Incentives for sustainable land use considering cost heterogeneity among farmers: Results from a computerized framed experiment

EXTENDED ABSTRACT

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1. Introduction

Payments for environmental services (PESs) are increasingly popular for incentivizing farmers to adopt sustainable land use practices (Engel et al., 2008). The design of these payments needs to overcome two principal challenges. First, cooperation among land users is often required to achieve environmental outcomes. Agglomeration payments, paid if and only if all members of a group of farmers adopt the sustainable activity (Drechsler et al., 2007), are a promising approach to promote farmer cooperation (Parkhurst & Shogren, 2007). Second, while uniform payment rates are most common in PES (Ezzine de Blas et al., 2016), spatial variation in resource and farmer characteristics lead in practice to different individual costs among land users in the implementation of conservation measures. Several studies have shown that differentiating payments according to land users' conservation costs can lead to significant gains in cost effectiveness of the PES program (Alix-Garcia et al., 2008, Armsworth et al. 2012). Moreover, in contexts where conservation costs are considerable, payments that both cover land users' opportunity costs and are designed uniformly can be too costly. The potential of group-based payments accounting for such cost heterogeneity has only been examined theoretically (e.g. Wätzold & Drechsler, 2014). Using a laboratory experiment, we empirically study the performance of differentiated vs. uniform payments for the case when farmers need to cooperate in a conservation program.

Our study is inspired by the issue of drained former peatland areas in Switzerland, which are characterized by intensive vegetable farming on organic soils. While conventional land use is highly profitable in these areas, drainage of organic soils leads to the degradation of the peat and to substantial greenhouse gas emissions (Bonn et al., 2016). Promoting the adoption of peat preserving practices would necessitate considerable funds to cover farmers' opportunity costs of conservation. Furthermore, opportunity costs are heterogeneous among vegetable producers because soil properties spatially vary across different land parcels. Moreover, preserving organic soils implies to rewet them. This requires farmers to cooperate as they depend on a joint drainage system. We investigated the effectiveness, efficiency and equity of three agri-environmental payment policy designs in a setting with heterogeneous players and where their cooperation is necessary to achieve the environmental outcomes.

2. Method

We developed a framed computerized economic experiment that captures the core components of the management problem on organic soils. The experiment was visualized and parameterized based on a Swiss case: the "Seeland" region. We conducted the experiment with students from Swiss Universities acting as farmers. Players were placed into groups of two: one with high opportunity costs of conservation (H player) and one with low cost of switching to a less profitable soil use (L player). We represented the situation via a two-stage decision procedure. In stage 2, participants decided either to adopt sustainable use of the soils (activity A) or to farm vegetables on drained soils (activity B). Activity A requires rewetting, which can only be done collectively due to the joint drainage system. Therefore, in stage 1 each group member was asked to vote either in favor of or against rewetting the organic soils. If at least one of the members rejected rewetting, the area remained drained and activity B was the only possible land use option in stage 2. In this case, H's farm profit equaled 4500 and L's farm profit equaled 2500. If both members voted in favor of rewetting, players could then choose between the two land use options in stage 2: activity A with a payoff of 250 or activity B with profits of 4500 or 2500 but subtracting a personal drainage cost of 220. For this decision set-up, we first conducted a 10-round baseline phase. This was followed by a 10-round treatment phase in which we introduced one agri-environmental payment policy design to incentivize the conservation of organic soils. Besides the main experiment, we assessed players' social preferences with an incentivized Social Value Orientation test (SVO) (Murphy et al, 2011) and we collected individual level information.

In settings that combine high conservation costs and necessity for farmers to cooperate, payments designed as an average across participants' opportunity costs could cope with the need for uniform payments in situations where budget is constrained. This design implies that L players (with low opportunity costs) may be excessively compensated for the adoption of a sustainable land use, while H players would be insufficiently compensated. This could be counteracted by side payments among players, which we allowed in our experimental design. In stage 1, before voting on rewetting the soils, each player could make a binding side-payment offer to his/her group member in return for the receiving player adopting activity A.

We tested three payment designs: 1) a differentiated agglomeration payment (DA) that accounted for differences in the opportunity cost of conservation of both players; 2) a uniform agglomeration payment (UA) which paid the same amount and based on an average across both players' opportunity costs; and 3) a uniform individual payment (UI) that also paid the same amount to players undertaking activity A but regardless of the land use decision of the other member. The agglomeration payments were made conditional on both players choosing activity A. We implemented each payment design treatment over a sample of 37 groups (i.e. 74 players). The baseline phase was implemented in all 111 groups.

We developed detailed behavioral hypotheses for payoff-maximizing players, including predictions on the nature of side payments. The SVO test enables to distinguish three main social-preference types of players: "individualistic", "inequality averse", and "joint maximizers" (Murphy et al., 2011). We illustrated how social preferences can change behavior by computing equilibrium outcomes with social preferences. In summary, we expect that payoff-maximizing players in the baseline scenario do not adopt the activity A and peat is exhausted. For all agri-environmental payment scenarios and with risk neutral players, the payoff-maximizing equilibrium outcome is full peat conservation. However, uniform payments require side payments from L to H players, and agglomeration payments involve a risk of coordination failure. Social preferences can also affect behavior, both with respect to land use and side payments.

3. Results

Our prime measure of environmental effectiveness is the rate of players who adopt activity A (Figure 1). The average percentage of players who adopt activity A across all rounds is significantly higher in all payment treatments (50.8% in DA, 51.8% in UA, and 42.8% in UI) than in the baseline scenario (3.5%). We found that the three payment types are equally effective in promoting the adoption of sustainable practices on organic soils. In contrast to the other two treatments, in the uniform payment treatments L are significantly more likely to adopt activity A than H players. This is due to the fact that under such payment L players have a considerable economic incentive to adopt activity A. Notably, rates of adoption of activity A under all payment treatments are relatively low considering that adopting activity A is the payoff-maximizing strategy for both players in all treatments. This could be due to the difficulty to coordinate on side payments, the risk of coordination failure, or social preferences.

With regard to collective outcomes, i.e. the percentage of groups where both players adopt activity A, we found that uniform individual payments perform worst in this regard (23.2%), while uniform agglomeration and differentiated agglomeration payments show similar rates as before (45.7% and 50% for DA and UA respectively). This is explained by the fact that under UI, more players (in this case mainly H types) continue conventional vegetable farming while at the same time voting for rewetting to permit agri-environmental payments made to their cooperative group member.

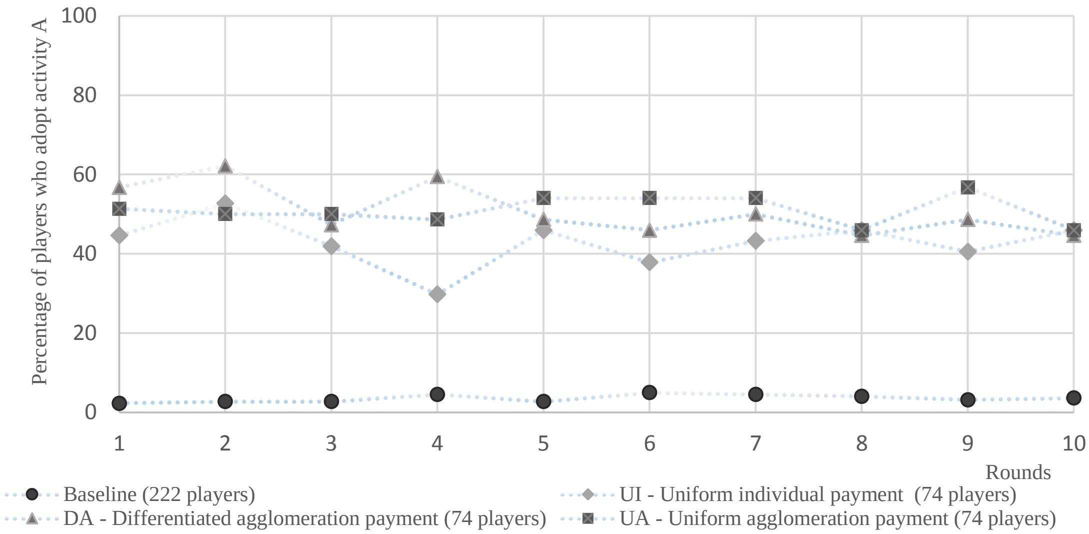

Figure 1: Percentage of players who adopt activity A across treatments

Next, we examined the use of side payments by players. In the baseline scenario and under the differentiated payment treatment, side payments are mainly offered from H to L players. These offers suggest that some players have inequality-averse preferences. Under uniform payment scheme (UA or UI), despite the low incentive of players with high opportunity cost to adopt an alternative land use we found many groups succeeding in implementing the cooperative outcome. Side payments are offered from L to H players, which is consistent with the predicted behavior of payoff-maximizing players. Thus, we observe considerable payoff redistribution aiming to create an incentive for high-cost players to adopt activity A. In fact, under uniform payments joint cooperation in adopting activity A is strongly driven by side payments. However, the level of the side payments offered is considerably lower than expected under payoff-maximization. This again suggests that inequality aversion is affecting players' behavior. Moreover, side-payment offers are on average significantly larger in the UA treatment than in UI. This difference in payoff redistribution may be explained by the fact that UA involves a risk of coordination failure.

Similar to findings in settings that do not require cooperation, our study confirms that the differentiated payment is most cost effective, i.e. it leads to the lowest amount of money units spent per peat unit preserved compared to the other two treatments. Yet, using the Gini coefficient we found that the DA treatment leads to highest income inequality in payoffs among players compared to the others.

Finally, we analyzed the effect of social preferences and other characteristics on players' decisions. Given the low variability of players' decision in stage 2 in DA and UA, we primarily studied stage 1-decision. We found a strong link between individual social preferences and behavior in the experiment. For instance, in uniform payment treatments social preferences significantly correlate with players' decision for rewetting. Moreover, we applied a panel random-effect logistic regression on players' vote for rewetting the soils to analyze the effect of players' risk and time preferences, socio-demographic characteristics, and opinions on behavior. We found that impatience, environmental consideration, and belief in cooperative approaches were potential positive predictors to an agreement among group members in rewetting the peat area.

4. Conclusion

We performed a framed experiment in order to provide insights into the performance of alternative designs of PESs to increase peat conservation. Agglomeration payments were analyzed as a promising policy option to promote cooperation among farmers. Using a framed laboratory experiment, we tackle a particular challenge in designing PESs by explicitly including heterogeneity in the costs for conservation. We found that all payment schemes are equally effective in incentivizing the adoption of a sustainable use of organic soils. Although uniform payment schemes only provide an incentive to players with low opportunity costs to enroll in a conservation program, players manage to successfully cooperate through side payments. Uniform payments require less information on the distribution of costs across farmers and are often thought to involve lower administrative costs. However, our study suggests that uniform payments may generate transaction costs by requiring the establishment of contracts between farmers for payoff redistribution.

In our setting, individual land use change is only feasible with a collective vote for rewetting. Therefore, the difference between individual and agglomeration payments is less pronounced than in other settings where individual land use change is always possible. Further research should analyze the performance of agglomeration vs. individual payments with heterogeneous farmers in those settings. Furthermore, our study focuses on the net present value of farm profits. The dynamic evolvement of farm profits as soils get degraded may also affect behavior in a more complex manner. We address this issue in a follow-up study based on a dynamic version of the experiment (Ferré et al., 2017).

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