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Analysis

Which Agglomeration Payment for a Sustainable Management of Organic Soils in Switzerland? – An Experiment Accounting for Farmers' Cost Heterogeneity

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ABSTRACT

Degradation of organic soils leads to substantial greenhouse gas emissions. Preservation of these soils is in conflict with their current intensive use, as preservation would require restricting drainage. Due to spatial interdependencies of organic soil areas, rewetting these soils requires cooperation among farmers. Agglomeration payments are a potential option to foster such cooperation. In order to test the effectiveness of this policy approach, we developed a dynamic and framed economic experiment to represent the decision situation of farmers operating on organic soils in Switzerland. Our sample population are farm apprentices. Unlike previous experiments on agglomeration payments, our design allows for heterogeneity and dynamic changes in farmers' opportunity costs and for side payments between players. We compared the effects of constant vs. variable agglomeration payment schemes on the adoption of sustainable use of organic soils. The variable payment mirrors the evolution of farmers' opportunity costs over time. We find that while both policy options promote sustainable land use, the constant payment option performs best in terms of environmental effectiveness. The constant payment also yields lower inequality in income and is more cost-effective than the variable option. Furthermore, risk aversion and inequality aversion appear to influence behavior and reduce cooperation among players.

1. Introduction

In Europe, organic soils are historically exploited in various manners: extracted for fuel and growing media in the horticultural sector, or used as a support for crops and livestock grazing. These activities require the draining of the soil, which leads to the degradation of the peat (upper layer of organic soils) that is oxidized and disappears (Xintu, 2009). Europe is the world's second largest hotspot of greenhouse gas (GHG) emissions from the degradation of organic soils (Couwenberg et al., 2011; Joosten, 2009). In Switzerland, organic soils represent < 2% of total agricultural land (Wüst-Galley et al., 2015) but their preservation would significantly contribute to national goals of GHG emission reductions. Because of agricultural production activities that include intensive drainage, part of these soils are severely affected and are at risk of disappearance in the immediate future. An example for such a situation is the case of a western region of Switzerland called "Seeland". This region is characterized by large areas of organic soils that have been historically managed for intensive and profitable vegetable production. In addition to the loss of important ecosystem services, peat degradation leads to uncertainties about the future of intensive agricultural production on these soils. Yet, these soils are not the object of specific management regulations.

Rewetting by restricting drainage is the most effective way to protect the remaining peat and to reduce GHG emissions (Lunt et al., 2010; Graves and Morris, 2013; Joosten and Couwenberg, 2009). However, such rewetting is in conflict with current land use. Two core aspects are identified as crucial in enabling sustainable management practices on organic soils. First, rewetting by raising the water table on these soils can only occur if all farmers who depend on the same drainage system agree. On average 10 to 40 farms use one pumping station. Thus, cooperation between farmers is necessary. Second, due to differences in past management practices and the conditions under which the peat was formed, organic soils are highly variable with respect to both the thickness of the peat layer and the future suitability of the underlying

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mineral soil layer to sustain current farming activities once the peat layer is lost. As a consequence, farmers vary in their vulnerability to peat degradation and in their future farm profits from vegetable farming on these soils. Therefore, opportunity costs for switching to sustainable use of organic soils and thus the incentives to do so differ among farmers. Motivated by this concrete issue and using the "Seeland" as the study region, we aimed at identifying economic policy instruments that are effective in promoting the sustainable management of organic soils in order to prevent their on-going degradation.

There are many instances where the effective provision of ecosystem services requires coordination among several land users. Another example is the implementation of tree corridors in the agricultural landscape to increase the population of particular types of fauna. Agglomeration payments have been proposed by economists as an approach for promoting coordination among farmers (Drechsler et al., 2010). Economic experiments (e.g. Banerjee et al., 2011, 2015; Parkhurst and Shogren, 2007; Bamière et al., 2013) and models (e.g. Bell et al., 2016; Drechsler et al., 2016) have demonstrated their potential. They are therefore potentially promising instruments in fostering sustainable use of organic soils. Building on the concept of an "agglomeration bonus" defined by Parkhurst et al. (2002), the concept of agglomeration payment was introduced by Drechsler et al. (2010) in the context of habitat pattern creation across farmland. These payments are used as an incentive for the spatial coordination of conservation areas. An agglomeration payment is based on the joint activities of multiple farmers and is only paid out if farmers commonly undertake a similar activity, while an agglomeration bonus includes a base participation component and a bonus component - the amount of which depends on the number of farmers undertaking the joint activity. In Switzerland for instance, as part of the agri-environmental scheme on "ecological compensation areas", the ecological network bonus offers an additional payment to farmers if their land belongs to a contiguous habitat network.

Existing empirical studies on agglomeration payments or bonuses generally assume homogeneous land users (e.g. Banerjee et al., 2012, 2015).[1] In practice, however, the opportunity costs of adopting a more sustainable land use usually differ among land users. Moreover, unsustainable land use can affect land users to different degrees in their own productivity, implying that opportunity costs may change over time and this varies across farmers. The case of organic soils in Seeland is an example for this: initial opportunity costs are high but when the peat gets degraded, the farmers with lower quality underneath soils face lower productivity and thus lower opportunity costs over time. These heterogeneities in opportunity costs raise additional complexities and questions for the design of effective policies, which we address in this paper: Should the agglomeration payment be homogeneous or aligned to farmers' opportunity costs over time? How does land user heterogeneity affect their strategic behavior when faced with a potential agglomeration payment? Different designs imply different incentives and may lead to different behavioral patterns. We compare the effects of two payment schemes: a constant agglomeration payment that pays the same amount to each farmer and a variable agglomeration payment that mirrors differences in farmers' opportunity cost over time.[2] Given that the development of productivity as a function of peat soil degradation is becoming increasingly known as research is conducted on this, it is becoming realistic to consider this knowledge in policy making.

We capture the key features that characterize the case of intensively used organic soils in a framed and dynamic economic experiment (e.g., Janssen et al., 2010). The experiment represents the decision situation of farmers on these soils. It allows for heterogeneous farmers who differ with respect to the dynamics of how peat degradation affects their future production potential in conventional land use. We analyze the resulting dynamics in the adoption of conventional vegetable production versus more sustainable land use, both with and without an agglomeration payment, and the results depending on payment design. Note that we test an agglomeration payment and not an agglomeration bonus as farmers cannot rewet their land on their own due to the dependence on a joint drainage system. We also analyze how farmers' social preferences affect behavior and three policy outcomes: environmental effectiveness, cost-effectiveness and income inequality. We conducted our web-based experiment with students of schools of applied agriculture in Switzerland who were to a large extent highly involved in farming activities.

This paper contributes to the literature in two main ways. First, while previous research on organic soils has concentrated on its degradation aspects and on restoration strategies, we address the management of organic soils from an agricultural and economic perspective. We test whether agglomeration payments could resolve this complex resource problem at hand. Second, in reference to the need for "real-world experience with agglomeration payments" (Parkhurst and Shogren, 2007), we contribute by testing agglomeration payments in the context of an innovative highly contextualized and dynamic experiment, involving participants from the field, and including the option of a variable payment scheme design.

We find that both agglomeration payment schemes are effective in promoting more sustainable practices on organic soils. However, the constant payment appears to be more effective than the variable payment in promoting sustainable management. One of the reasons for the better performance of constant payment is that the majority of the players who adopt sustainable land use do so already early on in the experiment, which contributes to the preservation of about half of the peat by the end of the experiment. Another reason may be that, considering the ten time periods, total joint payments are higher under the constant than under the variable payment. We therefore also analyze cost effectiveness, i.e., environmental effectiveness per unit of money spent on payments. We find that the constant scheme is also more cost effective than the variable scheme. Moreover, it leads to lower inequality in incomes. Social and risk preferences also play an important role regarding behavior in the experiment. In the subsequent sections, we first describe our experimental design and then present the results. We end with a discussion and conclusion section.

2. Methods

2.1. Implementation and Set-up

We developed an experiment in the form of an interactive representation of the management decision of farmers on organic soils. This web-based platform builds on the combination of the highly visualized "framed lab-in-the-field experiment" approach used by Reutemann and Engel (2014); Reutemann et al. (2016) and on real-time dynamic common-pool resource experiments used by Janssen et al. (2010). The core aspects of this experimental concept resides in the framing of the experiment with the actual context study including the representation of its actual economic data and the time dependence of the decisions. Contrary to Reutemann et al. (2016), our experiment includes interactions between players. The experiment was conducted with subjects characterized by a strong agricultural background, namely agricultural students from regional agricultural apprenticeship schools in Switzerland, of whom a majority intend to become farmers. In total, we recruited 254 farm apprentices for the experiment and

[1] Using auction mechanisms to incentivize provision of ecosystem services, Krawczyk et al. (2016) test laboratory experiments that explore spatially-connected auctions and account for cost heterogeneity among land user, and Lundberg et al. (2018) use an agent based simulation model to explore the potential additionality of different payment designs that are either fixed or set through a uniform or discriminatory auction.

[2] Ferré et al. (2017) consider the design of agri-environmental payment schemes in a static setting where profits differ, but do not evolve over time.