Understanding a Field Auction for Ecosystem Services using the Experimental Economics Laboratory

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Ecosystem Market

Supply

Demand

Landowners, farmers, wetland managers that provide ecosystem services.

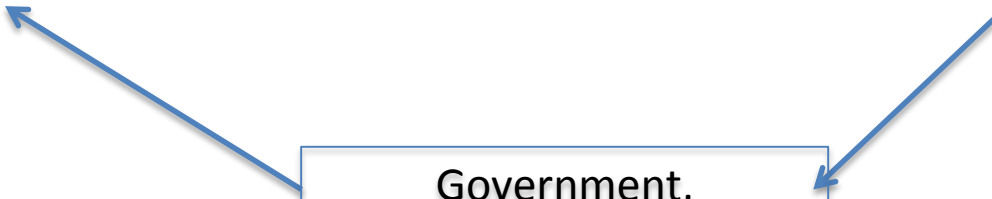
Individuals who benefit/value the ecosystem services.

Supply

Demand

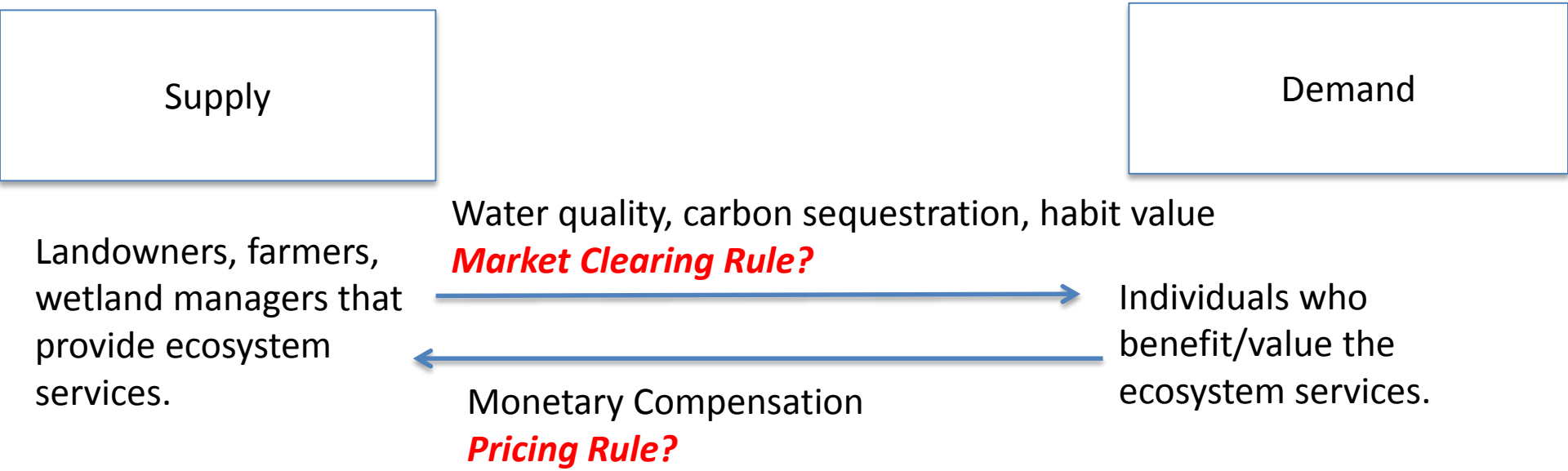
Landowners, farmers, wetland managers that provide ecosystem services.

Water quality, carbon sequestration, habit protection.



Individuals who benefit/value the ecosystem services.

Government, Conservation Programs.



- Most researches on ecosystem markets focus on the supply side: how to induce ecosystem service providers to provide more, or induce non-providers to provide ecosystem services.
- We focus on the demand side of the problem: ***How to induce ecosystem service beneficiaries to pay for such services***.

Introduction

- Well designed market-based approaches can provide potential solutions for the management of ecosystem services.
- The public good property of ecosystem services.
- Individuals have incentives to free or cheap ride on the contributions of others when providing public good.
- ***Different from traditional charities,*** we address this problem by designing several novel market institutions where the free riding incentive can be mitigated.
- We did a sequence of experiments to test the effectiveness of these market institutions.

Motivation

- Specifically, our research is about how to raise individual contribution for ecosystem services that have public good properties.
- Motivated by the difficulties to allocate contribution from residents to protect bird habitats (Swallow et al, 2012).
- Threshold public good. A minimum amount is required to protect each bird habitat.
- We need to decide 1) *market clearing rules*, how to decide if a field can be provided and 2) *pricing rules*, once a field is provided, how much each resident should pay.
- Overarching Objective: Achieve higher efficiency; providing the public good whenever the sum of individual values is higher than the cost.

Market Clearing Rules

- Ascending-Unit **(AU)** Auction
  - Compare the total bids from the group of individuals with the cost of the public good, starting from the first unit.
  - If individuals' total offer on the first unit is higher or equal to the cost of the first unit, we continue to compare the total offer on the second unit with the cost of the second unit, and so on.
  - We will stop when the total offer for a unit is smaller than the unit cost.
  - For example, if the total offers on the first unit, second unit and third unit are all higher than the cost, but the offer on fourth unit is smaller than cost of the fourth unit, we will provide three units in total.

Market Clearing Rules

- Descending-Unit **(DU)** Auction
  - Compare the total bids from all individuals with the cost of the public good, starting from the last unit, say unit 6.
  - If individuals' total offer on the last unit is higher or equal to the cost for the last unit, we will provide all 6 units; if the total offer is smaller than the cost of the last unit, we will continue compare the total offer on the 5th, with the cost of that unit, we will provide all 5 units if the offer is higher and continue to the 4th unit if we fail and so on.
  - We will stop when the total offer for a unit is smaller than the unit cost.

Pricing Rules

- Pay-Your-Price Auction (**PYP**)
  - Individual *i* pays what he bids on each unit.
  - Payoff is:

$$u_i(\cdot) = \begin{cases} 0 \\ \sum_{k=1}^{j} (v_i^k - b_i^k) \end{cases}$$

- Marginal Bid (**MB**)
  - Individual *i* pays what he bids on the LAST unit provided, times the number of unit provided .
  - Payoff is:

$$u_i(\cdot) = \begin{cases} 0 \\ \sum_{k=1}^{j} v_i^k - j * b_i^j \end{cases}$$

IPA

- Marginal Pivotal Price (**MP**)
  - Individual *i* pays her pivotal price on the LAST unit provided, times the number of unit provided .
  - Payoff is:

$$u_i(\cdot) = \begin{cases} 0 \\ \sum_{k=1}^{j} v_i^k - j * p_i^j \end{cases}$$

where $p_i^j = \max(0, C - \sum_{k \neq i} b_k^j)$.

Behavior Considerations

- CheapTalk Treatment
  - "...To understand the motivation of this approach, consider the following: Our approach is sort of like buying farm-fresh food at the grocery store, except we ask you to name your own price. If the store sells your favorite food at $3 per pound, you might buy 3 pounds for $9 (3 pounds × $3 = $9). But if the price was lower per pound you might buy more: Say the store offers $2 per pound for purchases of 5 pounds or more. In that case, you might decide to buy 6 pounds, bringing your purchase to $12 (6 pounds × $2 = $12)."

- The Change of Optimal Unit
  - In one treatment, we change the optimal unit from 4 to 6.
  - 4 unit optimal: (20, 16, 12, 8, 4, 0)
  - 6 unit optimal: (28, 24, 20, 16, 12, 8)

Experiment Procedures

Session	Treatment 1	Treatment 2	Group Size	Total/Optimal Unit	Unit Cost
1	PYP-AU	MB-AU	7	6/4	56
2	MB-AU	PYP-AU	6	6/4	48
3	MB-AU	MP-AU	5	6/4	40
4	MP-AU	MB-AU	6	6/4	48
5	MB-DU	MP-DU	7	6/4	56
6	MP-DU	MB-DU	6	6/4	48
7	MB-AU-CT	MB-DU-CT	7	6/4	56
8	MB-DU-CT	MB-AU-CT	5	6/4	40
9	PYP-AU	MB-AU	6	6/6	48
10	MB-AU	PYP	6	6/6	48

- We conducted ten experiment sessions at UConn in 2013.
- 122 subjects participated in the experiment.
- There are 6 units available to provide.
- Induced values followed a uniform distribution on the interval [20, 24] on Unit 1, [16, 20] on Unit 2, [12, 16] on Unit 3, [8, 12] on Unit 4, [4, 8] on Unit 5 and [0, 4] on Unit 6.

Period

1 of 2 ← **Number of Period**

Treatment2

Individual Induced Value

Your Value for	Unit1	Unit2	Unit3	Unit4	Unit5	Unit6
Your Value	10.00	9.00	8.00	7.00	6.00	5.00
Your Contribution						

Place Bid for Each Unit

OK

Result 1

- When providing 4 units is optimal, the overall rank of achieved social surplus in the last five periods is

  MB-AU>MP-DU>MP-AU>MB-DU>PYP-AU;

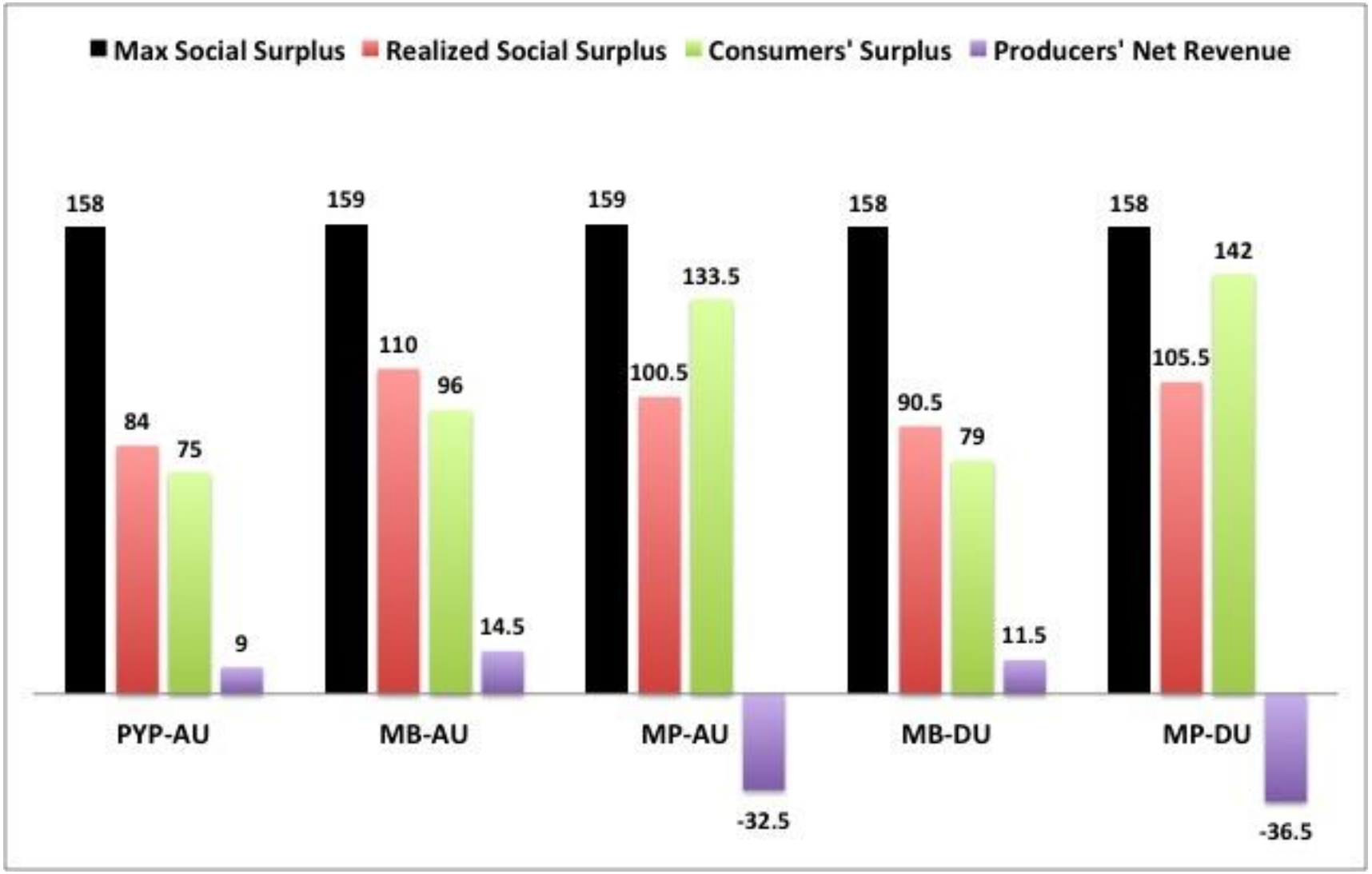
the overall rank of achieved consumers' surplus in the last five periods is

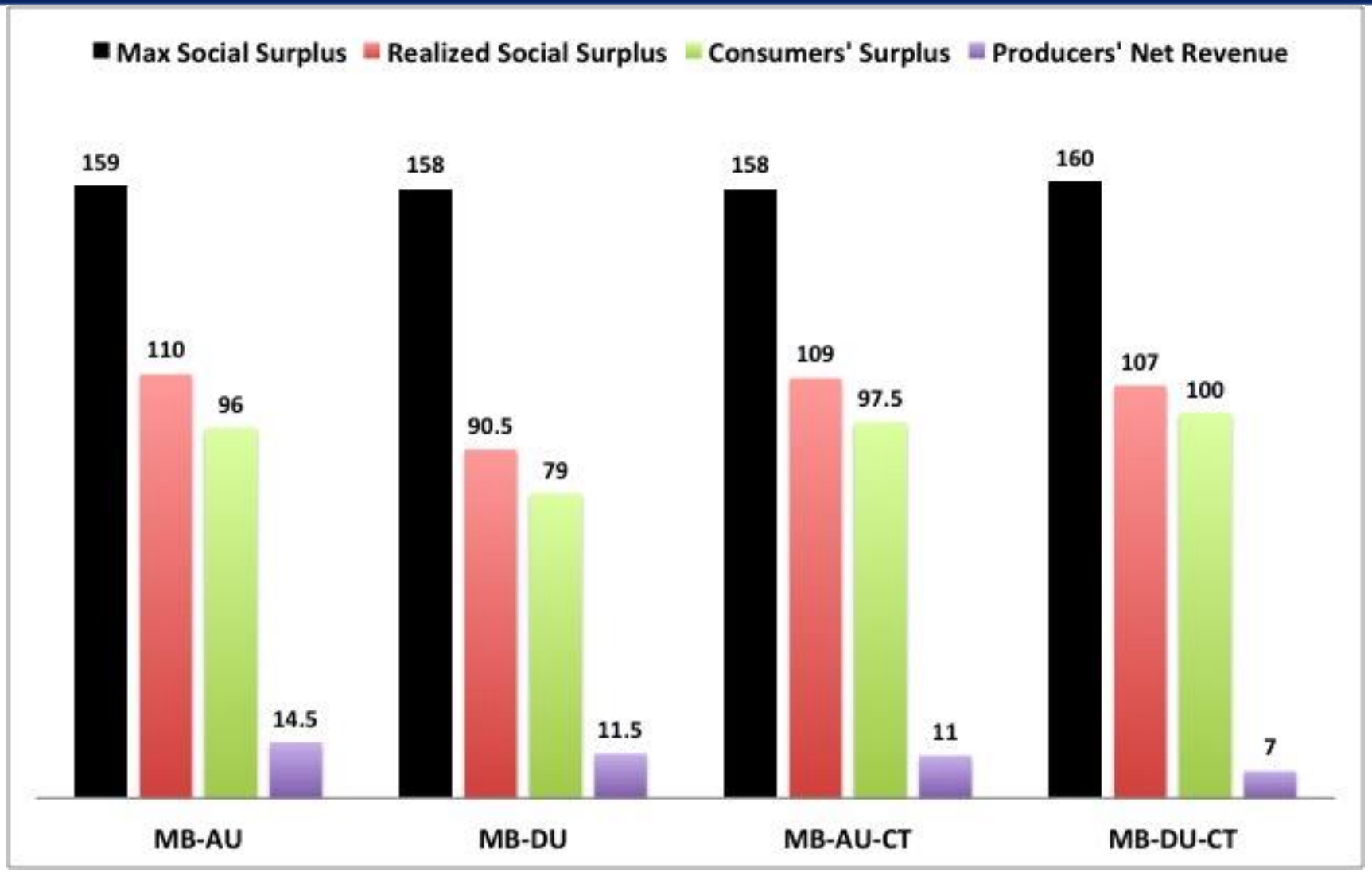
MP-DU>MP-AU>MB-AU>MB-DU>PYP-AU;

the overall rank of producers' net revenue in the last five periods is

MB-AU>MB-DU>PYP-AU>0>MP-AU>MB-DU.

- When providing 6 units is optimal, MB-AU-6 archives a higher social surplus and consumer's surplus, but a lower producers' net revenue compared to PYP-AU-6.


Max Social Surplus
Realized Social Surplus
Consumers' Surplus
Producers' Net Revenue
158
84
75
9
159
110
96
14.5
159
100.5
133.5
-32.5
158
90.5
79
11.5
158
105.5
142
-36.5
PYP-AU
MB-AU
MP-AU
MB-DU
MP-DU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110
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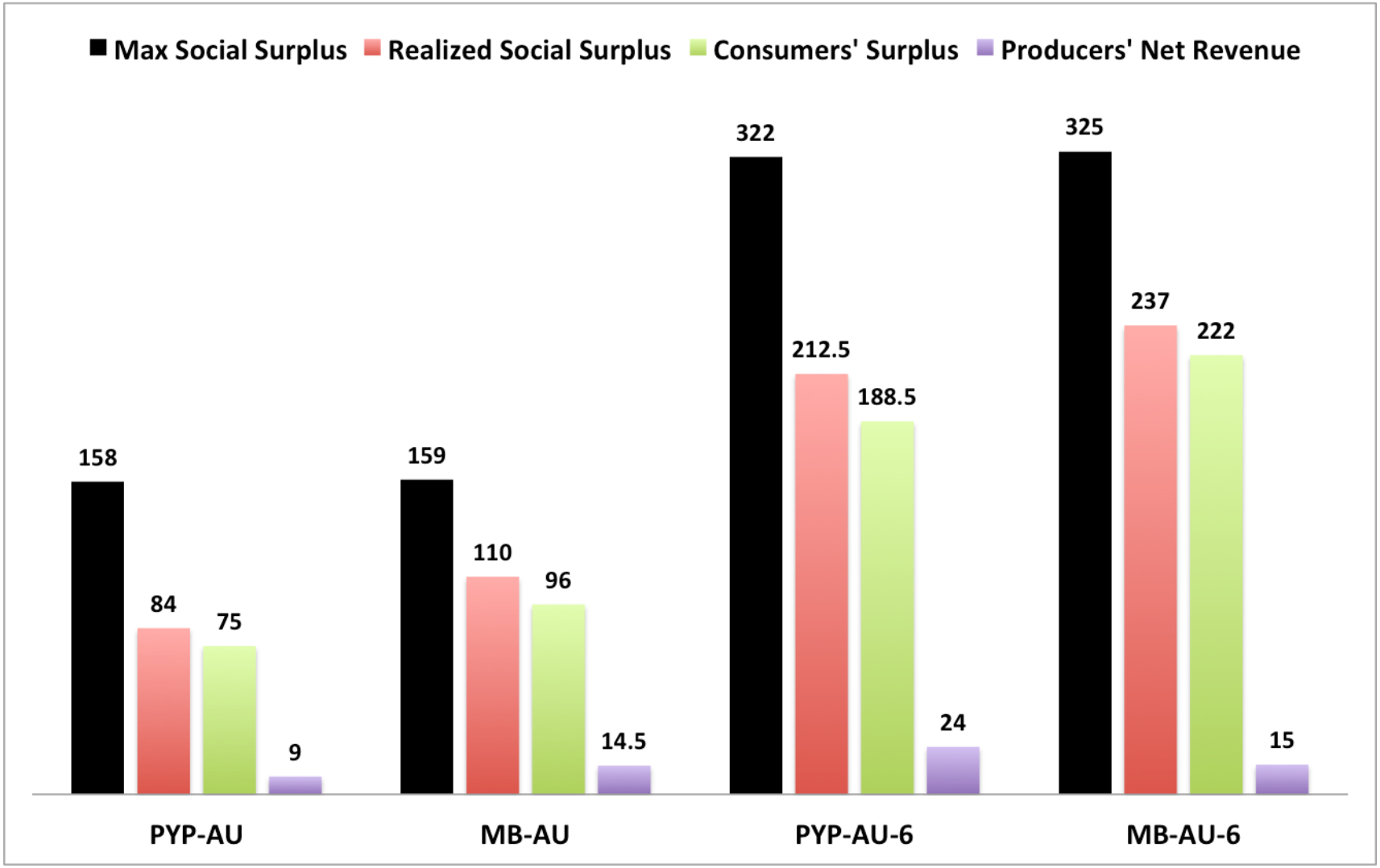
109
97.5
11
160
107
100
7
MB-AU
MB-DU
MB-AU-CT
MB-DU-CT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158
84
75
9
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110
96
14.5
322
212.5
188.5
24
325
237
222
15
PYP-AU
MB-AU
PYP-AU-6
MB-AU-6

Result 2

- Subjects rarely reach the Pareto optimal provision level in all mechanisms. The MP-AU has the highest rate, while the PYP-AU has the lowest rate in providing three or more units, when providing 4 units is optimal.

Provided	1 Unit or more	2 Unit or more	3 Unit or more	4 Unit or more	5 Unit or more	6 Unit
Baseline						
PYP-AU	90%	47.5%	20%	0%	0%	0%
Ascending-Unit Auction						
MB-AU	96.25%	75%	30%	0%	0%	0%
MP-AU	85%	65%	45%	2.5%	0%	0%
Descending-Unit Auction						
MB-DU	75%	55%	27.5%	0%	0%	0%
MP-DU	80%	65%	32.5%	5%	0%	0%
Cheap-Talk Treatment						
MB-AU-CT	92.5%	67.5%	32.5%	0%	0%	0%
MB-DU-CT	97.5%	67.5%	32.5%	0%	0%	0%
6 Units are Optimal						
PYP-AU-6	95%	75%	60%	37.5%	10%	0%
MB-AU-6	95%	85%	72.5%	40%	5%	0%

Table: Accumulative Provision Frequency

Result 3

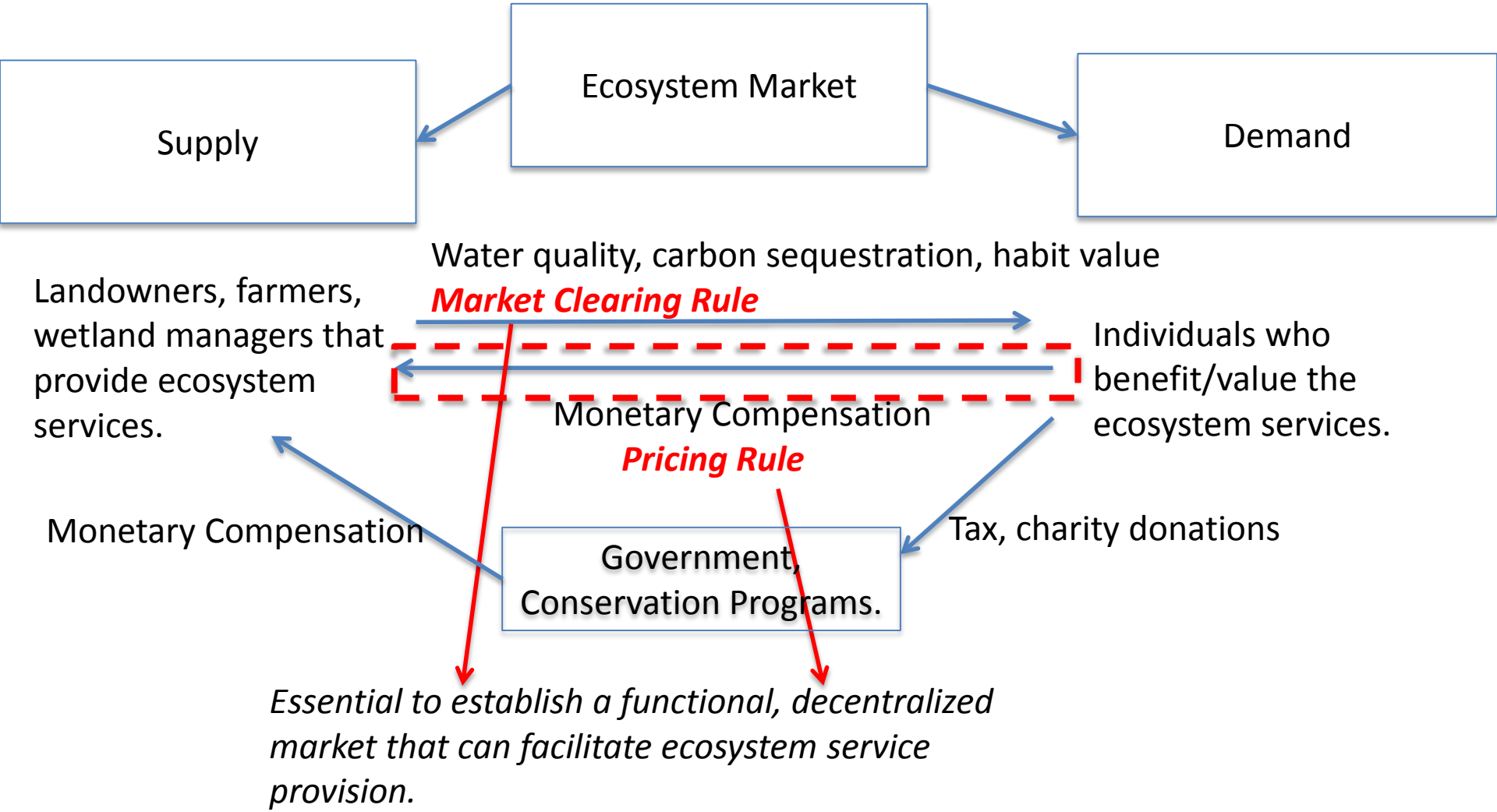
- The DU mechanisms has a larger probability of complete non-provision compared to AU counterparts. The cheap talk treatment significantly eliminates the complete non-provision in DU mechanisms.

Provided	0 Units
Baseline	
PYP-AU	10%
Ascending-Unit Auction	
MB-AU	3.75%
MP-AU	15%
Descending-Unit Auction	
MB-DU	25%
MP-DU	20%
Cheap-Talk Treatment	
MB-AU-CT	7.5%
MB-DU-CT	2.5%
6 Units are Optimal	
PYP-AU-6	5%
MB-AU-6	5%

Table: Provision Frequency

Conclusion

- All the IPA mechanisms improve social efficiency compared to PYP.
- Our explanation: MB lower the marginal cost compared to PYP; MP unties the marginal cost with one's bid on the marginal.
- These results are robust when we change the induced value and alter where the MSC crosses the MSB (change of the optimal number unit to provide).
- DU auctions are more likely to lead complete provision failure.
- The allocation of social surplus is very different across mechanisms. Compared to PYP-AU, MB-AU can lead to a higher realized social surplus, a higher consumer surplus and a higher net producer revenue.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Individuals who benefit/value the ecosystem services.
Monetary Compensation
Pricing Rule
Monetary Compensation
Tax, charity donations
Government, Conservation Programs.
Essential to establish a functional, decentralized market that can facilitate ecosystem service provision.