) will be **drawn** to calculate your win.

3. You are in competition with other sellers in your group.

The answer is **"True"** because if at least 2 other sellers in your group offer a lower price than yours you will not be able to sell your unit and your gain will be 0€. You will therefore have to make a compromise according to your preferences between asking a high price to potentially earn more or offering a lower price to increase your chances of winning (selling your unit).

A.3 Final questions

1. Was it easy for you to choose a price for each cost? From 0: not at all (I chose randomly) to 10: yes completely (I am sure of my choices)

2. Are you generally a risk-taker or do you try to avoid taking risks as much as possible? From 0: avoid taking risks as much as possible, to 10: very comfortable with the idea of taking risks

3. Age:

4. Gender:
Male
Female

5. What is your highest education level? (adapted from French education grade levels)
No high school diploma
High school diploma
Associate's degree
Bachelor's degree
Graduate studies

6. Individual monthly income before income tax:
Less than €1100
Between €1100 and €1899
Between €1900 and €2299
Between €2300 and €3099
Between €3100 and €3999
Between €4000 and €6499
More than €6500
Do not wish to answer

7. What is your socio-professional category?
Farmers
Craftsmen, retailers, entrepreneurs
Executives and higher intellectual professions
Employees
Students
Retired
Unemployed

B Sample description

General subject demographics for the experiment are shown in Table 4.

Table 4: Sample description

Sample description	**Value**
Number of subjects	371
Age (sd in parenthesis)	38.99 (13.69)
Income (proportion €1900 or more)	0.40
Gender (proportion female)	0.51
Education (proportion bachelor or beyond)	0.50
Student (proportion of students)	0.12

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