8-26-2015

Increasing Ecosystem Services Benefits through Spatially Coordinated Land Management: Role of Transaction Costs and Communication in an Experimental Setting

Simanti Banerjee
University of Nebraska-Lincoln, simanti.banerjee@unl.edu

Timothy N. Cason
Purdue University

Frans P. de Vries
Purdue University

Nick Hanley
University of St. Andrews

AGRICULTURAL ECONOMICS
Institute of Agriculture and Natural Resources

August 26, 2015

agecon.unl.edu/cornhuskereconomics

Cornhusker Economics

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Market Report	Year Ago	4 Wks Ago	8/21/15
Livestock and Products, Weekly Average			
Nebraska Slaughter Steers, 35-65% Choice, Live Weight.	152.66	145.76	149.00
Nebraska Feeder Steers, Med. & Large Frame, 550-600 lb.	258.48	268.16	272.37
Nebraska Feeder Steers, Med. & Large Frame 750-800 lb.	226.79	243.94	219.31
Choice Boxed Beef, 600-750 lb. Carcass.	251.96	232.67	245.75
Western Corn Belt Base Hog Price Carcass, Negotiated.	95.81	75.24	74.88
Pork Carcass Cutout, 185 lb. Carcass 51-52% Lean.	106.58	83.52	88.09
Slaughter Lambs, wooled and shorn, 135-165 lb. National.	157.88	155.80	155.36
National Carcass Lamb Cutout FOB.	364.00	355.32	354.96
Crops, Daily Spot Prices			
Wheat, No. 1, H.W. Imperial, bu.	5.58	450	4.14
Corn, No. 2, Yellow Nebraska City, bu.	3.49	3.70	3.55
Soybeans, No. 1, Yellow Nebraska City, bu.	12.52	9.71	9.20
Grain Sorghum, No.2, Yellow Dorchester, cwt.	6.09	6.57	5.96
Oats, No. 2, Heavy Minneapolis, Mn, bu.	3.95	2.66	2.49
Feed			
Alfalfa, Large Square Bales, Good to Premium, RFV 160-185 Northeast Nebraska, ton.	192.50	195.00	177.00
Alfalfa, Large Rounds, Good Platte Valley, ton.	100.00	85.00	85.00
Grass Hay, Large Rounds, Good Nebraska, ton.	87.50	95.00	82.50
Dried Distillers Grains, 10% Moisture Nebraska Average.	97.50	136.50	139.00
Wet Distillers Grains, 65-70% Moisture Nebraska Average.	38.00	42.50	42.50
* No Market			

The delivery of ecosystem services benefits from pro-environmental land use and land management activities on farmland can often be substantially enhanced if landowners are able to *coordinate their decisions across space*. For example, in the face of pollinator population collapse, greater crop pollination benefits will accrue if neighboring farmers commit to reducing pesticide usage, than if only a single farmer unilaterally curbs use, leaving bees vulnerable to pesticide drift from neighboring farms. Other examples which illustrate the importance of spatial coordination for generating environmental benefits across space are water quality improvement and biodiversity protection via reduction in habitat fragmentation.

Regulatory agencies implementing incentive policies, such as the Conservation Reserve Program, can thus further increase the environmental effectiveness of public funds by rewarding spatially coordinated land use. Yet there are challenges. Coordination is hard. Often it is not possible to gauge what a neighbor will do and it might be best to go it alone. Even if neighbors are likely to coordinate, reaching an agreement requires spending time, money and effort: termed transaction costs which can derail coordination even if there is the prospect of greater financial compensation. Thus, it is imperative to pilot test spatially targeted incentive schemes and evaluate stakeholder behavior and incentive performance before costly large-scale rollout.

Experimental Design:

In a recent study, we used **human-subject experiments** (Banerjee 2015) involving university students to evaluate enrollment rates and performance of a conservation subsidy, called the **Agglomeration Bonus** (Parkhurst and Shogren 2007) (AB), in the presence of **high and low transaction costs** in a simple yet realistic experimental setting. The AB provides a base subsidy and an additional payment (bonus) if neighboring landowners coordinate on similar land use decisions.

Our experiments involved groups of 8 university student-subjects who assumed the role of landowners and had the option to participate in an AB scheme involving two pro-environmental land use strategies: X and Y. The subjects were arranged in a circle and had a neighbor each to their left and right. Enrollment into the scheme entailed a transaction cost. If subjects chose not to participate, they received the agricultural return only, denoted by NP. If landowners paid the fee, they were then asked to select either X or Y. If both neighbors participated and selected X, the subject received more money from the AB scheme than if they all chose Y. While these decisions were being made, subjects did not know their neighbors' choices. This experimental design led to uncertainty for the subjects regarding their neighbors' decisions, creating a setting which is challenging for spatial coordination. This design choice was motivated by the fact that if we are able to demonstrate superior AB performance in a setting where spatial coordination is difficult, it is expected to perform much better when there are fewer obstacles.

We collected data from 16 groups in which student subjects repeatedly interacted with their neighbors 30 times or for 30 periods. We implemented our transaction cost variation treatment using a within-subject format: an individual was exposed to 2 cost conditions. In 8 groups for the first 15 periods (Phase I), a low transaction cost was imposed after which we increased the transaction cost value for the next 15 periods (Phase II). In the remaining 8 sessions, this cost ordering was reversed i.e., high cost in Phase I followed by low in Phase II.

Results:

Figure 1 presents the percentage of individuals who enrolled in the AB scheme after paying the transaction cost fee under the two costs conditions. Statistical tests indicate that participation is significantly higher with low cost than with the high one in Phase I (Figure 1a). Interestingly, over time enrollment falls in groups where costs are high while the rate is more stable in the groups with lower costs. This result suggests that conservation agencies have to focus on reducing transaction costs that may deter enrollment, specifically of neighboring landowners in the current context, if they are to produce greater ecosystem services benefits over time.

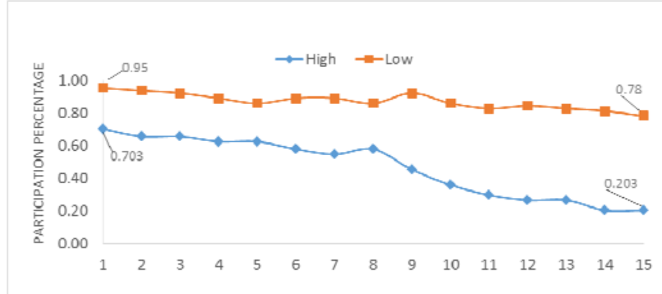

Figure 1a: Percentage of Participation in Phase I

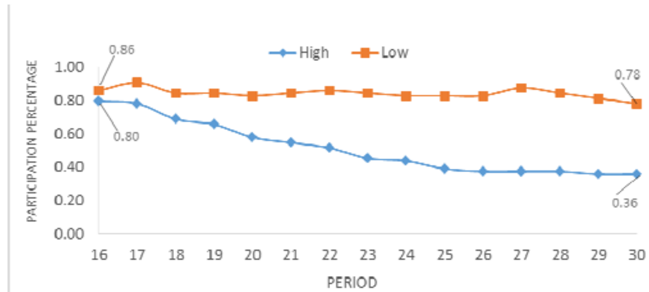

Figure 1b: Percentage of Participation in Phase II

Statistical analysis of Phase II data (Figure 1b) where the transaction cost values are switched for groups indicates no treatment effect. Thus, change in the cost setting has consequence for enrollment in the AB scheme for individuals who have prior experience with different cost values. For groups that go from high to low costs in Phase II, there is a significant improvement in enrollment (from 20% in Period 15 to 86% in Period 16 comparing Figures 1a and 1b). But, for those whose participation decision is now costlier i.e., those who went from low to high costs in Phase II, enrollment rates don't change significantly (78% in Period 15 to 80% in Period 16 comparing Figures 1a and 1b). This is an interesting finding and provides evidence that subjects respond to changes in their decision environment sluggishly – old habits are hard to break.

In Figure 2, we graph a metric representing policy performance defined as the percentage of spatially coordinated behavior (measured as the number of instances in which a subject and their two neighbors selected X) across all groups and all periods in both Phases. Focusing on Phase I, we find that AB performance is nearly double with low cost. Statistical tests indicate that this difference is significant between high and low cost groups *in the second part of the Phase* i.e., coordination takes time and experience. This result underscores the challenges associated with spatial coordination. While enrollment is significantly higher with low costs, it is not guaranteed that neighboring subjects will enroll.

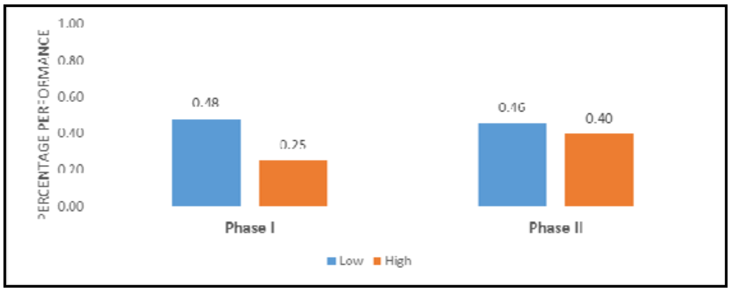

Figure 2: Percentage Performance (player and neighbors choose X) Pooled by Phase & Transaction Cost

In line with our previous findings about enrollment, prior experience with a particular transaction cost value influences policy performance as well. In groups which transition from low to high cost in Phase II, policy effectiveness goes down from 48% to 40%. On the other hand for groups that transition from high to low cost, performance improves from 25% to 46%. Given these performance levels, statistical analysis reveals no significant difference in policy performance by transaction cost in Phase II.

Can we improve outcomes?

In our realistic decision environment, transaction costs deter enrollment and prevent coordination. These results are influenced by the prior experience subjects have with enrolling and coordinating in the AB scheme. *So the question is can we improve performance?* Extensive research on coordination in experimental economics indicates that facilitating communication between individuals improves coordination. We thus ran 8 experimental sessions (with the same within-subject transaction cost treatment variation) where we allowed subjects to communicate with their two neighbors prior to deciding on their participation decisions. In keeping with the fact that messaging is almost always costly for the sender but not for the receiver, the experimental subjects had to pay a fee to send messages to their neighbors. Neighbors, however, received messages for free.

Figures 3 & 4 respectively present a comparative representation of the percentage of all choices (X, Y, & NP) and AB performance for groups with and without communication for the two transaction cost values. Clearly according to Figure 3 for both high and low costs, enrollment rates (taking X & Y together) are significantly higher with communication – nearly 90%. Additionally, performance (Figure 4) is nearly two times as high as that obtained without messaging. Thus, communication can facilitate coordination leading to spatially coordinated land management for enhanced delivery of ecosystem services and greater financial return for coordinating landowners.

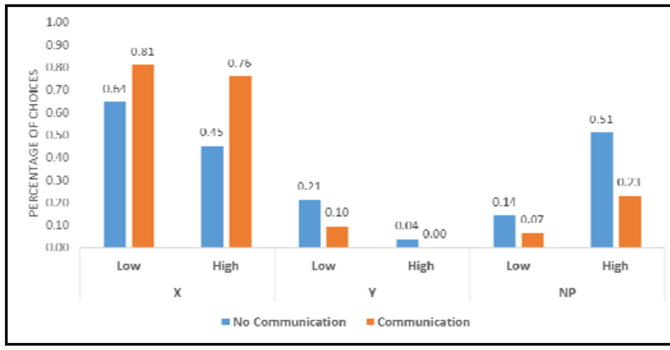

Figure 3: Percentage of Choices Pooled Over Time with and without Communication

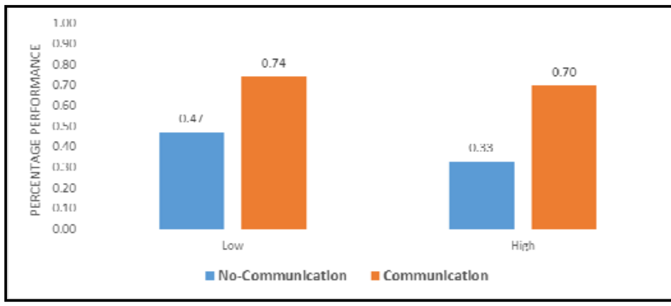

Figure 4: Percentage Performance Pooled Over Time with and without Communication

Policy implications and next steps:

The policy implications are clear. In the context of an AB scheme, *if the regulator can reduce transaction costs such that they are low relative to the payoffs of coordination, then it will be easier to achieve higher environmental performance via spatial coordination*. However, performance can fall over time. *Facilitating communication between landowners can prevent this negative result from emerging and lead to higher enrollments and improved policy performance*. Our study indicates that if policy makers are to introduce sophisticated incentive policies targeting greater ecosystem services delivery, they should be mindful of the various behaviors the policy beneficiaries may exhibit and the obstacles that might dampen performance. Controlled economic experiments provide a low-cost means of obtaining key insights about these behaviors and obstacles. However, we are cautious about extrapolating our study results since our model is a highly stylized version of the landowners' coordination problem. A next step in the policy evaluation spectrum prior to implementation would be to use results from the current study to benchmark hypotheses and run experiments with real landowners.

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Simanti Banerjee (corresponding author)
Assistant Professor
Dept of Agricultural Economics and
School of Natural Resources
University of Nebraska-Lincoln
simanti.banerjee@unl.edu

Timothy N. Cason
Professor, Dept. of Economics
Purdue University

Frans P. de Vries
Professor, Division of Economics
Stirling University

Nick Hanley
Professor
Dept. of Geography and Sustainable Development
University of St. Andrews