TARGETING AND SPATIAL IMPACTS OF AGRI-ENVIRONMENTAL SUPPORT – SPATIAL ECONOMETRIC ANALYSIS OF AGRI–ENVIRONMENTAL MEASURES IN SLOVENIA

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Abstract

The paper presents results of a spatial analysis of agri-environmental (A-E) measures in Slovenia. Spatial targeting and spatial patterns of A-E schemes are analyzed by a combination of exploratory spatial data analysis and spatial econometrics. Results suggest that A-E schemes in Slovenia are poorly spatially targeted against environmental priorities and needs in terms of water and biodiversity protection. This can be attributed to the fact that the most widely implemented A-E schemes in the country are implemented horizontally, with no spatially explicit criteria. Exploratory Spatial Data Analysis reveals spatial clusters of participation in A-E schemes, which is additionally confirmed by the results of the spatial econometric analysis. Participation in A-E schemes in general decreases with the average farm size of the area, and increases with per hectare CAP Pillar I payment rights and EAFRD payments. On the other hand, results of the spatial econometric analysis suggest that participation in organic farming appears to be a rational choice in areas with prevailing extensive, grassland-based farming. Results therefore suggest that farms maximize revenues from A-E schemes. Spatial clustering of areas with respect to the participation in A-E schemes occurs also in the absence of explicit spatial targeting and is closely linked with potential revenues from this source.

Keywords: Rural development policy 2007-2013, Agri-environmental payments, spatial econometrics

JEL classification: Q180, R580, C2

1. Introduction

Rural development policy is one of the core elements of the European Common Agricultural Policy (CAP). It is designed to promote and guide economic restructuring of rural areas, to promote sustainable management of natural resources and to help rural areas to meet challenges (economic, environmental) of the future. This system is uniform in all Member States, includes a single set of measures and it is based on pre-set objectives at the program level, priorities, and at individual measures. Due to the large range of tasks on the one hand and increasing budgetary restrictions on the other, it is reasonable that the EU policy of rural development for the period 2007-2013 understands the impact of the measures also in a spatial context, so that the limited budgetary resources can be effectively used.

Regarding the effectiveness of public expenditure on rural development, rural development policy should demonstrate a clear connection between measures and their impacts on rural areas. If the measure did not reach the target, it is reasonable to investigate the cause of it. Cause-effect relationship between the choice of measures, the way they are implemented and their effects are complex. Within the common policy framework, a system of evaluation and monitoring has been established to address these questions. Designation of the Common Monitoring and Evaluation Framework (CMEF) for the programming period 2007-2013 has been often seen as a major step towards a more effective rural development policy planning for the future. The establishment of the CMEF is an important step towards the unification of the monitoring of rural development policy. This should allow more effective planning for the future (CMEF, 2006a).

The paper highlights the spatial aspects of RD policy actions designed to promote environmentally-friendly farming as an example of good agricultural practices in order to provide environmental and social public goods. In terms of RDP budget for period 2007-2013, public spending on agri-environmental measures represents the largest share in Europe. The same applies to Slovenia, as the largest part of the planned EAFRD funds is intended for Axis 2, in the amount of 50,89 % of total funds (Mid-term evaluation, 2010). Regard to this fact, it is a relevant question whether the agri-environmental measures are spatially targeted in terms to improve the environment and contribute to rural development. Some of the specificities of measure design in Slovenia in comparison to EU measure description are that rural development policy is programmed at national level and a number of agri-environmental activities are implemented horizontally. The problem with that kind of approach is that measures becomes available to all farmers in region which resulting in a large number of farmers and land covered by A-E measures, but without any clear decision about the desirable degree of spatial targeting (Matthews, 2012; Uthes et al., 2010) That also leads to the inefficient achievement of the main objectives of A-E, namely contributing to EU-level priority areas, such as biodiversity, water, climate change, as well as improving the environment and the countryside.

The article is trying to bring a deeper knowledge into spatial targeting of agri-environmental measures. There is a great need to improve the environment and to achieve higher public goods, but there are limited financial resources and these funds will be in the future even more limited. Regarding the cost-effectiveness, achievement of objectives of A-E measures and spatial targeting is important. Our focus in to verify whether the design of agri-environmental measures in Slovenia allows to achieve these objectives. Moreover, we want to improve the understanding of factors that affects the participation rate of agricultural holdings in decision-making when applying for A-E measures.

The goal of our paper is to analyze the measure Agri-environmental (A-E) payments in Slovenia with the use of spatial econometric approach. We also analyzed the targeting of agri-environmental measures by comparing the spatial pattern of implementation of A-E measures with the spatial pattern of areas of a special environmental interest. Empirical analysis is based on the following data sources: (a) individual farm data (in the later stage, aggregated at NUTS 5 level[1]), (b) secondary statistical and GIS information data, and (c) RDP monitoring data (CMEF). As to the latter data source, analytical potential of the CMEF remains largely untapped. Researchers identify that CMEF does not cover all the EAFRD objectives (particularly not environmental ones) and does not to capture the key impacts of rural development policy sufficiently well. These criticisms may be justified but has not yet been empirically investigated. One of the implicit aims of this paper is also to investigate the potential of CMEF for spatial analysis of agri-environmental measures.

The paper is organized as follows. In the following section, we present the implementation of agri-environmental measures in Slovenia and measure description while the third section describes a detailed description of data. Spatial econometrics techniques used for the empirical applications are also described. In the section four, we apply spatial econometric models to understand under which factors is influenced participation rate of utilized agricultural area and agricultural holding in analyzed A-E schemes. As exploratory analysis we also check for possible spatial targeting. Final section concludes with a discussion and underlining the interesting points for further research.

2. Agri-environmental measures in Slovenia under RDP 2007-2013

Agri-environmental payments are designed to support the supply of environmental public goods in agriculture, with the help of the sustainable farming methods, which should contribute towards the reduction of environmental pollution, the conservation of biodiversity and specific values of Slovenian countryside. As well as providing protection and improvement of the environment, landscape, natural resources, genetic diversity and also public health. A-E payments are aimed at conducting environment friendly farming methods emphasizing the multifunctional role of agricultural production reflecting in the public function of maintaining the landscape and biodiversity as well as preserving the settlement of Slovenian countryside by taking into account ecological, social and spatial settlement patterns in the rural areas. These payments should be seen as payments for public goods, which are not directly measurable from the marketing viewpoint. Payments are disbursed per hectare of utilized agricultural land, in some cases per animal, and are intended for partial compensation of costs for additionally invested effort due to the environmental and landscape protection requirements (PRP, 2007).

A key-tool of evaluation is intervention logic which represents the causal chain from the budgetary input, via the output and the results of measures, to their impact. In this way, the intervention logic guides the consecutive assessment of a measure's contribution to achieving its objectives (CMEF, 2006b). The intervention logic starts from the needs, which describe the environmental requirements to which the programme and/or measure should respond. The policy

[1] NUTS is the French acronym for Nomenclature of territorial units for statistic

response is carried out through the hierarchy of objectives, representing the break down from the overall objective, via more specific objectives, to operational objectives. Implementation of schemes starts from the inputs (financial resources) which should generate the outputs of programme activities pursuing operational or measure related objectives. The consequences of an action are results, which should contribute to the achievement of the specific objectives (CMEF, 2006b). The results should contribute to reaching the specific objectives at program level and correspond to the previously identified needs (Figure 1).

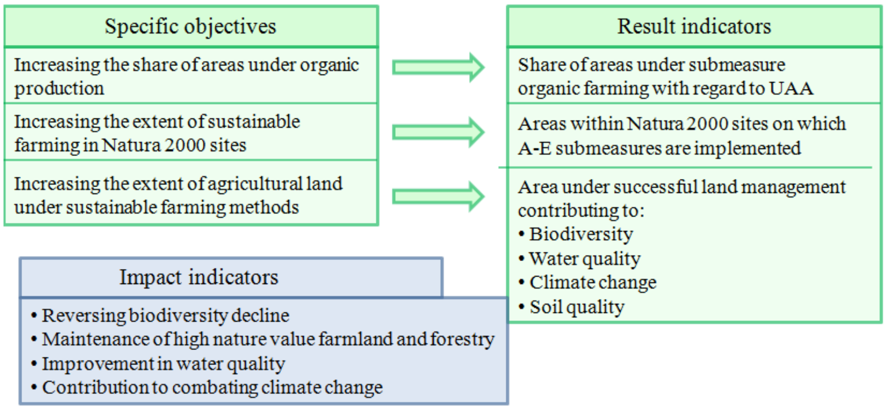

Figure 1: Results of the implementation of the A-E measure and impact indicators (PRP, 2007)

All CMEF indicators, such as input and output indicators are collected at farm level and they can be easy quantified. However, the impact indicators are an exception. In the indicators hierarchy of the CMEF impact indicators are crucial for providing information on the impact of the implementation of the A-E measure but unfortunately they are not monitored at sub-national level and as such do not allow for any deep analysis.

A-E measures in Slovenia are divided into three groups of schemes, targeting the following priorities:

(i) Reduction of negative impacts of agriculture on the environment (schemes: Preservation of crop rotation, greening of arable land, integrated production and organic production),

(ii) Conservation of natural conditions, biodiversity, soil fertility and traditional cultural landscape (schemes: Mountain pastures, steep slopes mowing, humpy meadows mowing, meadow orchards, rearing of autochthonous and traditional domestic breeds, production of autochthonous and traditional agricultural plant varieties, sustainable rearing of domestic animals and extensive grassland maintenance), and

(iii) Conservation of biodiversity and specific countryside values (schemes: Animal husbandry in central areas of appearance of large carnivores, preservation of special grassland habitats, grassland habitats of butterflies and litter meadows, bird conservation in humid extensive meadows in Natura 2000 sites and permanent green cover in water protection areas)

Agi-environmental payments are granted at the national level, with an exemption of some schemes related to the certain geographical areas, these are: Mountain pastures, steep slopes mowing, humpy meadows mowing, extensive karst pastures, animal husbandry in central areas of appearance of large carnivores, preservation of special grassland habitats, grassland habitats of butterflies and litter meadows, bird conservation in humid extensive meadows in Natura 2000 sites and permanent green cover in water protection areas.

Our focus is to investigate whether the A-E measure achieves its objectives with the use of spatial econometric approach. In the exploratory stage we analyzed the targeting of A-E measures by comparing the spatial pattern of implementation of A-E measures with the spatial pattern of environmental problems in some areas and the actual areas.

3. Data and methods

The geographical units for our analysis are the local municipalities (NUTS 5). We take into account all Slovenian municipalities; therefore, we end up basing our spatial analysis on 210 municipalities. Empirical part consists of two steps. First part of the analysis is exploratory. We analyze the targeting of A-E measures by comparing the spatial pattern of implementation of A-E measures with the spatial pattern of areas of a special environmental interest. In the absence of spatially-disaggregated indicators for RDP Axis 2 measures, spatial targeting is tested against two indicators which RDP Slovenia identifies as relevant in this respect, namely Natura 2000 sites and water protection zones.[2] The basis of this exploratory analysis is a 2-layer graphical presentation: the first layer is represented by the targeting rates (defined as percentage of UAA in a municipality under A-E measure) and the second layer is represented by thematic maps (Natura 2000 areas, water protection zones).

The core of the analysis deals with the spatial econometric methods. In territorial sense, the process of CAP RD programming, consultation, and implementation is taking place only at the national level (Juvančič and Jaklič, 2008). RDP monitoring data, which should be the main data source of the analysis, does not include impact data and results indicators are not monitored at sub-national level. From this perspective, the spatial econometric analysis is limited and we must look for alternatives. The alternative data are taken from three different databases. Data from the first group IACS database ("RDP data") have been collected from approved applications for A-E measure. These data were supplied by Agency for Agricultural Markets and Rural Development, which is responsible for collection of monitoring data. Database with individual data on A-E payments in the period 2007-2010, contains information on area under each scheme, and aggregated data on net area under groups of similar schemes. Apart from the A-E data, the IACS database contains a number of other policy-relevant data (basic structural data, payment rights, LFA support). We have aggregated the individual applications at municipality level. The RDP monitoring database has been augmented by two other groups of secondary data: general socio-economic data[3] and Agricultural census 2010 data[4]. Both these two groups of secondary data were already collected at municipality level.

Due to the unavailability of indicators measuring spatial and environmental impacts of A-E measures at the sub-national level, spatial econometric analysis is restricted to the participation models. Two indicators have been selected as dependent variables in the econometric analysis:

a. Share of utilized agricultural area (UAA) participating in analyzed A-E schemes (y1) and

b. Share of agricultural holdings participating in analyzed A-E schemes (y2)

Econometric analysis of participation in the A-E measure starts with the net figures for the whole group of 22 schemes. In the analyzed period, 20.773 agricultural holdings have applied in at least one A-E scheme on the area of 213.701 hectares. This is followed by an in-depth analysis of two other groups of A-E schemes:

(i) Organic farming (as one scheme)

(ii) A-E schemes designed for arable land (3 schemes: Integrated crop production, Greening of arable land and Preservation of crop rotation)

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[2] "The implementation of the measures under axis 2 captures the accomplishment of the objectives on the conservation of the Natura 2000 sites, reversing the biodiversity decline under the Göteborg commitment, water quality preservation in accordance with the Directive 2000/60/EC of the European Parliament and of the Council as well as mitigating the climate change under the Kyoto Protoco " (RDP Slovenia 2007-2013, p.78).

[3] Source: Statistical office of the Republic of Slovenia, Statistical Yearbook 2011: http://www.stat.si/letopis/LetopisPrvaStran.aspx?lang=en (last acceded 7th August 2012).

[4] Source: Statistical office of the Republic of Slovenia, Agricultural Census 2010 Database: http://pxweb.stat.si/pxweb/Database/Agriculture_2010/Agriculture_2010.asp (last acceded 7th August 2012).

1.976 agricultural holdings have participated in A-E support for organic farming and 5.389 holdings in A-E support for arable land group. The table below presents the figures about implementation of selected groups of A-E schemes analyzed in Slovenia.

Table1: Implementation of analyzed groups of agri-environmental measures

Schemes	No. of contracts in 2009*	Area (ha) in 2009*
Agri-environmental measures, total		
Grand Total (net)	20.773	213.701
schemes relating to organic agriculture		
Organic farming	1.976	28.088
schemes relating to arable land		
Integrated crop production	1.813	45.475
Greening of arable land	4.960	61.942
Preservation of crop rotation	2.111	18.909

* Sub-measures within the same group can not be combined on the same plot, presented figures are thus additive.
Source: RDP Annual report 2011

As a starting point in the selection of explanatory variables, we have excluded the variables that do not correlate to any of the dependent variables. Multicollinearity which increases the standard errors of the coefficients and leads to misleading results was checked using the test Variance inflation factors (VIF). The variables that satisfied the significance and multicollinearity checks were then tested in several versions of econometric models. To determine the most suitable explanatory variables, we checked each of them individually. Selection was based on various criteria. We checked theoretical relevance of included variables, significance of variables and the regression equation that explains the most variance (highest R^2). Once we have chosen dependent and corresponding independent variables, we estimated the econometric models using standard OLS procedure.

Next step of the analysis consisted of spatial exploration. Spatial analysis of the data, as well as estimation in the case of spatial models, involves a formal definition of the spatial patterns. This pattern is usually represented by a matrix of spatial interactions – weight matrix (W). The matrix defines the relationship among different locations, or in other words defines the spatial neighbourhood for every location - the elements take the value of 1 if two municipalities share a common boundary, otherwise 0 (Kelejian and Robinson, 1995). In our study we selected as weight matrix queen contiguity. Matrix (in our case 210 x 210) has been row standardized. Exploratory Spatial Data Analysis (ESDA) was our first step to check weather spatial patterns exist. With this analysis we can see how the spatial patterns of two variables interact (positive spatial correlation could be defined as high-high or low-low). In most of the cases, ESDA revealed spatial patterns in our data, which gave rise to the decision to re-estimate the (a-spatial) models by including spatial weight matrices into standard OLS, and thus estimating spatial econometric models. We performed ESDA with LISA cluster map. In LISA analysis (Local Indicators of Spatial Autocorrelation) clustering is analyzed through the use of Local Moran's I. This indicator takes on values between -1 and +1, where 0 represents a random spatial pattern. The two extremes indicate two types of spatial association. If Local Moran's I approaches +1 we have a cluster of similar values (high-high or low-low), but if it goes down to -1 we have high and low values suspiciously mixed across the space (Smit and van Leeuwen, 2011).

Spatial interaction effects are important because municipalities are related to each other. The rural development policy in one municipality can have an impact on other neighboring municipalities. With spatial econometrics we analyzed the participation rate of A-E measures. We are interested in whether the participation rate of utilized agricultural area (y1) or agricultural holdings (y2) is effected only by rural development policy or is the participation rate in one municipality affected also by participation rate in neighboring municipalities.

Roughly speaking, in spatial econometric, there are two types of models, spatial lag and spatial error model. If the participation rate in one municipality is affected by the participation rate in neighbouring municipalities, we could characterize that as spatial lag model. On the other hand, if the participation rate in one municipality is affected by unknown effect, we can talk about error model. Lagrange Multiplier (LM) tests have been applied to determine which spatial model fits better to the analyzed our data (spatial lag or spatial error). As a final step, we compared standard OLS models with spatial models and of course interpreted the results. Participation models for utilized agricultural area and agricultural holdings have been carried out for three groups of A-E measures: all A-E scheme, organic farming and schemes relating to arable land.

4. Results

Targeting of A-E measures: exploratory graphical analysis

Ensuring that A-E schemes are targeting specific environmental problems and needs is of key importance for enhancing the good status of environment, and to ensure cost-effective disbursement of public funds (European Court of Auditors, 2011). Nevertheless, several authors report that agri-environmental measures, particularly when implemented in a horizontal 'soft&shallow' manner, fail to meet the targeting criteria (Matzdorf et al., 2008; Uthes, 2010; van der Horst 2007).

As a starting point of our analysis, we challenged the issue of spatial targeting by a cartographical comparison of the occurrence of environmental problems, and the actual implementation of A-E schemes in Slovenia.

The Figure 2 presents the spatial pattern of A-E schemes at municipality level and the locations of water protection areas. Water quality and reduction of water pollution are among the dominant objectives of agri-environmental actions (Vojtech, 2010). Apart from the minimum standards which all farmers must observe to prevent water pollution, further improvement in water quality may be desired because of their importance for drinking water supplies or for other reasons (Armsworth, 2012). This type of reasoning is present also in Slovenian RDP 2007-2013. A range of A-E schemes apply to address this issue, either explicitly (eg. permanent green cover in water protection areas), or at least implicitly (most of the remaining 22 schemes). However, if we compare the gross rates of implementation of A-E schemes (which includes all areas participating in at least one A-E scheme), no concentration along the water protection zones can be identified. This is to some extent understandable, as the prevailing part of agricultural areas are included in horizontal A-E schemes, with no particular eligibility criteria linked to water protection areas. Furthermore, if we restrict this comparison only to the areas engaged in organic farming (which should by definition be the most appropriate agricultural use of water protection zones), the mismatch between the implementation rate and the incidence of water protection areas becomes larger. Similar can be observed in the case of A-E schemes on arable land. Here, it has to be borne in mind that the implementation rate is spatially biased, as the share of arable land in total agricultural land varies (the highest share of arable land is in NE Slovenia). On the other hand, also water protection zones are located primarily in lowland areas, where the share of arable land is usually higher. Figure 2 shows that extensification of arable land appears to be concentrated only around water protection zones in NE Slovenia.

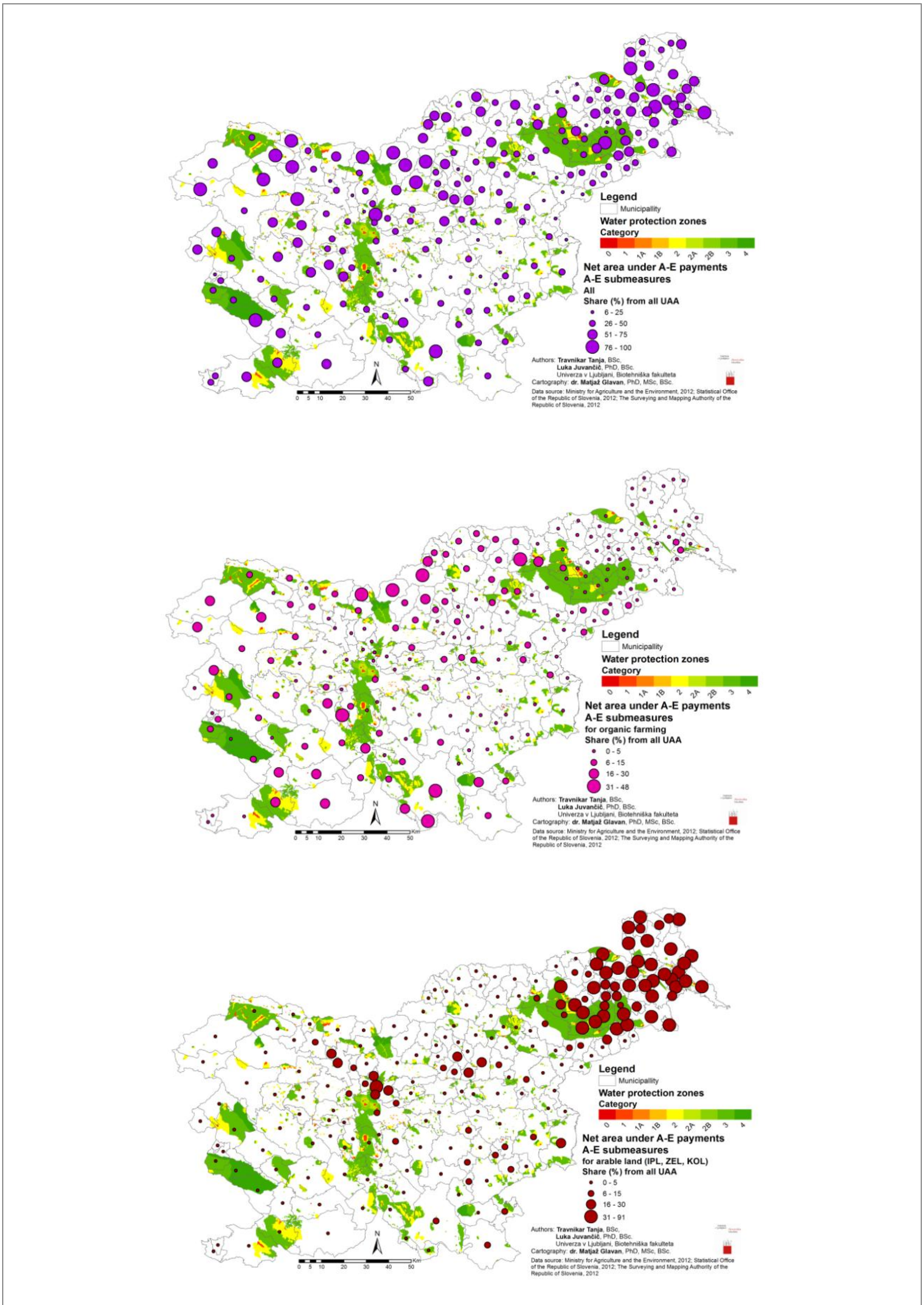

Figure 2: Spatial targeting of A-E measures in Slovenia with respect to water protection

Ability of A-E schemes to meet the targeting criteria was challenged also with respect to their biodiversity impacts, especially on wild species and habitats. Such habitats have come under increasing pressure from changes in farming practices – including increased field size, reduced crop rotations and increased fertilizer and pesticide use, or from agricultural land abandonment. In general, measures designed to preserve or enhance biodiversity are important in some specific regions (presumably those with more fragile ecosystems) (Armsworth et al., 2012). In this respect, we departed from a hypothesis that A-E schemes are expected to be more concentrated in areas of a greater importance in terms of biodiversity preservation (eg. Natura 2000 sites). Figure 3 presents the implementation rates of A-E schemes at the local (municipality) level against the map of Natura 2000 sites in Slovenia. Looking from the perspective of A-E measures in general (represented by all areas participating in at least one A-E schemes), there appears to be no spatial correlation between high implementation rate and Natura 2000 status of the area. On the other hand, areas with a higher share of areas engaged in organic farming often coincide with Natura 2000 status. There is no positive discrimination or other targeting criteria attached to support to organic farming. On the basis of this we can conclude that favorable spatial pattern of organic farming should be attributed primarily to the coincidence that organic farming in Slovenia is the most widespread in extensive livestock farms on absolute grassland, often located in Natura 2000 areas.

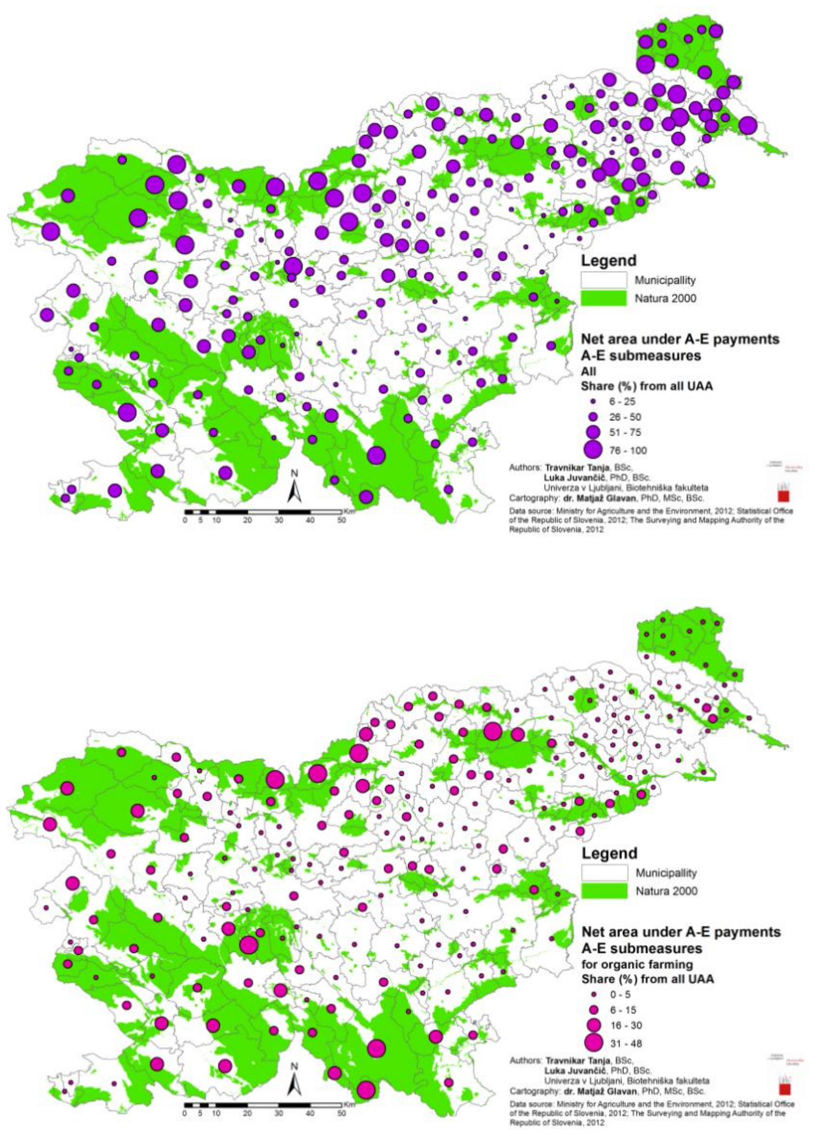

Figure 3: Spatial targeting of A-E measures in Slovenia with respect to protected areas (Natura 2000)

Spatial econometric analysis

In order to analyze the participation models with spatial econometric approach, we selected two indicators as dependent variables, share of utilize agricultural area (UAA) in analyzed A-E schemes (y1) and share of agricultural holdings participating in analyzed A-E schemes (y2). Analysis of participation in the A-E measure starts with the net figures for the whole group of 22 schemes. This in followed by an in-depth analysis of two other groups of A-E measure, organic farming as one scheme and group of similar scheme for arable land. Dependent variables are listed and briefly describes in the table below (Table 2).

Table 2: Dependent variables for participation models

Variable description	Name	Unit	Year	Source
Share of UAA participating in at least one A-E scheme	y1_all	%	2009	AAMRD (2012)*
Share of agricultural holdings participating in at least one A-E scheme	y2_all	%	2009	AAMRD (2012)
Share of UAA participating in A-E schemes for organic production	y1_organic	%	2009	AAMRD (2012)
Share of agricultural holdings participating in A-E schemes for organic production	y2_organic	%	2009	AAMRD (2012)
Share of UAA participating in A-E schemes for arable land	y1_arable	%	2009	AAMRD (2012)
Share of agricultural holdings participating in A-E schemes for arable land	y2_arable	%	2009	AAMRD (2012)

*Agency for Agricultural Markets and Rural Development; subset of IACS database

Once we have chosen dependent variables and corresponding independent variables, we estimate the econometric model using standard OLS procedure. Exploratory Spatial Data Analysis (ESDA) was next step to check weather spatial patterns exist. As a result of ESDA we enclosed LISA cluster maps and Moran I statistic. ESDA revealed spatial patterns in our data, which give rise to the decision to re-estimate the (a-spatial) model by including spatial weight matrices into standard OLS and thus estimating spatial econometric model. As final step, we compared standard OLS model with spatial models and interpreted the results.

a. Agri-environmental measures, total

As mentioned, for all schemes we tested two dependent variables, y1_all - density of A-E implementation [% of participating UAA] and y2_all – participation rate [% of participating farm]. First, we checked whether spatial pattern exist with LIZA cluster map (Figure 4). The value of Moran's I of 0.4238 for y1_all and 0.4616 for y2_all confirms the presence of a positive autocorrelation between the neighbouring municipalities in the sample.

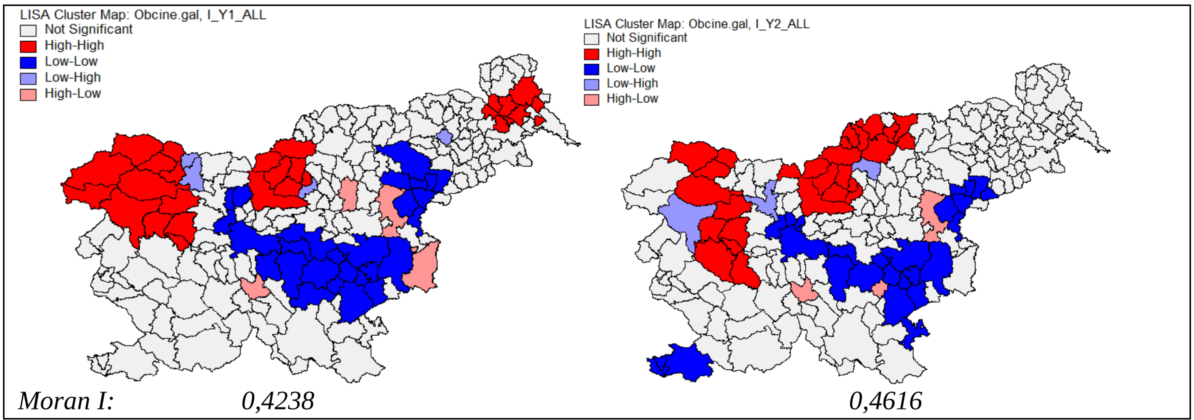

Figure 4: LISA cluster map and Moran I for all scheme, y1_all (left) and y2_all (right)

The spatial dependence was further explored by LM test, which suggest that the spatial lag model better captures the spatial patterns in both models than the spatial error model.

Table 3: Results of the participation models for all A-E scheme

Density of all schemes implementation [% of participating UAA] and [% of participating farms]	y1_all		y2_all	
	a-spatial	spatial	a-spatial	spatial
Purpose of agricultural production, % of sale [%]			0,19***	0,13*
Average UAA* per farm [ha]	-2,32***	-2,05***		
UAA, % of large farms (>10 ha) [%]			-0,19*	-0,11
Avg land area participating in A-E –all (farms) [ha]	0,19*	0,24**		
Payment rights grassland (Pillar I), all farms [€/ha]	0,03***	0,03***	0,04***	0,03***
EAFRD payments (all schemes) per ha UAA [€/ha]	0,26***	0,23***	0,08***	0,08***
Intercept	21,22***	11,59***	3,37*	0,32***
Number of observations	210		210	
Adjusted R^2	0,83		0,75	
R^2	0,83	0,86	0,75	0,77
Rho (spatial lag model)		0,25***		0,22***

Significant codes: 0 ***, 0.001 **, 0.01 *, 0.05 .

* UAA – utilized agricultural area

From table given above the coefficient parameter (Rho) of spatial dependence has positive effect and is highly significant in both models. Also, in both cases we have improvement in R^2. Through the spatial dependence of explanatory variables we explained more variance of the dependent variables, for 3 % in the first case and 2 % in the second. There is not to see major improvement, but the data are spatially connected. Also, density of all schemes implementation in one municipality is affected by the density of all schemes implementation in neighbouring municipalities.

Rather surprising, results of the first model reveal a negative relationship between average farm size and percentage of land under A-E measures. On the other hand, percentage of land under A-E measures increase with growing payments rights (CAP Pillar I) on participating farms, and with the actual sum of environmental payments (EAFRD) per hectare.

The second model reveals a positive relationship between the market orientation of farms and the share of agricultural holdings participating in A-E measures. What is interesting is that the large farms (>10 hectare) have a negative impact on participation rate, but this is no longer significant in the spatial model. Furthermore, results confirm the findings of the first model that payments rights and sum of the environmental payments increase the participation rates of farms.

b. Organic farming

According to the same principles, we also analyzed the participation models for organic farming. Density of organic farming is characterized by a highly clustered spatial distribution (Figure5). With a Moran I coefficient of 0.4396 for share of UAA participating in A-E schemes for organic production and 0.4876 of participation rate of agricultural holdings participating in organic production shows significant clusters.

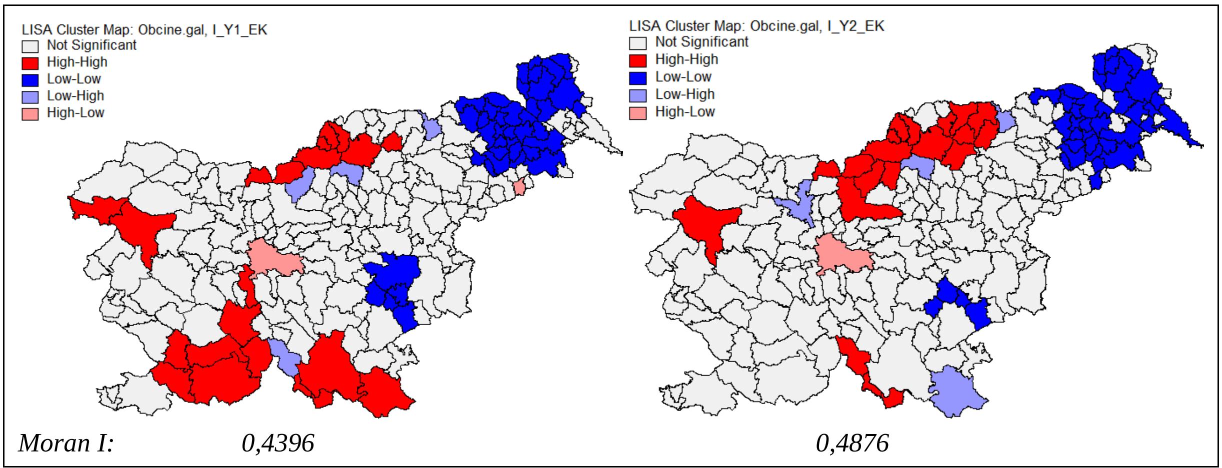

Figure 5: LISA cluster map and Moran I for organic farms, y1_organic (left) and y2_organic (right)

In both LISA maps we have small clusters of high high-high values and one big cluster of low values. For both cases of models, simple LM test of the lag and error are significant, indicating presence of spatial dependence. The robust LM tests help us understand what type of spatial dependence may be at work. The robust test for error is still significant, but the robust lag test becomes insignificant, which means that when lagged dependent variable is present the error dependence disappears. The coefficient of spatially correlated errors (LAMBDA) is positive and highly significant in both cases. When we compare OLS with spatial error model, significance of the model coefficients is very similar. We have also improvement in R^2, but we cannot confirm that density of organic farming and participation rate of organic farming in one municipality are affected by neighbouring municipalities. Density of organic farming and participation rate in one municipality are affected by unknown effect. But still, spatial model in the first case explains 12 % more variability and in the second 2 %, which is a great improvement.

Table 4: Results of the participation models for organic farming

Density of organic farming implementation [% of participating UAA] and [% of participating farms]	y1_organic		y2_organic	
	a-spatial	spatial	a-spatial	spatial
Land productivity proxy (SO per ha UAA)* [€/ha]	-1,22	-1,33.	-0,45	-0,52.
Average UAA per farm [ha]			-0,27**	-0,30**
UAA, % of small farms (0<2 ha) [%]			0,06*	0,04
UAA, % of large farms (>10 ha) [%]			0,18***	0,17***
Share of farms engaged in plant production [%]			-0,04**	-0,03*
% of UAA located in Natura 2000 areas [%]	0,05**	0,05*		
Share of LFA in total agricultural area [%]	-0,03.	-0,04.		
Payment rights (CAP Pillar I), average/hectare [€/ha]	-0,07***	-0,07***	-0,03***	-0,03***
Payment rights grassland (Pillar I), all farms [€/ha]			0,00***	0,00***
EAFRD payments (all schemes) per ha UAA [€/ha]			0,03***	0,03***
Intercept	27,07**	27,19**	5,21***	6,47***
Number of observations	210		210	
Adjusted R^2	0,37		0,69	
R^2	0,38	0,50	0,71	0,73
Lambda (spatial error model)		0,50***		0,37***

Significant codes: 0 ***, 0.001 **, 0.01 *, 0.05 .

*SO – standard output, UAA – utilized agricultural area

Apart from spatial clustering, only two factors contribute significantly to the first model, which explains the share of municipality area under organic farming. There is a positive relationship between the share of area under organic farming and the share of ecologically vulnerable areas (denoted by Natura 2000 sites). This result can be interpreted as positive in terms of spatial targeting of organic farming. The second significant factor refers to the CAP Pillar I payment rights; result of the first model suggests that areas with high payment rights appear to have a lower representation of areas under organic farming. As the payment rights for arable land in Slovenia surpass the payment rights for grassland, the result can be interpreted that areas with a high representation of extensive, grassland-based livestock production opt for organic farming more frequently.

The second model, which attempts to identify factors affecting participation rate of farms in organic farming, brings somewhat contradictory results concerning farm size. Negative coefficient for average farm size suggests that participation in organic farming falls with the average farm size, suggesting that small farms decide for organic farming more often (this is confirmed by a positive coefficient for small scale farming (up to 2 hectares) in the aspatial model). On the other hand, the sign is positive also for the group representing the largest farms. Interpretation of this result is speculative, but might represent previously mentioned relatively large, extensive grassland-based livestock farms. Results of the second model (negative coefficient for arable farming and CAP Pillar I payment rights) additionally confirm higher participation of livestock farms in organic farming, which was found already in the first model. Positive coefficient for the volume of agri-environmental payments can be interpreted to additionally confirm spatial clustering. Many factors can contribute towards this situation. It can be due to favourable (production/natural) attributes for participation in agri-environmental measures. Differences in participation rates can occur also by varying interest (or acquaintance?) of areas in agri-environmental measures. A possible explanation can also be in varying level of professional support (eg. associations of organic farmers, extension services).

c. Arable land

LISA cluster map and Moran I for density of arable land implementation are presented in the figure below. Moran I of 0.7246 for the percent of participating UAA and 0.7070 of percent of participating farms under arable land indicates a very strong spatial autocorrelation. High values are found in north-eastern Slovenia, we also have one big cluster of low values in the western part of Slovenia. This largely corresponds to the natural characterictics, as the share of arable areas in total agricultural area is by far the largest in North-Eastern Slovenia.

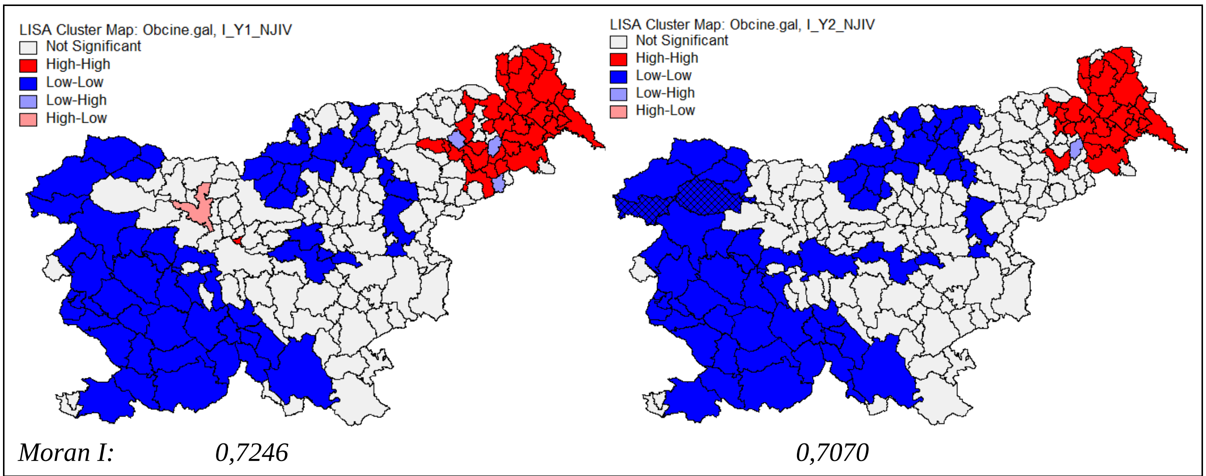

Figure 6: LISA cluster map and Moran I for arable land, y1_arable (left) and y2_arable (right)

LM tests suggest that both spatial model are significant (lag and error) but robust test suggest that spatial lag model is better in both models. In comparison with standard OLS models, spatial lag models show similar results. R^2 in spatial model is higher and also the improvement is significant. In that case we can confirm that density of arable land implementation and participation rate for arable schemes in one municipality are affected by implementation and participation rate for arable schemes in neighbouring municipalities. As the observed group of (arable) A-E schemes depends greatly from the structure of agricultural land, spatial clustering is obvious.

Table 5: Results of the participation models for arable land

Density of arable land implementation [% of participating UAA] and [% of participating farms]	y1_arable		y2_arable	
	a-spatial	spatial	a-spatial	spatial
Land productivity proxy (SO per AWU)* [€/ha]	0,88***	0,75***	0,99**	0,91***
Average economic size of agricultural holdings [€]	-0,69***	-0,56***	-0,92***	-0,75***
Purpose of agricultural production, % of sale [%]	-0,14*	-0,10*		
UAA, % of medium-large farms (5<10 ha) [%]	0,30***	0,27***		
Share of farms engaged in plant production [%]	-0,08*	-0,07*		
Share of farms engaged in livestock production [%]			0,10**	0,09**
Self-employed farmers [%]			0,61***	0,34**
Registered unemployment rate [%]	0,51**	0,29*	0,71**	0,29
Share of LFA in total agricultural area [%]	-0,05**	-0,05**	-0,07*	-0,06*
Average land area participating in A-E – arable land (farms participating A-E) [ha]	0,22***	0,21***		
Payment rights (CAP Pillar I), average/hectare [€/ha]	0,15***	0,11***	0,16***	0,11***
Payment rights grassland (Pillar I), just farms participating in A-E [€/ha]	-0,01***	-0,01***		
EAFRD payments (all schemes) per ha UAA [€/ha]	0,14***	0,13***	0,09***	0,06***
Intercept	-32,27***	-26,06***	-50,22***	-36,16***
Number of observations	210		210	
Adjusted R^2	0,90		0,77	
R^2	0,91	0,92	0,78	0,83
Rho (spatial lag model)		0,22***		0,42***

Significant codes: 0 ***, 0.001 **, 0.01 *, 0.05 .

* SO – standard output, AWU – annual work unit, UAA – utilized agricultural area

Although the estimated models analyze different aspects of participation (participation rate as a percentage of agricultural land in the first and as a percentage of farms in the second), model coefficients are to a large extent mutually consistent. Results reveal a positive relationship between farm economic size (models 1 and 2), full-time farming (model 2) and agricultural labour productivity (both models) on one side and participation in arable agri-environmental schemes on the other. These results indicate that full-time, larger and more productive farms opt for these schemes more frequently. This is partly relativized by a negative coefficient (at the edge of statistical significance) for the impact of the percentage of sales in the first model. The first model highlights that participation in arable A-E schemes is higher in areas with higher representation of (small to middle size) group of farms from 5 to 10 hectares. Furthermore, results of second models suggest that the uptake is higher in the areas with a higher percentage of livestock farming. Both models show a positive relationship between the unemployment rate and participation in arable schemes. This result might only reflect the fact that agriculture tends to be stronger represented in areas facing general economic difficulties (eg. lack of non-farm jobs). Somewhat surprising are positive coefficients for the share of areas located in LFAs, especially as this result to some extent contradicts to the equally positive coefficient for the share of arable land (model 1). In contrast to organic farming participation models, model coefficients for payment rights (Pillar I) as average per hectare are positive. This is understandable, as payment rights are currently about three times higher as payment rights on grassland.

5. Concluding remarks

The question of targeting of agri-environmental measures is gaining interest in both in policy (ECA, 2011) and academic spheres (Armsworth et al., 2012; Uthes et al., 2010). The current situation with prevalence of horizontal 'one-size-fits-all' A-E schemes has been widely criticised for yielding limited environmental benefits and poor cost-effectiveness. In the presence of significant spatial heterogeneity, these schemes result in significant variations in benefits and costs of agri-environmental services across the landscape (Lankoski et al., 2005).

The paper is addressing the above issues by analyzing A-E schemes in Slovenia, carried out within the national Rural Development Programme 2007-2013. Nevertheless, the findings might be relevant also for other regions with ambitious agri-environmental programmes, prevalence of 'soft and shallow' A-E schemes and weak territorial targeting.

Starting from the last, results of our exploratory spatial data analysis reveal that in the absence of spatially explicit eligibility and implementation criteria, A-E schemes either fail to address specific problems and needs of an area, or become unnecessarily costly in terms of the trade-off with environmental gains. A more spatially-targeted approach in implementation of A-E schemes would improve this situation.

Results of the exploratory spatial data analysis also suggest that, even in the absence of spatially targeted implementation of A-E schemes, area-specific patterns of implementation occur. Clustering of areas with similar patterns of implementation of A-E measures can be attributed to various factors. Some factors that trigger participation of agricultural holdings in A-E schemes were tested by spatial econometric models. Somewhat surprisingly, there are no straightforward linkages between participation in A-E schemes and farm size. On the other hand, results of the spatial econometric analysis clearly reveal a positive link between the amounts of received CAP Pillar I direct payments and EAFRD payments on one size and participation in A-E schemes on the other. The result can be interpreted that agricultural holdings behave as rational decision-makers; they treat revenues from A-E payments with equal importance as revenues from market production[5]. This result just underlines the importance of informed planning of A-E schemes. In order to provide well defined and targeted public goods and not merely 'greenwashing' of public transfers of agriculture, A-E payments have to be economically justified by and technological requirements have to be clearly defined.

Implicitly, the paper also unveils the spatial analytical potential of the present monitoring framework (CMEF) for Axis 2 of the CAP RD policy, which deals with management of environmental resources. The data for CMEF indicators are captured in a spatially disaggregated manner only in the case of input (ie. financial) and output indicators (eg. hectares under A-E scheme). Unfortunately, in the case of impact indicators data are representative only for the whole programming area. Spatial analysis of impacts of A-E schemes can thus not be implemented, which thwarts the potential for more evidence–based planning of A-E schemes in the coming programming period.

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[5] In fact, recent analysis of agricultural structures and economic status of agriculture in Slovenia (Volk, 2012) reveal that occurrence of farms in Slovenia that optimize their production according to A-E payments is far from negligible.

6. Literature

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