The effects of peer group information and group size on spatial coordination in agri-environment schemes: a laboratory experimental study of the Agglomeration Bonus.[1]

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Abstract

In this paper we use controlled laboratory experiments to study the role of peer group behavior in influencing landowner behavior in the context of agri-environmental schemes with an Agglomeration Bonus format. Prior research has indicated that strategic uncertainty within the economic environment of the Agglomeration Bonus (resembling a coordination game with multiple payoff ranked Nash Equilibria) can lead to coordination failure and limited spatial coordination on the preferred land use (that can generate the greatest ecosystem benefits). High levels of strategic uncertainty can be a result of large community sizes where landowners' actions are interdependent yet where limited information is available concerning behavior of the peer group. Our experiment reduces participants' strategic uncertainty by increasing the amount of information available to them. In control sessions, groups of 12 individuals (arranged on a circular local network on which every individual has 2 strategic neighbors) participate in an Agglomeration Bonus game and receive payoffs and information about their neighbors' actions. In the treatment sessions, in addition to this information, subjects are also informed about the choices of all members of their entire peer group. We combine this information treatment with a group size reduction from 12 to 8 to further decrease game strategic uncertainty and create an environment where socially desirable efficient coordination is more likely. Our results indicate that more information in smaller groups significantly improves the likelihood of making the efficient choice. However, repeated interaction leads to a reduction in the likelihood of choosing the efficient action unless both neighbors make the same choice. Analysis of group level spatial patterns indicate no significant treatment effect with increasing instances of coordination failure over time. Thus even if increases in information and reductions in group size increase the likelihood of efficient choices, this setup does not ensure that these choices are by adjacent individuals which is necessary for environmental successes. Hence, additional mechanisms are needed to incentivize spatially contiguous efficient land use choices in the long run.

Keywords: *Agglomeration Bonus, Ecosystem Services, Information, Local Networks, Spatial Coordination, Strategic Uncertainty*

JEL Codes: Q57, Q24, D83, D85, C72, C91, C92

Introduction:

Economic incentives in agri-environmental schemes have been used by regulatory agencies in many countries such as the US, UK, and Australia. Such schemes attempt to incentivize environmental beneficial uses of private land. Examples of major programs include the Environmental Quality Incentives Program (EQIP) and the Conservation Reserve Program (CRP) in the US, the Higher Level Stewardship Scheme in the UK and state-level conservation tenders in Australia. However, these programs face several challenges. First, reduced public funding for such conservation payments is a key challenge. The United States Congress reduced funding for USDA programs by about US$500 million in 2011 with future reductions expected (Shortle et al. 2012). A second problem, and the subject matter of the current paper, is that many programs that target ecological objectives which require spatially-coordinated land uses to deliver on multiple ecosystem services benefits such as habitat fragmentation reduction, water quality improvements, enhancement and maintenance of pollinator populations, may not live up to their promise given the nature of landowner interactions within their communities and the rewards available from competing land uses. For example, previous research on the Agglomeration Bonus scheme (see below) has indicated that if payoff magnitudes are conservative, than spatial coordination can be achieved at the local level only with a few adjacent landowners – landscape level coordination where everyone in the community chooses the same environmentally-beneficial land use is unlikely.

In this context, *we investigate whether providing information about one's peer group can serve as a means to improve performance via selection of the same land use action and sustained delivery of key ecosystem services*. The rationale for this research is based on the fact that actions of one's peer group can potentially influence individuals to make decisions that are both incentive compatible and social welfare enhancing. For example, (*i*) a group of Iowa landowners were able to influence their community counterparts to participate in water quality improvement schemes (McGuire et al 2013), (*ii*) participation in the Conservation Reserve Program was improved by providing peer information (Wallander et al. 2014), (*iii*) information on community-level land use actions can create a social norm, which can nudge individuals in the direction of environmentally-friendly choices (Kuhfuss et al, 2015) and (*iv*) in urban contexts information about peers' behavior was found to impact one's own choices in the context of residential water usage and conservation (Ferraro and Price 2013) and energy use (Alcott 2011).. We contribute to this literature by investigating the role of information with specific focus on programs with an Agglomeration Bonus format (Parkhurst and Shogren 2007) that reward similar land uses on spatially adjacent properties.

The Agglomeration Bonus is a two-part payment scheme in which landowners receive compensation for participating or enrolling in a conservation scheme, plus a bonus payment if their neighbors participate and enroll tracts under the same land uses such as reduced tillage, retirement of cropland, low-intensity livestock grazing, creating of pollinator foraging patches etc. In this format, the Agglomeration Bonus produces a strategic environment which is a coordination game with multiple Nash equilibria. These Nash equilibria can be classified as Pareto dominant (efficient) and Risk dominant (Harsanyi and Selten 1988) Nash equilibria and can be ranked on the basis of their payoff magnitudes. Selection of any one of these Nash equilibria is dependent on various factors such as the relative sizes of the basins of attraction of the two equilibria (which is dependent on the magnitude of payoffs and deviation losses: Battalio et al. 2001), the learning rule adopted by subjects during repeated interactions that could lead to imitation or best response learning (Alos-Ferrer and Weidenholzer 2006, 2008), features of the game environment such as group size (Van Huyck et al. 1991) and information available to the players that reduces their strategic uncertainty. Prior experimental research with Agglomeration Bonus schemes have indicated that choice of the efficient action (corresponding to a preferred land use) is more likely in smaller groups (Banerjee et al. 2012) and when subjects have more information about others' choices (Banerjee et al. 2014). However, repeated lab interaction are found to reduce the likelihood of choosing the socially desirable land use strategy (even with more information), whilst efficient land use choice is found to be more likely in small groups.

Given these prior findings, in this paper we jointly study the rolls of information and group size, by varying the information available to players on Agglomeration Bonus performance between larger and smaller groups. This treatment is aligned with the policy driven agenda of this paper which is to provide the Agglomeration Bonus with the best chance to succeed in generating efficient coordination patterns. The economic laboratory provides an appropriate setup for this research given the absence of existing data which can be used to assess the effectiveness of the strategic uncertainty reduction treatment over multiple repetitions. The economic laboratory also permits low-cost wind-tunnel testing of how policy interventions can influence decisions in a controlled setting while avoiding confounding factors that may influence behavior observed in reality (Shogren 2004).

Our paper present results from two types of experiments. The experiments comprise of groups of subjects who make land use choices and are paid on the basis of an Agglomeration Bonus scheme. The subjects are arranged on a circular local network with every individual connected to two direct neighbors (one to their left and one to their right) and indirectly to the others (Jackson 2010). This network structure allows us to explicitly consider the role of location on decision making and contribute to the experimental literature on equilibrium selection and individual behavior in local network coordination games (Berninghaus et al. 2002; Cassar, 2007).

In the first set of experiments, groups comprise of 12 subjects who receive information about their own choices and those of their two direct neighbors after making a choice between two land use strategies in the Agglomeration Bonus game. In the second set of experiments, we consider groups with 8 individuals who receive the above information about direct neighbors but are also additionally provided with information about the total number of choices of their entire peer group. This two-dimensional treatment variation creates a streamlined experimental testbed (Plott 1997) in which to test the effect of more information in an environment with relatively lower strategic uncertainty. While, changing two features of the testbed at the same time is uncommon, it is not problematic to our study: ample evidence from the experimental coordination game literature indicates that the expected effect of these two treatment changes are not orthogonal to each other (both group size and more information reduces player's strategic uncertainty in favor of the efficient strategy). In that sense, our joint treatment variation is not expected to create any potential confounding problems. In both studies we consider the same payoff magnitudes for the Agglomeration Bonus game, allowing us a common reference frame on the basis of which to compare behavior and policy outcomes.

Our results indicate a significant improvement in likelihood of selecting the efficient land use choice within the smaller group when peer group information is available. In large groups, repeated interactions leads to increase in chances of coordination failure. In the smaller groups where subjects have more information, the effect is not that straightforward and is contingent on neighbors' behavior. Repeated interactions increase the likelihood of efficient choice (and thus avoid coordination failure) only if one or both neighbors coordinate actions with the player. If no neighbor chooses the efficient strategy, then over time the likelihood of efficient choice selection falls. Focusing on patterns of efficient coordination, the Agglomeration Bonus is able to provide incentives for coordination but this is restricted to parts of the network only: the entire networked group is unable to choose the efficient strategy under both treatments. For ecosystem services which require spatially coordinated land uses on area of some critical size, this outcome represents ecological ineffectiveness and economic inefficiency. Thus, the challenge for agri-environmental policy design is to devise supportive mechanisms that the positive effects of information remain and that the requisite acreage is brought under the desired land use in a spatially coordinated fashion to deliver on the ecosystem services benefits for which the Agglomeration Bonus policy has been implemented in the first place.

The Agglomeration Bonus Scheme:

There are $i = 1, \dots, N$ landowners who have to choose out of two decision opportunities, $\sigma_i = T, C$ corresponding to two land uses within the context of the Agglomeration Bonus scheme. Option C refers to conservation management on agricultural land ("land sharing": Balmford et al. 2012), and T refers to retirement of cropland such as under the CRP referred to as "land sparing" by Balmford et al. (2012). We assume that the payments for each land use option is pegged to the magnitude of societal (environmental) benefits from it. Let any parcel of land under either land management option yields ecosystem service benefits, $s(\sigma_i)$, and let these "stand-alone" benefits be larger under T than under C.[2] Let us assume that $s(C) = 5$ and $s(T) = 10$.

[2] Land sharing option C maybe conducive to species that like the "openness" of fields such as the burrowing and short-eared owls (Holt and Leasure 1993). Land sparing option T, can provide good habitat for those species that do not prefer the open nature of cultivated land, such as the boreal toad (Keinath and McGee 2005) and birds like the sage grouse (Crawford et al. 2004). Non-crop habitats on retired tracts like flower patches and hedgerows are beneficial for increasing the populations of natural pollinators such as honey bees (Carvell et al. 2007) whose colonies have seen a collapse in recent times and have called for action by President Obama. Additionally,

Let $n_{i\sigma}$ denote the number of parcels adjacent to that of landowner *i* that are under the same land management option σ_i as the plot of landowner i. Environmental agglomeration benefits from both types of land management options and are denoted by $b(\sigma_i)$ per neighboring parcel. The total agglomeration benefits are then denoted by $n_{i\sigma}b(\sigma_i)$. We assume that these benefits are larger for T than for C given the nature of ecosystem services delivered from land sparing and sharing options. Let the agglomeration benefit values be *b(C) = 10* and *b(T) = 40*.

Within the economic environment of the Agglomeration Bonus, the *N* landowners are arranged around a circular local network where every landowner shares property boundaries with two other individuals. While somewhat stylized, this circular representation ensures that every landowner has the same number of direct and indirect neighbors (individuals to which they are connected via connections to direct neighbors) and hence faces identical levels of strategic uncertainty within the coordination game. This feature is especially important to this study as we are primarily interested in how mechanisms that reduce strategic uncertainty impact behavior and policy performance. The identical strategic uncertainty feature allows for an insightful analysis of our strategic environment modification without having to worry about potential complications (or confounding) arising from different networked individuals having different numbers of direct and indirect neighbors and hence varying levels of strategic uncertainty. On this circular landscape, we also assume that the landscape-level ecosystem services benefit contributed by a landowner choosing a management option depends on the direct neighbors' decisions, but not on those of their indirect neighbors. This assumption allows us to capture the spatial nature of environmental processes and benefits which are decreasing with increasing geographical distance.[3]

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uncultivated and undisturbed land can provide stand-alone global carbon sequestration benefits at levels higher than cultivated lands under conventional tillage agriculture.

[3] Of course we could have considered benefits unrestricted over space and extending beyond direct neighbors' land uses. This would imply spatial benefits (and bonuses) increasing in total number of landowners on the

Finally, in addition to the conservation benefits of land use, there are private/social values from agricultural as well and these are assumed to be larger under land sharing *C* than under land sparing *T*. Let $r(\sigma_i)$ denote a landowner's profits from agriculture. When land is managed for profit-based agriculture, profits are positive (*r(C) = 55*) whilst they are zero when land is retired from agriculture (*r(T) = 0*). Given this setup, the total societal benefits provided by landowner i's land use choice (environmental and private benefits) is:

(1) $$w(\sigma_i) = r(\sigma_i) + s(\sigma_i) + n_{i\sigma}b(\sigma_i) \quad \sigma_i = T, C \quad \forall i = 1, 2, \dots, N$$

Given this setup, we assume that the regulator designs the Agglomeration Bonus payment parameters to reward landowners with payments equal to the full social benefits generated by their pro-environmental land use activities, i.e., they receive subsidies equal to $s(\sigma_i) + n_{i\sigma}b(\sigma_i)$. Thus, the subsidy is set at the Pigouvian level and expression (1) is the total payment received by landowner *i* when choosing land option σ_i (that includes the market returns from agriculture as well). Also, Eq. (1) indicates that the bonus payment $n_{i\sigma}b(\sigma_i)$ depends on the number of neighbors choosing similar land use practice, $n_{i\sigma}$. This feature makes the current game analogous to critical mass coordination games where the payoff from choosing an action is positive only if a critical mass of players also choose that action (Devetag, 2003).

landscape. While this is not unrealistic, this feature adds more strategic uncertainty within the game environment without adding any other notable feature which might inform behavior and policy performance.

Table 1: Agglomeration Bonus Payoff Table

	Direct neighbors' choices		
Landowner choice	TT	TC	CC
T	**90**	50	10
C	60	70	**80**

Using Expression (1), Table 1 represents the payoffs (corresponding to social and private benefits) associated with the AB scheme involving a landowner and two direct neighbors. On the basis of this payoff table, the AB scheme resembles a 3-player network Stag-Hunt coordination game. This three-player game has two pure strategy Nash equilibria where all players choose *T* (Pareto dominant) or *C* (risk dominant). At the network level, choice of the same strategy by all *N* players creates a convention: the Pareto efficient convention *all-T* corresponding to land sparing or the risk dominant *all-C* convention corresponding to land sharing.

In this game, the equilibrium selection principles of risk and payoff dominance select different strategies as option T, while more profitable, is riskier relative to strategy C as it yields a higher payoff loss when neighbors do not coordinate on *T* (Straub 1995). Additionally, the network setup within which every player has direct and indirect neighbors has the potential to increase strategic uncertainty considerably if information is limited to direct neighbors only. These two features of the game environment may prevent coordination on the efficient strategy and lead to the inefficient outcome – a scenario referred to as coordination failure. Given this setup and our conjectures, this study explores the impact of reducing the strategic uncertainty of players by providing more information to subjects about land use selection of their peer group (a low cost mechanism) and supplementing the information treatment by reducing group size to evaluate whether policy performance and patterns of coordination can be improved through efficient strategy choice.

Experimental Design:

We report data from 9 sessions distributed between two treatments: 6 baseline 12INFO sessions with a large group of 12 players and 3 treatment 8INFO sessions with 8 subjects per session, producing a data set with 96 subjects. During a session, subjects adopted the role of private landowners who had to choose between strategies *T* or *C* in the context of an Agglomeration Bonus scheme. The participants were arranged on the local circular network on which their locations and identities were determined by a randomly determined ID. For example, Player 5 is directly linked to Player 6 and Player 4. These two direct neighbors make up the player's local neighborhood. Every subject is *indirectly* connected to the remaining players (9 in 12INFO and 5 in 8INFO) via their direct neighbors. The subject IDs (and hence neighbor identities) are kept unchanged for the entire experiment under both treatments for two reasons. First we want to study the impact of reputation within groups and reputation takes time to build. Second, landowner identity and location are often fixed on actual geographical landscapes for prolonged periods, indicating that the same set of landowners may be participating in the conservation scheme over multiple signup periods.

Each experiment repeats for 30 periods during which subjects make choices in the Agglomeration Bonus coordination game with payoffs as shown in table 1. At the end of each period, subjects receive information about their two direct neighbors' land use choices. In addition, in the 8INFO groups, subjects are also provided with information about the total number of *T* choices (and consequently *C* choices) in the whole group and total group earnings.

The group earnings information was included to increase the transparency within the environment and provide further support for the increased information treatment (since earnings are positively correlated with *T* choices). Thus subjects have individualized information about direct neighbors and aggregated information about other community members' choices.[4]

The experiments are implemented using Z-Tree (Fischbacher 2007) and sessions last between 45 and 75 minutes. Sessions were conducted at the Pennsylvania State University and University of Nebraska-Lincoln. At the beginning of every session a figure representing the circular network and players' neighbors was shown to the subjects. All instructions are made available on a computer screen and are read aloud to maintain an environment of common knowledge. Subjects are aware of the total number of game periods. This information was also provided to them while they were making a decision so that at no point did subjects make choices as they would in an infinitely repeated game. We refrained from using contextual terminology such as ecosystem services, biodiversity conservation or endangered species in the experimental instructions because we want to study how financial incentives impact experimental outcomes and also because pro-environmental terminology can potentially trigger subject behaviors and confound the treatment effect (Smith 1976; Cason and Raymond, 2011). Moreover, presence of explicit pro-conservation motivations that typically vary across landowners can introduce subject heterogeneity in our experiment vis-à-vis behavior that can lead to loss of control which can confound the results of our information treatment as well.

[4] One can argue that providing information about all group members' choices would create the best set of circumstances for the Agglomeration Bonus to succeed. However, we are unsure whether in reality conservation agencies would provide such disaggregated individualized information since many landowners may construe such information sharing as a privacy violation. By providing aggregated group level information (and neighbors' choice information) we believe that we have created a testbed environment which circumvents the privacy issue and still corresponds to a real farming community in which landowners can query indirect neighbors about their choices if they should choose to do so. Providing direct neighbors' choice information is not problematic as any individual would just have to "look over the fence" to gather this knowledge.

Before starting the experiment, all subjects participated in a quiz about different features of the experiment to verify their understanding of the strategic environment.

Results:

Our results are classified into a discussion about individual behavior on the local network; and the resultant spatial patterns produced which represent policy performance at the landscape level. Since the goal of the Agglomeration Bonus is to generate spatially land use patterns and coordination failure and choice of risk dominant strategy *C* is the norm rather than the exception in most strategic environments, there is considerable appeal in discussing the factors that incentivize land sparing (the more difficult riskier alternative) than land sharing, that maximize social welfare. Thus we present our analysis in terms of Pareto efficient *T* choices.

Figure 1 presents the fraction of *T* choices by each of the 9 groups under both treatments for all 30 periods of the experiment. We find that there is only one group where the value is 1 indicating that every individual chooses *T*. In all other groups, regardless of information and group size, the value is less than 1 suggesting a combination of both land use choices in all periods of the experiment. Moreover the fraction of *T* choices is falling over time in all but one 8INFO group, whilst those in the 12INFO groups (with very high strategic uncertainty) fall to zero beyond Period 15. Yet, *T* choices in both groups for many early periods of the experiment.

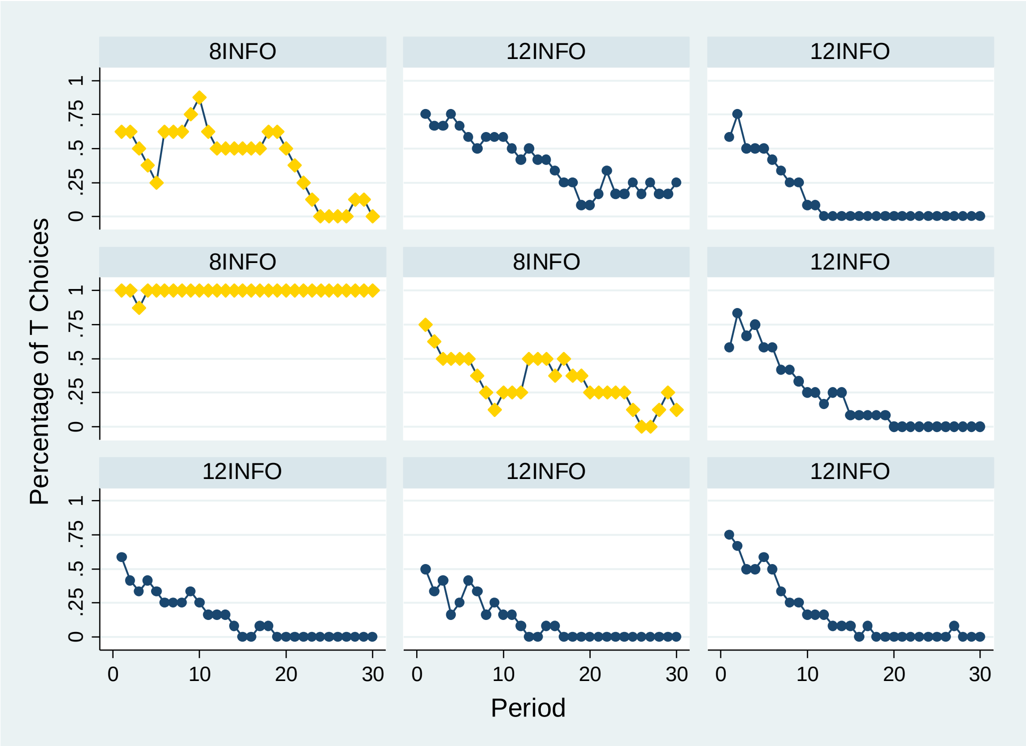

Figure 1: Fraction of T choices by Group

For a better understanding of these results, we consider results of a probit regression with errors clustered at the individual subject level.[5] The dependent variable is a binary variable y_{it} taking a value of 1 for an T choice and 0 for a C choice by subject i ($i = 1,2, \ldots ,96$) in period t ($t = 1, 2, \ldots ,30$). The independent variables include the combined information-group-size treatment dummy D to which every subject is randomly assigned, the reciprocal of the Period variable denoted by $1/t$ that controls for non-linear rates of learning by subjects during the experiment, and an interaction term between the treatment dummy variable and the reciprocal of the Period variable to control for the fact that learning can be different in smaller groups with more information. We also include a variable signifying the effect of a subject's previous period

[5] Given the small size of the dataset for the 8INFO treatment, we cannot use the session level Wilcoxon-Mann Whitney Test for our analysis.

choice on the likelihood of selecting *T* in any period denoted by $y_{i(t-1)}$ in order to control for an effect which has been variously termed strategy inertia, a precedence effect or simply "force of habit" (Blume 1993). This variable in interacted with the reciprocal of the Period variable to account for the fact that the precedence effect might be different at different levels of player experience. Since neighbors' choices influence a subject's action, we include the variable $n_{i(t-1)}$, measuring the frequency of direct neighbors' previous period *T* choices. This variable can take a value between 0 and 2, depending on the number of neighbors selecting *T*. This variable is interacted with the reciprocal of the Period variable as well to explore the effect the frequency of neighbors' choices on a subject's likelihood of choosing *T* at different levels of subject experience and with $y_{i(t-1)}$ to analyze whether the effect of strategy inertia interacts with behavior of direct neighbors to impact one's own choice in the game. Expression (2) represents the model for the analysis.

$$(2) \quad y_{it} = \alpha + D + \beta y_{i(t-1)} + \gamma \frac{1}{t} + \omega D \frac{1}{t} + \delta \frac{1}{t} y_{i(t-1)} + \theta n_{i(t-1)} + \pi \frac{1}{t} n_{i(t-1)} + \mu y_{i(t-1)} n_{i(t-1)} + \varepsilon_{it}$$

$$(i = 1,2, \ldots \ldots .96; t = 1,2, \ldots \ldots 30)$$

Table 2 below presents the results of the regression analysis. We obtain a significant estimate for the treatment dummy suggesting that providing more information about one's peer group in the context of a reduced group size significantly reduces strategic uncertainty, and so improves the likelihood of making an efficient *T* choice. The estimates for the precedent effect is positive and significant as expected given the strategy inertia effect. The estimates for neighbors' previous choices and its interaction with the reciprocal of the period variable are positive and negative respectively, and significant. Thus, the choice state within a player's local neighborhood impacts their likelihood of selecting *T* differently at different points of the game. Initially, when game experience is low and players' reputation within their local neighborhood for the play of any strategy is only just building up, a player is unlikely to given any weight to the information provided about their neighbor's actions. However this effect is restricted to

Table 2: Results of Clustered Probit Regression for Likelihood of Selecting *T* choice

Dependent Variable	(=1 if Action = T & 0 otherwise)
Learning	2.605**
	(2.99)
Own Action in Previous Period	1.409**
	(9.55)
Direct Neighbors' Action in Previous Period	1.377**
	(9.99)
Treatment	0.372*
	(2.03)
Own Action in Previous Period x Learning	-0.185
	(0.25)
Own Action in Previous Period x Direct Neighbors' Action in Previous Period	0.213
	(1.22)
Direct Neighbors' Action in Previous Period x Learning	-1.799**
	(3.34)
Learning x Treatment	-0.971
	(1.24)
Constant	-2.555**
	(19.82)
Number of observations	2,784
Number of clusters	96

** represents significance at 1% level of significance & * significance at 5% level

Period 1 beyond which the positive effect of experience starts reinforcing the effect of *T* choices within a player's local neighborhood, so that greater the number of neighbors choosing *T*, the greater is the player's own likelihood of selecting *T*. The estimate for the learning variable is positive and significant (the interaction with the treatment dummy is not) and the interaction with previous neighbors' choices is negative and significant as mentioned. Thus, the effect of game experience is contingent on the environment existing within a player's local neighborhood. If no neighbor or only one neighbor makes a *T* selection, then the likelihood of *T* choices is falling as learning rates go down and game experience increases. However the opposite effect is obtained for the scenario where everyone in a player's local neighborhood chooses *T*. In that case, as subjects learn about the game environment and gather more experience, the likelihood of *T* choices increase as they are more likely to appear in one's local neighborhood.

Based on this discussion of individual behavior, we now focus on how such behavioral responses impact the performance of the Agglomeration Bonus at the group level. Since global efficient coordination where everyone in the group chooses *T* is not obtained as a common spatial pattern in our experiment (we observe this outcome in only one group as shown in Figure 1), we focus on *localized efficient coordination* only – a situation where a player and their two direct neighbors choose strategy *T*. We developed a performance metric that is the ratio of the sum of every instance where a player and their two direct neighbors *locally coordinate* on land use strategy *T* relative to group size *N*. This also indicates the number of unique instances of localized efficient coordination where every player choosing *T* is at the center flanked by both direct neighbors choosing *T* as well.

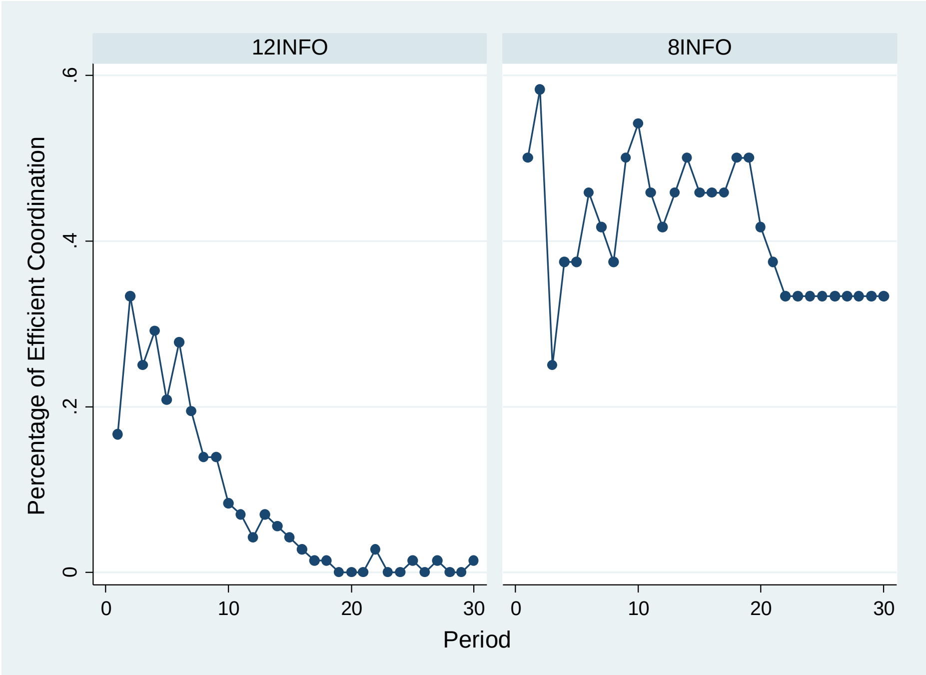

Figure 2: Percentage of Localized Efficient Coordination by Period

This metric can take a maximum value of 1 signifying that all group members are perfectly or *globally coordinated* on strategy *T*. A lower value indicates only localized clustering of similar choices on the network. A minimum value of 0 signifies the *all-C* risk dominant convention. In this format, the same metric can capture instances of both local and global coordination that are observed in all groups during the experiment. Figure 2 presents the proportion of efficient localized coordination across both 8INFO and 12INFO sessions by period and Figure 3 by individual groups.

Comparing Figures 2 and 3, we can conclude that averaging across all sessions, the global efficient coordination in the second 8INFO session is contributing to more localized coordination in 8INFO than in 12INFO sessions, where there is a high degree of game strategic uncertainty. There is also an overall negative trend effect to represent how repeated interactions (and signups) negatively impacts group level performance.

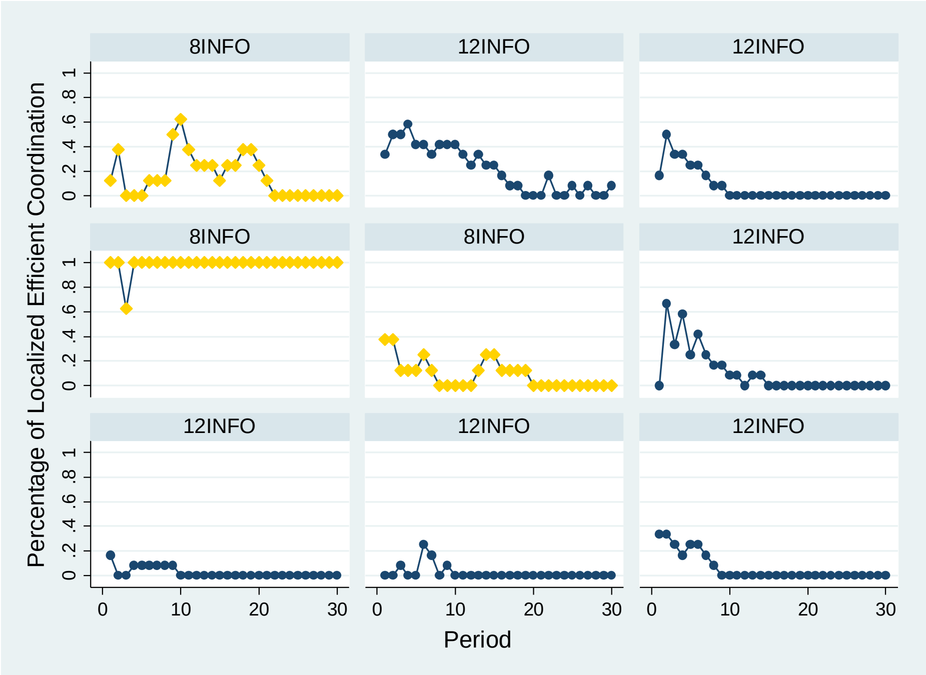

Figure 3: Percentage of Localized Efficient Coordination by Group

For a systematic understanding of these results, we present the results of a tobit regression where the dependent variable is the level of localized efficient coordination in a group in a particular period regressed on the Treatment variable that takes a value of 0 for 12INFO groups and 1 otherwise, the Period variable to capture the trend effect and an interaction term between the Period variable and Treatment variable to capture any differences in trend by treatment.[6] The errors are clustered at the session level (total of 9 clusters). Table 3 presents the results of the analysis.

Our analysis reveals a negative (and significant) estimate for the Period variable and no significant effect for the Treatment variable. The lack of significance for the Treatment effect is a surprising and interesting result in context of the spatial/network structure of the environment.

[6] We use the Period specification rather than the Learning specification in this regression model since our focus is on group level decision making rather than on individual behavior.

Table 3: Results of Tobit Regression for Localized Efficient Coordination

Dependent Variable	Group-Level Localized Efficient Coordination			
Independent Variables	**Treatment**	**Period**	**Period X Treatment**	**Constant**
Estimates	0.243 (0.75)	-0.051* (2.41)	0.039 (1.57)	0.348** (3.7)
Total Number of Observations	270			
Total Number of Clusters	9			

** represents significance at 1% level of significance & * significance at 5% level

It suggests that while more information and smaller group sizes can resolve players' game strategic uncertainty in favor of the *T* choice, it is not necessary that those players who are more likely to choose *T* will be adjacent to each other, an outcome that is essential for environmental success of the Agglomeration Bonus policy. Moreover, experience reduces performance. Thus, given the conservative magnitude of the game payoffs, providing more information and reducing the size of the community network is not sufficient to ensure long term policy success at the local level. This result suggests a serious policy deficiency as it implies that the Agglomeration Bonus can be expected to have applicability over multiple signups in generating localized coordination only, and has little ability to produce globalized efficient coordination given the current payment magnitudes. This result implies that ecosystem services or biodiversity objectives that require some critical minimum acreage of similar land use may not be achieved with the Agglomeration Bonus scheme.

Discussion & Conclusion:

The results of our analysis indicate that a reduction in strategic uncertainty of individuals participating in an Agglomeration Bonus by providing them with additional information about their community peers' choices in smaller groups can improve the likelihood of making the efficient choice. However, while more information increases individuals' likelihood of *T* choices on the network, it is not guaranteed that these individuals will be adjacent to each. Thus, instances of localized coordination are not significantly different between treatments. This is an important study finding and unique to our strategic setting that emphasizes spatially coordinated efficient choices for efficiency and improved policy performance. Moreover, repeated interaction can increase likelihood of efficient choice in this environment but only when both direct neighbors choose *T*. This requirement may be a stiff one given the conservative nature of the game payoffs that makes strategy *C* less risky and hence more likely. Thus, in the case of policies relying on spatial coordination, we have to focus on mechanisms that reduce the strategic uncertainty of as many adjacent landowners as possible (if not all of them) and also ensure that coordination does not move to the inefficient convention over repeated interactions and multiple signups.

Given these findings, this paper can be extended in many directions. First, we can increase the payoffs associated with land use *T*. While design-wise the easiest option, in reality this modification might run up against policy roadblocks especially given the current climate of financial austerity in some countries such as the US where conservation budgets have suffered (Shortle et al. 2012). Moreover, the well-developed literature on coordination games indicates that payoff increases may not suffice in ensuring long term improvements in game performance since it is not a powerful mechanism to resolve strategic uncertainty in favor of the efficient strategy and make it a focal point (Cooper 1994). Second, our conclusions may be predicated on the predominance of observations from the baseline 12INFO sessions. This calls for additional data collection for the treatment groups. Finally, we can consider a separate set of treatments where every landowners within a community is provided with information about choices made by another community participating in the Agglomeration Bonus scheme. The idea behind this treatment is to evaluate whether information exchange between multiple communities, about land use choices can improve own-community behavior through imitative action (Huck et al. 2002, Cartwright 2014) or through inter-group competition (Bornstein et al. 2002, Reichmann and Weimann 2008) especially if communities competing to secure higher levels of *T* choices are rewarded with payments in addition to the bonus. The second and third courses of action are the subject matter of ongoing research.

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