The role of mandatory and voluntary joint bidding in promoting efficiency in conservation auction

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Provision of Ecosystem services: Some Challenges

- To produce monetary values for Environment: Payment for Environmental Services (PES).
- To obtain efficiency in biodiversity conservation.
- To integrate and to promote interactions between actors.

Provision of Ecosystem services: Some Challenges

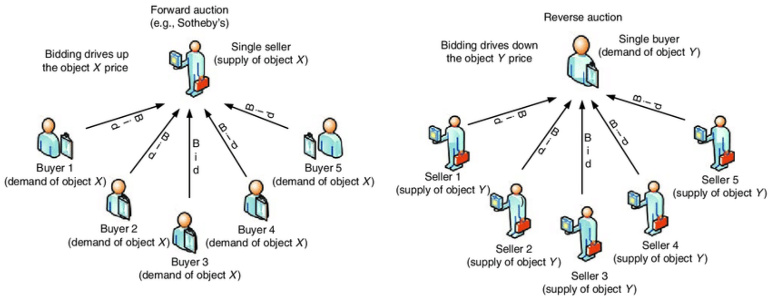
- Target conservation areas and conservation measures
  - A joint question/work with ecologists (Calel, 2012).
  - Identification of producers' land use.
- Joint participation: Spatial coordination of groups of producers.
  - Communication: Effective & clear information plus a good understanding of conservation measures to build trust and develop acceptance.
  - Cooperation ("International cooperation to promote green growth", OECD)

Provision of Ecosystem services: Some Challenges

- Designing Incentive Policies:
  - Payment for Ecosystem Services (e.g. Biodiversity Conservation).
    - A key policy instrument.
    - Farmers, forest owners, producers, suppliers... are more willing to participate if they are more informed.
  - Agglomeration bonus.
  - Spatially-connected auctions.
- Following Efficiency or Equity.
  - Efficiency vs equity: a real dilemma?

Introduction

Conservation auction



- Conservation auction is a reverse auction.
  - Auctioneer: policymakers (e.g., GOs, international GOs or NGOs).
  - Bidders: agricultural producers (e.g., forest owners).

[1] Figure obtained from Chen, C. M., & Bailey, M. D. (2018).

Introduction

Joint bidding auction

- Single bidding: each bidder submits single bid.
- Joint bidding: two or more bidders submit a single bid.
- Existing literature on the role of joint bidding in conservation auction.
  - A simulation study: joint bidding could be preferable since it helps reduce payment for taking conservation measures if the environmental externalities are positive (Calel, 2012).
  - Decontextualized lab experiment: joint bidding could improve environmental outcomes but it can be **less cost-effective** (Banerjee et al., 2021).
- Our study: role of joint bidding, voluntary vs. involuntary, communication and bonus payment incentives.

Model and hypotheses

Single bidding conservation auction

- An agricultural producer i (or a forest owner) has an environmental good (e.g., a parcel of forest land) with an environmental value v_i.
- Decision: to consume her good (e.g., cut down trees) or to sell it to a policymaker as an ecosystem service (ES). Opportunity cost is denoted as c_i.
- Participating into an auction: each bidder submits a single bid b_i based on his or her private information and the buyer (i.e. the auctioneer) select items (ES) that maximize his or her payoff.

Model and hypotheses

Joint bidding conservation auction

- Two land managers (e.g., forest owners) locate in a relatively cohesive geographical area.
- Environmental externalities η: one's effort has external effects on his or her neighbors (i.e., spatial issue).
- If conservation efforts (e.g., biodiversity conservation) generate **positive externalities** $\eta > 0$, encouraging coordination or collaboration is important (i.e., spatial coordination).
- How to promote spatial coordination?
  - **Agglomeration bonus**: one could earn an amount of payment if his or her neighbors put efforts in ES conservation.
  - **Joint participation/joint bidding**: two or more ES producers collaborate together to achieve the conservation target.

Single- and joint-bidding conservation auction

$$E[\pi_i^S(p_i)] = (p_i - c_i)Pr[x_i = 1]. \qquad (1)$$

- expected payoff in a single bidding and winning case

$$E[\pi_{i,d}^J(p_{i,d})] = \frac{1}{2}\left(p_d - \sum_{i \in d} c_i\right) Pr[x_d = 1]. \qquad (2)$$

- expected payoff in a mandatory joint bidding and winning case of the team d

Single- and joint-bidding conservation auction

$$\max_s V(x_s) = \sum_s \frac{v_s + b_s}{p_s} x_s, \quad (3)$$

$$s.t., \sum_s p_s x_s \leq W, \quad (4)$$

- the regulator's program - CES (Cost-Effectiveness Score)

$$E[\pi^J_{i,d}(p_{i,d})] \geq E[\pi^S_i(p_i)]. \quad (5)$$

- preferences for joint bidding

$$E[\pi^J_{i,d}(p^J_{i,d})] = \frac{1}{2}\left(p^J_d + \sum_{i \in d}(b_i\delta - c_i)\right) Pr[x_d = 1]. \quad (6)$$

- expected payoff in case of bonus payment in a team d

- **Hypothesis 1**: Joint bidding could be more efficient than single bidding in promoting auction efficiency.
- **Hypothesis 2**: Bidders with lower values and higher costs are more likely to join a team than other counterparts.
- **Hypothesis 3a**: A bonus payment could incentivize joint bidding participation.
- **Hypothesis 3b**: A bonus payment could encourage higher auction efficiency.
- **Hypothesis 4**: Communication during the experiment could positively impact joint bidding auction efficiency.

Experimental design

Treatments

	Single bid (baseline)	Joint bid	
		Involuntary	Voluntary
Treatment	No treatment (T0)	No communication (T1)	Communication (T3)
		Communication (T2)	Communication and Bonus payment incentive (T4)

Figure: Four treatments and one control treatment (baseline).

Experimental design

- Contextualized: each subject has a parcel of forest land to harvest or conserve for biodiversity.
- 10 subjects per treatment and control.
- Each subject participates in an 8-periods auction game.
- Subjects will receive a different and symmetric set of items and be assigned to different teams with different partners across periods ("perfect strangers").
- A total of 300 students at the University of Strasbourg were recruited for the experiment from February to March 2022 (60 subjects per treatment).

Experimental design

- Part 1: Risk elicitation task (Eckel and Grossman, 2008).
- Part 2: Ultimatum game to capture the level of fairness (i.e., degree to which players care about inequality) or other-regarding preference (Blanco et al., 2011).
- Part 3: Auction game.
- Part 4: Survey questionnaires.

Experimental design

Auction game

- Single bidding auction: 10 bidders bid individually.
- Joint bidding auction:
  - Subjects are randomly assigned into team of two.
  - They receive their private information and their partners' ones (i.e., cost, value and bonus).
  - **Voluntary**: Decide to joint a team.
  - **Communication**: Each member in a team has **two minutes to discuss** with his or her partner via a chatbox.
  - Subjects will be invited to give a bidding price for their team.
  - The average/mean price will be the joint bidding price.
- How are winners selected? Discriminatory pricing rule.
- selection of the 4 highest CES in every auction round

Results 1

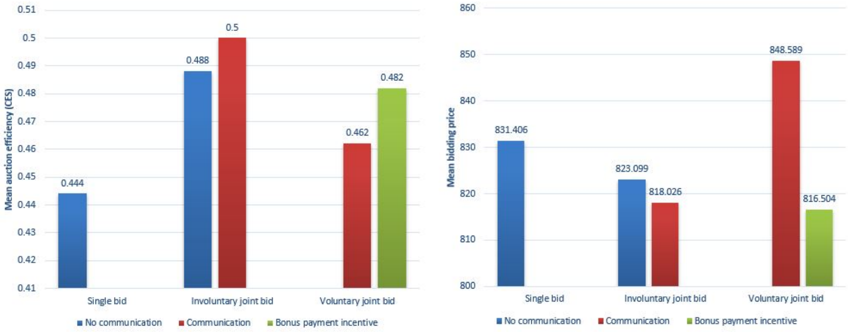


Figure: Histogram of mean auction efficiency (CES) and bidding price.

- More efficient bids in joint bidding than in the baseline (single-bidding auctions).
  $\Rightarrow$ higher CES
  $\Rightarrow$ lower bidding prices
- Mandatory bidding performs better than voluntary ones
  $\Rightarrow$ improved efficiency (T2 vs T3)
- Communication improves efficiency (T2 vs T1)
- Bonus partially improves efficiency in voluntary bidding with communication (T3 vs T4) : bidding prices but not CES

Results- Level of bids

		Mandatory		Voluntary	
	Full sample	No communi-cation	Communication	Communication	Communication & Bonus
Variables	(1)	(2)	(3)	(4)	(5)
Value	0.087***	0.101***	0.029***	0.101***	0.101***
	(0.016)	(0.016)	(0.008)	(0.016)	(0.016)
Cost	-13.388***	-11.803***	-11.104***	-12.609***	-11.611***
	(3.014)	(3.069)	(1.536)	(3.045)	(3.066)
$Cost^2$	1.039***	0.921***	0.876***	0.982***	0.907***
	(0.226)	(0.230)	(0.115)	(0.228)	(0.230)
Bonus value	0.001***	0.0004***	0.0005***	0.0004***	0.0004***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Treatments					
Mandatory (Treatment T1)	-0.066***	-0.011**	-	-	-
	(0.015)	(0.005)			
Mandatory & Com (Treatment T2)	-0.080***	-	-0.015***	-	-
	(0.015)		(0.005)		
Voluntary & Com (Treatment T3)	-0.015	-	-	0.035***	-
	(0.012)			(0.007)	
Voluntary & Com & Bonus (Treatment T4)	-0.062***	-	-	-	-0.015**
	(0.013)				(0.007)
Intercept	49.289***	43.890***	41.770***	46.551***	43.223***
	(10.031)	(10.212)	(5.118)	(10.134)	(10.204)

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

Results

Table: Estimation results of joint decisions and probability of winning.

	Joint decisions		Winnings	
Variables	(6)	(7)	(8)	(9)
High value	-1.523***	-1.094***	2.093***	1.042***
	(0.257)	(0.350)	(0.235)	(0.305)
Low cost	-1.543***	-1.122***	2.220***	1.248***
	(0.259)	(0.348)	(0.208)	(0.268)
High value*Low cost	-	-0.921**	-	1.945***
		(0.429)		(0.412)
Bonus value	5.164	5.163	4.324***	4.650***
	(164.942)	(163.067)	(0.740)	(0.746)
Team	-	-	16.076***	17.080***
			(3.030)	(3.041)
Voluntary & Com & Bonus (Treatment T4)	0.184	0.219	-	-
	(0.272)	(0.274)		
Intercept	2.426	2.720	-2.152	-1.467
	(3.167)	(3.186)	(2.160)	(2.210)

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

Results

		Bidding item's value and cost			
		High value		Low value	
Mean probability (SD)	N	Low cost	High cost	Low cost	High cost
Treatment T3	489	0.575	0.800	0.853	0.916
		(0.496)	(0.401)	(0.350)	(0.277)
Difference-in-mean		-	0.225	0.278	0.341
P-value			$<$0.001	$<$0.001	$<$0.001
Treatment T4	489	0.694	0.924	0.858	0.900
		(0.462)	(0.265)	(0.351)	(0.301)
Difference-in-mean		-	0.230	0.164	0.206
P-value			$<$0.001	0.002	$<$0.001

Discussions and conclusions

- Joint bidding auction is more efficient than single bidding auction. **Hypothesis 1** is satisfied.
  $\Rightarrow$ Promote joint participation in conservation auction.
- A strategic situation: high-cost and low-value participants always have a lower probability of winning when they play as a single bidder than joining a team with their partner. **Hypothesis 2** is satisfied.
  $\Rightarrow$ Heterogeneities in subjects' profile matter!

Discussions and conclusions

- Bonus payment seems to be effective in encouraging subjects to submit more efficient bids. **Hypothesis 3a** is not satisfied, but **Hypothesis 3b** is satisfied.
  $\Rightarrow$ Adverse effects of bonus payment on auction outcomes leading to higher PES should be carefully considered!
- Communication helps facilitate coordination and improving overall auction efficiency. **Hypothesis 4** is satisfied.
  $\Rightarrow$ A well-designed joint bidding auction with communication is important!

Discussions and conclusions

- Voluntary joint bidding auction is less effective than the involuntary joint bidding auction in promoting auction efficiency.
- Subjects receiving a high-value and low-cost item (i.e., the best situation) are making rational bidding decisions by being more likely to play solo.
- The number of bidders participating in a voluntary joint bidding design is significantly lower compared to the mandatory design.
  $\Rightarrow$ The reduction in the number of joint bidding teams makes the auction efficiency ambiguous.

Going further...

- Improve the possibilities to:
  - communicate
  - collaborate
  - take into account the behavioral disparities between agents
- Continue to develop experiments investigating the performance of spatial conservation auctions
  $\Rightarrow$ Necessary to understand the distribution of agents and the way they interact and exchange according to environmental issues.

Provision of Ecosystem services: Some other Challenges

- Social acceptance of conservation measures; Adherence to common objectives and compliance: the drivers of motivations to participate to a program (Mitani. Y & Lindhjem. H, 2015).
- Obtaining a permanent change in consumers' behavior: new ways to behave.
- Designing Public Policies and adapt them to spatial and temporal variations.

Thank you for your attention!

Econometric specifications

$$Bid_i = \beta_0 + \beta_k \sum_{k=1}^{K} Treatment_k + \eta_l \sum_{l=1}^{L} Item_l + \lambda_m \sum_{m=1}^{M} Control_m + \epsilon_i, \tag{7}$$

$$Pr(Join_i = 1 | Treatment\_T4, Control_i) = F(\alpha_H High\_value \tag{8}$$
$$+ \alpha_L Low\_value + \alpha_{HL} High\_value * Low\_value + \alpha_{T4} Treatment\_T4$$
$$+ \gamma_m \sum_{m=1}^{M} Control_m).$$

$$Pr(Win_i = 1 | Team, Control_i) = F(\alpha'_H High\_value \tag{9}$$
$$+ \alpha'_L Low\_value + \alpha'_{HL} High\_value * Low\_value + \alpha'_{team} Team$$
$$+ \gamma'_m \sum_{m=1}^{M} Control_m).$$

Descriptive statistics

	Definitions	Mean	Std.Dev	Min
Dependent variables				
Bidding decision	Log of subjects' bidding price.	6.770	0.155	6.404
Joint decisions	=1 if a subject assigned to a Voluntary joint bidding auction decides to join a team with her partner.	0.815	0.387	0
Winnings	=1 if a subject wins the auction.	0.415	0.492	0
Explanatory variables				
Mandatory	=1 if a subject is assigned to a Mandatory bidding auction (Treatment T1).	0.20	0.40	0
Mandatory & Com	=1 if a subject is assigned to a Mandatory joint bidding auction with communication (Treatment T2).	0.20	0.40	0
Voluntary & Com	=1 if a subject is assigned to a Voluntary joint bidding auction with communication (Treatment T3).	0.20	0.40	0
Voluntary & Com & Bonus	=1 if a subject is assigned to a Voluntary joint bidding auction with communication and bonus payment incentives (Treatment T4).	0.20	0.40	0
Team	=1 if a subject is in a joint bidding team.	0.258	0.437	0
Bonus payment	Log of bonus payment.	0.623	1.552	0
Value	Log of environmental value.	5.668	0.249	5.303
Cost	Log of cost.	6.662	0.196	5.881
Bonus value	Log of bonus value.	2.680	1.937	0

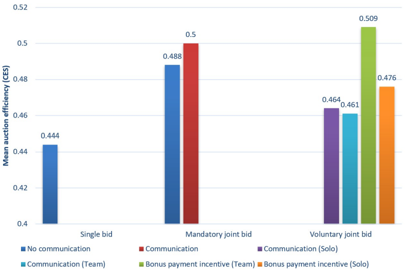
Descriptive statistics

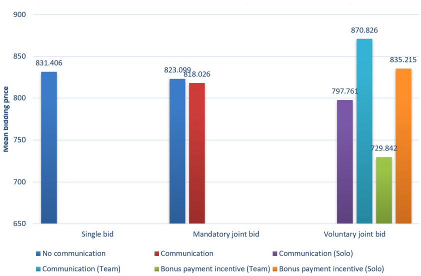
	Definitions	Mean	Std.Dev	Min	Max
Control variables					
Period	Experimental period.	4.50	2.29	1	8
Socio-demographic variables					
Female	=1 if an individual is female.	0.570	0.495	0	1
Age (in log)	Log of individual age.	3.084	0.139	2.890	3.689
Age (in years)	Individual age.	22.070	3.427	18	40
Psychological variables					
Environmental attitude	Aggregate score of 15 Environmental Attitude questions with Cronbach alpha = 0.6684.	44.390	4.786	31	57
Risk	Respondents' switching point in the risk elicitation task.	3.097	1.433	1	5
Altruism	=1 if respondents decided to give at least or more than one half of their initiate endowment to their partner.	0.453	0.497	0	1
Descriptive norm	=1 if respondents believed that most of their friends is taking actions to protect the environment.	0.780	0.414	0	1
Injunctive norm	=1 if respondents believed that the actions to protect the environment will be approval by most of their friends.	0.833	0.372	0	1

Other results

	Mean (SD)				
	T0	T1	T2	T3	T4
Environmental value	360.182	398.762	404.056	388.135	389.342
	(40.336)	(71.697)	(68.061)	(63.884)	(71.296)
Efficiency (CES)	0.444	0.488	0.500	0.462	0.482
	(0.084)	(0.072)	(0.079)	(0.073)	(0.074)
Bidding price	831.406	823.099	818.026	848.589	816.504
	(142.984)	(97.274)	(116.317)	(118.005)	(115.608)

Other results





Experiments

Lottery	State A (50%)	State B (50%)
1	5€	5€
2	7€	4€
3	9€	3€
4	11€	2€
5	13€	1€

Your decision :

Lotterie 3

Please choose your lottery number and validate your choice by clicking on the 'Validate' button.

Validate

Experiments

Your decision as an A player	
Proposal	**Earnings for A and B**
1	10€ for A and 0€ for B
2	9€ for A and 1€ for B
3	8€ for A and 2€ for B
4	7€ for A and 3€ for B
5	6€ for A and 4€ for B
6	5€ for A and 5€ for B
7	4€ for A and 6€ for B
8	3€ for A and 7€ for B
9	2€ for A and 8€ for B
10	1€ for A and 9€ for B
11	0€ for A and 10€ for B

Your decision :

Proposal 6

Please choose your proposal and validate your choice by clicking on the 'Validate' button.

Validate

Experiments

Your decision as a B player			
Proposal	**Earnings for A and B**	**Accept**	**Refuse**
1	10€ for A and 0€ for B	○	◉
2	9€ for A and 1€ for B	○	◉
3	8€ for A and 2€ for B	○	◉
4	7€ for A and 3€ for B	○	◉
5	6€ for A and 4€ for B	○	◉
6	5€ for A and 5€ for B	◉	○
7	4€ for A and 6€ for B	◉	○
8	3€ for A and 7€ for B	◉	○
9	2€ for A and 8€ for B	◉	○
10	1€ for A and 9€ for B	◉	○
11	0€ for A and 10€ for B	◉	○

Votre décision :

Proposal 5

Please choose the proposal up to which you will refuse the proposal of player A and then validate your choice by clicking on the button 'Validate'.

Choose 'Accept All' to accept all of Player A's proposals.

Validate

Experiments

You are the player 1 **Period n° : 1 / 8** **You are the seller V1**

	Your good	*Good of the seller V2*	*Common good*
Value	*357*	*388*	*745*
Cost	*974*	*984*	*1958*

Calculation of CES and potential gains

Individual bidding

Individual CES = 357 / 1042 = 0,343

Your potential gain = 1042 - 974 = 68

1042

974 974 1024 1074 1124 1174 **1200**

Joint bidding

*Joint CES = (745+745 * 0,2) / 2108 = 0,424*

Your potential gain = (2108 - 1958) / 2 = 75

2108

1958 1958 2058 2158 2258 2358 **2400**

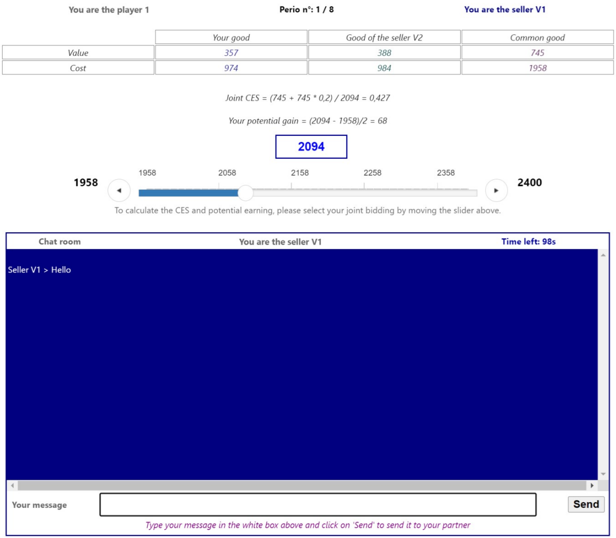
To calculate the CES and potential earnings for both situations, please select your individual and joint bidding by moving the sliders above.

Would you like to team up with the seller V2 to make a joint bidding?
Your decision :

Team up ***Not to team up***

Please make your decision by clicking on one of the 2 options.

Experiments



Single- and joint-bidding conservation auction

$$E[\pi_i^S(p_i)] = (p_i - c_i)Pr[x_i = 1]. \tag{10}$$

$$E[\pi_{i,d}^J(p_{i,d})] = \frac{1}{2}\left(p_d - \sum_{i \in d} c_i\right) Pr[x_d = 1]. \tag{11}$$

$$\max_s V(x_s) = \sum_s \frac{v_s + b_s}{p_s} x_s, \tag{12}$$

$$s.t., \sum_s p_s x_s \leq W, \tag{13}$$

$$E[\pi_{i,d}^J(p_{i,d})] \geq E[\pi_i^S(p_i)]. \tag{14}$$

$$E[\pi_{i,d}^J(p_{i,d}^J)] = \frac{1}{2}\left(p_d^J + \sum_{i \in d}(b_i\delta - c_i)\right) Pr[x_d = 1]. \tag{15}$$

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