Modelling and Financing of Agri-environmental Measures: Assessment of Regional Preferences in Poland

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Abstract. The main objective of the paper is to assess the importance of regional preferences in financing of agri-environmental measures. The analysis is based on results of a case study conducted in South-eastern Poland. As environmental protection in agriculture is complex and often considered in political strategies, it is worth analyzing the differences in perception of the respective environmental objectives from a regional perspective. Taking into account natural conditions and the economic situation in agriculture in the voivodship Subcarpathia, the question is how regional environmental objectives could be achieved effectively with a given budget. Using Linear Programming, we discuss how regional preferences would guide optimal and objective-oriented budget allocations.

Keywords: agri-environmental programs; environmental objectives; linear programming; budget allocation; Poland

JEL Code: Q14, Q57, C6

1. Introduction

Since Poland accessed the European Union (EU) in May 2004, the agri-environmental programs are obligatory political measures in creating the policy of rural areas. Due to the short membership in the EU little experience with financing the agri-environmental policy and especially with financing of agri-environmental programs is given. The decisions on how to create agri-environmental programs are, basically, made centrally at the Ministry for Agriculture and Rural Development in Warsaw. As natural conditions in the voivodships (administrative regional units) in Poland are differentiated, an important question is: How could the budget allocation meet regional preferences? To discuss this question we use a Linear Programming approach according to Kirschke and Jechlitschka (2002). To assess regional preferences for the National Agri-Environmental Program, regional actors in the voivodship Subcarpathia in South-eastern Poland were interviewed. As the region is characterized by a high value of natural resources it is worth analyzing the budget allocation in this region with regard to the objectives of environmental protection.

The paper is structured as follows. The next chapter provides an overview about the development of the agri-environmental policy in Poland since 1990 and the experience with agri-environmental programs in the European Union. In the following section, a Linear Programming approach is used to calculate budget allocation scenarios with respect to regional preferences as well as to estimate trade-offs between objectives. Finally, conclusions about the importance of the analyzed objectives of environmental protection in the budget allocation are drawn.

2. Agri-environmental policy in Poland and the EU

Since May 2004 the agri-environmental measures are obligatory in creating the policy for rural areas in Poland according to the EU regulation 1257/99 (EG-Verordnung, 1999). However, the idea of environmental protection in agriculture is relatively new in Poland.

The first political measures to protect natural resources in agriculture were established in 1990 with the „National Environmental Policy" (Ministry of Environmental Protection, Natural Resources and Forestry, 1991). The next step in developing an agri-environmental policy was the program SAPARD (Special Accession Program for Agriculture and Rural Development) for the years 2000-2006. According to this plan, agri-environmental programs were planned, too. However, due to political strategy changes as well as due to missing legal rules, the planning of agri-environmental measures was abandoned under SAPARD (Ministerstwo Rolnictwa i Rozwoju Wsi, 2002 pp. 117-121). The first successful agri-environmental measures were realized in the year 2000 and 2001 with an EU project Phare99.

After the accession of Poland to the EU, the financing and creating of agri-environmental measures ('Sustainable agriculture', 'Organic farming', 'Extensive meadow farming', 'Extensive pasture farming', 'Ground and water protection', 'Buffer zones', and 'Protection of domestic farm animal species') was based on the National Agri-Environmental Program 2004-2006. The National Agri-Environmental Program is an integral part of the Plan for Development of Rural Areas (Plan Rozwoju Obszarów Wiejskich – PROW). According to this plan the available budget for agri-environmental measures amounted to 348.9 million € for 2004-2006, which is 9% of the total budget for all measures realized with PROW. The National Agri-Environmental Program was co-financed by the European Agricultural Guidance and Guarantee Fund (EAGGF) (80%) and by the Polish state budget (20%) (Ministerstwo Rolnictwa i Rozwoju Wsi, lipiec 2004 pp. 111). The main objectives of the Program are: protection of natural resources, protection and conservation of biodiversity, and protection of cultural landscape in rural areas. The objectives of the Program reflect environmental priorities with regard to natural conditions in many regions in Poland; especially in those characterized by a large number of nature protection areas.

While the agri-environmental programs are new in Poland, the experience in the member countries of the EU-15 confirms, in most cases, positive effects of the programs. Since the McSharry-Reform in 1992 the agri-environmental programs are an integral part of the EU policy and a precondition for support from the EAGGF. Although the whole budget for agri-environmental programs amounts solely to 4% of all expenditures from the EAGGF (Section Guarantee), the evaluation of the programs is optimistic (Europäische Kommission, GD V, 2004). However, some authors mention negative aspects in the realization process of the agri-environmental programs. The Report to the European Commission (Baldock et al., 2002) points out the necessity of change in calculating agri-environmental payments to farmers and considering special conditions in some regions, where the co-financing share from the European Community is said to be too low.

Agriculture is an important sector in the Polish economy (the employment share amounts to 26 %), which is reflected in its great influence on the usage of natural resources in rural areas. As the agri-environmental measures are new, little experience in creating financial strategies is given. The question of objective-oriented and efficient budget allocation is, therefore, of a great importance for political decision-makers and for regional societies.

3. Problem setting

According to the National Agri-Environmental Program in Poland the agri-environmental measures can be realized in two ways: on a horizontal level (in the whole country) or in 69 selected priority regions (characterized by specific environmental problems or by particular environmental conditions). The measures such as 'Sustainable agriculture', 'Extensive meadow farming', and 'Extensive pasture farming' are conducted in priority regions, which

were selected by regional working groups on behalf of the Ministry for Agriculture and Rural Development. The other measures can be realized horizontally, which creates more possibilities for farmers. A problematic issue in this context is the central financing of agri-environmental measures. The prerequisite for realizing the agri-environmental measures is the support permission from the Ministry for Agriculture and Rural Development. As natural conditions as well as farming conditions in different regions of the country are differentiated, the priorities regarding environmental objectives in agriculture are different. In this context there arises a question, how the agri-environmental measures could be financed to meet regional preferences and to what extent weighting the objectives would effect the budget allocation? Answering these questions could help to determine budget allocations for agri-environmental measures to achieve the objectives of environmental protection in the region Subcarpathia in a best possible way.

Considering differentiated objectives in rural areas in every region of the country and the increasing interest in agri-environmental programs, the aim of the paper is to analyze the scenarios of budget allocation between political measures with regard to the achievement of environmental objectives.

4. Research region

The discussion in this paper is based on a case study conducted in the voivodship Subcarpathia in South-eastern Poland in 2005. The voivodship is characterized by a large number of valuable natural resources and protected areas. Most areas in the voivodship are involved in the Carpathian Euro-region (an association of Carpathian regions between five neighbor countries of the Central and Eastern European Countries (CEEC) which includes Poland, Ukraine, Romania, Hungary and Slovakia). The main aim of the Carpathian Euro-region is focused on an efficient and sustainable usage of natural resources in all associated countries. The problem of an efficient use of natural resources has such a big importance in this region due to its economic situation. The region can be characterized by the third biggest number of agricultural farms in Poland (311.855) (Urząd Statystyczny w Rzeszowie, 2003 pp. 20; Główny Urząd Statystyczny, 2003 pp. 171), while the employment share in agriculture amounts to about 47% (Podkarpacki Urząd Wojewódzki, 2004). The agricultural production has, therefore, a great effect on the utilization of natural resources. Also the size of agricultural farms in the voivodship (3.5 ha on average) (Dmochowska, 2003) in comparison to large-sized farms in other countries of the European Union (17.5 ha on average) (Boschma et al., 2005) points out the importance of agri-environmental programs in sustainable development of the agricultural sector. Considering these aspects, the voivodship seems to be a good example to analyze questions of budget allocation with regard to the objectives of environmental protection in agriculture.

5. Methodical approach and data

Taking into account the interest in agri-environmental programs in the first years of membership of Poland in the EU as well as regional natural conditions in the voivodship Subcarpathia, the main research questions are:
 – How the budget should be allocated to meet regional preferences with regard to environmental conditions, and
 – How the objectives of environmental protection in the agricultural sector could be achieved in a best possible way.

To answer these questions we use a Linear Programming approach according to Kirschke and Jechlitschka (2002). This model helps us to discuss the problem of objective-oriented budget allocation in the region as it delivers results of maximal objective function values under defined restrictions. For this approach, political measures, objectives, objective coefficients and restrictions have to be identified.

The political measures were derived from the National Agri-Environmental Program for Poland. The measures are: 'Sustainable agriculture', 'Organic farming', 'Extensive meadow farming', 'Extensive pasture farming', 'Ground and water protection', 'Buffer zones', and 'Protection of domestic farm animal species'. The objectives 'Protection of natural resources', 'Conservation of biodiversity', and 'Protection of cultural landscape' subsume all objectives adopted in the National Agri-Environmental Program and express biotical, abiotical, and aesthetic aspects in rural areas.

To assess the importance of the measures with respect to the named objectives, eight agricultural experts in the Marshal Office in the Division for Agriculture and Rural Development the voivodship have been asked to state their preferences. They assessed the importance of the respective political measures on an interval scale 1-9 ("one to nine") taking into account regional agricultural and environmental conditions. The objective coefficients were included in the model as an interval mean value of all given answers. The objective coefficients for the respective measures in the National Agri-Environmental Program are displayed in figure 1.

Figure 1. Programming resources for agri-environmental measures in the voivodship Subcarpathia


Source: Author's compilation based on statistical data from the Statistical Office in the voivodship Subcarpathia (Urząd Statystyczny w Rzeszowie, 2003)

Additionally, restrictions were defined. The restriction 'state budget of Poland' indicates the co-financing share of 20% for the Agri-Environmental Program. The upper budget bounds were calculated on a basis of data set from the Ministry for Agriculture and Rural Development and Statistical Office in the region Subcarpathia. The upper bounds are a product of areas to be involved in the realization of agri-environmental measures and payment rates for each measure in each voivodship in Poland. The restriction 'available farming area' was calculated as a product of the agricultural area in the voivodship Subcarpathia and the payment rate for each measure.

The estimation of regional actors shows that the objective coefficients vary in the case of each measure and each objective. However, most measures were assessed as most suitable to achieve the objective 'Protection of natural resources' and 'Conservation of biodiversity'. The measure 'Ground and water protection' was assessed as most important to reach the objective 'Protection of natural resources', while 'Sustainable agriculture', 'Organic farming', and 'Extensive meadow farming' have the same magnitude for the objective 'Protection of natural resources'. 'Protection of domestic farm animal species' is the most important measure to achieve the objective 'Conservation of biodiversity' and 'Extensive pasture farming' to

achieve the objective 'Protection of cultural landscape'. Most measures have similar importance with regard to the analyzed objectives. There is only one measure 'Extensive pasture farming' which was assessed as the most important to achieve the objective 'Protection of cultural landscape'. Figure 2 visualizes the relative magnitude of the objective coefficients.

Figure 2. Comparison of coefficients in terms of objective achievement
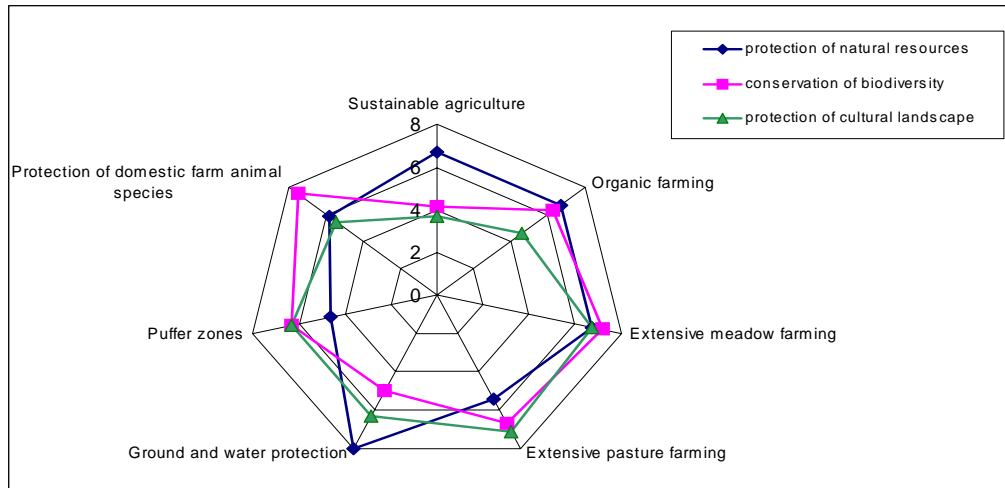
Source: Author's calculation

6. Results and discussion

### 6.1. Optimal allocation for agri-environmental measures

Taking into account the objective coefficients and the defined restrictions, the optimal allocation for agri-environmental measures to maximize the regional objective achievement can be determined. Considering the available budget for the case study region we assumed an equal financial allocation between the voivodships in Poland. Hence, the budget was set on the level computed as an average amount for each voivodship in the first years of the membership of Poland in the EU. To point out trade-offs between the objectives, two of them: 'Protection of natural resources' and 'Conservation of biodiversity' were included in the sensitivity analyses. These objectives were chosen due to the importance of the respective measures with regard to the objective achievement given by regional actors. The last objective was involved in the model as a restriction in order not to exclude its potential influence on the budget allocation. Using the Linear Programming approach an optimal budget allocation in the first years of the membership of Poland in the EU was computed. In this calculation the objective coefficients for the objective 'Protection of natural resources' and 'Conservation of biodiversity' were equally weighted and set on the level of 0.5, respectively, while the objective 'Protection of cultural landscape' was not weighted.

The computed results show that, under the given restrictions, 'Protection of domestic farm animal species' and 'Extensive meadow farming' should be supported as the only measures from the regional perspective. The measure 'Protection of domestic farm animal species' and 'Extensive meadow farming' were assessed by regional actors as most important and also the upper budget bound for the realization of the first named measure is high in comparison to the other measures. Due to the lower importance of the other measures reflected in lower objective coefficients and due to a high level of the upper bound in the case of the measure 'Protection of domestic farm animal species', there is no budget left for financing the other measures.

A difference to the current allocation, derived from this calculation, is displayed in figure 3. According to the results and an objective-oriented budget allocation, the budget should be extended for the measures 'Extensive meadow farming' by 480.3 thousand € and 'Protection

of domestic farm animal species' by 3323.2 Thousand €. All other measures should be reduced, while 'Organic farming' by the highest amount of 1299.5 Thousand €.

**Figure 3. Difference to the current allocation from a regional point of view**
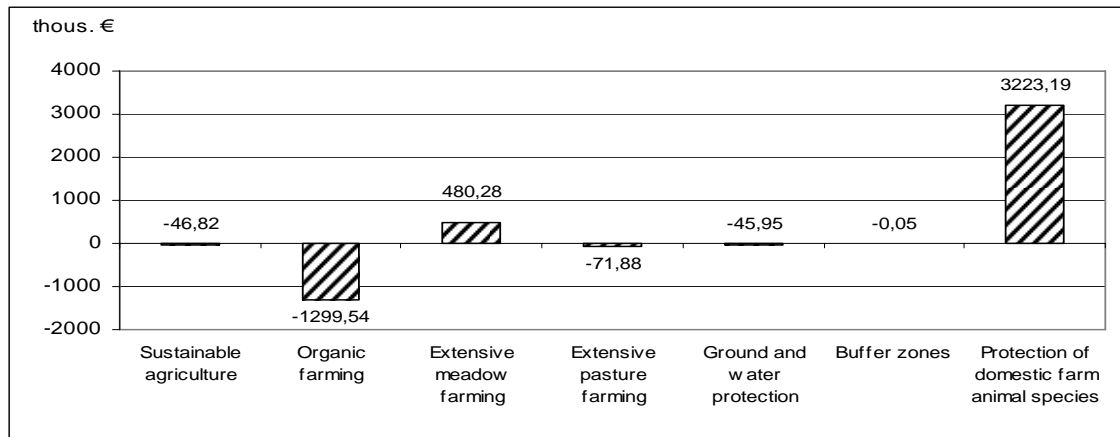
Source: Author's calculation

6.2. Sensitivity analyses

While discussing an optimal budget allocation, changes in the budget allocation for different objective weights should be considered. Hence, the weight for the objective 'Conservation of biodiversity' was set gradually from zero to one while the weight for the objective 'Protection of natural resources' was set in the inverse sequence. The results of this parameterization are displayed in figure 4.

The results show that at a low importance level of the objective 'Conservation of biodiversity' the advisable measures to realize are: 'Ground and water protection', 'Organic farming', and 'Extensive meadow farming'. With growing importance of the objective 'Conservation of biodiversity' the budget should be allocated to 'Protection of domestic farm animal species' and 'Extensive meadow farming', and, finally, only to 'Protection of domestic farm animal species'. According to these results a trade-off between the two main objectives in the budget allocation can be stated.

Figure 4. Trade-off between the objective 'Protection of natural resources' and the objective 'Conservation of biodiversity'
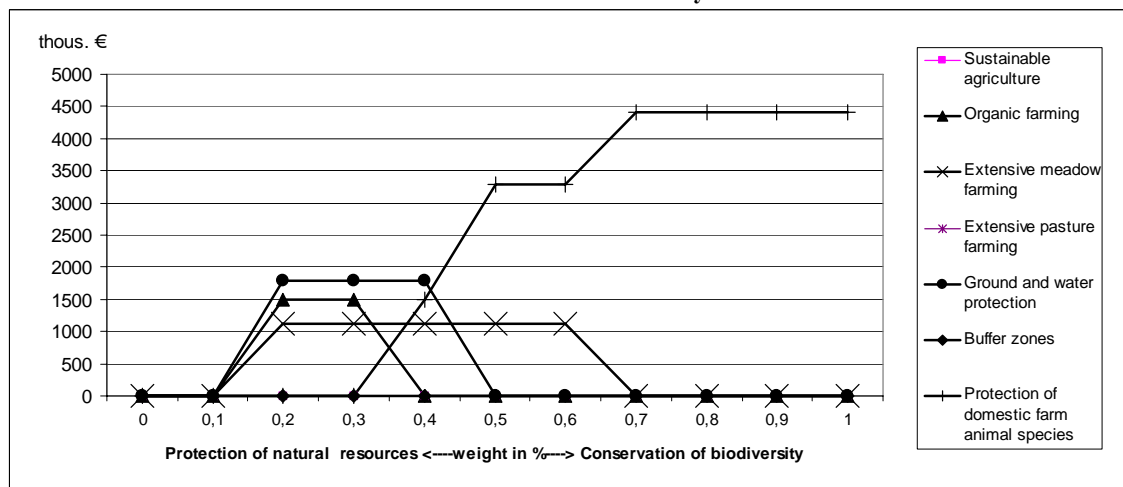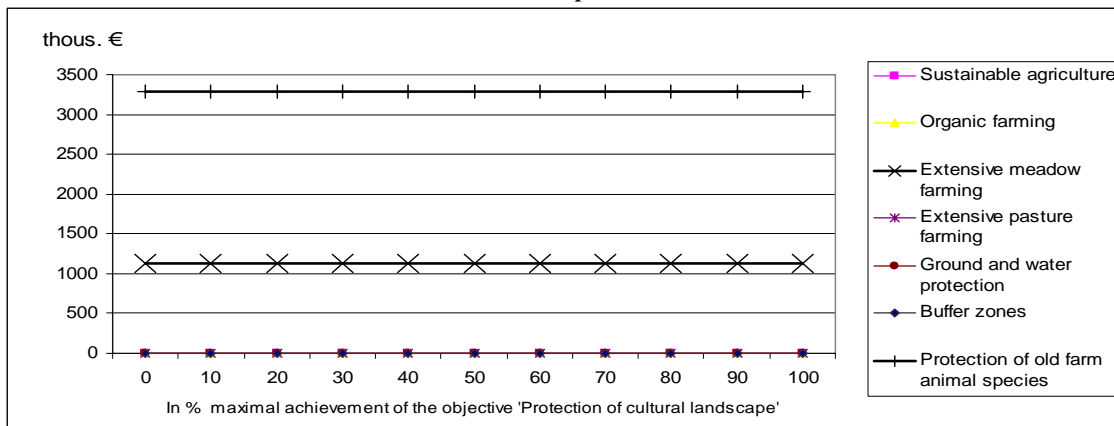

Source: Author's calculation

Another aspect to be discussed is the relevance of the third objective 'Protection of cultural landscape' for the optimal budget allocation. Therefore, the objective 'Protection of cultural landscape' was included in the model as a restriction. To analyze its importance, it was parameterized between 0 and 100 %. The weights for the objectives 'Protection of natural resources' and 'Conservation of biodiversity' were unchanged in comparison to the initial situation and were set at the level of 0.5. The results of this analysis are displayed in figure 5.

Figure 5. Budget allocations subject to the importance of the objective 'Protection of cultural landscape'

Source: Author's calculation

According to the analysis, the measures to be preferably financed are: 'Protection of domestic farm animal species' and 'Extensive meadow farming'. There is no change in budget allocation while weighting the objective 'Protection of cultural landscape'. Due to available budget and given upper bound restrictions, there would be no budget left for financing the other measures. Hence, the objective 'Protection of cultural landscape' does not influence the budget allocation. A final analysis refers to a varying budget allocation for the Agri-Environmental Program for the period 2007-2013. This should help to assess the impact of political allocation in the voivodship Subcarpathia. The sensitivity analysis of the budget amount is displayed in figure 6.

Figure 6. Sensitivity analysis for the available budget
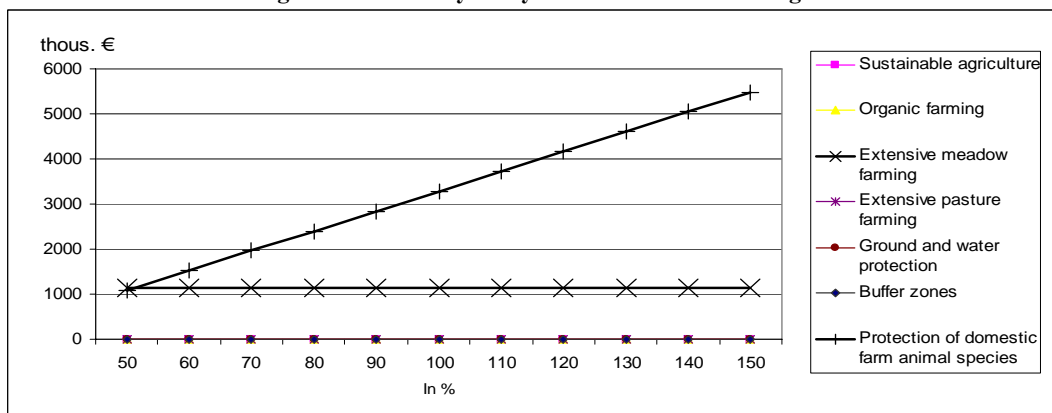
Source: Author's calculation

Given an increase in the available budget for the Agri-Environmental Program, under unchanged restrictions, the calculations show a growing importance of the measure 'Protection of domestic farm animal species'. While reducing the available budget, the support for this measure would decrease. On the other hand, 'Extensive meadow farming' would be financed

at an unchanged level. The analysis shows that 'Protection of domestic farm animal species' is highly dependent on the available budget.

7. Conclusions

The presented analysis shows that regional preferences regarding agri-environmental programs would have a considerable impact as comprised to the given allocation. According to the presented analysis under the defined restrictions and coefficients the budget should be reallocated to maximize the environmental benefit. The most important measures in the voivodship Subcarpathia to reach the environmental objectives defined in the National Agri-Environmental Program are 'Protection of domestic farm animal species' and 'Extensive meadow farming'. These measures seem to have the highest importance for reaching both the first objective 'Protection of natural resources' and the second objective 'Conservation of biodiversity'. The third objective 'Protection of cultural landscape' has no impact on the budget allocation. Additionally, visible trade-offs in financing of agri-environmental measures were found while weighting the objectives 'Protection of natural resources' and 'Conservation of biodiversity', which applies for the measures 'Protection of domestic farm animal species' and 'Organic farming', 'Extensive meadow farming', 'Ground and water protection'. Moreover, the increase of the available budget for agri-environmental measures would result in growing spending on the measure 'Protection of domestic farm animal species'. The presented results have an explorative character and can be helpful in more effective and objective-oriented financing of agri-environmental measures in future.

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