Land Use Policy
Manuscript Draft

Manuscript Number: LUP-D-14-00098

Title: The role of policy priorities and targeting in the spatial location of participation in Agri-Environmental Schemes in Emilia-Romagna (Italy)

Article Type: Regular Paper

Keywords: Agri-Environmental Schemes, participation, targeting, priority implementation

Abstract: The objective of the paper is to understand the determinants of spatial location of participation in Agri-Environmental Schemes and, in particular, to understand the interplay between structural determinants, priority criteria and spill over effects in guiding participation. In a first step, the paper tries to conceptualise the issue based on existing literature. Second, an empirical application is provided based on an econometric model on data about participation in measure 214 of the Rural Development Programme 2007-2013 in an Italian region (Emilia-Romagna). The results show that both priority scores and the spatial dimension are significant in affecting participation.

*Highlights (for review)

Highlights

- Regional priorities are significant in affecting the participation in measure 214
- Spatial component are significant in improving the explanatory ability of the model
- Explanatory variables were sharply differentiated by sub-measures

The role of policy priorities and targeting in the spatial location of participation in Agri-Environmental Schemes in Emilia-Romagna (Italy)

1. Background and objectives

Participation in Agri-Environmental Schemes (AES) has been studied from several angles in the literature. Determinants of AES participation have been analysed mainly by applying econometric models, using cross sectional data or panel data, usually collected as farm level data. Results of early papers on this issue highlight that profitability, risk reductions, attitude toward sustainable methods of production, are determinants of adoption. The literature has also pointed out positive effects of motivations and incentives in promoting the use of AESs (Morris an Potter, 1995).

Several paper have provided further evidence in the last decades and various papers also provide rich reviews of determinants of participation available from the literature (e.g. Defrancesco et al., 2008; Uthes and Matzdorf, 2013). The determinants have been organized in different ways depending on the scientific approach of the researchers. It can be recognized, however, that the macro areas of interest can be ascribed to the socio-economic characteristics of the farmer and his/her household (e.g. age, composition, presence or lack of a successor), the attitudes and beliefs of the farmers (e.g. opinions about the environment), structural characteristics of the farm (e.g. size, specialisation, stocking density, financial constraints) and context variables (e.g. information received, neighbours' participation) (Vanslembrouck et al., 2002; Defrancesco et al., 2008; Jongeneel et al., 2008; Peerlings and Polman, 2009; Barreiro-Hurlé et al., 2010; Wauters et al., 2010; Uthes and Matzdorf, 2013).

Studies based on secondary information (e.g. FADN) tend to put less focus on individual variables and more on the structural or environmental characteristics of each area, being driven by the information available at the appropriate scale (Borsotto et al., 2008; Hynes and Garvey, 2009; Capitanio et al., 2011; Lapple and Kelley, 2013). At this level, taking into account selection processes remains very difficult, due to the fact that information about the full process is rarely available for researchers. For example, FADN information tends to record only funded participants with no specific information about the measure or sub-measure, while the selection process is usually rather differentiated among sub-measures and areas.

Following Schimidtner et al. (2012) the participation in AESs are also assumed to be affected by agglomeration effects due to spatial dependence of explanatory variables. The authors pointed out that vectors of prices and costs are heterogeneously spatially distributed due to spatial differences in distance to markets or to positive values of transportation costs. Furthermore, the authors argue that production functions and transaction costs required to participate in AES are heterogeneously distributed across the space due to different natural conditions, which implies changes in input-output relations, heterogeneity in quality of institutions and in social capital elements. In addition, a growing body of literature on spatial phenomena points to the relevance of proper spill over effects, due to, for example, imitation or economic signals outside the involved farms (e.g. through effects on prices) (Anselin 2010; Bell and Dalton, 2007; Brady and Irwin, 2011).

Bartolini et al. (2013) found that selection criteria and priority mechanisms increase spatial targets of the agri-environmental measures. However, authors found that sub-measures react heterogeneously to economic incentives due the relevance of motivation and social capital in explaining spatial concentration (e.g. organic farming).

The literature above, largely based on *ex-post* studies about participation, only marginally addresses policy design variables. This issue is more directly dealt with in literature eliciting farmer preferences for different contract alternatives based on hypothetical questions (e.g. Ruto and Garrod, 2009; Christensen et al., 2011; Broch et al., 2013). However, given the particular focus on individual behaviour of this type of study, they focus more on “hard” variables of direct interest to the farmer (such as payment levels, contract length, transaction costs etc.), rather than on variables that matter mainly on the aggregate, such as those related to how the policy includes selection mechanisms for farmers.

Altogether, while policy priorities and targeting mechanisms may play an important role, this has attracted little attention in the existing *ex-post* studies on participation. This may be justified by the fact that the case studies from which the participation data were taken had little targeting or poor selection priorities. Another case for the potential irrelevance of this issue is when selection criteria are in place, but the existing budget is large enough to allow participation by all of the farms applying. However, even in this case, farmers’ decisions could be affected by the knowledge of the potential priority mechanisms.

The objective of the paper is to understand the determinants of spatial location of participation in AES and, in particular, to understand the interplay between structural determinants, priority criteria and spill over effects in guiding spatial distribution of participation in AES.

The objective is addressed through an application of spatial econometrics to participation in measure 214 (Agri-Environmental measure) in Emilia-Romagna, Northern Italy, including priority variables to reflect the mechanisms of the selection process. Emilia-Romagna offers a very interesting case in this respect. Not only is the region very heterogeneous in terms of territorial and agricultural conditions, but the regional administration has also put in place a complex system of scoring, based on several criteria, which is aimed at guiding the prioritization of applications in each area.

The main originality of the paper rests in addressing (*ex-post*) priority setting in the context of spatial econometrics models, allowing for discussions of the interplay between spatial effects, priority targeting and other explanatory variables of participation. It also provides insights into how this applies to different sub-measures (also interpretable as different types of measures). Due to the novelty of the approach and the data limitations (see discussion), this is to be considered mainly as an explorative exercise.

Section 2 provides a formalization of the problem addressed and the description of the methodology. Section 3 describes the case study area. The results are illustrated in section 4, followed by a discussion and concluding remarks in section 5.

2. Problem setting and methodology

Morris and Potter (1995) have identified four behaviour typologies for participation in AESs. Farmers are grouped as follows: active adopters, passive adopters, conditional non-adopters and reluctant adopters. With the exclusion of the first and the fourth group, in which the placement follows mainly motivation reasons (e.g. farmers participated because of their believe or motivations), payment levels and priority setting have a central role in explaining movement between adopters and non-adopters.

Let us initially assume that the different factors affecting willingness to participate contribute to decisions through (and are well represented by) the Willingness to Accept (WTA) a payment for participation in AES, equal to the perceived compliance cost. Let also assume that the Public Administration, together with establishing the payment and a budget for the measure, can set a priority index calculated based on farmer or farm characteristics (e.g. age of applicant, location). This may be related to the presumed higher relevance in terms of measure's objectives (e.g. higher likely ability to produce environmental externalities or increase value added through investment).

The problem of interpreting participation and priority setting in *ex-post* econometric models can then be illustrated as in Figure 1.

Figure 1: Exemplary illustration of selection process (stars, square dots and circles refer to different hypothetical populations with different distributions)

(figure 1 about here)

The Figure depicts the distribution of a set of farms by compliance costs and decreasing priority scores. On the y-axis, farms will then decide on participation based on the positioning of the payment level. Farms with WTA below the payment level will be willing to participate. On the other hand, the public regulator makes a selection of farms based on a priority score. Priority will be then given to the farms with the highest score among those applying for the payment. Assuming that there are budget limitations, the subset of funded farms will be that of the farms falling into area A. Area B includes those applying, but not funded due to the fact that the budget was used up entirely by farms with higher priority. Area D collects those farms that would not apply, but would compete for the budget based on the priority score if they did. On the other hand, E includes all farms that would not apply, but would not be funded even if they did due to the priority mechanism.

In addition to this, the regulator can also set eligibility rules. This is the case, for example, of farmers located in specific zones excluded from funding (e.g. altitude or specific rural zoning) or that do not satisfy farmer and farm characteristics for participation (e.g. legal status or farm size). For the sake of simplicity, in Figure 1 it is assumed that eligibility can be specified as a given level of the priority dimension. In this case, areas C and F can be further identified to include farms that could not apply due to restrictions in eligibility rules. Of the two sets, C represents the one that would have incentives to participate, as their costs would be lower than the payment.

The simple framework above allows for several considerations.

A first group of considerations concerns the distribution of farms in an area on the two main dimensions and its connection with potential analytical issues. In figure 1, one case is that of the square dots. These farms are distributed without any particular order on the quadrants, meaning that there is no relationship between WTA and the priority score. The stars represent hypothetical farms of a region in which the priority is higher for farms that also have lower WTA. It may be expected that in this case priorities will push participation in the same direction as pushed by WTA and that the policy variable "priority" would be highly correlated to other factors affecting participation. The circles represent hypothetical farms of a region in which priority is basically inversely distributed with respect to WTA. In this case it may be expected that the policy variable "priority" acts as a more relevant independent variable in affecting participation.

From the point of view of policy design, it is relevant to understand the interrelationships between the different policy variables in the figure. The setting of payments (higher or lower) clearly affects interest in participating in AESs. On the contrary, the number of selected participants will depend on budget availability. For an individual farm willing to participate, however, the budget constraint will be more or less constraining depending on the number of other participants. In order to be selective with respect to the priority criterion, hence to be effective in selecting farms with high priority, a scheme needs to set the payment high enough to encourage excessive participation. However, increasing unit payments also means strengthening the budget constraint, making the selection process more difficult, i.e. allowing participation from fewer farms. On the other hand, if the payment is so low that the farms willing to participate are less than allowed by the budget, the priority will not be selective at all. This problem is also different depending on population distribution. For example, for the star type distribution there is no trade off and moving the payment higher or lower will end up selecting the "right" farms. It simply needs to be set high enough to avoid unexploited budgetary resources. The situation is the opposite, i.e. the search for the right combination matters, in the case of a "cloud" type distribution.

From the point of view of spatial econometrics applications, it is first relevant to note that econometric studies may in fact use different samples with respect to this framework. Studies based on WTA usually observe the full set of farmers. Studies using information by applicants, on the other hand, observe only the components A+B of the population (except when motivations other than profit affect participation). When only actual participants (approved applications, i.e. beneficiaries) are used, we observe only section A of the quadrant (with the same caveat as above). This means that, in the latter case, investigating the effect of priority setting is impossible, as in order to do so, it would be necessary to have information about the whole population characteristics and the ultimately funded farms.

In this paper, spatial econometrics methods are used in order to explain participation at the municipality level (1 municipality=1 observation), which is a way to approximate the full set of potential participants (i.e. all components of figure 1).

The applied methodology is composed of two steps. In the first step, a LISA cluster map and Moran scatter plot are performed in order to investigate the spatial regime of distribution of uptake of measure 214. Then, within the second step, spatial econometrics models of uptake are applied with the aim of investigating determinants of spatial distribution, focusing on both individual characteristics and the priority mechanisms implemented. The models applied are: a linear regression model with Ordinary Least Square method (OLS), a spatial lag model and a spatial error model.

Spatial econometrics models can be thought of as an extension of standard linear regression models (Lesage and Page, 2009). In this paper spatial lag models and spatial error models are performed. Following Mur (2013) the reduced form of the spatial lag model could be written as

$(I - \rho W)y = x\beta + \varepsilon$, while the spatial error reduced form could be written as: $(I - \lambda W)y = (I - \lambda W)x\beta + u$. Where β, ρ, λ are the parameters to be estimated.

In this paper spatial weight matrices used are based on neighbourhood: all spatial models use first order of contiguity as weight matrixes.

The models have been applied both to the whole participation to measure 214 and to selected individual sub-measures (organic farming, integrated production and meadows and grazing payments).

The dependent variable is the percentage of participating farms in each municipality. The explanatory variables have been selected based on the preliminary analysis of expected determinants and spill over mechanisms (see "*[name deleted to maintain the integrity of the review process]*), on the previous literature and on local policy design. In particular, based on the discussion above, the determinants are organised into three main levels:

1. level of priority of the farms in the area (which effects of the prioritisation index);
2. characteristics of the environment, of the farms or the farmers in the area, affecting WTA for participation;
3. residual spatial effects, described by neighbourhood causes and hence potentially attached to spill over effects.

The second category concerns variables related to location of the municipalities (altitude, density of inhabitants), farm structure (amount of household and external labour used on the farm, farm specialisation income from the farming activity, farm specialisation) and farmer characteristics (age).

The details and statistical descriptives of the dependent and of the explanatory variables are available in Annex A of this document, while more details about participation in the case study area and policy priority design are given in the next section.

3. The case study: regional features, AES implementation and uptake distribution

The Emilia-Romagna region is located in north-eastern Italy and is part of the Po plain, along with the neighbouring regions of Piedmont, Lombardy and Veneto. In the southern part of the region the plain is linked with the hilly and mountain areas of the Apennines. The territory is therefore divided into a fertile plain with intensive agriculture dominated by arable crops, a hilly area with specialised vineyards and orchards, a mountain area with extensive agriculture (mainly grassland, arable crops) and woods.

From an environmental point of view, the plain area is highly urbanized and includes intensive agriculture on land that was reclaimed over the past centuries. The result is a loss of natural wetlands and plain woods. This area has a very low level of biodiversity and faces various risks related to water quality (mainly pollution by nitrates).

The mountain area suffers marginality and land abandonment due to the distance to services, water erosion and landslide risks for cultivated soils.

Given the agricultural and environmental context of the region, the AESs managed in the regional government's RDP were structured in the present and previous programming periods to address different agri-environmental issues. The Agri-Environment payments (Measure 214) are responsible for the sustainable management of the territory, with a specific focus on increasing water quality, soil quality and biodiversity conservation. The measure is divided into 10 sub-measures, strongly differentiated in terms of environmental objectives and target areas for application, such as organic production, integrated production, meadows and grazing payments, agro-biodiversity, conservation of landscape elements, realization of wetlands etc.

The variety of sub-measures and environmental issues result in the need to prioritize the application of the measure in the territory. The RDP provides a range of selection criteria, with a stronger focus on the concentration of committed area in the most environmentally sensitive areas.

The prioritizing process is based on three criteria: territorial, sub-measures and farm structural characteristics. The territorial criteria is associated with the highest level of priority, while the other two criteria generate a lowest rank, mainly distinguishing farms with the same territorial score: a farm located in an environmentally sensitive area always has a higher priority than one that applies for the most prioritized sub-measure. A farm with the highest level of structural characteristics always has a lower rank than one with the lowest territorial or sub-measure priority. The territorial criteria presents a relatively high level of complexity, in that the RDP refers to 15 different types of themes used for the selection of measures at the regional level (as well as others defined at the provincial level). The themes are grouped into four separate typologies of protection as depicted in Table 1, in which the actions affected by the various preference criteria are also presented.

(table 1 about here)

The most important territories in the selection, according to EU strategic approach, are Natura 2000 and Nitrate Vulnerable Zones (NVZ), followed by lower levels of priority based on regional territorial planning and linked to nature conservation (parks, ecological networks etc.), water protection areas (related to the risk of pollution for water bodies), soil protection areas (related to the risk of erosion) and protected landscape areas. In this design, each level of territorial priority represents a different rank of environmental sensitivity, regarding the kind of area (e.g. Natura 2000 has a higher rank than parks). The scores given for each kind of area are added in case of their overlapping, which is common at the local level. The second level of priority, related to the sub-measures, enables the regional administration to link the selection to the RDP objectives: for example, a high rank in this case is provided for organic production, following a cross-cutting priority designed above the whole Programme. Other priorities are applied to a selection of measures, based on specific environmental objectives addressed by given sub-measures. In some cases the sub-measure priority is linked to the territorial criteria (highest rank for sub-measures related to water quality, i.e. integrated production, are provided when the farm is located in a water protection area).

The third level of priority, linked to the structural characteristics of farm and farmer, always has a lower rank than the previous ones, as these characteristics are not directly linked to the environmental objectives of the Programme.

In this paper we focus on territorial priorities. In order to feed this information into the econometric model, specific variables have been created in order to account for each of the preferential dimensions above (see Table 1 again). The municipal level data was processed by calculating the overall preferential area (plots included in at least one of the areas) for each group of protection type. The resulting preferential area of the plots included in the RDP applications was compared to their total surface area: with a threshold value of 50% the municipality is thereby classified as "preferential" or "not preferential" for a certain group of protection type (water protection, nature protection etc.), hence creating a binary variable (which takes the value 1 or 0) for each group of priorities.

A first call for application was published in 2008, with 81,600 ha committed at the regional level: the results of this paper are based on the uptake data for this first call. Considering the share of the different interventions, the most important sub-measures were: 2 - organic production (51% for over 42,000 ha), 1 - integrated production (26% for 21,000) and 8 - meadows and grazing payments (17% for 13,800 ha). In this paper we focus on the aggregate of measure 214 and on these three most important individual sub-measures. In the 2008 call and in the following (2011 and 2012, not studied in this paper) the resources allocated were sufficient to fund all of the admissible applications, which may be expected to nullify in part the efforts of the regional government to define articulated priorities.

As mentioned, in this study the dependent variable for all models and all measures is the participation expressed as the percentage of participating farms over the total of the farms in the municipality. The number of observation is hence equal to number of municipalities in Emilia-Romagna (341) at the time of the first call (2008).

The distribution on the regional area, in terms of the percentage of participating farms per municipality, is rather differentiated and is different between the aggregate and specific sub-measures (**Error! Reference source not found.**2).

Also, the concentration of participation is very different across municipalities and already hints at the fact that participation follows the zoning rules applied.

Figure 2: Spatial distribution for measure 214 and sub-measures

(figure 2 about here)

In particular, sub-measure 1 (integrated production) is mainly located in the plain and very focused on areas characterised by a concentration of fruit production (eastern part of the region). This is largely connect to a deliberate strategy of valorisation and targeting to the sector. On the contrary, organic production (sub-measure 2) is much more contracted in hill and mountain areas, characterised by more extensive systems and easier plant protection. This is true with the exception of Ferrara Province, which is a completely flat area, and the main farming systems there are cereal and alfalfa crops in the municipalities with the highest participation rate. Measure 8, which is related to meadow and grazing conservation, is mainly distributed in the hill and mountain area, and in the area of the Parma and Reggio Emilia Provinces, characterised by a high concentration of dairy farming.

4. Results

4.1 LISA cluster map and Moran scatter plots

The LISA cluster map and Moran scatter plots for the distribution of participation in measure 214 and the three selected individual sub-measures are presented in Figures 3 to 6 respectively. In all figures the participation is measured as the ratio between uptake and the total number of farms in each municipality.

The figures show different spatial distributions of participation in the 214 sub-measures and in the overall measure and, in addition, a different level of spatial agglomeration. This largely reflects the concentration and occurrence of hotspots already noted in the participation maps. The Moran Index (Moran's I) varies from 0.28 to 0.45, hence representing not overly strong evidence of spatial correlation.

Measure 214 as a whole shows a large hot spot (i.e. high participation municipalities close to high participation municipalities), represented by red cells in the centre-west mountain area of the region, in contrast to a large cold spot (i.e. low participation municipalities close to low participation municipalities) in the lowland area. Moran's I is 0.377.

Figure 3: LISA Cluster Map and Moran's I for measure 214 (all sub-measures)

(figure 3 about here)

Two sub-measures (1 and 2) have higher Moran's I compared to the overall, i.e. higher spatial correlation. In the LISA maps, sub-measure 1 shows a major hot spot in the eastern part of the region (specialised in orchards and vineyards), while cold spots are small (basically derived from the association of a couple of municipalities) and located in the Apennine area.

Figure 4: LISA Cluster Map and Moran's I for measure 214 (sub-measure 1)

(figure 4 about here)

Sub-measure 2 - Organic farming (Figure 5) has one major hot spot and one major cold spot. In particular, the main hotspot area is located in the western Apennines, while the main cold spot is in the centre-east part of the low plain area, though agglomeration also occurs in most of the lowest part of the whole plain area.

Figure 5: LISA Cluster Map and Moran's I for measure 214 (sub-measure 2)

(figure 5 about here)

Sub-measure 8 – Meadows and grazing payments (Figure 6) is the least spatially correlated according to the Moran's I (0.285). A large cold spot covers in this case the plain area where the participation is very low or null (particularly the east side), while small hot spot areas can be identified in the Apennines and in the plain area close to Reggio Emilia (the main dairy cattle area of the region).

Figure 6: LISA Cluster Map and Moran's I for measure 214 (sub-measure 8)

(figure 6 about here)

4.2 Spatial econometrics models

The results are presented in tables 2 to 4, presenting respectively the results of the OLS a-spatial model, the spatial lag model and the spatial error model. For each table a model is applied to data considering participation to measure 214 as an aggregation of all sub-measures, while additional separate models are applied to the data of individual sub-measures 1, 2 and 8. This presentation allows for a smooth comparison of the results of the same set of explanatory variables across the different sub-measures.

In the OLS linear regression model (table 2) adjusted R^2 are basically satisfactory, though not very high, with the lowest performance of sub-measure 8 (Adjusted R^2=0.1907) and highest for sub-measure 2 (adjusted R^2=0.4469). No variable is significant for all sub-measures and the aggregate, but several variables are consistently relevant across several measures.

(table 2 about here)

The constant is significant only for sub-measure 2, the only measure most uniformly distributed across the region.

Some variables related to different preferential areas are relevant for all sub-measures, though different preferential features apply to each sub-measure. In particular, the absolute preference variable (PREFASS) is positively and highly significantly related to the participation in the aggregate measure, for integrated production and grazing, but not for organic production. PREFIDRO and PRESUOLO are never significant on the aggregate or for the sub-measures considered. PREFNAT is negatively related to sub-measure 2 and positively to sub-measure 8. Finally, PREFPAE is only positively and significantly related to sub-measure 2.

Density of inhabitants is always negative, showing that participation tends to be higher in the more remote areas. The presence of only household labour is relevant only on the aggregate with a positive effect. The share of different crops has markedly different behaviour across sub-measures. In particular, the share of arable farming in the municipality negatively affects the aggregate measure 214 as well as sub-measure 1 and 8, while fruit positively affects sub-measure 2, which is also negatively affected by grazing land. The share of forest is also positively associated to the aggregate and sub-measure 2. The livestock variable also has complex behaviour, as it is positively associated to participation in the aggregate and in organic farming, but is negatively related to integrated production (sub-measure 1). Part time farming is negatively related only to integrated production (sub-measure 1) hinting at the fact that this measure is the one best fitting measures for professional productive farms.

Table 3 illustrates the results of the spatial lag models. The ρ parameter (coefficient of spatial dependence) has a positive value and is highly significant in all models, corroborating the idea that relevant spatial concentration phenomena occur. Also R^2 increases.

(table 3 about here)

The results in terms of significant variables are altogether consistent with the OLS regression model, with a few exceptions, notably the inhabitant density (DENS_AB) loses significance in the overall measure model, and arable crops and livestock also lose significance. Preferential area variables maintain the same effect, except for PREFASS (most of the municipality is in Natura 2000 or nitrate vulnerable zones) which is no longer significant in the case of integrated production.

In the spatial error model (**Error! Reference source not found.**4) the spatial variable (λ) is highly significant, in analogy to ρ. The resulting R^2 is very similar to the one of the previous model. On the contrary, the significant variables change more substantially. In particular, the constant becomes significant for integrated production (again one of the most uniformly diffused measures), but loses significance in sub-measure 2.

(table 4 about here)

Except for PREFPAE, the role of preferences shows some change in all cases with only PREFASS maintaining a significant and positive role in explaining participation in the aggregate measure 214.

Land use variables change slightly. Of the socio-economic variables, age over 65 and part-time farmers maintain some significance, but they are now only relevant for sub-measure 8, with negative and positive signs respectively.

6. Discussion and conclusions

The main objective of this paper was to understand the determinants of spatial location of participation in AESs and, in particular, to understand the interplay between structural determinants, priority criteria and spill over effects in guiding participation.

This work was affected by several limitations, the main one of which was the lack of flexibility regarding the scale of analysis, as the only feasible scale was on the municipality level. This has implications in terms of consistency with potential spill over effects and, partly, with priority criteria used by the regional administration, that are mainly related to the farm level. This also affects the availability of explanatory variables, which in most cases are limited to a small amount of information related to secondary data about crops, age and population in a given municipality. As is the case with other studies using aggregated data, this study was not able to take into account personal and attitudinal variables that are considered so important in explaining participation in AESs. This, on the one hand, leaves open the possibility that relevant spill over is not taken into account by the model, while, on the other hand, the spatial variable also incorporates spatial differentiation that is explained by other variables not available for the model.

In spite of the limitations , the spatial econometric exercise showed altogether a satisfactory ability to explain participation in measure 214. Within the estimated models, the regional priorities are significant in affecting the results. This occurs in a differentiated way across sub-measures and the effects are more evident for sub-measures than on the aggregate. It is relevant to note that the priorities affected participation level and its localisation, even if all the applications were financed (i.e. despite the low level of applications received from farmers). This may point to the importance of expectations with regard to farmers' decisions whether or not to apply.

The concentration of the commitments followed the territorial priorities, especially for the absolute preference which is consistently relevant in all models. This is not the case for the other preference variables (cfr. Table 1), with extreme cases for hydrological and soil preferences, that are never significant, while they should be relevant for all of the measures considered, according to the intended design of such preferences. The nature protection variable is not always significant and, when it is, it has contradictory results (signs). The landscape priority variable is only significant for sub-measure 2, while it should also be for sub-measure 8. This result can be explained with the territorial correspondence between the concentration of sub-measure 8 and the location of nature protection area.

Also, the spatial component was highly significant and important in improving the explanatory ability of the model, demonstrating the efficacy of the selection criteria in concentrating the participation in the most environmental sensitive territories. The other explanatory variables were sharply differentiated by sub-measures. Among them, socio-economic indicators appear to be less often significant and less stable across models, hinting at a process strongly affected by “harder” structural and agricultural variables (though this may have been affected by data limitations related to personal and attitudinal information).

Altogether, the paper shows the relevance of accounting for policy design variables and, in particular, policy priorities, in studying participation to AESs. This exploratory study hints at several directions for further research in this field. The most relevant ones include the extension of the range of policy variables in the model (including e.g. payments level) and the investigation of the connection between econometric models and normative policy design models able to exploit information about policy design in ex-ante policy evaluation exercises. In order to be effective, however, this needs to be backed by an appropriate design data collection systems.

Acknowlegments

“*[text deleted to maintain the integrity of the review process]*

Annex A - Descriptive statistics for dependent and independent variables

Table A.1 Descriptive statistics of independent variables

Code	Description	Mean	Sd	min	max	n
PREFASS	1 for location in prefered area 0 else	0.31	0.46	0	1	341
PREFIDRO	1 for location in prefered area 0 else	0.31	0.46	0	1	341
PREFNAT	1 for location in prefered area 0 else	0.25	0.43	0	1	341
PREFPAE	1 for location in prefered area 0 else	0.18	0.38	0	1	341
PREFSUOLO	1 for location in prefered area 0 else	0.36	0.48	0	1	341
PLAIN	1 for location in plain 0 else	0.50	0.50	0	1	341
HILL	1 for location in hill 0 else	0.22	0.41	0	1	341
MOUNTAINT	1 for location in mountain 0 else	0.28	0.45	0	1	341
DENS_AB	Density of in-habitants (n. per square Km)	219.3	318.2	3.9	2793.8	341
COND_DIR	Percentage of farms directly conducted by farmers	91.0	8.5	8.8	100	341
ONLY_HHLAB	Percentage of farms that used only household labour on-farm	82.0	12.1	47.7	100	341
ARABLE	Percentage of farms with arable crops	73.6	20.6	0	100	341
FRUIT	Percentage of farms with fruit crops	22.5	22.3	0	94.1	341
GRAZING	Percentage of farms with grazing	26.5	30.1	0	100	341
FOREST	Percentage of farm with forest	38.9	39.2	0	100	341
LIVESTOCK	Percentage of farm with livestock	14.5	11.7	0	67.1	341
YOUNG	Percentage of farms youger than 40 years old	8.8	3.4	0.8	21.2	341
AGE_MORE65	Percentage of farms older than 65 years old	38.2	8.0	18.0	63.4	341
PARTIME	Percentage of part-time farming	58.6	13.9	24.6	95.1	341

Table A.2: Descriptive statistics for dependent variables (percent of funded farms over the total number of farms in each municipality)

	Mean	sd	min	max	n
All 214	8.4675	10.2610	0	100	341
Sub-measure 1 (integrated production)	1.0234	2.5388	0	23.2560	341
Sub-measure 2 (organic farming)	4.8410	7.0432	0	46.6256	341
Sub-measure 8 (Meadows and grazing payments)	2.3380	6.4744	0	100	341

References

Anselin L. (2010). Thirty years of spatial econometrics, *Papers in Regional Science* 89, 3-25.

Barreiro-Hurlé J., Espinosa-Goded M., Dupraz P. (2010). Does intensity of change matter? factors affecting adoption of agri-environmental schemes in Spain, *Journal of Environmental Planning and Management* 53(7), 891-905.

Bartonin F., Brunori G., Fastelli L., Rovai M. (2013). Understanding the participation in agri-environmental schemes: evidences from Tuscany Region, 53rd ERSA conference: "Regional integration: Europe, the Mediterranean and the World economy", Palermo, Italy.

Bell K.P., Dalton T.J. (2007). Spatial Economic Analysis in Data-Rich Environments, *Journal of Agricultural Economics* 58, 487-501.

Borsotto P., Henke R., Macrì M.C., Salvioni C. (2008). Participation in rural landscape conservation schemes in Italy, *Landscape Research* 33(3), 347-363.

Brady M., Irwin E. (2011). Accounting for Spatial Effects in Economic Models of Land Use: Recent Developments and Challenges Ahead, *Environmental and Resource Economics* 48, 487-509.

Broch S.W., Strange N., Jacobsen J.B., Wilson K.A. (2013). Farmers' willingness to provide ecosystem services and effects of their spatial distribution, *Ecological Economics* 92, 78-86

Capitanio F., Adinolfi F., Malorgio G. (2011). What explains farmers' participation in rural development policy in italian southern region? an empirical analysis, *New Medit* 10(4), 19-24.

Christensen T., Pedersen A.B., Nielsen H.O., Morkbak M.R., Hasler B., Denver S. (2011). Determinants of farmers' willingness to participate in subsidy schemes for pesticide-free buffer zones-A choice experiment study, *Ecological Economics* 70(8), 1558-1564.

Defrancesco E., Gatto P., Runge F., Trestini S. (2008). Factors Affecting Farmers' Participation in Agri-environmental Measures: A Northern Italian Perspective, *Journal of Agricultural Economics* 59, 114-31.

Hynes S., Garvey E. (2009). Modelling farmers' participation in an agri-environmental scheme using panel data: An application to the rural environment protection scheme in Ireland, *Journal of Agricultural Economics* 60(3), 546-562.

Jongeneel R.A., Polman N.B.P., Slangen L.H.G. (2008). Why are dutch farmers going multifunctional? *Land Use Policy* 25(1), 81-94.

Lapple D., Kelley H. (2013). Understanding the uptake of organic farming: Accounting for heterogeneities among Irish farmers, *Ecological Economics* 88, 11-9.

Lesage J.P., Pace R.K. (2009). *Introduction to Spatial Econometrics*. Chapman and Hall/CRC.

Morris C., Potter C. (1995) Recruiting the New Conservationists: Farmers' Adoption of Agri-environmental Schemes in the U.K, *Journal of Rural Studies* 11, 51-63.
Mur J. (2013). Causality, Uncertainty and Identification: Three Issues on the Spatial Econometrics Agenda, *Italian Journal of Regional Science*, 631-47. 12, 5-28.
Peerlings J., Polman N. (2009) Farm choice between agri-environmental contracts in the European Union, *Journal of Environmental Planning and Management* 52(5), 593-612.
Ruto E., Garrod G. (2009). Investigating farmers' preferences for the design of agri-environment schemes: a choice experiment approach, *Journal of Environmental Planning and Management* 52
Schmidtner E., Lippert C., Engler B., Haring A.M., Aurbacher J., Dabbert S. (2012) Spatial distribution of organic farming in Germany: does neighbourhood matter?, *European Review of Agricultural Economics* 39, 661-83.
Uthes S., Matzdorf B. (2013). Studies on Agri-environmental Measures: A Survey of the Literature, *Environmental Management* 51, 251-66.
Vanslembrouck I., Van Huylenbroeck G., Verbeke W. (2002) Determinants of the Willingness of Belgian Farmers to Participate in Agri-environmental Measures, *Journal of Agricultural Economics* 53 (3), 489-511.
Wauters E., Bielders C., Poesen J., Govers G., Mathijs E. (2010) Adoption of soil conservation practices in Belgium: An examination of the theory of planned behaviour in the agri-environmental domain, *Land Use Policy* 27 (1), 86-94.

Table(s)

Table 1 – Regional Cartography used for the management of axis 2 in RDP 2007-2013

Type of protection	Sub-measures involved	Description	Variable in the model
Absolute	All	Natura 2000 network Area vulnerable to nitrates	PREFASS
Water protection	1 – 2 – 3 – 8 – 9 – 10	Protected area for environmental characteristics of lakes, basins and streams. Protected area for superficial and subterranean water bodies. Area of protected water for human consumption. Protected area for subterranean water in foothills and plains. Protected area for subterranean water in hills and mountains. Hydrologic pertinence of drainage canals.	PREFIDRO
Nature protection	1 – 2– 8 – 9 – 10	Parks and reserves Nature protection area Faunal areas (Fauna hunting farms – Faunal Protection Oasis– Faunal production centres) Ecological network.	PREFNAT
Landscape protection	8 – 9 – 10	Area of particular landscape-environmental interest	PREFPAE
Soil protection	3 - 8	Risk of erosion	PREFSUOLO

Table 2: Results of the participation models, considering a linear regression model (OLS Method)

Variable	**All 214**	**214-sub-measure 1**	**214-sub-measure 2**	**214-sub-measure 8**
CONS	13.0174	4.2897	12.4616*	-2.9120
PREFASS	**4.3047*** **	**0.9297*** **	0.4710	**2.4660*** **
PREFIDRO	-1.8020	-0.5414	-0.6447	-0.2928
PREFNAT	-0.7995	-0.4340	**-2.4242*** **	**2.2028*** **
PREFPAE	1.4905	-0.0455	**2.0256** **	-0.4516
PREFSUOLO	-0.2204	0.4867	-0.2576	-0.1884
PLAIN	-9.8394	-0.2432	-8.4111	-1.3251
HILL	-8.1707	0.0043	-7.0536	-1.2984
MOUNTAIN	-6.7816	-1.1080	-6.1824	0.3295
DENS_AB	**-0.0029* **	**-0.0010** **	-0.0011	-0.0004
COND_DIR	-0.0879	0.0054	-0.0691	-0.0309
ONLY_HHLAB	**0.1050* **	0.0172	0.0570	0.0279
ARABLE	**-0.0796** **	**-0.0221** **	-0.0084	**-0.0514** **
FRUIT	0.0303	0.0022	**0.0381** **	-0.0043
GRAZING	-0.0018	0.0023	**-0.0325* **	0.0283
FOREST	**0.0852*** **	-0.0085	**0.0979*** **	-0.0026
LIVESTOCK	**0.1245* **	**-0.0583*** **	**0.1204*** **	0.0769
YOUNG	0.2521	0.0661	-0.0760	0.1887
AGE_MORE65	0.0195	0.0147	-0.0446	0.0480
PARTIME	0.0072	**-0.0533*** **	-0.0078	0.0727
R^2 adjusted	0.3680	0.2150	0.4469	0.1907
Log likelihood	-1189.27	-759.804	-1038.25	-1074.43

Note: Single, double, and triple asterisks indicate significance at the 10, 5, and 1 percent level of significance.

Table 3: Results of the participation models, considering a spatial lag model

Variable	**All 214**	**214-sub-measure 1**	**214-sub-measure 2**	**214-sub-measure 8**
CONSTANT	14.0261	3.6916	**11.4725***	0.6823
PREFASS	**3.4612*****	0.4070	0.2353	**1.8907*****
PREFIDRO	-1.5096	-0.1493	-0.6430	-0.1669
PREFNAT	-0.5706	-0.2032	**-1.9573*****	**1.7176****
PREFPAE	1.2625	-0.0528	**1.7565****	-0.4359
PREFSUOLO	-0.6406	0.3600	-0.6497	-0.2694
PLAIN	-9.0208	-0.2611	-6.6975	-2.4023
HILL	-7.2658	0.1415	-5.4062	-2.2714
MOUNTAIN	-5.9619	-0.6989	-4.6015	-0.8809
DENS_AB	-0.0024	**-0.0006****	-0.0009	-0.0003
COND_DIR	-0.0816	0.0006	-0.0687	-0.0134
ONLY_HHLAB	**0.0955***	0.0038	0.0514	0.0285
ARABLE	**-0.0888*****	**-0.0187****	-0.0136	**-0.0605*****
FRUIT	0.0174	-0.0014	**0.0275***	-0.0092
GRAZING	-0.0143	0.0009	**-0.0333****	0.0102
FOREST	**0.0656*****	-0.0031	**0.0782*****	-0.0113
LIVESTOCK	**0.1190***	**-0.0364****	**0.1012****	0.0750*
YOUNG	0.2353	0.0406	-0.0255	0.1131
AGE_MORE65	-0.0164	0.0154	-0.0453	-0.0169
PARTIME	0.0117	**-0.0381****	-0.0112	0.0733
ρ	**0.2389*****	**0.5607*****	**0.2757*****	**0.3996*****
R^2	0.4256	0.3985	0.5070	0.3125
Log likelihood	-1184.7800	-726.9450	-1031.1100	-1062.2900

Note: Single, double, and triple asterisks indicate significance at the 10, 5, and 1 percent level of significance.

Table 4: Results of the participation models, considering a spatial error model

Variable	**All 214**	**214-sub-measure 1**	**214-sub-measure 2**	**214-sub-measure 8**
CONSTANT	16.5613	**4.3760***	10.8363	5.2333
PREFASS	**2.4189****	0.2443	0.0548	0.8757
PREFIDRO	-0.7178	-0.0506	-0.4862	0.5896
PREFNAT	-0.5491	-0.1589	-1.7659**	0.9194
PREFPAE	1.2325	-0.0272	**1.8242****	-0.4529
PREFSUOLO	-1.3801	0.2867	-0.9645	-0.6753
PLAIN	-6.8951	0.0898	-4.8672	-3.0182
HILL	-4.7557	0.5566	-3.5826	-2.3294
MOUNTAIN	-3.2362	-0.2251	-2.5001	-1.2522
DENS_AB	-0.0021	-0.0006	-0.0010	0.0003
COND_DIR	-0.0261	0.0076	-0.0557	0.0471
ONLY_HHLAB	0.0788	-0.0073	0.0492	0.0224
ARABLE	**-0.1341*****	**-0.0156***	-0.0274	**-0.1089*****
FRUIT	0.0037	0.0016	0.0244	-0.0294
GRAZING	-0.0340	-0.0039	**-0.0340****	-0.0181
FOREST	**0.1003*****	**-0.0056****	**0.1055*****	0.0104
LIVESTOCK	**0.1444****	-0.0422	**0.1003****	**0.1234****
YOUNG	0.1297	0.0338	-0.0254	-0.0707
AGE_MORE65	-0.0854	0.0112	-0.0410	**-0.1233****
PARTIME	0.0081	-0.0383	-0.0274	**0.0920****
λ	**0.3572*****	**0.5954*****	**0.3082*****	**0.5752*****
R^2	0.4359	0.3936	0.5064	0.3548
Log likelihood	-1184.3116	-730.208	-1032.01	-1058.89

Note: Single, double, and triple asterisks indicate significance at the 10, 5, and 1 percent level of significance.

Figure(s)

Figure 1: Exemplary illustration of selection process (stars, square dots and circles refer to different hypothetical populations with different distributions)

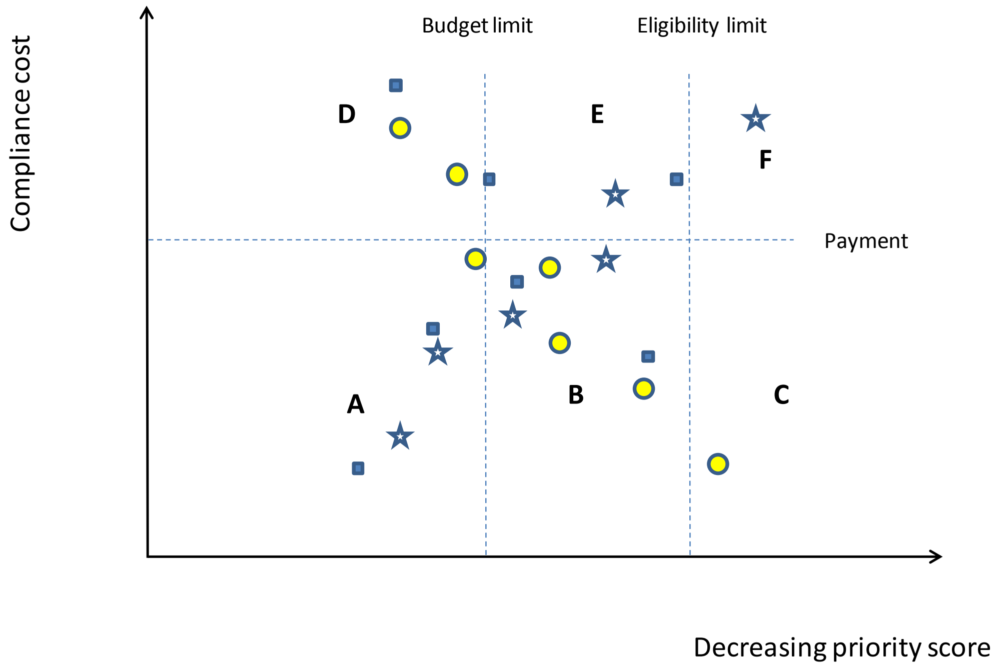

Figure 2: Spatial distribution for measure 214 and sub-measures

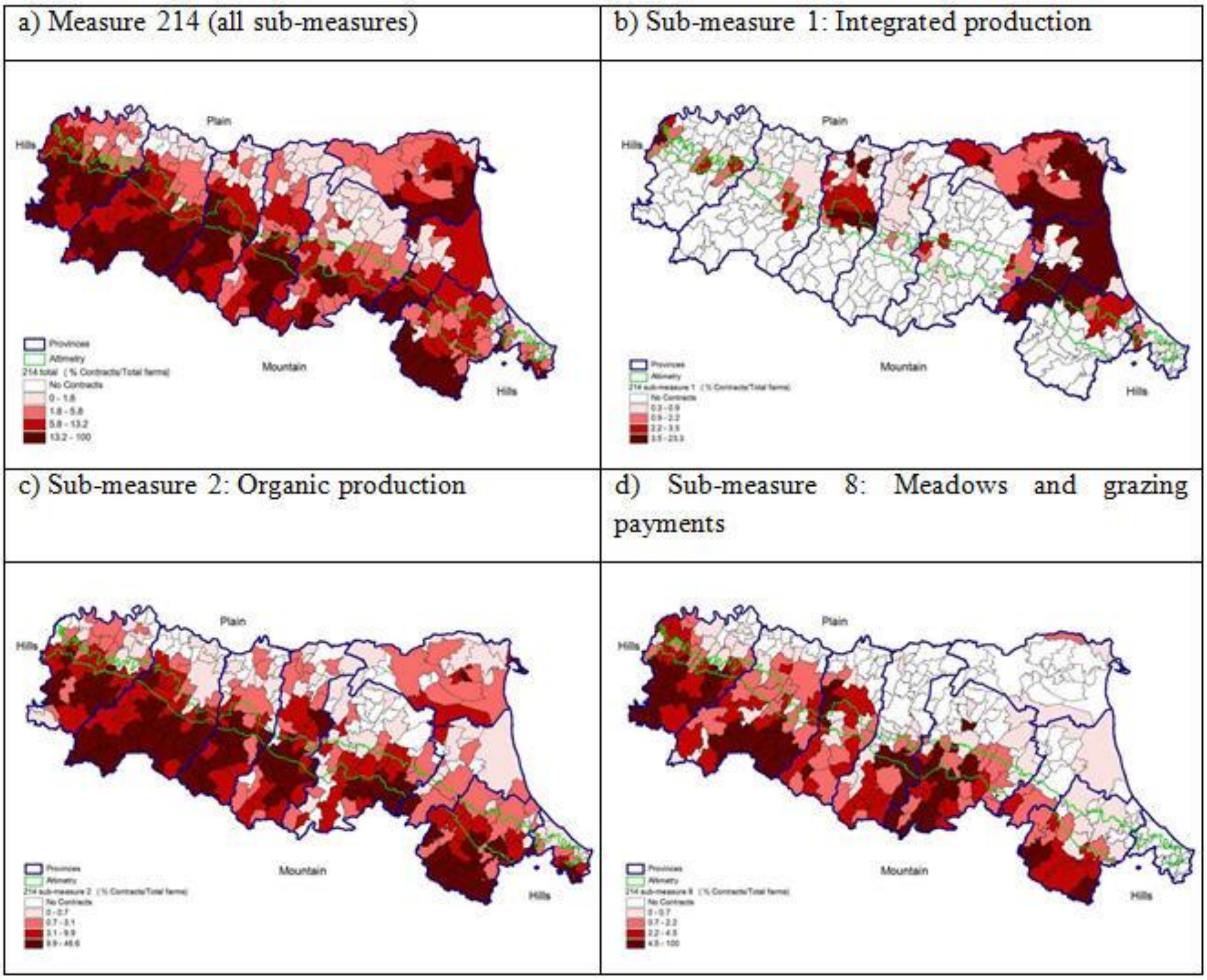

Figure 3: LISA Cluster Map and Moran's I for measure 214 (all sub-measures)

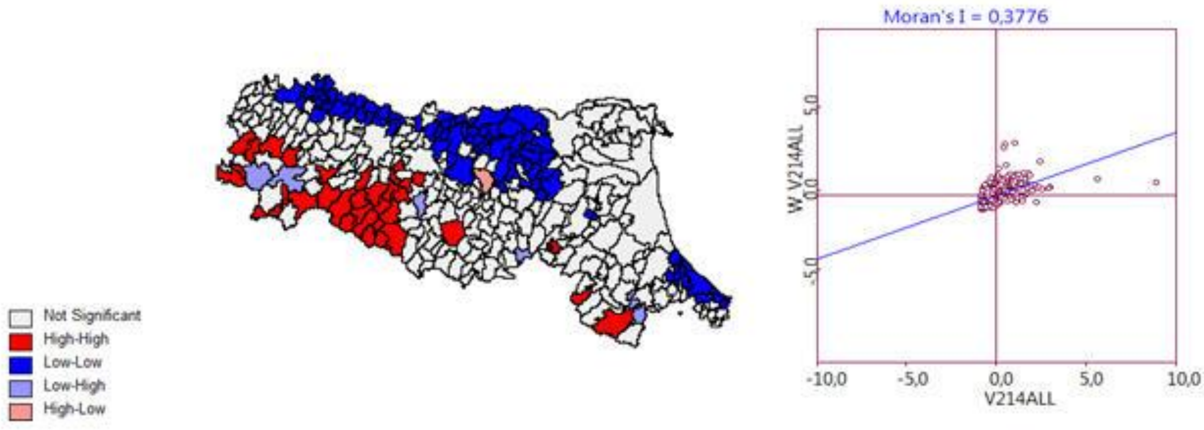

Figure 4: LISA Cluster Map and Moran's I for measure 214 (sub-measure 1)

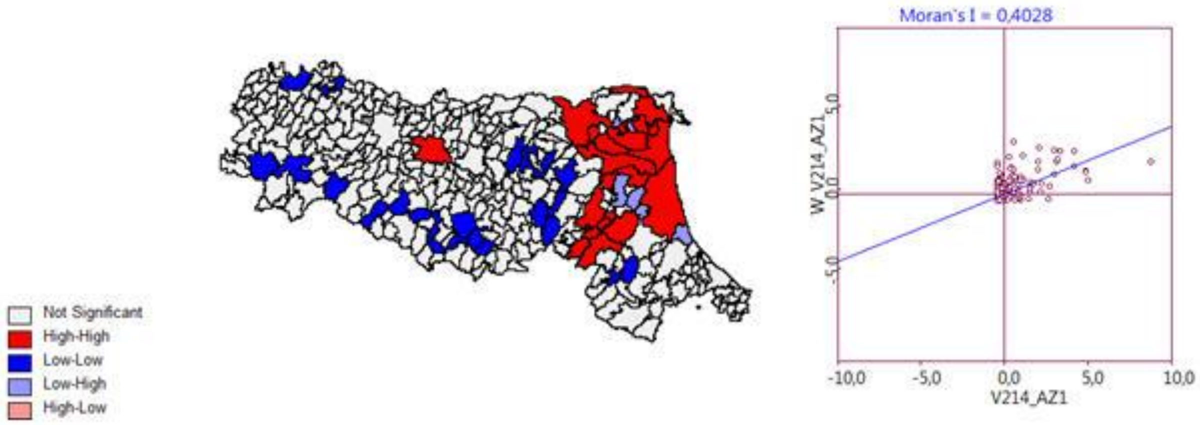

Figure 5: LISA Cluster Map and Moran's I for measure 214 (sub-measure 2)

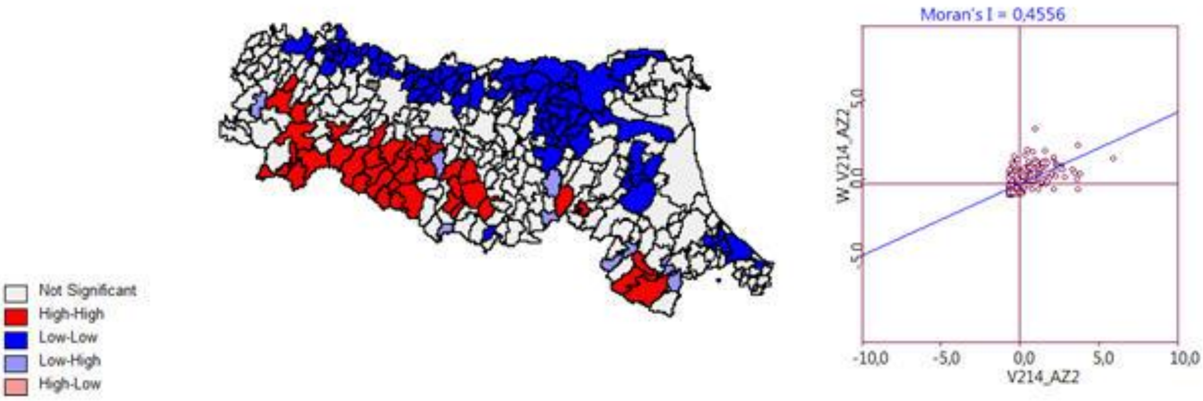

Figure 6: LISA Cluster Map and Moran’s I for measure 214 (sub-measure 8)