Conserving Spatially Explicit Benefits in Ecosystem Service Markets

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Conservation Auctions

- Public-good, ecosystem services (like CRP, EQIP, agricultural land preservation, etc.)
  - Conservation produces a positive externality: The "Conservation Externality"
  - "Reverse" auctions
- Presumably, auctions decrease rent extraction
  - Budget constraint, enables maximum public goods
- Information asymmetry prevents "efficient" auctions
  - Sellers secure premiums above reservation rents
  - Kirwan et al (2005) estimate premiums of 10-40% of CRPs rental payouts
- Recent literature explores auction performance

Agglomeration

- Extensive work on spatial interdependency and benefit nonlinearity
  - Corridors, green infrastructure, thresholds, shape factor, boundaries
  - Targeting
  - Williams, ReVelle, and Levin (2005); Malcolm and ReVelle (2002)
- Agglomeration Bonus - Parkhurst, Shogren, etc. (2002, 2007, 2008)
  - Adjacent landowners along a river…
  - Selectively pay bonuses to incentivize certain outcomes
  - Spatially explicit coordination games and experiments
- All this literatures suggests an additional positive externality associated with proximity
  - The “Spatial Externality”

Framing Spatial Literature

Demand / Supply	Buyer Spatial Preferences in Selection	No Buyer Spatial Preferences in Selection
Bonuses Paid	???	Agglomeration literature
No Bonuses Paid	Targeting literature	Most programs in real world

"Buyer" refers to a social planner

Buyer may have preferences for the spatial externality

"Bonuses" are additional premiums paid to landowners for the spatial externality

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Policy Hypotheses

- Which combination of institutions produce the greatest social welfare?
  - Political considerations tend to spread funds more evenly (IV)
  - Might (I) reflect optimal internalization? But what about collective rent seeking from bonuses? Individual strategic rent seeking?
- Will agricultural landowners behave differently from student subjects in the lab? Evidence from farmer experiments
- Can an optimal bonus be set?

Demand / Supply	Buyer Spatial Preferences in Selection	No Buyer Spatial Preferences in Selection
Bonuses Paid	I	II
No Bonuses Paid	III	IV

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Experiment Design

- Key Elements:

Subjects	120 Subjects (96 Undergraduates, 24 Farmers)
Session Setup	3 Rooms; 12 Subjects, 4 per room
Time Structure	9 Enrollment Periods, 3-6 rounds each
Parcel Distribution	3 per subject, grouped by room
Treatments	Within: Bonuses Between: Communication, Spatial Weighting
Average Earnings	$30 for Undergraduates, $75 for Landowners
Time	2.5 Hours

Experiment Design

- Each subject acts as the owner of three parcels of land.
- In each round, subjects decide between retaining parcels in their current use, or entering an auction to try to "sell" the parcel to the administrator.
- Subjects know the distributions of returns and budgets, and are told the current budget during each round.
- In each new enrollment period the world resets, and subjects receive new parcels
- Opportunity costs are heterogeneous between rooms; high, medium, and low cost rooms – similar to real life situations.

1000s			
1	2	3	Room 1
4	5	6	
7	8	9	
10	11	12	

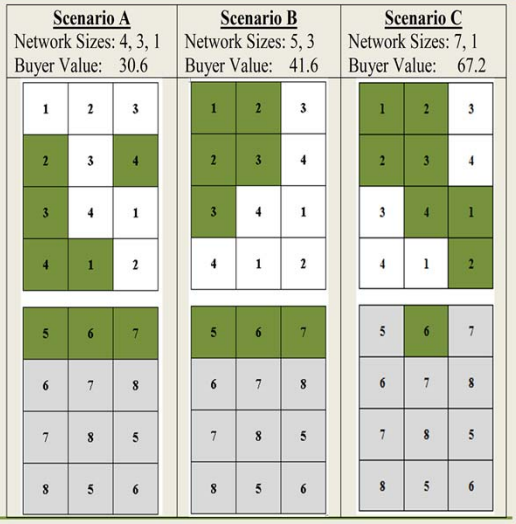
2000s			
1	2	3	Room 2
4	5	6	
7	8	9	
10	11	12	

3000s			
1	2	3	Room 3
4	5	6	
7	8	9	
10	11	12	

7

Experiment Design

- The buyer decision criteria may be effected by the
- Connectivity is calculated by the "walkthrough" length of a network.
- Networks are defined as groups of parcels that share adjacent sides.
- Connection across diagonals ("rook" connectivity) or in different rooms not included.
- Networks are cumulative over rounds within an enrollment period.



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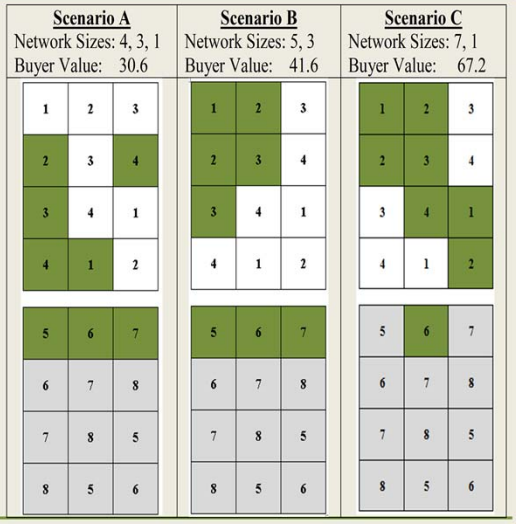
Experiment Design

- Bonuses are paid on a one time basis to all members of a network of size 2 or more for each parcel that enters the network.
  - Bonus payments are $50,000 per parcel in the network.
  - When a new parcel enters an existing network, all current members of the network receive a “top-up” bonus.



Experiment Design

Maximized a grading function over all possible network configurations of submitted parcel offers, B^*:

$$max_{X \epsilon B^*} G = \sum_{x_n \in X} (x_n + \beta x_n^2)$$

$$s.t. \sum_{i,n} b_i + \gamma x_n \leq C$$

where:

X is a configuration of networks

x_n is the length of an individual network, n

b_i is the offer submitted for parcel i

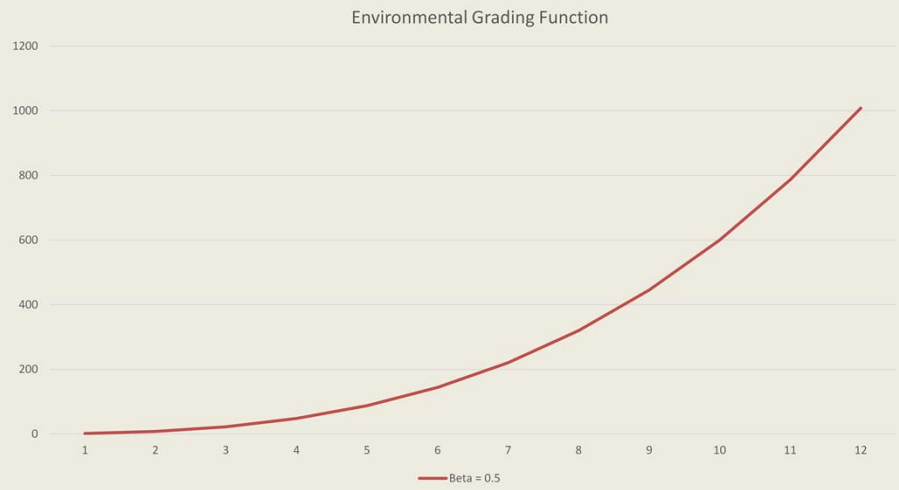
C is the total budget for the conservation program

β is a contiguity preference parameter

γ is a bonus payment rate parameter

Solved using an evolutionary algorithm in Risk Solver Platform

Experiment Design



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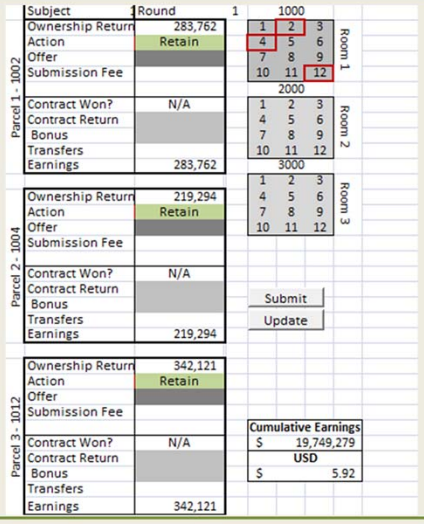
Experiment Design



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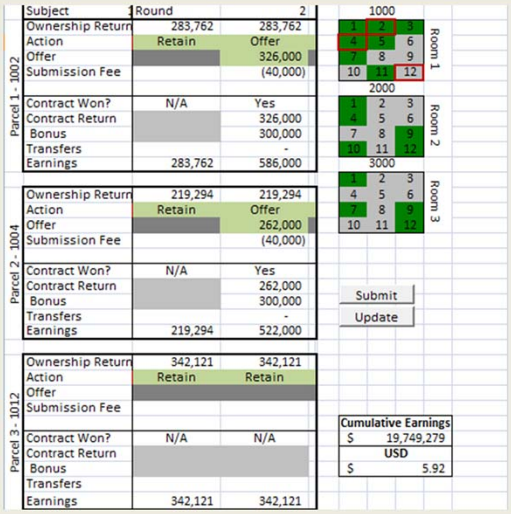


Subject 1	Round	2
Parcel 1 - 1002		
Ownership Return	283,762	283,762
Action	Retain	Offer
Offer		326,000
Submission Fee		(40,000)
Contract Won?	N/A	Yes
Contract Return		326,000
Bonus		300,000
Transfers		-
Earnings	283,762	586,000
Parcel 2 - 1004		
Ownership Return	219,294	219,294
Action	Retain	Offer
Offer		262,000
Submission Fee		(40,000)
Contract Won?	N/A	Yes
Contract Return		262,000
Bonus		300,000
Transfers		-
Earnings	219,294	522,000
Parcel 3 - 1012		
Ownership Return	342,121	342,121
Action	Retain	Retain
Offer		
Submission Fee		
Contract Won?	N/A	N/A
Contract Return		
Bonus		
Transfers		
Earnings	342,121	342,121

1000 — Room 1

1	2	3
4	5	6
7	8	9
10	11	12

2000 — Room 2

1	2	3
4	5	6
7	8	9
10	11	12

3000 — Room 3

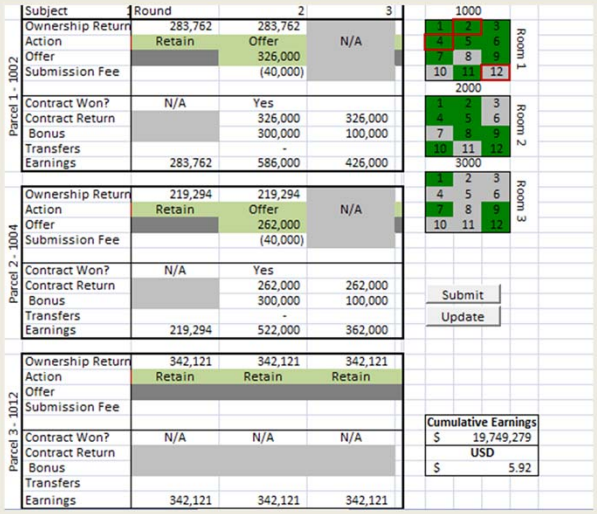
1	2	3
4	5	6
7	8	9
10	11	12

Submit

Update

Cumulative Earnings	
$	19,749,279
USD	
$	5.92

Experiment Design



	Subject 1	Round	2	3
Parcel 1 - 1002	Ownership Return	283,762	283,762	
	Action	Retain	Offer	N/A
	Offer		326,000	
	Submission Fee		(40,000)	
	Contract Won?	N/A	Yes	
	Contract Return		326,000	326,000
	Bonus		300,000	100,000
	Transfers		-	
	Earnings	283,762	586,000	426,000
Parcel 2 - 1004	Ownership Return	219,294	219,294	
	Action	Retain	Offer	N/A
	Offer		262,000	
	Submission Fee		(40,000)	
	Contract Won?	N/A	Yes	
	Contract Return		262,000	262,000
	Bonus		300,000	100,000
	Transfers		-	
	Earnings	219,294	522,000	362,000
Parcel 3 - 1012	Ownership Return	342,121	342,121	342,121
	Action	Retain	Retain	Retain
	Offer			
	Submission Fee			
	Contract Won?	N/A	N/A	N/A
	Contract Return			
	Bonus			
	Transfers			
	Earnings	342,121	342,121	342,121

1000 — Room 1

1	2	3
4	5	6
7	8	9
10	11	12

2000 — Room 2

1	2	3
4	5	6
7	8	9
10	11	12

3000 — Room 3

1	2	3
4	5	6
7	8	9
10	11	12

Submit

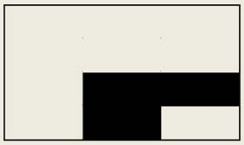
Update

Cumulative Earnings	
$	19,749,279
USD	
$	5.92

Results

Low Cost

Medium Cost



High Cost

"Ideal" enrollments in round one for a certain opportunity cost/budget set.

Represents the set that would be chosen if the buyer could price discriminate perfectly.

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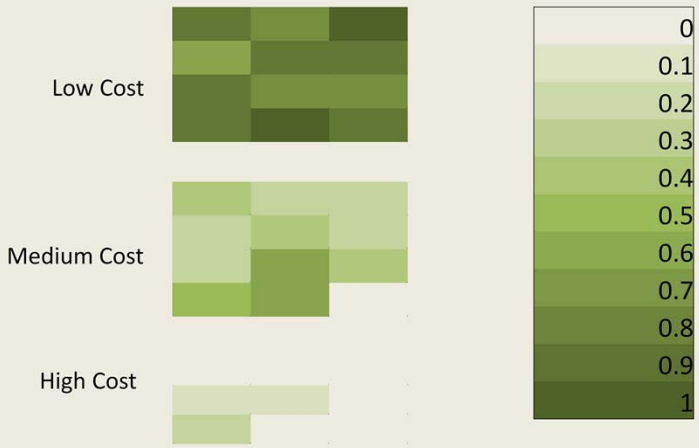
Results

"Ideal" enrollment rate in round one over cost distributions



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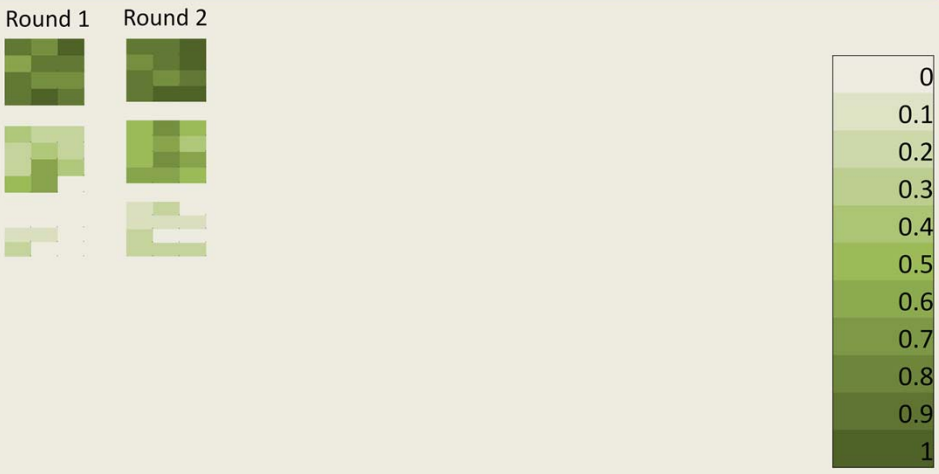
Results



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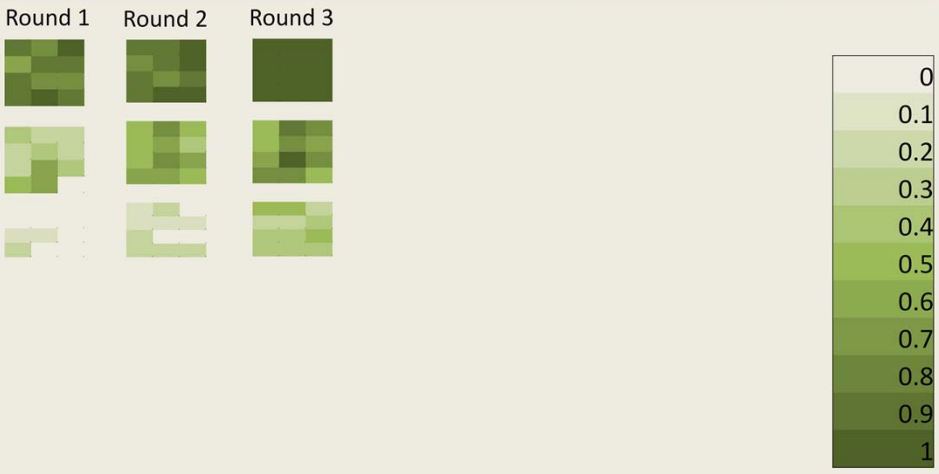
Results



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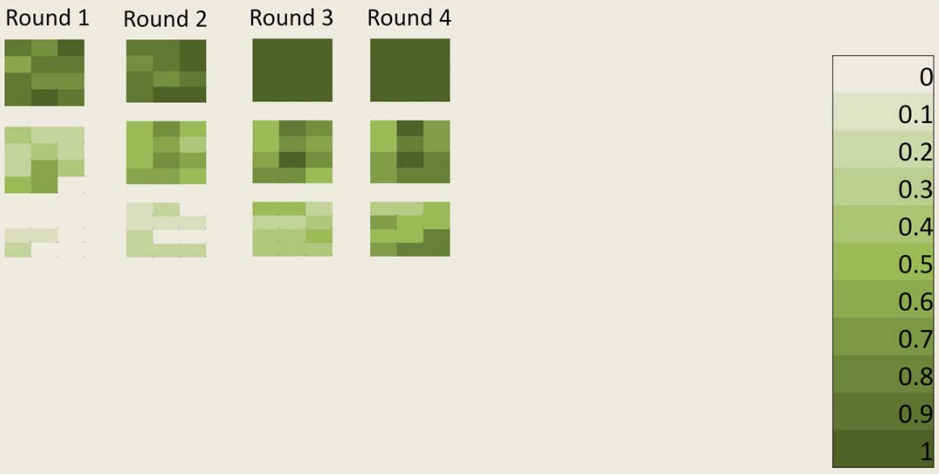
Results



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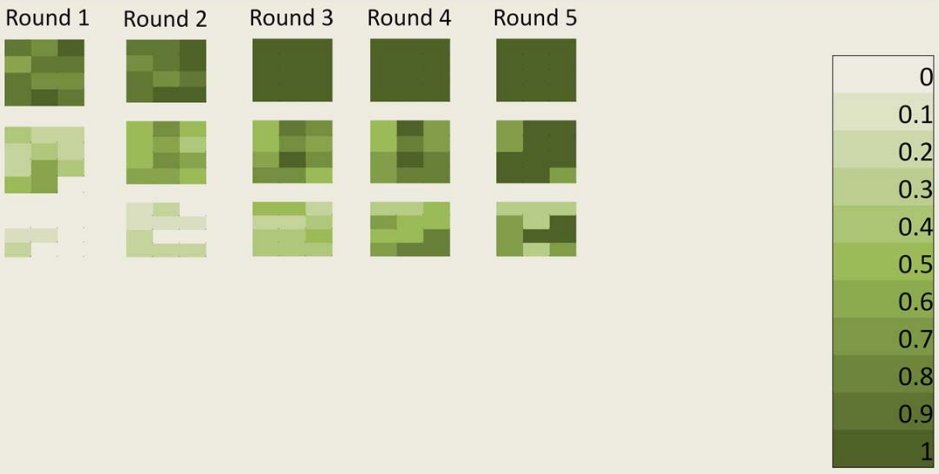
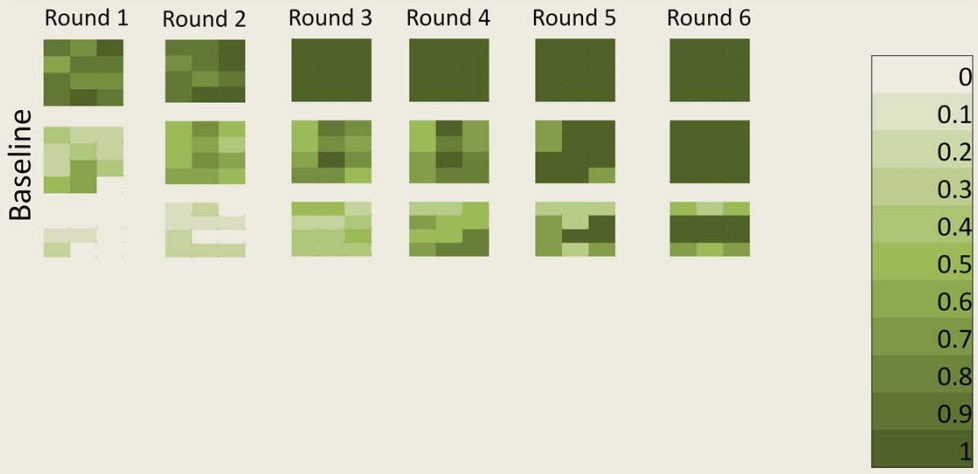
Results


Round 1
Round 2
Round 3
Round 4
Round 5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

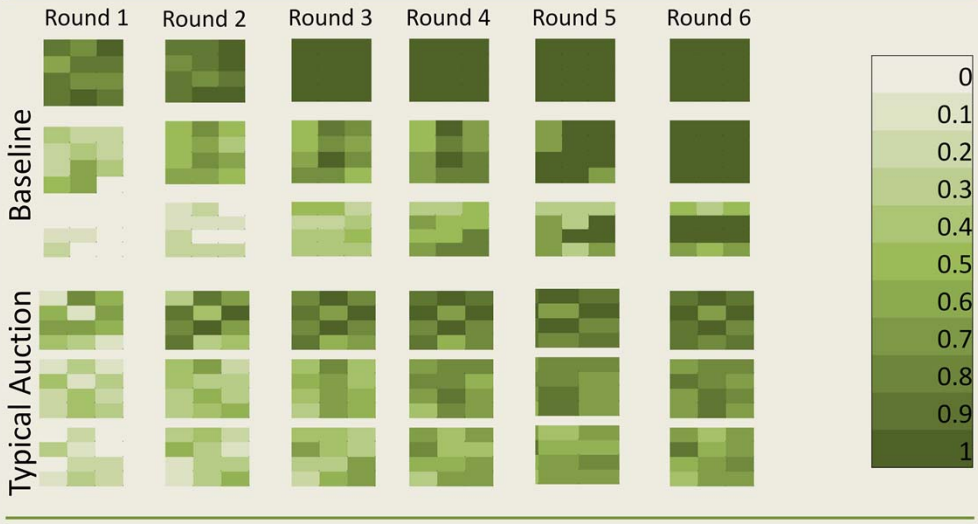
20

Results


Round 1
Round 2
Round 3
Round 4
Round 5
Round 6
Baseline
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

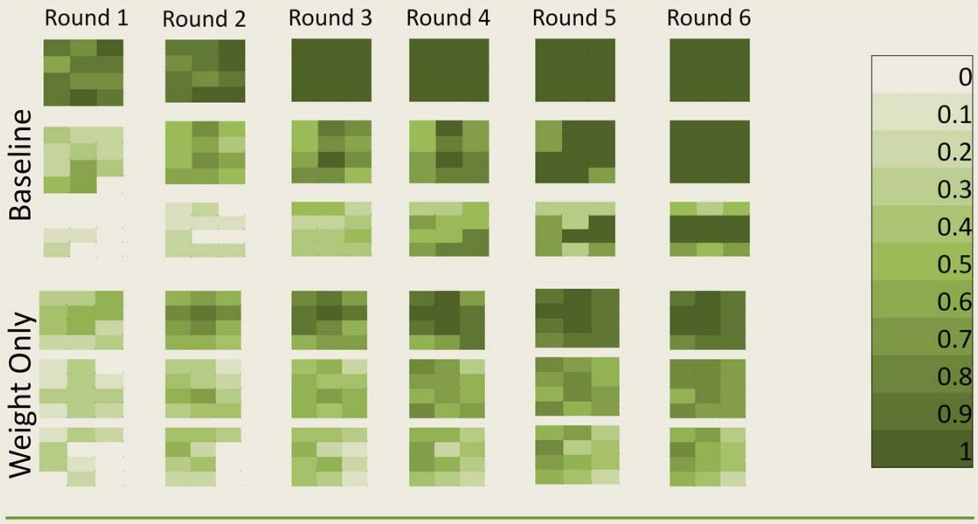
21

Results


Round 1
Round 2
Round 3
Round 4
Round 5
Round 6
Baseline
Typical Auction
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

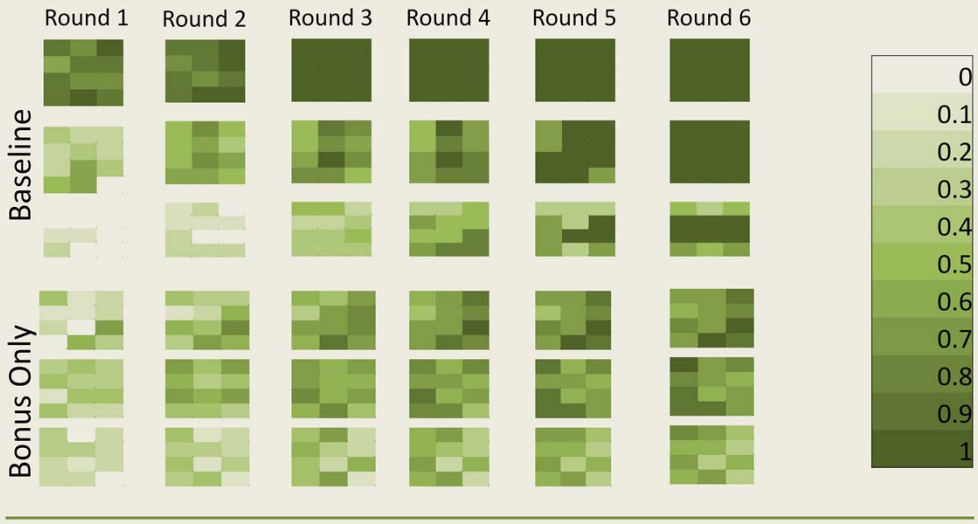
22

Results


Round 1
Round 2
Round 3
Round 4
Round 5
Round 6
Baseline
Weight Only
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

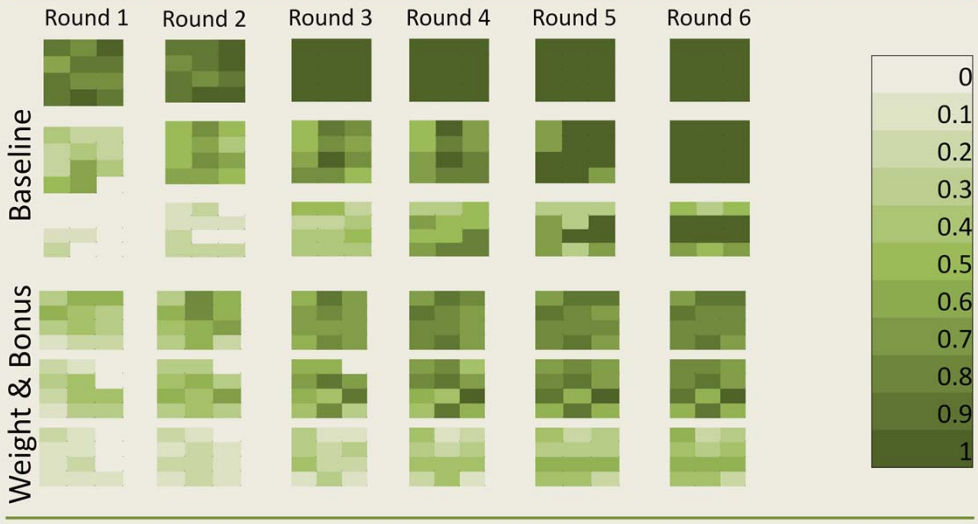
23

Results


Round 1
Round 2
Round 3
Round 4
Round 5
Round 6
Baseline
Bonus Only
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

24

Results


Round 1
Round 2
Round 3
Round 4
Round 5
Round 6
Baseline
Weight & Bonus
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

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Results – Program Performance

	Environmental Benefits		Net Welfare Effect	
Budget	0.0183***	0.0164***	0.0148***	0.0132**
Field Session	9,901,003**	9,907,067**	9,315,439**	9,318,556**
Sp.Targeting (BST)	8,249,789***	2,732,467	8,812,298***	3,652,419
Bonuses	-8,617,984***	-13,364,055**	-8,318,537***	-12,072,892***
Communication	-808,532	-612,989	9,932	375,386
BST*Bonuses		11,500,181**		10,254,004**
BST*Comm		-404,408		348,455
Bonuses*Comm		127,485		-794,330
R^2	0.4527	0.4876	0.4683	0.5029
N	88	88	88	88

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More Results

	Auction Entry Probability	Offer Inflation
Buyer Spatial Targeting (BST)	-0.0385	-710
Bonuses	0.0831**	-15,996**
Communication	-0.0656	33,204***
BST*Bonuses	-0.0543	19,518***
BST*Communication	0.0434	-27,395***
Bonuses*Communication	0.0244	-12,587
Edge	0.0415***	-4,921
Interior	0.0508***	-11,395***
Bonuses*Interior	0.0520**	-4,528
BST*Edge		11,673**
BST*Interior		8,828**
Log-likelihood	-13,041	-117,497
N	12,602	12,602

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Primary Conclusions

- If spatial externalities exist, a social planner can improve outcomes by specifically targeting them.
  - Will select sets closer aligned with social values
  - Can also increase strategic waiting
- Spatial targeted bonuses have mixed effects.
  - Induce entry of desirable parcels into the market
  - Very budget intensive (in this case largely dominated – optimal bonus?)
- Bonuses work best in conjunction with a spatial targeting mechanism
  - There is a synchronicity between the two approaches; bonuses help correct for strategic waiting, while targeting is able to optimally take advantage of larger offer pool.
- Field experiments with farmers show similar, slightly stronger dynamics.

Questions?

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