A multi-agent model for the Swiss Alpine farming

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***Abstract* - Alpine grazing areas fulfils several functions in the context of multifunctionality in agriculture fulfilling several roles for society as protection of biological diversity, touristic and recreational attraction, traditional landscape and regional economy. Aims of this project are the evaluation of agricultural policy measures for the Swiss Alpine region and the forecast of Alpine seasonal grazing areas under different scenarios until 2020, based on a multi-agent model for Switzerland (SWISSland Alpmodel). In the model, 675 real existing summer farms are simulated. Tradition plays a major role for Alpine farming and soft factors are therefore taken into account in order to simulate the behavior of the agents as similar as possible to reality. Simulations' results allow detecting different reactions to policy change and the identification of farm-specific factors influencing structural changes. The results imply that the optimal policy strategy for Alpine farming depends on the objective in this area. Since land management in the Alpine region is the activity that provides public goods, it would be plausible to enforce payments that maximize the management of the Alpine meadows.**

INTRODUCTION

Every summer 120000 cows and 350000 calves, 220000 sheep and 20000 goats spend ca. three months on the Alpine pastures in Switzerland (BLW, 2004). Alpine grazing areas represent 1/3 of Swiss farmland and their semi-natural habitats depend entirely on the continuation of extensive agricultural practices (Ostermann, 1998). For many farms in lower regions these pastures represent an important fodder resource which allows the maintenance of a higher total number of livestock. In spite of their multifunctional importance, Alpine grazing areas are playing a relatively small role in the agricultural and environmental policy, receiving in 2008 less than 4% of the public payments in Switzerland. Although in the last years contributions for the alpine farming had increased, the trend of the land use in this region is in decline. Animal-referred direct payments are essential for the maintenance of the management of the Alpine dairy farming in Switzerland (Mack et. al., 2008; Von Felten 2011) but these financial contributions do not control its declining trend and neither the polarization of the land use with the ecologically unsustainable exploitation of asily accessible production sites and the abandonments of remote or scarce pastures (Flury et. al. 2000, Lauber et. al. 2011).

METHOD AND DATA

Agent-based models (ABMs), where several agents are optimized independently, represent a new frontier as modelling method and are increasingly being developed replacing the use of the sector models, in which regional farms are optimised as a whole (Möhring et. al, 2010). In order to forecast future structural changes in the Swiss alpine region an add-on to the SWISSland model specifically developed for Alpine farming was realized. When applied to agriculture, ABMs can simulate, at the micro-level, the behaviour of individual farmers, without the need of aggregating them in "representative" agents, and then generate the macro (aggregate)-evidence (Lobianco and Esposti, 2010). The SWISSland Alpmodel allows the simulation of agricultural activities as well as interactions between alpine-farms and farms located in lower regions.

In Switzerland, tradition plays a major role for alpine farming. Therefore, sociological and spatial data from a wide variety of sources were integrated. Data obtained with surveys of the Swiss Federal Institute for Forest, Snow and Landscape Research (von Felten, 2011) on the socio-economical situation of alpine farming in Switzerland were used to simulate the importance of the traditional and human behaviors of the agents. The sample was randomly chosen, represents 9.5% of the total amount of summer farms and all simulated agents. The parameters collected with the survey were then combined with other data available in the Swiss agricultural information system (AGIS).

Data about accessibility, altitude and surfaces enable the consideration of the geographical location and condition as well as the consideration of transportation costs, interactions and competitions between the summer farms. One of the main assumptions of the model is that the manager's overall objective is to maximize its agricultural income. This is realized solving an objective function which maximizes the summer farm's yearly agricultural income and which is limited by farm factor endowments and production activities (e.g. grassland, labor and assets). The primary model output is the value of the agricultural income of the summer farms. Main inputs are the livestock, the surfaces, the labor force (family and hired) and the cost of those inputs. The time horizon studied is 2008-2020 with 2008 as reference year for calibration. For the calibration of

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the model, the Positive Mathematical Programming (PMP) approach is currently applied.

RESULTS

The SWISSland Alpmodel enables an ex-ante analysis of effectiveness of the agricultural policies under different scenarios of the Swiss alpine region. Moreover the different reactions and behavior of the summer farms can be analyzed. Being able to interact with a more complex model (SWISSland) (Möhring et. al 2010) in which farms of lower regions are simulated, relationships between the agents and the impact of policy changes on the structure are extended to an interregional level. Results derived from following simulated scenarios: reference scenario: no political change until 2020 (REF); increase of the direct payments coupled to the livestock by 25% (DPA); provision of contributions coupled to an extensive use and conservation of the alpine pastures (ECO). Both policy changes start in 2014. Last scenario is based on the results of other research projects (e.g. Mack and Flury, 2008) and seems to meet stakeholder's and researcher's interests as the most promising approach in avoiding land use polarization and ensuring the maintenance of the Alpine meadows flora and fauna biodiversity.

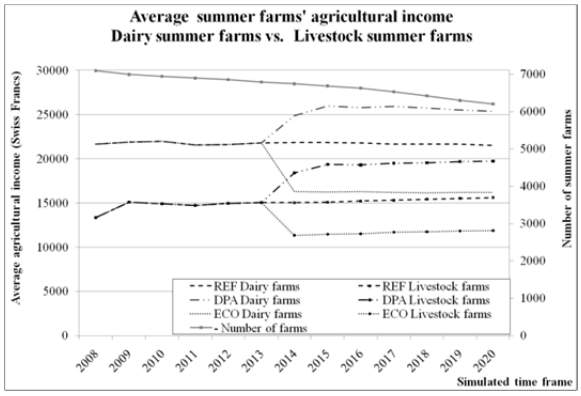

Figure 1. Developments of the agricultural income under different scenarios and for different summer farms' specialization.

A change in the agricultural policies in the Swiss Alpine region would affect differently the summer farms depending from their specialization (e.g. dairy cattle, beef cattle) and size (Fig. 1). Such impacts can be observed on several parameters as the agricultural income, number of livestock or number of farm exits. If no political change is made (REF) no strong effects on the structure of the summer farms are observable. However, according to the model results a decline of about 12% of the summer farms between 2008 and 2020 could be expected. Under scenario DPA, the total number of animals spending the summer at Alpine grazing increases after the policy change. Thus, summer farms belonging to smaller sized categories are switching to bigger sized groups. In the last simulated scenario (ECO), the total amount of livestock drops after the policy change (2014) and therefore, also the structure of the Alpine region consequently changes. The number of summer farms holding less than 60 livestock units is expected to increases while the summer farms belonging to the bigger sized groups decrease.

CONCLUSIONS

The results imply that the optimal policy strategy for Alpine farming depends on the objective in this area. Since land management in the Alpine region is the activity that provides public goods, it would be plausible to enforce payments that maximize the area of summered land as the observed scenario with area based payments obviously does. However, in this case there would be a strong need for monitoring systems that control which areas in the Alpine regions show signs of agricultural over use to avoid opportunistic overstatements of grazed areas.

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