The Choice Architect Meets PES Design
Non-pecuniary Interventions for Spatially Coordinated Conservation Actions

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Abstract

How can the choice architecture toolkit be utilized to improve policy design for private land conservation? To study effective interventions, we investigate several combinations of tools that encourage landowners to take spatially coordinated conservation actions in payment for ecosystem services (PES) schemes. In particular, we ask whether setting a minimum participation requirement (MPR) at the local community level together with nudging about pre-existing participants improves spatially coordinated participation in comparison with a conventional design. Based on an experiment included in a survey carried out in the field targeting non-industrial private forest landowners in Japan, we find that the most effective alternative choice architecture is associated with a 65% increase in ZIP code-level agglomeration and an 11% increase in stated conservation program participation. Under the proposed choice architecture, even a modest increase in participation can have significant implications for ecosystem fragmentation. Next, we address the underlying mechanism of how the non-pecuniary interventions work. A discrete choice model accounting for social interactions reveals that the combined intervention boosts the conformity of individual behavior to that of local peers. Local clustering of participation, enhanced through increased conformity, facilitates substantial improvements in spatially coordinated conservation efforts. Finally, we investigate what tools are responsible for the improvement by varying the geographical units and requirement levels for MPRs as well as the availability of social comparison information. The results indicate that only the combination of nudging and MPR set at the local level significantly improve conservation. Any single intervention does not have a statistically significant effect. Overall, our analysis suggests that introducing a MPR to the smallest administrative unit, together with nudging about pre-existing participants in the unit, can substantially improve the cost-effectiveness of PES schemes.

Keywords: payment for ecosystem services, spatial coordination, minimum participation requirement choice architecture, non-pecuniary interventions, peer effect
JEL Codes: C93, D90, Q18, Q28

1. Introduction

Private land conservation plays an important role in generating biodiversity and ecosystem services for society. The protection and enhancement of biodiversity and ecosystem services from private land through the change and adaptation of land uses often incurs large opportunity costs for landowners. Over the last decades, payment for ecosystem services (PES) schemes have been widely used as a policy instrument to financially compensate landowners for the costs associated with land conservation.[1] However, the performance of such incentive-based schemes relies heavily on landowners' willingness to participate (Mitani and Lindhjem, 2021). Since landowners typically choose on an individual basis whether to participate or not, these conventional schemes often suffer from poor performance due to fragmented participation (Nguyen et al., 2021). A major challenge for policy designers of PES schemes is to facilitate spatial coordination of conservation efforts to increase the ecological effectiveness, while obtaining sufficient participation for achieving a desired ecological threshold. One way to improve spatially coordinated participation is to increase the amount of financial compensation for coordinated

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[1] Examples include the Conservation Reserve Program (CRP) in the United States and the Agri-Environmental Schemes (AES) of the EU Common Agriculture Policy.

participants (Nguyen et al., 2021). However, use of financial compensation sometimes provides unintended incentives among landowners and is always costly and restricted by budget constraints. Given tight public budgets, policymakers have been giving increasing attention to the role of non-pecuniary strategies in the design of PES schemes (Palm-Forster et al., 2019).

In an effort to respond to policymakers' knowledge needs, we ask how the choice architecture toolkit can be utilized to influence landowner's willingness to participate in a spatially coordinated manner. We investigate several combinations of tools that encourage landowners to take spatially coordinated conservation actions in PES schemes. We consider a PES scheme as choice architecture and conceptualize resource managers as the choice architect who use pecuniary and non-pecuniary incentives to design schemes that alter landowners' behavior to accommodate the challenge of fragmented participation in a cost-effective way. In particular, we examine three features of a PES choice architecture: (1) introduction of a minimum participation requirement (MPR) for program implementation, (2) selection of geographical units and requirement levels for MPR, and (3) giving verbal cues about pre-existing participants. Our proposed choice architecture is a combined intervention of setting the MPR at the local community level and informing about pre-existing participants in the same community.

We test whether the combined intervention improves spatially coordinated participation when compared to a conventional design without MRE and information about others' behavior. We use the stated participation behavior data from 496 non-industrial private forest (NIPF) landowners in Japan. Based on an experiment included in a survey carried out in the field, we find that our proposed choice architecture is associated with a 65% increase (relative to the conventional design) in ZIP code-level agglomeration and an 11% relative increase in participation in a hypothetical conservation program. Hence, even a modest increase in participation can have significant implications for ecosystem fragmentation. Next, we explore the underlying mechanism of how the non-pecuniary interventions work. A discrete choice model accounting for social interactions reveals that the combined intervention boosts the intensity of conformity among local peers on individual participation behavior. This suggests that the local-level clustering of participation, enhanced through increased conformity, substantially facilitates spatially coordinated conservation efforts. We also investigate what tools are responsible for the improvement. The result indicates that only the combination of nudging and MPR set at the local level significantly improves outcomes while any single intervention has no significant effect on spatially coordinated participation.

2. Conceptual Framework

We develop a conceptual framework to understand possible channels through which our interventions may influence landowners' participation behavior. We consider the following utility function for landowner i that includes non-pecuniary incentives (S) as well as pecuniary incentives (π):

$$u_{iy_i} = U(\pi_i(y_i, y_{-i}|x_i), S(y_i, y_{-i}|w_i)|T_i),$$

where (y_i, y_{-i}) is a vector of all landowners' participation decisions where $y_i = \{0,1\}$, π_i is i's pecuniary incentives with respect to program participation, x_i is a vector of landowner specific characteristics that reflect the opportunity and transaction costs of program participation, S is non-pecuniary, social incentives where a weighting matrix w_i identifies i's peers, and T_i is the PES choice architecture treatment that i receives. For social incentives (S), we focus on a landowner's conformity among their local peers (identified by their local community networks), which implies that landowners may incur disutility when deviating from their peers' actions. Pecuniary incentives (π_i) for conventional scheme with no MPR can be modeled as a linear public good game if the cost of participation exceeds the compensation amount for all landowners and the sum of marginal benefits of all individuals including landowners and third-party beneficiaries exceeds the marginal cost of public good provision per individual. Program participation under this condition can be interpreted as a voluntary provision of ecosystem services.

Our choice architecture (T_i) can influence both pecuniary (π_i) and non-pecuniary (S) components of utility. First, an introduction of a MPR changes the mechanism (from a linear to threshold public good game) and directly influences landowner's monetary payoff function with respect to program participation. Under the choice architectures with MPR, multiple equilibria create a coordination problem with other landowners. Any changes in geographical units (either local community or municipality levels) or requirement levels (either 30% or 50%) also influence their payoff function. Second, the choice architect may influence non-pecuniary incentives because the selection of geographical units and requirement levels for MPR shapes at what level and with whom coordination would be beneficial to participants. To see this, consider that landowners tend to conform to their own local community even in the conventional scheme without MPR. Our proposed choice architecture introduces a MPR of 50% at the local community level together with nudging about pre-existing participants of 20% in the same community. Social incentives may become even more salient under this intervention than the conventional scheme.

Assume that the landowner has well-defined preferences that can be represented by the general utility function above and that their behavior is consistent with utility-maximization, then they will choose to participate in the program if $u_{i1} > u_{i0}$. This simple model provides the basis for our empirical analysis and interpretation of results.

3. The Survey Experiment

The study site, Kuma municipality, is in the center of Ehime prefecture, approximately 600km southwest of Tokyo, Japan. The municipality is mountainous and has about 43,000ha of private forestland, which is 74% of the total land (584km^2) in the municipality. In 2014, the resident population of the municipality was 9327 with 45% of them older than 65 years of age, indicating that the municipality faces an aging and shrinking population. The municipality is divided into 36 ZIP code subdivisions and 219 small and cohesive communities. The local community is the minimum administrative unit in the municipality. Community members typically interact through daily life and collective actions (Mitani, 2021). Forestry activity in the area had been successful until the 1980s because of increasing domestic timber demands associated with the economic growth of Japan. However, many private forest landowners lost their motivation for timber productions as timber prices began to decline (Mitani and Shimada, 2021). The local authority seeks to establish conservation reserves, which consisted by continuous forestland that has several owners so that environmental services and cost-effectiveness would be enhanced.

Experimental Design

We use contingent behavior questions, elicited in a survey, regarding landowner's willingness to participate in a hypothetical conservation program. The main elements of the program were described in the questionnaire as: "*<u>Forest Ecosystem Conservation Program</u>: Suppose that there is a Forest Conservation Incentive Program under consideration in this municipality. The program is designed to improve forest ecosystem and habitat for wildlife. The program relies on private forest owner's participations. You can voluntarily make a five-year contract with the authority to provide the whole or parts of your forest for conservation program. Although you receive a financial compensation for the loss of timber income, you will not be able to harvest timber or do other activities that affect the forest ecosystem in the next five years.*"

We consider three features of a PES choice architecture and create five treatment groups. Table 1 shows the five groups. T0 is our control group and shares the same features as the conventional scheme while T4 is our proposed choice architecture and combines interventions. The main purpose of this study is to evaluate the effects of combined intervention on spatial coordination and participation relative to the conventional design. We included additional three treatments (T1-3) to investigate further what parts of choice-architecture features work. We employed a between-subject, random split-sample design where individual landowners were randomly assigned to one of five treatments. For treatments T1 to T4, the following information about mechanism of the program was additionally provided: "*Because of the effectiveness of this conservation program, a minimum participation rate of* [MPR Level]*% among landowners in the* [MPR Unit] *is required for program implementation. This program is cancelled in your* [MPR Unit] *if fewer than* [MPR Level]*% participate.*" Following this, further information was added in T4: "*Assume that 20% of landowners have already participated in your community. Thus, 30% participation among you is required for implementation.*"

Following this information, the participation question we analyze in this paper was asked as follows: "*If you were to get equivalent monetary compensation for the loss of timber revenue, would you voluntarily participate in setting aside the whole or parts of your forest as a conservation reserve? [Yes, No].*" Following this question, landowners were also asked "*What percentage of landowners in your local community do you expect to participate in this conservation program?*"

We mailed survey booklets to 1,430 residential NIPF landowners, followed by a reminder sent 10 days after the initial letter. The number of respondents totaled 733 and the response rate was therefore slightly above 50%. After excluding incomplete questionnaires and respondents who did not belong to any community in the municipality, we obtain a usable sample comprising 496 respondents.

Table 1. Treatments and Summary Statistics

	Choice Architectures				Observation (N=496)	
	MPR Unit	MPR Level	Nudge		Part.	Spat. Coord.
T0	N.A.	N.A.	N.A.	*Conventional*	0.793	0.433
T1	Mun.	50%	N.A.		0.818	0.500
T2	Lcl. Comm.	50%	N.A.		0.811	0.567
T3	Lcl. Comm.	30%	N.A.		0.844	0.538
T4	Lcl. Comm.	50%	20% Pre.extg.	*Combined Int.*	0.882	0.714
			T0 vs T4 (% relative increase)		11.3%*	64.9%**

Notes: Part.: participation rates; Spat. Coord.: full participation rates at the ZIP code subdivision; * p<0.1; ** p<0.05

4. Results

Descriptive Results

Table 1 presents descriptive results of participation rates and spatial coordination. We evaluate spatial coordination by computing the rate of full participation in the ZIP code subdivision. The result reveals that our proposed choice architecture demonstrates a 64.9% increase ($z = -2.14$, $p = 0.032$) in ZIP code-level agglomeration relative to the conventional design and an 11.3% relative increase ($z = -1.66$, $p = 0.096$) in participation. Even a modest increase in participation seems to produce substantial impacts on spatial coordination of participants at the ZIP code subdivision. Figure 1 shows how the rate of subdivisions that exceeded a given cutoff threshold (Agglomeration Index) decreases with increasing the cutoff from 50% (half participation in a subdivision) to 100% (full participation in a subdivision). Our combined intervention performs well relative to the conventional design especially when we require high participation rates at the subdivision level. The results from balance tests indicate systematic differences in covariates between treatments. For pairwise comparisons of means between T0 and T4, two out of ten covariates differ at less than the 5% level of statistical significance. Therefore, we control for individual landowner specific characteristics (x_i), which are associated with their opportunity and transaction costs of program participation in the following analyses.

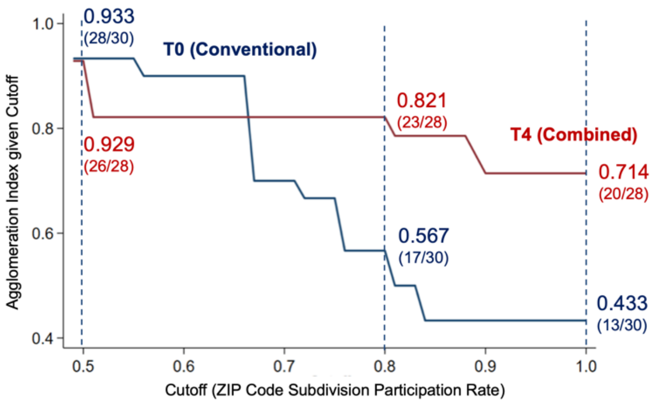

Figure 1. Subdivision-level Agglomeration Index (T0 vs. T4)

Empirical Strategy

Following the conceptual model, we include non-pecuniary incentives (S) by employing a binary choice model with social interactions, in which landowner's individual behavior is influenced by his or her expectation about peers' behavior (Brock and Durlauf, 2001). Instead of calculating a rational expectation equilibrium from the model to derive individual subjective expectation p_i, in the way proposed in Brock and Durlauf (2001), we use self-reported, subjective data on expectation as suggested by Li and Lee (2009). Self-reported subjective expectation enables us to analyze the intervention effects on participation indirectly through social incentives by simply including interaction terms between treatment dummies and subjective expectation ($p_i d_i^T$). We specify a landowner i's utility function as follows:

$$u_{iy_i} = x_i'\beta_{y_i} + d_i^{T\prime}\alpha_{y_i} + \gamma_{y_i} p_i + p_i d_i^{T\prime}\delta_{y_i} + \varepsilon_{iy_i},$$

where d_i^T is a vector of treatment dummies, p_i is i's subjective expectation about peers' decisions elicited in the survey, and ε_{iy_i} captures idiosyncratic shocks following a Gumbel distribution. The probability that a landowner i participates in the conservation program is described as $\Pr[u_{i1} - u_{i0} > 0] = \Pr[x_i'(\beta_1 - \beta_0) + d_i^{T\prime}(\alpha_1 - \alpha_0) + (\gamma_1 - \gamma_0)p_i + p_i d_i^{T\prime}(\delta_1 - \delta_0) > \varepsilon_{i0} - \varepsilon_{i1}] \equiv \Pr[x_i'\beta + d_i^{T\prime}\alpha + \gamma p_i + p_i d_i^{T\prime}\delta > \varepsilon_i]$. The main estimand of interest is treatment effects: $E(y_i|d^T = 1, x_i) - E(y_i|d^T = 0, x_i)$. Given our assumption on ε_{iy_i}, we use the logit model for empirical estimation to deliver estimates of treatment effects: $\alpha + \bar{p}\delta$. Connecting the empirical specification with our conceptual model, α can be interpreted as the intervention effect on participation through a direct change in economic incentives (π) while δ captures the intervention effect on participation through an indirect change in social incentives (S). Aside from the treatment effects, β captures the impact of the variation in landowner's opportunity and transaction costs of program participation on participation while γ captures the impact of conformity (i.e., social incentives) on participation in the conventional design of T0.

Estimation Results

"With Interaction" in Table 2 presents our main estimation results of robust standard error logit model.

Table 2. Estimation Results

	No Interaction		With Interaction	
T1: 50% Mun.	-0.001		1.811	**
T2: 50% Lcl.Comm.	0.897	*	2.026	**
T3: 30% Lcl.Comm.	0.740	*	0.817	
T4: Combined Int.	1.151	***	-1.109	
Expectation	7.674	***	10.363	***
T1 × Expectation			-6.811	***
T2 × Expectation			-4.963	
T3 × Expectation			-0.020	
T4 × Expectation			17.074	***
Covariates	Yes		Yes	
Pseudo R2	0.327		0.367	
Log Likelihood	-154.04		-144.84	
N Obs.	496		496	

Notes: * p<0.1; ** p<0.05; *** p<0.01; 10 covariates and a constant were included in the model.

Figure 2 shows the average subdivision-level agglomeration index over 500 simulated trials after controlling for covariates. This parametric estimation-based simulation supports our earlier descriptive result shown in Figure 1. Figure 3 shows estimated participation under different levels of expectation. The slope indicates the intensity of conformity among the peers for individual participation (δ). This comparison suggests that our combined intervention increases the intensity of conformity on participation. Thus, our proposed choice architecture facilitates spatially coordinated participation by influencing landowner's social incentives. Finally, we decompose the combined effects into single interventions. The result shown in Table 3 indicates that only the combined intervention significantly improves outcomes while any single tool has no statistically significant effect on spatially coordinated participation.

5. Concluding Remarks

Our results suggest that introducing a MPR to the smallest administrative unit, together with nudging about pre-existing participants in the unit, can substantially improve the cost-effectiveness of PES schemes. Our analysis suggests that this improvement can be achieved by sharply boosting the impact of conformity among neighboring landowners on their participation.

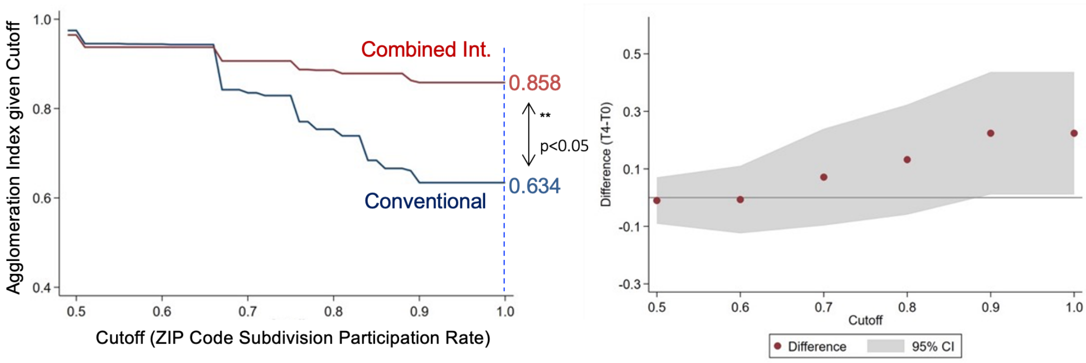

Figure 2. Subdivision-level Agglomeration Index by Simulation based on Estimated Model

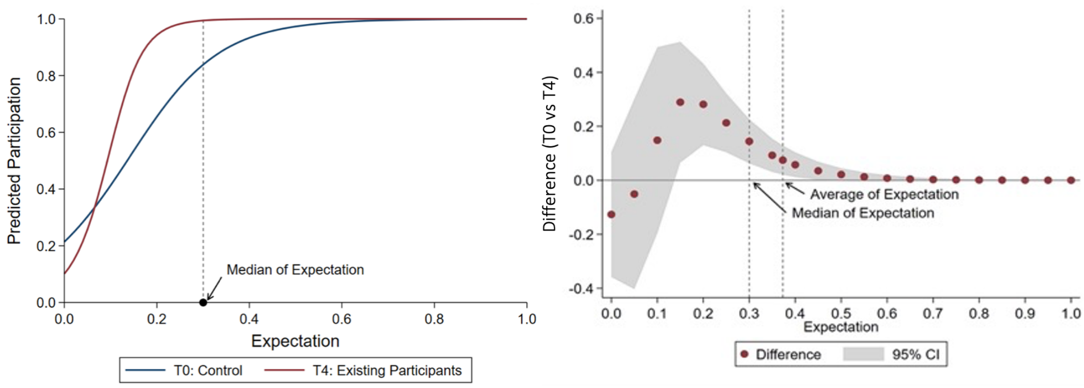

Figure 3. Predicted Participation with Different Expectations

Table 3. Percentage Point Change by Change in Choice Architecture

Difference in Choice Architectures		Pred. Part.	Pred. Spat. Coord.
Nudge (With vs. Without)	T4-T3	+7.8%	+9.3%
MPR Level (30% vs. 50%)	T3-T2	+2.1%	+7.2%
MPR Unit (Lcl.comm. vs. Mun.)	T2-T1	+8.6%	−0.5%
MPR (With vs. Without)	T1-T0	−3.0%	+6.4%
Combined Intervention	T4-T0	+15.5%***	+22.4%**

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