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Optimal targeting and payment design for Agri-Environmental Measures: A resource allocation model for Emilia Romagna (Italy)

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Abstract

The European Agri-Environmental Measures (AEMs) account for more than half of the rural development budget of the Common Agriculture Policy. Several factors influence the effectiveness of these measures, within which the poor spatial target is still a major concern. Improving the spatial targeting of these policy tools could improve their cost-effectiveness and support better policy design solutions. The objective of this paper is to develop an optimization model for the AEMs jointly aiming at optimal targeting and payment setting with a focus on resource and incentive compatibility differentiated by zone. Moreover the model tests the potential for integration of information coming from spatial analysis of participation to AEMs whithin mathematical programming at regional level. The model is used to simulate the potential contribution of spatially differentiated compensation payments to efficient targeting of sub-measure 214.1 in Emilia Romagna (Italy). Results highlight that the differentiated payment scheme allows a significant cost saving over flat rate mechanism by reducing farmers' rents and consequently the deadweight loss for cost effectiveness of the measures. The method used, which improves the acknowledgement of the spatial information, may have a potential for the design process of Agri-Environmental Schemes (AES) and support better policy design solution.

Keywords: Agri-environmental policy, compensation payments, economic efficiency, spatial econometric, mathematical programming.

JEL Classification codes: Q18; Q58

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1. INTRODUCTION

The EU Agri-environmental measures (AEMs) may be seen as an example of payments for environmental services (PES) in which the public administration supports farmers to provide environmental goods and eco-system services. Since the Common Agricultural Policy (CAP) reform in 1992, the EU has increased its support[1] to encourage sustainable resource use and to develop environmentally-friendly farming practices. Moreover, this major shift in EU policy has emphasized the importance of sustainable and integrated rural development which is largely based on AEMs as a determinant of the production of environmental goods and landscape services. These measures, based on a subsidiarity principle under Council Regulation (EC) 1698/2005, are part of voluntary schemes designed by the local administration to address specific agricultural, natural and cultural issues. Voluntarily, the farmers commit themselves for a five year period to adopt agricultural management practices that reduce environmental risk or preserve the cultivate landscape (Uthes et al., 2010). In return they receive by the national/regional administration an AEMs payments as an incentive to participate. The payment is justified by the additional costs and/or loss of income (plus transaction costs) that the farmer has to bear due to the uptake of the measure (DG Agriculture and Rural Development, 2005).

However, despite their importance, various types of inefficiency are deemed to affect these measures. The limited information about measure and the high administrative burden causes difficulties for farmers to access and use properly the funds, while the absence or lack of monitoring on farmers' commitments may allow cases of cheating over the prescriptions of the measures. Moreover the lack of information about actual compliance cost regards the cases of the public administration which has a lack of information about farmers' compliance costs resulting in a miscalculation of the payments. When the offered payment is below the farmers' participation cost, according to Engel et al. (2008) this payment is insufficient to induce the adoption of environmentally-friendly farming practices. In the opposite cases, when the payment is greater than the actual compliance cost, it can generate a surplus for the farmer. In those cases, the presence of information asymmetries about compliance cost, between the regulator and the farmers, does not allow the regulator to set a proper level and differentiation of payment and generating high profits for all those farmers who have to cover lower compliance cost than the flat rate payment. Also the absence of spatial targeting, resulting from a lack of knowledge about the main local needs and environmental vulnerability, can

[1] AEMs account for more than half of the rural development budget of the Common Agriculture Policy and are the most important examples of payments for environmental services (Uthes et al., 2010). Moreover average data published by the EU for the period 2000-2003 show that in Italy the national agri-environment spending for 2000-2003 is more than 60% of the Rural development budget.

determine cases of payments directed to practices that would have been adopted anyway, generating the wasteful use of public resources. Moreover, the poor spatial targeting occurs when this measures are applied uniformly throughout the local space, failing to take account of areas in where the environmental benefits are lower than the high implementation costs. In those cases Uthes et al. (2010) identify the poor spatial targeting as a major cause of low effectiveness of AEMs, while the rationale of spatial targeting applying conservation measures is that environmental effects can be provided at a lower cost when applied on the most vulnerable land parcels. To improve the targeting of this measure focusing on the main local concerns, the local administration needs to set and identify zoning and target policies. However, this process entails higher public transaction costs and lead to greater administration efforts, as compared to a lower targeting effort.

To improve the efficiency of such measures in this paper we develop an optimization model jointly aiming at optimal targeting and payment setting with a focus on resource and incentive compatibility differentiated by zone, building on participation functions generated from a previous spatial econometric analysis. Moreover the objective is to provide a methodology that allows the integration of the information coming from spatial analysis of participation to AMEs into a mathematical programming model at regional level.

This is a rather new methodology from the literature on optimization of RDP measure which aims to overcome the limitations of programming models in contributing to a better design of payments, due to the lack of appropriate and readily usable information about the actual costs differentiation and willingness to participate. In addition, the literature behind programming and simulation models is often limited to the assumption of profit maximisation which is based only on economic information, e.g. revenues and costs from accounting data. More complex phenomena, i.e. a wider range of determinants of participation, such as distance, the location, the agglomeration and the neighbourhood effects, are instead considered by ex-post analyses of participation to AES through econometric models (Midmore et al., 2001; Padel, 2001; Pietola and Oude Lansink, 2001; Kerselaers et al., 2007, Defrancesco et al. 2008). A developing branch of such literature, i.e. spatial econometrics, also accounts for downstream effects such as spill-overs (Schmidtner et al., 2012). Other literature recognizes that agglomeration effects resulting from the presence of local markets and institution can facilitate the acquisition of information and the implementation of Agri-environmental commitments by reducing transaction costs. However, to the best knowledge of the authors, the literature provides no example of the use of the information provided by these instruments in programming models for optimal policy design. This is not surprising as one of the main problems encountered in econometric models is the lack of explanatory variables related to policy design, which would yield the main link to ex-ante analysis.

Moreover, the developed model simulates the potential contribution of spatially differentiated compensation payments to efficient targeting of sub-measure 214.1 (Integrated Production) in Emilia-Romagna (ER), taking into account that both the costs and the compensation payments are subject to spatial variation. On one hand, this approach requires the determination of the total compliance cost of AEMs, which is known to be rather difficult to obtain. In order to overcome this problem, a function of marginal compliance cost of participation to RDP sub-measure 214.1 is taken from a previous study, which allows us to model farmers' economic behaviour in participating to Integrated Production measure. On the other hand, through this analysis it is possible to highlight the territorial consequences of differentiated payments through zoning on farmers' participation to the programme. A cost-effective implementation of AEMs, which is relevant for the allocation of funds for rural areas, needs different ways of setting the compensation payments.

The paper outline is the following: section 2 describes the background literature about targeting, payments setting of participation to AEMs. Section 3 describe the methodology adopted, followed in section 4 by the results of a case study. The paper ends in section 5 with some discussion and concluding remarks.

2. TARGETING, PAYMENT SETTING AND PARTICIPATION ISSUE OF AEMS

The decentralized design of RDP implies that each local administration is in charge of setting and identifying target and zoning policies, in order to better design the measures with focus on the main local concerns. Often this process entails higher public transaction costs and lead to greater administration efforts. A reasonable improvement has to be evaluated comparing the transaction costs associated with factors such as additional data needs and changes in administrative procedures (Wünsher et al., 2006). The RD literature of targeting issues concerns a set of different priority or eligibility criteria applying to the measures mainly based on population density or the amount of inhabitants of the municipalities. Uthes et al. (2012) distinguish different approaches to targeting mechanism, which range from relatively simple approaches based on benefit, cost targeting, eligibility criteria only, to more complex and selective targeting mechanism based on zoning policies, or scoring systems. In the case study region the local administration of Emilia-Romagna (ER) has set a territorial priority to the Less Favourable Areas (LFA), which follows the application of EU directives (Natura 2000, WFD, Nintrate Directive; etc.), that determines through a scoring system, assigned by the various provinces of ER, the selection of applications for participation to the measures presented by the farmers.

Many factors could influence the choice for a particular targeting approach, such as administration costs, budget availability, spatial variability in terms of benefits and costs, but once identified the target areas, the regulation must be accompanied with the provision of an adequate system of incentives since the purpose is to encourage farmers' participation to the RDP. For example, measure 214 of RDP Emilia-Romagna, introduces compensatory payments targeting to farms in areas affected to nitrogen pollution to achieve the environmental objective of encouraging organic production and reduce nitrogen pollution. By this way farmers commit themselves to adopting organic farming or less resource-intensive farming practices. In return, they receive payments that compensate them for additional costs and loss of income (DG Agriculture and rural development, 2005). However it is also possible that the regulator uses the targeting mechanism to exclude some participant to the application. This case happens when the number of applications to participate exceeds the available budget, so the regulator uses the targeting to select among applicant sites to maximize the program's financial efficiency (Engel et al., 2008).

To incentive the farmer to adopt Agri-environmental measures, the payments must be high enough to cover compliance cost but also should prevent farmers' rents and consequently the deadweight loss of effectiveness for the measures. The literature from AE payments recognizes the possibility to introduce a differentiated payment policy in order to reduce the farmer's surplus. Wätzold and Drechsler (2005) discuss the possibility of spatially heterogeneous compensation payments for biodiversity-enhancing land-use measures. Their results show that the cost-effectiveness of uniform payments may be low and depending on the assumption on the variability of cost and benefit function and on the correlation between them. The costs of Agri-environmental measures such as biodiversity-enhancing land-use measures clearly differ because of the variations in soil quality, the opportunity cost for land, and the availability of equipment to carry out such measures, while different levels of benefit may due to different habitat quality (Wätzold and Drechsler, 2005). Other works have studied the issue of spatial differentiation of environmental policy instruments by analyzing the efficiency losses with spatial uniform regulation (see e.g. Kolstad, 1987; Babcock et al., 1997; Ferraro, 2003; Johst et al., 2002). These studies, focusing on biodiversity conservation, try to incorporate the ecological and economic knowledge into the evaluation of conservation instruments through an estimation of biodiversity benefit function. Their findings seem to confirm, the opinion of efficiency losses with uniform payments policy and the need of alternative payment mechanisms that consider heterogeneous costs.

However it is very difficult for the administration to know the different compliance costs and it could involve high administrative effort. For this reason, the actual payments are designed on the basis of average compliance costs as uniform between different areas and targets. Anyway, also in this case the correct average is not necessarily known to the regulator. A branch of the economic literature on AES has analysed the efficiency of flat rate compensation schemes based on average costs compared with the possibility of introducing other mechanisms, including auction mechanisms and menus of contracts, to reveal farmers' marginal compliance costs, in order to reduce information rents and increase policy cost-effectiveness (Stoneham et al., 2003; Schilizzi and Latacz-Lohmann, 2005; Glebe, 2008).

A more cost-effective policy design requires a consistent combination of policy instruments, connected payments levels and differentiation, as well as monitoring (Bazzani and Viaggi, 2004). Indeed alternative ways of setting the payments could be closer to the actual compliance costs of heterogeneous farmers differentiated by zone thus the payments should be able to provide incentives to participate, while reducing as much as possible farmers' rents. With the objective of maximize participation in these specific zones, measured by the degree of uptake, the whole effect of this kind of policy instrument would be a screening, restricting participants to only those having cost below the resulting payment. However, more precise instruments imply a greater degree of information about compliance costs on the part of public decision maker. This is not completely unrealistic if measures are targeted to some specific area (e.g. ER LFA areas, mountain, hill, plain) that is also characterised by compliance costs different from the average (Viaggi et al., 2008).

3. METHODOLOGY

This paper provides a methodology that allows the integration of the information coming from spatial analysis of participation to AEMs into a mathematical programming model focused on incentive compatibility at regional level. The methodology is based on the maximisation of participation rate of AEMs (focusing on area-related measures, such as sub-measure 214.1) under resource (public funds) and participation constraints.

The method is based on the assumption that the area targeted by the measures has different characteristics in term of farmers' compliance costs. As a consequence, it is defined three hypothetical areas (mountain, hill, plain), where payments change taking into consideration the different compliance costs. Moreover, it is also assumed that the regulator knows of the existence and the characteristics of the different types of farmers, as compliance costs of each type, and the proportion of each type in the population, but cannot identify individual compliance costs (Bartolini et al., 2007). As a reference, however, it is also considered the possibility that the regulator is informed about which type each individual famer belongs to determining the theoretical reference point of first best solution.

Moreover it is assumed that the Public Administration objective is to maximize participation, measured by the degree of uptake (DU), without consideration, for example, to the value of different environmental services produced by different farmers. The type of instrument considered is the classical rationality incentive constraint given by the comparison between the payments level offered to farmers for participating to the RDP programme and the compliance costs.

With these hypotheses, given a fixed value of the available budget ($\mathbf{B}$) it is assumed the public administration will maximize the area under contract (x_i):

$$Max$$

$$DU = \sum_{i=1}^{I} x_i$$

Subject to:

$$\sum_{i=1}^{I} \rho_i x_i \leqslant B$$ Budget constraints

$$\rho_i - \theta_i \geq 0$$ Rationality Constraints

$$\theta_i = C(x_i)\left(1 - \sum_{k=1}^{K} r_{k,i}\right)$$ Participation Cost function

$$x_i \leq S_i$$ Area constraints

$$x_i \geq 0 , \rho_i \geq 0, \theta_i \geq 0$$

Where:

$\mathrm{i} = 1, 2, \ldots, \mathrm{I}$ denote an index for various area type, and ρ_i the marginal payments per hectare in each area type.

The rationality constraints allows the model to minimize the farmers' rents. In this equation θ_i is the participation cost function (EUR/ha) which is composed by the product of the distribution function of average regional participation cost $C(x_i)$ and a parameter of the willingness to accept the payments for sub-measure 214.1 based on the estimation of participation $\sum_{k=1}^{K} r_{k,i}$.

$k = 1, 2, \dots, K$ denotes the variables representing farm characteristics and features included in the spatial regression model following Breustedt and Habermann (2011), where $r_{k,i}$ is the dependent variable of the spatial lag model:

$$r_{k,i} = \rho W_1 r_{k,i} + Y_{k,i} \beta_k + \varepsilon \qquad \text{(Spatial Regression Model)}$$

with

$$\varepsilon \sim N(0, \sigma^2 I)$$

While I denote the identity matrix (an n x n matrix with 1s on the diagonal and zeros everywhere else) and $N(0, \sigma^2 I)$ indicates that the errors are distributed normally with a constant variance and that the cross products of the error covariance matrix are 0.

Under the assumptions that ρ=0 there is no spatial dependence, and then the spatial model could yield a standard linear regression model (OLS), which as has been mentioned above constitutes the econometric part used in the Model 1; if ρ≠0 then the equations return a spatial lag model, that has been used for Model 2.

Therefore, in Model 2 is expected that the econometric component taking into account the presence of spatial heterogeneity and spatial dependence effects (Anselin, 1988; Schmidtner et al., 2012) between the variables that influence the choice of participation in the measure, determining differences in participation costs across areas.

$r_{k,i}$ express the estimated participation to sub-measure 214.1 in terms of percent of participating farms per municipalities. In the regression model $Y_{k,i}$ denotes a vector of variables representing farm characteristics related to farm location, such as municipalities (i), socio-economic (i.e. age, UAA, level of instructions, etc.) and institutional factors (i.e. LFA, regional priorities, etc.). Moreover, the $\beta_1, \beta_2, \dots, \beta_k$ are the estimated coefficients of the regression model in VIAGGI et al., 2012.

In participation cost function, the parameter $\left(1 - \sum_{k=1}^{K} r_{k,i}\right)$ express the willingness of accept the payments. Multiplying this parameter by the distribution function of average regional participation cost $C(x_i)$, it determines the participation cost $\theta(x_i)$. A low willingness to accept the payment is determined by a high level of participation in the measure which results from a low level of participation cost. Vice versa a low level of participation is assumed to hint at high participation cost and determine a high level of payments which is required by farmers to participate. This solution derives from the assumption that the willingness to accept the payments operates as a linear parameter, influencing the slope and height of the average marginal cost function.

4. CASE STUDY AND RESULTS

The methodology described in the previous section has been implemented through a simulation exercise carried out for RDP ER Axis 2, sub-measure 214.1 (Integrated Production).

The Emilia Romagna has an heterogeneous territory in which there is also a part of hill and mountain and is located in the highly productive, densely populated and industrialized Po valley (northern Italy). With a total area of more than 2.2 million hectares, in 2007, the utilized agricultural area (UAA) was nearly 1.1 million hectares with an average of 12.8 ha per farm, with a total of approximately 82,000 farms. The UAA is about the 47.6 percent of the entire area of the region, and this is for this reason that Emilia-Romagna region has the highest percentage of utilized agricultural area between the Italian regions, even higher than the national average (42.3 per cent), while among the top in European regions. The total UAA considered in the analysis is 1 million hectares which is divided into 649,047.53 ha for plain, 218,617.47 ha for hill and 244,332.52 ha for mountains, according to the Regional Landscape Territorial Plan which identity the various areas of "plain", the "hill" and "mountain". This zones are an expression of the specific Agri-environmental sensitivities which for the regional public administration constitute the prerequisite for implementing the entire strategies provided for Axis 2 of Rural Development Program.

The analysis was conducted through two version of the model. The first one, which will be named as Model 1, does not contain in the econometric part any spatial information and it representing a term of comparison for the Model 2 which is based on spatial lag model.

Measure 214 is organized in several sub-measures in Emilia-Romagna which target different environmental objectives and areas. This measure covers a substantial part of the RDP budget: in 2010 the share of public resources is about the 30 percent of the entire RDP, with total budgetarty resources of approximately 295,962,544 EUR (Regione Emilia-Romagna, 2010). Taking note of the financial resources used in the RDP ER 2007-2013 for measure 214 from Regione Emilia-Romagna (2010) interim evaluation report, it was chosen to simulate the programming period 2007-2013, setting a budget for the model in the order of magnitude of this amount of public resources. More in detail, an amount of public resources for sub-measure 214.1 that varies in the range from 0 to 27,500,000.00 EUR. This budget level can covers the entire program period including any carry-over in the following years and it has been chosen in order to perform a wide sensitivity analysis.

Viaggi et al. (2012) show how the distribution of the participation (percent of participating farms per municipality) is differentiated in the plain area and in the hill-mountain area, the results are different considering the whole measure or single specific sub-measure. For the whole measure 214 the uptake in 2010, net of carryover from the old program, was about the 49 percent of UAA for the plain area, the 14 percent of UAA for hill area and 25 percent of UAA for mountain. Moreover, the distribution of participation of the whole measure 214 also differs across municipalities with some spatial agglomeration that partially follows the regional zoning system as well as the targeting policies previously described. In this spatial characterization the sub-measure 214.1 (integrated production) is mainly located in the plain areas of Emilia Romagna, characterised by large share of fruit production (eastern part of the region).

Data for the distribution function of average regional participation cost $C(x_i)$ (EUR/ha) are taken from Viaggi et al. (2008). This function is derived from FADN data, and the formulation used is:

$$C(x_i) = 1415.2x_i^3 - 1670x_i^2 + 701.9x_i \qquad \textit{Marginal Cost function } C(i)$$

which is based on the same calculation used for the estimation of compliance cost for integrated production measure, in the justification of payments[2] for the RDP Emilia Romagna 2007-2013. Moreover, it composes a part of the marginal cost function of the optimization problem and it is a monotonically increasing third degree function. While the cost function in Viaggi et al. (2008) has been applied to the cumulative UAA of the whole region, in this paper it has been parameterized to be applied in the range from 0 to 1, on each municipality's area. This operation was done to be able to adapt and homogenize this function to the different level of analysis of this study. Moreover, it allows to consider the compliance cost of participating to sub-measure 214.1 as a distribution function of average regional participation cost to be applied in each municipality.

The results are summarized in the four tables below considering the two hypothesis about the regression model (model 1, the linear regression and model 2, the spatial lag model). Table 1 shows the results considering model 1 (linear regression model) as the econometrically-derived component of the cost function. As expected, an increase in the available budget reflects a growth in the degree of uptake. Also the share of UAA on the different zones is growing, but at different ratios depending on marginal costs and payment in combination with the variables which influence more the participation from the regression model. In other words, the different degree of participation in the measure for the target areas indicate a different profitability/attitude of farmer to participate beyond a certain level of budget depending on the different compliance cost and characteristic of farms of each zone.

Table 1. Results of Participation Model 1

Budget (EUR)	Marginal cost (EUR/ha)			Average Marginal payment (EUR/ha)	Plain (ha)	Hill (ha)	Mountain (ha)	DU total (ha)	DU/UAA (%)
	Plain	Hill	Mountain						
0	0	0	0	0	0	0	0	0	0
1,000,000.00	38.82	38.00	37.99	38.60	24803.13	178.34	144.71	25126.2	2.2
5,000,000.00	83.18	74.03	73.99	77.17	59329.38	348.07	282.22	59959.68	5.3
10,000,000.00	111.51	92.10	92.05	98.55	89022.56	433.47	351.33	89807.38	8.0
15,000,000.00	129.83	100.29	100.22	110.11	114868.55	472.17	382.63	115723.37	10.3
27,500,000.00	155.84	102.13	102.06	120.01	175890.07	480.90	389.69	176760.67	15.8

Source: own elaboration

Table 2 shows the results using Model 2 (spatial lag model) as the econometrically-derived component of the cost function. Also in this case is highlighted the concentration of participation to the plain area which has the main share on the total of DU (ha) for each budget level. Moreover the marginal costs (and consequently the payments) are higher than the value of marginal costs obtained from the previous model and therefore the share of uptake is lower.

Table 2. Results of Participation Model 2

Budget (EUR)	Marginal cost (EUR/ha)			Average Marginal payment (EUR/ha)	Plain (ha)	Hill (ha)	Mountain (ha)	DU total (ha)	DU/UAA (%)
	Plain	Hill	Mountain						
0	0	0	0	0	0	0	0	0	0
1,000,000.00	174.08	173.34	173.32	173.58	4327.93	681.38	741.09	5750.43	0.5
5,000,000.00	386.42	382.58	382.49	383.83	9803.13	1517.7	1650.06	12970.91	1.1
10,000,000.00	543.43	535.56	535.38	538.12	14002.85	2139.04	2324.92	18466.81	1.6
15,000,000.00	662.67	650.62	650.36	654.55	17295.27	2612.11	2838.45	22735.84	2.0
27,500,000.00	889.57	866.61	866.12	874.10	23774.36	3513.90	3816.67	31104.95	2.7

Source: own elaboration

In table 3 and 4 below, the differences (surplus) between the total cost function and the total payment for the two model for the three areas (plain, hill, mountain) are reported. The estimation of the total cost function for sub-measure 214.1 is achieved by calculating the integral of the marginal cost function, which is a 3rd degree cost function derived from a previous study, combined with the regression model.

Table 3. Deadweight loss (surplus) in Model 1

Budget (EUR)	Plain			Hill			Mountain		
	Total Payment	Total Cost	Surplus	Total Payment	Total Cost	Surplus	Total Payment	Total Cost	Surplus
0	0	0	0	0	0	0	0	0	0
1,000,000.00	987,723	509,476	478,247	6,777	3,391	3,386	5,498	2,750	2,748
5,000,000.00	4,953,349	2,675,191	2,278,158	25,768	12,900	12,868	20,882	10,450	10,432
10,000,000.00	9,927,732	5,590,376	4,337,356	39,927	19,995	19,932	32,340	16,188	16,152
15,000,000.00	14,914,296	8,720,588	6,193,708	47,355	23,718	23,637	38,348	19,197	19,151
27,500,000.00	27,411,110	17,542,132	9,868,978	49,116	24,601	24,515	39,772	19,911	19,861

Source: own elaboration

The differences in the cost level between the three areas is reflected in a different weight of the surplus. In both Hill and Mountain areas the ratio between the surplus and the payment is about the 50% while in the plain area is slightly lower, it is about the third part (33%) of the surplus. Table 4 below show the same results for model 2 with a surplus which is approximately equal to the costs.

Table 4. Deadweight loss (surplus) in Model 2.

Budget (EUR)	Plain			Hill			Mountain		
	Total Payment	Total Cost	Surplus	Total Payment	Total Cost	Surplus	Total Payment	Total Cost	Surplus
0	0	0	0	0	0	0	0	0	0
1,000,000.00	753,434	378,724	374,710	118,114	59,203	58,911	128,451	64,380	64,071
5,000,000.00	3,788,197	1,917,170	1,871,027	580,652	291,937	288,715	631,150	317,280	313,870
10,000,000.00	7,609,679	3,871,516	3,738,163	1,145,589	577,287	568,302	1,244,731	627,112	617,619
15,000,000.00	11,454,472	5,851,823	5,602,649	1,699,506	857,912	841,594	1,846,020	931,624	914,396
27,500,000.00	21,149,059	10,894,435	10,254,624	3,045,203	1,542,360	1,502,843	3,305,736	1,673,702	1,632,034

Source: own elaboration

5. DISCUSSION

This paper provides an exploratory attempt to use econometric estimated information within an optimal targeting model. The model shows the possibility to improve the targeting of AEMs by modelling farmers' economic behaviour in participating to scheme 214.1 and it offers an alternative approach to the design of payment mechanism, based on differentiated payments instead of the classical flat rate payments. The results from the optimization problem also confirm/exploits the hypothesis of heterogeneity in cost and payment functions which could depend on location, type and farmers' characteristics. This also confirms the findings of Drechsler and Wätzold (2005) and Viaggi et al. (2008) about the efficiency losses for AEMs associated with the uniform payment mechanism. In this way, the model which consider both the costs and payments spatially heterogeneous may lead to a more efficient allocation of funds for Agri-environmental measures. Moreover the additional information given by the econometric analysis allows the model to explain with some neighborhood effects the different influence in the uptake ratio between zone.

The model used in this paper, while reflects a number of plausible assumptions, also remains rather simplified and could be improved in the further research. The main weakness of the approach rests in the fact that the econometric information was particularly poor in terms of effect of policy design parameters (in particular payments), due to the limited range of payment observation. Also prioritisation was only tentatively modelled. Due to this, a participation cost function, the ideal input one would expected for this type of model, was not available. Hence, in this paper we used an approximate coefficient derived from spatial econometrics to correct an exogenously derived cost function.

In addition, while the spatial correlation term was used in the econometric analysis, it was not in the optimisation model, which hence used a somehow more limited information than potentially available from the models. Another point was that a meaningful empirical functional form for compliance costs in the area was not "well behaving" in terms of sought economic properties for a cost function, which yielded difficulties in managing the model from a numerical point of view.

The model can be improved on several other grounds, particularly considering the complexity of factors which affect participation and the difficulties to model hidden transaction cost.

However the results confirm the relevance of a Policy design related to connected payments or in the case of the Emilia Romagna Region to explicit policy priorities (targeting and zoning system). Also the factors related to farmers' characteristics, features and institutional factors, included in the model with the regression term, play a role in encouraging participation and stressing the different structure of compliance cost which depends to the location and to those spatial characteristic. The study highlighted the importance of spatial differentiation to explain the determinants of farmers' participation to AEMs schemes and the relevance of considering this differentiation in optimisation tools searching for optimal incentive-compatible targeting.

6. CONCLUDING REMARKS

This paper focuses on developing an optimization model jointly aiming at optimal targeting and payment setting with a focus on resource and incentive compatibility differentiated by zone. It also investigates the use of spatial econometric information within mathematical programming to support the design of AEMs policies, in particular concerning spatial targeting and payment differentiation.

Based on the importance of spatial differentiation to explain the determinants of farmers' participation to AEMs schemes, the paper highlights the relevance of considering such differentiation in optimisation tools searching for optimal incentive-compatible targeting. The overall message goes in the direction that further improvements are possible in efficiency of AEMs. Such improvements would require a consistent development of implementation data collection, data analysis and ex-ante policy design and evaluation.

The discussion also showed the weaknesses of this approach in the current form. Despite this limitation, due mainly to data availability, the analysis showed the potential in contributing to the design process of an alternative incentive scheme based on different farmers' compliance cost through space instead of the classical flat rate payments. Future research may attempt to improve the integration between the spatial econometrics approach and optimisation methods to explain the determinants of farmers participation to AEMs schemes.

By this way it could be possible to identify better policy design option that could help the definition of appropriate RDMs and a larger involvement of farmers, hence a better delivery of environmental goods.

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