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Determinants of agri-environmental measures adoption: do institutional constraints matter?

Abstract

As a consequence of the 'greening' process of the Common Agricultural Policy (CAP), the demand for an evaluation of actual agri-environmental measures (AEMs) calls for a deeper analysis of this policy instrument implementation. The idea behind this paper is that farmer willingness to participate is a necessary, but not always sufficient, condition for explaining the local adoption of AEMs. Specifically, the authors test whether AEMs adoption depends on the farms and farmers' characteristics, and also on the local political and institutional framework. Discriminating between genuine farmer incentive and attitude towards AEMs, from the role of the local institutional environment, appears a crucial step towards a better understanding of agri-environmental schemes uptake. Empirical evidence found in the 'universe' of AEMs eligible farms located in the Lombardy region gives support to this hypothesis.

Keywords: agri-environmental measures, social capital, EU rural development policy.
JEL Classification: Q18, Q24, Q58.

Introduction

Recent reforms of the Common Agricultural Policy (CAP) increasingly recognize the central role the European agricultural sector plays in environmental management. This acknowledgement has led legislators to partly modify CAP objectives and, consequently, to set up new policy instruments. Indeed, agri-environmental measures (AEMs) have progressively gained centrality in CAP.

AEMs, since their introduction in 1992 and their subsequent inclusion in 2000 into Rural Development Policies, have been widely implemented in all the European Union member states, becoming a familiar instrument for farmers. Given their high adoption rate, the question that arises is whether AEMs are really effective policy instruments or, differently, do they simply represent a form of disguised agriculture protection (Anderson, 2000; Swinbank, 2001; Garzon, 2005). This question calls for a rigorous and reliable analysis into this policy's instrument implementation, starting from the determinants influencing farmers' enrolment in agri-environmental schemes. Indeed, it is to be noted that the patterns of farmer participation strongly affect the policy's objective attainments (e.g., Wilson, 1997).

Many studies have investigated the determinants of farmer participation in rural development schemes, starting from the assumption that such participation is mainly the outcome of a farmer utility maximization process (e.g., Vanslembrouck et al. 2002; Defrancesco et al., 2007; Barreiro-Hurlé et al., 2008). The relevant literature also considers factors like social commitment and the environmental attitude of farmers as drivers in the participation (e.g. Damianos and Giannakopoulos, 2002; Wossink and Wenum, 2003). However, with the notable exceptions of Vandermeulen et al. (2006) and Hackl et al. (2007), factors related to the policy decision-making environment have been largely neglected, despite the central role played by regional and local political bodies in the design and implementation of AEMs.

This paper contributes to this literature by assessing the determinants of farmer AEM implementations in an important North Italian region, that of Lombardy. We add to the previous literature in two main directions. First, by focusing on the political institution constrains that potentially affect the level of AEMs uptake at the local level. Secondly, by working not through a farm survey as does all the previous relevant literature, but on the total population of 62,454 regional farms receiving CAP payments.

More specifically, in this paper we test whether AEMs adoption depends both on farms and farmers' characteristics, and also on the political institutional framework. Indeed the relevant decisions concerning AEMs design and implementation could be affected by transaction costs embodied in the bargaining process among farmers, other interest groups and regional and sub-regional governments. Thus, disentangling genuine farmer incentive and attitude towards AEMs from the role played by the local political-institutional environment appears a crucial step toward a better understanding of agri-environmental schemes (Bertoni and Olper, 2008).

To deal with this kind of issue we exploit the sample of *all* eligible farmers in the Lombardy region agri-environmental program, taking advantage of the Regional Agricultural Information System (SIARL) database. Such a database includes all the farms that received payments on the I and II pillar of the CAP. The database collects, for each farm, information related to several technical and structural parameters and to farmer characteristics, as well as the affiliation to a farmer organization. We have integrated this information with official data on social, demographic, territorial and political variables at sub-regional (district) and municipal levels.

With respect to the methodology, we applied a parametric approach (Probit model) to explain the probability of farmer AEMs adoption conditioned upon three broad categories of determinants: farm and farmer characteristics, territorial and geographical context and, finally, political and institutional environment. With respect to the last category of determinants, we expect that variables proxy of the transaction costs involved in the political bargaining process – such as membership in a specific farmer organization, the 'ideology' orientation of the district and the degree of homogeneity of farmers' interests – might influence the probability of individual participation in AEMs.

The paper is structured as follows. A background of the Lombardy institutional context is given in Section 1. Section 2 summarizes the conceptual framework for understanding the issues of AEM adoption. Section 3 presents data and variables, while section 4 describes the econometric model and results. The final section concludes the paper.

1. Background

In Italy, since 1997[1], many agricultural and rural development responsibilities have been devolved from central to regional administrations. At the same time some regions partly devolved such powers to sub-regional administrations (provinces). This is the case of the Lombardy region, which in 1998 delegated its 11 provincial administrations to receive, to process and, if it is the case, to authorize farmers' applications for public funding[2].

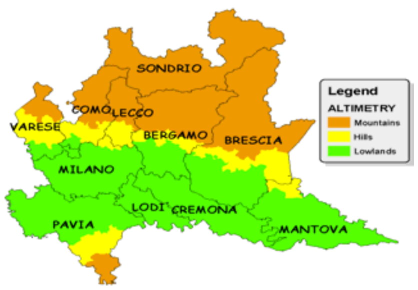
Thus, the process of political decentralization has also involved the implementation of the EU Rural Development Policy. The Council Regulation (EC) n. 1257/99 allowed Member States (MS) to retail Rural Development Programs to the geographical level deemed to be the most appropriate, in order to adapt them to the different agronomic, environmental, economical and political conditions. Consequently, Italy, in line with its institutional organization, chose to implement 21 RDPs, one for each administrative region. In Italy, then, the relevant decision-making bodies for Rural Development Policies implementation are represented by regional administrations. Focusing on the Lombardy RDP 2000-2006, and particularly on the AEMs, we observe that, at the sub-regional level, also provinces are involved in such implementation processes.

Figure 1 summarizes the responsibilities assigned to the regional and provincial administrations. Regional administration defines the scheme's structure, determining aims, requirements, payment rates, breaches and penalties, etc.; furthermore, regions have to notify their program proposals to the European Commission for final approval. On the other hand, Provinces directly manage the RDP bureaucratic process, in this way representing the interface between farmers and regional administration.

Regional Administration:

- ♦ Defines scheme typologies following Reg. (EC) 1257/99 prescriptions;
- ♦ Defines aims, commitments, eligibility criteria, payment rates, checks and monitoring procedures following Reg. (EC) 1257/99 prescriptions;
- ♦ Sets priorities for the implementation of agri-environmental contracts.

The 11 provinces of the Lombardy region



Provincial Administrations:

- ♦ Collect and process farmers' applications for agri-environmental premiums;
- ♦ Set additional priorities for agri-environmental contracts implementation;
- ♦ Promote AEM and help farmers in administrative tasks;
- ♦ Provide technical assistance;
- ♦ In more practical terms there is an inter-institutional political bargaining process between the regional administration and the provinces competing for financial resources allocation.

Fig. 1. Institutions involved in the implementation of AEM in Lombardy RDP 2000-2006

[1] See Dlgs (legislative decree) n. 143/1997.
[2] See Regional Law n. 11/1998.

In financial terms, AEMs represent the main policy instrument within the Rural Development Program (RDP) 2000-2006 of the Lombardy region. During the program implementation the AEMs absorbed almost 328 million euro, 165 of which was derived from the EAGGF contribution (36% of the total public expenditure in Lombardy RDP, 45% if we consider only the EAGGF allocation). Over 215,000 hectares were under agri-environmental commitments, corresponding to the 20% of the regional utilized agricultural area (UAA).

Within the AEMs framework farmers could choose from among five different categories of schemes:

- farming input reduction and integrated production (AEM1);
- organic farming (AEM2);
- management of meadows and pastures (AEM3);
- landscape conservation, restoration and creation (AEM4);
- breeds in danger of being lost (AEM5).

In Appendix the commitments, the eligibility criteria and the amount of annual public support related to each scheme are summarized. Given its specificity and its poor implementation rate, AEM5 is not considered in this analysis.

2. Conceptual framework

The conceptual model to analyze factors affecting the adoption of AEMs follows the micro-economic modelling framework developed in Vanslembrouck et al. (2002) and Dupraz et al. (2003), and recently applied by Barreiro-Hurlé and Espinosa-Goded (2007) and Barreiro-Hurlé et al. (2008). According to this literature, the determinants of AEMs farmers' adoption can be divided into *extrinsic* and *intrinsic* factors (see Vanslembrouck et al., 2002). The former rely on program characteristics, like the nature of the specific agro-environmental scheme, and market conditions (supply and demand) for both food and environmental goods. Differently, the latter rely on *farm* characteristics like size, location, type of farming, and *farmer* attributes, such as age, education, and composition of the family farm. More recently, a further factor has been included in the analysis of AEMs adoption: the 'governance structure' often called 'social capital' (see Jongeneel et al., 2008; Barreiro-Hurlé et al., 2008; Mathijs, 2002), which emerges from the interaction between the extrinsic and intrinsic factors with political and institutional context.

Following Barreiro-Hurlé et al. (2008), the farmers' choice to uptake AEMs is based on the assumption that they derive utility from four key components: economic benefit (m), provision of agri-environmental goods (v), farmer individual characteristics (Z^U), and farmer's social capital (Z^{SC}).

The farmer problem can be expressed as follows:

$$\underset{m,v}{Max} U(m, v, Z^U, Z^{SC}) \text{ s.t.,} \quad (1)$$

$$m \leq \overbrace{\pi^R(p, v, Z^\pi)}^{a} + \overbrace{\rho v}^{b} - \overbrace{TC(Z^U, Z^\pi, Z^C, Z^{SC})}^{c}, \quad (2)$$

$$v > 0. \quad (3)$$

Thus, farmers maximize their utility given by equation (1), subject to restrictions (2) and (3). Restriction (2) implies that farmers' economic benefit is derived from farm activity (a) and their participation in AEMs (b), minus the transaction costs (c) due to their participation in the AEMs. More specifically, the economic benefit from farming (π^R) is a function of relevant prices (p), the area devoted to AEMs (v) and farm technical characteristics (Z^π). The benefit from AEMs participation depends on the premium (ρ) multiplied by the intensity level v. The transaction costs component (TC) is a function of farmer (Z^U), contract (Z^C) and farm characteristics (Z^π), as well as the farmer's social capital (Z^{SC}). Finally, restriction (3) simply recalls the logic of the AEMs, namely that in order to obtain a subsidy the level of agri-environmental goods production should be greater than a minimum level, currently defined by the good farming practice.

The modelling framework above suggests the following basic relationships. First, an increase in income derived from farming (a), as an effect of, let us say, food price increase, should reduce the environmental goods provision, and thus the income coming from the AEMs (b) because it increases the opportunity costs of AEMs adoption. Differently, an increase in the AEMs premium ρ, or in the marginal utility of the environmental provision should increase the surface devoted to AEMs. Moreover, a reduction in the transaction costs component necessary to implement AEMs (c), should increase the provision of environmental goods (v).

It should be noted that all the previous papers that have used a similar framework in studying the different determinants of AEMs adoption have been mainly based on farm surveys, collected from among the population of AEMs eligible farms. From this point of view, the main contribution of our paper is to work on data gathered from the entire farming population rather than from a restricted sample. This massive data availability offers both advantages and some drawbacks, however. The key advantage of working on the entire population is to overcome the problem of sample selection bias that always takes place in this kind of analysis. However, this happens at the cost of some over-simplification in terms of our ability to control for 'all' the relevant factors affecting AEMs adoption. The second main contribution of the analysis is to put particular emphasis on the identification of factors affecting transaction costs, particularly referring to several district level political-institutional variables. More specifically, our basic assumption is that interaction within the specific local institutional environment affects the bargaining process between farmers and local institutions and should, in turn, influence the farmers' sign-up decision.

3. Data and measures

In order to analyze factors affecting farmer participation in AEMs we use data extracted from the agricultural information system of the Lombardy Region (SIARL). SIARL is the instrument by which the regional administration collects, and processes, farmers' applications for public funding (and consequently for RDP funds). Particularly, The SIARL dataset contains information concerning farm and farmers' characteristics and CAP administrative proceedings. These data have been integrated with territorial, institutional and political information in order to control for potential determinants of AEMs participation.

With respect to a survey approach, the exploitation of the SIARL dataset allows us to work with a sample representing almost the entire universe of Lombardy farms. Thus problems of sample representativeness have been totally overcome. On the other hand, we lack some information which is only directly available by survey (for example farmers' attitudes toward the environment). We partially reduce this problem by replacing missing sample information with proxy variables measured at a very detailed territorial level.

Because of the pluriennial nature of the AEMs commitments, we also faced the problem of choosing a reference year. This choice was made by excluding the initial implementation years of the Lombardy RDP in which the SIARL dataset was not representative of the actual farmers' adoption rate. As a consequence, 2005 was considered to be appropriately representative as this was the year the old Reg. (EC) 2078/92 commitments were almost exhausted and all the new Reg. (EC) 1257/99 contracts were being put into effect.

In 2005 there were 10,793 farms participating in at least one agri-environmental scheme with an annual public expenditure of about 45 million euro. The most adopted schemes were AEM1 and AEM3, while AEM2 and AEM4 represented a small share of the total AEMs expenditure (see Table 1).

The size of the selected sample is 62,454 farms, among which 10,483 were entered into at least one AEM scheme. Although not all the farms contained in the dataset met the AEMs eligibility criteria (see Appendix A, Table A.1), non-eligible farms were excluded from the analysis. It should be noted that the number of eligible farms can change, depending on the considered scheme (see Table 1). Furthermore, sample size is influenced by a lack of observations for some variables.

Table 1. Farmers participation and public funds expenditure in Lombardy AEMs (2005)

Scheme	*AEM_TOT* (At least 1 scheme)	*AEM_1*	*AEM_2*	*AEM_3*	*AEM_4*
Sample	62.454	62.454	62.454	62.454	62.454
Eligible farms	58.766	37.396	40.409	43.412	58.766
Participants	10.483	3.555	443	5.801	2.324
Expenditure in € (2005)	45.922.813	25.394.003	3.106.996	14.493.273	2.928.450
% of expenditure (2005)	100%	55,3%	6,8%	31,6%	6,4%

Source: Our elaboration on SIARL dataset.

3.1. Dependent variables. The dependent variable, *AEM_all*, is a dichotomous variable indicating the participation (= 1) or non-participation (= 0) of eligible farms in at least one agri-environmental scheme. However, because agri-environmental schemes differ in terms of their asset specificity (see Barreiro-Hurlè et al., 2008), we expect that factors affecting participation will vary across the different instruments.

Thus, to deal with, and to test this hypothesis, we also considered participation choices within each scheme, by creating four different dichotomous dependent variables, namely *AEM*_1, *AEM*_2, *AEM*_3, and *AEM*_4, respectively referred to the participation of eligible farms in each single scheme.

3.2. Independent variables. *3.2.1. Farm and farmer characteristics.* Current literature on farmers' willingness to participate in AEMs indicates that variables related to farms and farmers' characteristics are the main explanatory factors for the sign-up decision (see, e.g., De Drancesco et al., 2007). Given the lack of reliable information about the family and non-family agricultural labor force, our key variables aimed at describing the farm level context are mainly represented by farm characteristics (rather than those of the farmers'). Data available for the attributes of the farmer are: farm heads age (*age*), which is also a proxy of the education level; the percentage of property land (*landown*); and the average farmer income of the farm district[1] (*farmer_income*).

[1] The 'farm district' is a territorial classification based on census agricultural data. It indicates an homogeneous area from the agricultural point of view. In Lombardy there are 87 'farm districts'.

For farm characteristics, we include farm economic size (*esu*); type of farming, distinguishing among field crops (*field_crop*), permanent crops (*permanent_crop*) and dairy production *(dairy*); farming intensity, expressed by the number of livestock units per hectare (*lsu_ha*) and the number of horsepower per hectare (*hp_ha*); and, finally, the area share of grasslands and pastures (*pasture*) indicating the inverse degree of farming intensity as well. A summary description of the explanatory variables discussed above is reported in Table 2.

3.2.2. Social capital characteristics. In our framework 'social capital' describes the complex relationships between farmers and socio-economic and institutional environment. In fact, farmers are part of a complex social network in which different categories of stakeholders act (farmer groups, commodities and public goods consumers, taxpayers, institutions, etc.). The nature and size of the relationships within this social network and, generally speaking, the social, economic and institutional context in which farmers operate, should be considered an important determinant of their choices. In this work we extend such an assumption to the AEMs implementation.

As proxy variables for social capital we include in the analysis the average per capita income of the 'farm district' (*income*), the educational attainment of the population (*education*), the tourism intensity (*beds, agtourism*), the shares of specific political parties and 'ideology' orientations at the municipal level[1] (*greens, euroskeptic, left*)[2], and the political affiliation of the Province agriculture councillor (*councillor*). These variables should proxy for social needs and demands, farmer's attitude toward agri-environmental issues, and the district political orientation.

Furthermore, farmer participation in Rural Development measures other than AEMs, like farm investments (*investment*) and less-favored areas payments (*lfa_payment*), should reveal the farmer familiarity applicants with EU policies, thus reducing transaction costs involved in their activation.

Finally, another institutional dimension worth considering is the farmers' affiliation to a specific farmer organization distinguishing among five different existing associations (*sisa, copagri, cia, confagri, coldiretti*). Membership in the farmers organization has been proxied utilizing the proceedings of single farm payments[3]; consequently, the inclusion of these variables led us to exclude from the sample all farms without CAP Pillar I funds. For that reason they have been treated in a specific separate model in which the *pillar*_1 variable is appropriately excluded to avoid perfect collinearity problems.

Table 2. Variables definition

Variable	Description and measurement
Farm characteristics	
esu	Number of economic size units per farm
lsu_ha	Number of livestock standard units per hectare
hp_ha	Number of horsepower per hectare
field_crop	Dummy variable indicating field crops type of farming
permanent_crop	Dummy variable indicating permanent crops type of farming
dairy	Dummy variable indicating dairy specialized type of farming
pasture	Share of pasture and grasslands on the agricultural utilized area
Farmer characteristics	
age	Age of the farm holder
landown	Share of the property land on the total agricultural area
farmer_income	Average farmer income of the 'farm district' (euro)
investment	Dummy variable indicating farms participating in the 'investment in agricultural holdings' RDP measure
lfa_payment	Dummy variable indicating farms taking the LFA payment
income	Average income of the 'farm district' (euro)
education	Share of the population having an education level ISCED 3 or upper
participation	Share of participation in the regional Lombardy elections (2005) at the municipal level
greens	Share of votes obtained by the Green Party in the regional Lombardy elections (2005) at the municipal level
left	Share of votes obtained by the left-oriented parties in the regional Lombardy elections (2005) at the municipal level
councillor	Dummy variable indicating the province's agriculture councillor coming from the regional parliament majority party
euroskeptic	Share of votes obtained by the euroskeptic parties in the regional Lombardy elections (2005) at the municipal level

[1] In Lombardy there are 1547 municipalities.

[2] For the classification of left-oriented and euroskeptic parties we follow Kemmerling and Bodenstein (2006), who include in these categories parties and political movements enrolled in specific EU Parliament political groups.

[3] In Italy, farmers' applications for the single farm payment are forwarded annually by technical assistance services belonging to the farmers' groups. On that subject we think that farmer membership is correctly explained by this issue.

Table 2 (cont.). Variables definition

Variable	Description and measurement
Farmer characteristics	
beds	Number of beds per inhabitant in accommodation establishments at the 'tourism district' level
agtourism	Number of rural tourism establishments per inhabitant at the 'tourism district' level
sisa	Dummy variable indicating if farmer is enrolled to Sisa farmers group
copagri	Dummy variable indicating if farmer is enrolled to Copagri farmers group
cia	Dummy variable indicating if farmer is enrolled to Cia farmers group
confagri	Dummy variable indicating if farmer is enrolled to Confagricoltura farmers group
coldiretti	Dummy variable indicating if farmer is enrolled to Coldiretti farmers group
Location and other determinants	
pillar_1	Dummy variable indicating farms receiving the CAP single payment
plain	Dummy variable indicating if farm is located in a lowland area
mountain	Dummy variable indicating if farm is located in a mountain area
periurban	Dummy variable indicating if farm is located in a periurban area
park	Dummy variable indicating if farm is located in a municipality included in a natural park
nzv	Dummy variable indicating if farm is located in a 'nitrate vulnerable zone' according to the Directive (91/676EC)

3.2.3. Geographical location and other covariates. For different reasons, also farm geographical location should represent a relevant factor affecting farmers involvement in voluntary schemes. This is even more true if we refer to a policy intervention strongly related to rural areas management like AEMs. The relevant territorial levels are related to altimetry, with two dummies for *mountain* and *plain*, respectively (reference, omitted dummy, is *ill*), a dummy for periurban location (*periurban*), dummies for farms located in a natural park (*park*) and in a 'nitrate vulnerable zone' (*nzv*). Moreover it is important to emphasize that the few regional priorities on AEMs implementation are, in fact, related to mountain areas, and natural and rural parks[1]. Thus controlling for location should represent an ex-post evaluation of the Regional priorities accomplishment. On this ground also *nzv* verifies if the AEMs targeting in environmentally sensitive areas has been reached.

Finally the *pillar*_1 variable was included in the model to represent both farmers income integration through CAP Pillar I and, more generally, to verify the issues of overlapping between Pillar I and Pillar II payments.

4. Econometric model and results

4.1. Econometric model. Our dependent variable is a dichotomous choice variable taking the value 1 when a farmer participates in at least one agri-environmental scheme, and 0 if he does not. In this case the use of standard least square methods is inappropriate. Thus, the econometric model is based on a binary response model, where we are interested in the so-called response probability, namely the probability that a farmer uptakes an agri-environmental scheme conditioned to a set of endogenous variables.

Following the previous literature (see, e.g., Barreiro-Hurlé et al., 2008; Dupraz et al., 2003; Vanslembrouck et al., 2002), we model this probability as the latent variable, y^*, in a Probit model[2]. This latent variable represents the conditional participation in the AEMs, and can be interpreted as the result of the farmer utility maximization process, discussed in section 2. Formally, we have:

$$y^* = \alpha + \beta x_i + u_i, \tag{4}$$

$$Y_i = \begin{cases} 0 & if \quad y^* \leq 0 \\ 1 & if \quad y^* \geq 0 \end{cases},$$

where y^* is the latent variable reflecting the marginal utility from AEMs adoption; Y_i is a binary variable reflecting what we really observe, namely whether the farmer adopts AEMs or not (Y_i takes the value 1 when the latent variable is positive and 0 when is negative); x_i is a vector of covariates affecting the farmer's participation choice and is related to farm, farmer and other determinants of the adoption choice; α and β are the estimated model constants and coefficients parameters, respectively.

Denoting with $\Phi(\bullet)$ the cumulative normal distribution function and the standard error, σ, the probability of up-taking an agri-environmental scheme is then defined by $P(y^* \geq 0) = \Phi(x'\beta_k/\sigma)$. The parameters β/σ have been estimated via the maximum likelihood estimator (MLE), correcting the standard errors for unknown correlation of the residual within

[1] Since 1974 the Lombardy region has established several parks (22% of the total regional area is protected). The main characteristic of Lombardy regional parks is that they include many agricultural areas, some of which are exclusively or mostly dedicated to the preservation of agricultural landscape.

[2] As suggested by Vanslembrouck et al. (2002) both Logit and Probit models are appropriate for this kind of binary response problem. The fundamental differences between these models is the assumption concerning the cumulative distribution function (CDF): logistic CDF in the case of Logit and normal CDF for the Probit model (see Wooldridge, 2002).

each district. Indeed, by measuring some farmer and social capital characteristics at the district instead of the farmer level, we potentially introduce some unknown form of correlation between each individual error at the district level. Thus, to be on the safe side, and in order to eliminate such potential source distortion, we measure robust standard errors clustered at the district level.

4.2. Results. Table 3 reports the MLE results of five different models, the first related to the adoption of all types of AEMs, while the others refer to each single scheme. In selecting the final specification we adopt the following strategy (see Jongeneel et al., 2008). In a first step we model a specification that considers the effect of several potential determinants of AEMs adoption (see Table 2). Then we simplify it, putting emphasis on both theoretical considera-tion and the robustness of the different determinants. Moreover, for comparability and symmetry, we chose to include in the final specification the same set of variables for all five models. The criterion adopted for the final specification is to include a variable only if it turns out to be significantly different from zero in at least one model.

Figures in Table 3 report the marginal effect (*dF*/*dx*) calculated at the sample mean, that is, the change in predicted probability associated with changes in explanatory variables (see, e.g., Greene, 2003), as well as their respective *p*-values. All five models have a significant χ^2, meaning that all the regressors are jointly significantly different from zero, thus the set of our explanatory variables plays a role as a whole in explaining the probability of the farmer's enrolment in AEMs. Indeed, the fraction of correct predictions is quite high, ranging from 83.8% for the overall model to 99% for the organic farming scheme.

Table 3. Estimation results for the general model and the single schemes

Model	*AEM_All*		*AEM_1*		*AEM_2*		*AEM_3*		*AEM_4*	
Parameter	*dF/dX*	*p*-value	*dF/dX*	*p*-value	*dF/dX*	*p*-value	*dF/dX*	*p*-value	*dF/dX*	*p*-value
Farm characteristics										
esu	0.0222	0.000	0.0063	0.001	0.0003	0.499	0.0114	0.000	0.0060	0.000
lsu_ha	-0.0223	0.000	-0.0019	0.017	-0.0005	0.003	-0.0005	0.005	-0.0002	0.018
hp_ha	-0.0004	0.000	-0.0003	0.005	-0.0001	0.000	-0.0002	0.020	-0.0001	0.130
field_crop	0.0456	0.049	0.0789	0.000	0.0017	0.136	-0.0538	0.000	0.0231	0.000
permanent_crop	0.0295	0.191	0.1474	0.000	0.0046	0.007	-0.0838	0.000	0.0059	0.148
dairy	0.1568	0.000	0.0129	0.467	-0.0025	0.023	0.1298	0.000	0.0061	0.213
Farmer characteristics										
age	-0.0019	0.000	-0.0010	0.000	-0.0002	0.000	-0.0003	0.070	-0.0007	0.000
landown	-0.0335	0.000	-0.0087	0.027	-0.0005	0.601	-0.0161	0.004	-0.0006	0.780
farmer_income	-0.0059	0.491	-0.0052	0.309	-0.0002	0.497	-0.0005	0.947	-0.0022	0.099
Social capital										
investment	0.1192	0.000	0.721	0.000	0.069	0.000	0.0127	0.045	0.390	0.000
lfa_payment	0.3572	0.000	0.1447	0.000	0.068	0.069	0.1307	0.000	-0.0023	0.847
income	0.0116	0.012	0.0016	0.612	0.0002	0.359	0.0058	0.280	0.0027	0.002
education	0.0014	0.317	0.0009	0.295	-0.0002	0.069	0.0023	0.019	0.0002	0.495
greens	-0.0065	0.285	-0.0143	0.000	0.0005	0.190	0.0092	0.068	-0.0041	0.005
euroskeptic	-0.0052	0.001	-0.0046	0.000	-0.0001	0.109	0.0007	0.543	-/0025	0.000
left	-.0006	0.552	0.0009	0.040	0.0001	0.028	-0.0015	0.158	0.0000	0.782
Location and other determinants										
pillar_1	0.0888	0.000	0.0318	0.000	-0.0001	0.897	0.0302	0.002	0.0260	0.000
plain	-0.0958	0.004	-0.0405	0.064	-0.0080	0.000	-0.0398	0.228	0.0026	0.656
mountain	0.0083	0.850	-0.0018	0.956	0.0001	0.970	0.1831	0.000	-0.0046	0.656
park	0.0129	0.324	-0.0239	0.001	0.0008	0.257	0.0364	0.005	0.0101	0.010
nzv	-0.0029	0.893	-0.0190	0.005	-0.0001	0.928	0.0245	0.250	-0.0007	0.862
No. of observations	54177		37142		40101		43346		54177	
Chi square (*p*-value)	0.000		0.000		0.000		0.000		0.000	
Pseudo R^2 (McFadden)	0.203		0.2593		0.1111		0.2653		0.1469	
Fraction of correct predictions	83.8%		91.5%		99.1%		88.7%		95.7%	

Notes: *p*-value based on standard error clustered at district level to adjust for heteroschedasticity and spatial autocorrelation of unknown form. Coefficients for *income*, *landown*, and *esu* are multiplied by 100; coefficient for *farmer_income* is multiplied by 1000.

However, the goodness of fit, measured by McFadden (Pseudo) R^2, is quite low but in line with similar studies (see e.g., Vanslembrouck et al., 2002; Barreiro-Hurlé et al., 2008; Jongeneel et al., 2008). For the overall model (*AEM_all*) the Pseudo R^2 is equal to 0.2, and ranges between 0.11 (*AEM_2* – organic farming), and 0.26 (*AEM*_3 – management of meadows and pasture). Thus, several other unknown factors are at work in explaining AEMs adoption, other than those considered here. However, in evaluating this general conclusion it should be remembered that the sample employed for this analysis was of a huge dimension, counting more than 50,000 farmers.

In what follows we discuss the results by grouping the set of explanatory variables into the above mentioned categories of determinants.

4.2.1. Farm characteristics. Farm characteristics seem to strongly affect participation in AEMs as a whole and in single schemes as well. Farm economic dimension (*esu*) increases the probability of AEMs adoption, except for organic farming scheme that is insignificant. Previous evidence is quite contrasting on this aspect (see Defrancesco et al., 2007; Mann, 2005). However, the positive relation could be explained through reference to the transaction costs related to participation (that are mainly fixed costs). In fact, smaller farmers could have been discouraged from uptaking AEM schemes as they are not able to spread the fixed transaction costs over a reasonably large financial base (see Falconer, 2000). Moreover small farms, many of which are part-time farms, probably lack adequate entrepreneurship and sufficient information about these voluntary policy instruments.

As economic size is not necessarily correlated to farming and capital intensity, we represent this issue by using *lsu_ha* and *hp_ha* variables. In this case the signs of the coefficients are always significantly negative, confirming the well-known adverse selection effect in AEMs implementation (Hart and Latacz-Lohmann, 2005; Latacz-Lohman, 2004). Notably, more intensive farms are less likely to participate in AEMs as they usually incur higher opportunity costs in complying with schemes commitments. This consideration appears particularly true if we refer to the higher negative marginal effect in the *AEM*_1 equation (input reduction), which is the scheme involving more farm management changes than others (Barreiro-Hurlè et al., 2008).

With regard to farming type, the probability that a dairy farm will participate in AEMs is 15% higher than other specializations, a result in line with evidence reported by Jongeneel et al. (2008). Differently, *AEM*_1 adoption is more likely for permanent crops type of farming. Finally, also field crops specialization somewhat affects the probability of AEMs uptake, in *AEM_all*, *AEM*_1 and *AEM*_4.

4.2.2. Farmer characteristics. As expected *age* negatively affects the probability of entering AEMs, in line with the large part of the previous evidence (see, e.g., Vanslembrouk et al., 2002; Bonnieux et al., 1998). Thus, older farmers show a low propensity towards measures involving strong change, with respect to the usual farming practices. However, in contrast with Barreiro-Hurlè et al. (2008), also *AEM*_3, comparable with their "traditional farm management" scheme, shows a negative age coefficient, even if the marginal effect is smaller than in the other schemes. *Farmer_income* is generally insignificant, except for *AEM*_4. Nevertheless this variable was calculated as a mean of the 'farm district', thus, as previously highlighted, variables related to farming intensity should better explain the role of opportunity costs in discouraging participation.

Finally we note that the share of property land (*landown*) negatively affects the farmer's willingness to participate in AEMs, indicating that landlords are less concerned about public goods production than tenants.

4.2.3. Social capital. With respect to 'social capital' variables, evidence has been found that farmers participating in other RDP measures (*investment* and *lfa_payment*) are more likely to sign-up for AEMs. This effect appears quite plausible if we think that some transaction costs related to participation could be spread among different measures. In any case this finding would indicate that a greater familiarity with RDP measures increases implementation probability.

The per-capita income (*income*) at the district level increases the probability of farmer enrolment in agri-environmental schemes. According to Bimonte (2002), income level is a good indicator of social demand for amenities and public goods and, more generally, of environmental sensitivity. Moreover it is important to note that the level of development goes hand in hand with the quality of institutions. *Education* seems, at least partially, to confirm this assumption, but its estimated effect on the probability of implementation is significantly positive only for *AEM*_3.

Interestingly, also ideological orientation influences the probability of participation in AEMs, confirming the Vandermeulen et al. (2006) and Hackl et al. (2007) interpretations of the influence of institutions and local policies on the uptake of agri-environmental and multifunctional-oriented commitments. Indeed, left parties share (*left*) positively affects the probability that a farmer will join both *AEM*_1 and *AEM*_2. Such evidence appears in line with the notion that left-oriented political movements take more care of environmental issues. Nevertheless, the results of the *greens* variable seem to be at odds with the last statement. This apparent contradiction could be partly explained by the fact that, in Lombardy, the Green Party electorate tends to have little political power and lacks strong territorial variability[1]. Consequently we ascribe environmental concerns to the entire left coalition to which the Green Party belongs.

Moreover, farmers are less likely to participate in AEMs where the share of euroskeptical parties (*euroskept*) is higher. At first glance this could indicate the rejection, or limited knowledge, of EU policy instruments. At a more profound level, it must be remembered that the eurosceptics of the Lombardy region are mainly represented by the Lega Nord party, whose members have often reaffirmed the strengthening of the productive role of agriculture *vs* the environmental/multifunctional one, giving stronger emphasis to farm competitiveness priority[2].

To complete the discussion on social capital, the role played by farmers' associations needs to be clarified. To do this we resort to a second model applied to a smaller sample from which we have information on farmers' group affiliation (see Table 4). Notably, the effect of other variables does not change with respect to the 'general' model, confirming the robustness of our specification. In the sample, all five existing organizations are represented. First of all Coldiretti (catholic-oriented), representing 61% of farmers in the sample, followed by Confagricoltura (traditionally repre-enting landlords, right-wing oriented), CIA (left-wing oriented), and two other minor organizations, SISA (moderate left-wing oriented) and Copagri (recently founded on an agreement between agronomists and agricultural contractors' associations).

The outcomes highlight the fact that farmers enrolled in *sisa* and *copagri* – compared with *coldiretti*, the omitted reference dummy – are more likely to participate in AEMs, by 7% and 8.5%, respectively. No particular effects were highlighted with respect to the other three main organizations, except for *cia* in *AEM_2*, confirming the traditional positive attitude toward organic farming of the left-wing orientation. An interpretation of this outcome suggests that in small organizations transaction costs are lower because, among other things, of the deeper level of technical assistance (for example, think of the agronomists involvement in *copagri*). This interpretation appears quite convincing if we consider AEMs implementation as needing long-term planning and substantial changes in farm management.

Table 4. Estimation results for models including farmers' organizations

Model	*AEM_All*		*AEM_1*		*AEM_2*		*AEM_3*		*AEM_4*	
Parameter	*dF/dX*	*p*-value	*dF/dX*	*p*-value	*dF/dX*	*p*-value	*dF/dX*	*p*-value	*dF/dX*	*p*-value
Farm characteristics										
esu	0.0232	0.000	0.0035	0.019	0.0001	0.705	0.0135	0.000	0.0078	0.000
lsu_ha	-0.0024	0.000	-0.0012	0.028	-0.0003	0.010	-0.0005	0.007	-0.0003	0.014
hp_ha	-0.0008	0.000	-0.005	0.000	-0.0021	0.002	-0.0002	0.019	-0.0003	0.001
field_crop	0.0667	0.005	0.0591	0.000	0.0011	0.195	-0.0560	0.000	0.315	0.000
permanent_crop	0.1302	0.000	0.1370	0.000	0.0057	0.002	-0.0744	0.000	0.0261	0.001
dairy	0.1878	0.000	0.0166	0.208	-0.0019	0.019	0.1513	0.000	0.0110	0.107
Farmer characteristics										
age	-0.0023	0.000	-0.0009	0.000	-0.0001	0.000	-0.0006	0.002	-0.0009	0.000
landown	-0.0317	0.000	-0.0024	0.449	-0.0004	0.640	-0.0249	0.000	0.0005	0.847
farmer_income	-0.0094	0.382	0.185	0.185	0.0000	0.843	-0.0015	0.874	-0.0034	0.076
Social capital										
investment	0.1075	0.000	0.0525	0.000	0.0028	0.000	0.0114	0.134	0.0498	0.000
lfa_payment	0.2439	0.000	0.0240	0.388	0.0074	0.000	0.1249	0.000	-0.0168	0.331
income	0.0175	0.005	0.0032	0.270	0.0002	0.222	0.0084	0.201	0.0044	0.000
education	0.0038	0.013	0.0009	0.133	0.0000	0.951	0.0030	0.010	0.0007	0.174
greens	-0.0126	0.114	-0.0124	0.000	-0.0002	0.355	0.0087	0.141	-0.0076	0.001
euroskeptic	-0.0054	0.006	-0.0046	0.000	-0.0001	0.035	0.0010	0.500	-0.0034	0.000
left	-0.0005	0.690	0.0007	0.091	0.0001	0.057	-0.0018	0.174	0.0001	0.656
sisa	0.0704	0.009	0.0530	0.000	0.0201	0.001	-0.0108	0.518	0.0251	0.027
copagri	0.0858	0.001	0.0139	0.286	0.0302	0.000	0.0322	0.068	0.0121	0.063
cia	-0.0012	0.940	-0.0095	0.106	0.0070	0.000	0.0037	0.753	-0.0113	0.090
confagri	0.0092	0.468	-0.0022	0.543	0.0027	0.003	0.0075	0.526	0.0009	0.852
plain	-0.1005	0.025	-0.0146	0.033	-0.0052	0.000	-0.0447	0.240	0.0027	0.765
mountain	0.0865	0.234	0.0171	0.719	0.0014	0.372	0.2179	0.000	-0.0012	0.975
park	0.0247	0.133	-0.0177	0.005	0.001	0.808	0.0428	0.005	0.0138	0.016
nzv	-0.0082	0.751	-0.0183	0.004	-0.0008	0.205	0.233	0.340	-0.0021	0.720

[1] In 2005 Lombardy regional election the Green Party took 2.5% of the total votes and did not run in the Sondrio Province.

[2] For example, during the recent CAP 'Health Check' discussion the Italian Minister of Agriculture (Lega Nord) claimed a reduction in the proposed rate of modulation from Pillar I to Pillar II.

Table 4 (cont.). Estimation results for models including farmers' organizations

Model	*AEM_All*		*AEM_1*		*AEM_2*		*AEM_3*		*AEM_4*	
Parameter	*dF/dX*	*p*-value	*dF/dX*	*p*-value	*dF/dX*	*p*-value	*dF/dX*	*p*-value	*dF/dX*	*p*-value
No. of observations	38447		30076		32477		35424		38447	
Chi square (*p*-value)	0.000		0.000		0.000		0.000		0.000	
Pseudo R^2 (McFadden)	0.2116		0.2599		0.1579		0.2701		0.1339	
Fraction of correct predictions	81.7%		93.2%		99.2%		87.7%		94.5%	

Notes: *p*-value based on standard error clustered at district level to adjust for heteroschedasticity and spatial autocorrelation of unknown form. Coefficients for *income*, *landown*, and *esu* are multiplied by 100; coefficient for *farmer_income* is multiplied by 1000.

4.2.4. Location and other determinants. The outcome of the variables related to farm location seem to highlight the failure of the agri-environmental schemes territorial targeting (see Table 4). Indeed, *mountain*, *park* and *nzv* are largely not significant; furthermore, and surprisingly, farm location in nitrate sensitive areas reduces the probability of activating *AEM*_1, which is the scheme most concerned with tackling water pollution problems. Once again, the opportunity cost to participate – note that in Lombardy nitrate vulnerable areas are usually in an intensive farming context – discourage farmers from adopting AEMs. An exception to the above-mentioned lack of participation is the increase in probability of *AEM*_4 implementation, characterizing farms situated in *parks*, where landscape-amenity social demand is, for obviously reasons, stronger.

Finally, the *pillar*_1 positive marginal effect denotes a discrete overlapping of Pillar I and agri-environmental payments, thus it would seem that the redistributive nature of AEMs are only partially confirmed.

Concluding remarks

In this paper we study the determinants of farmers' adoption of AEMs in the Lombardy region, our aim being to disentangle farm and farmer determinants from political and institutional ones. Working with the 'universe' of farms eligible for AEMs and with four different AEMs schemes, we obtain evidence about the effect of both farm and farmer characteristics on AEMs adoption. At the same time, our results corroborated the idea that the local institutional framework, by affecting the inter-relations of farms, local stakeholders and government bodies, influences the farmers' probability of uptaking AEMs.

The main findings of our analysis highlight how intensive farming seems to discourage AEMs implementation, while farmers' participation in other RDP measures exerts a positive effect. On the 'social capital' side, we found that local institutions affect AEMs uptake in the direction suggested by *a priori* considerations. However the weight of 'social capital' variables seems to be less important than that of farm and farmer characteristics. Finally, territorial location variables, explaining regional administration priorities, do not seem to affect, to any degree, the farmer's decision-making process to join AEMs.

This evidence leads us to highlight three main, interlinked, issues. First, a confirmation of the adverse selection phenomenon, notably the fact that the farmers entering AEMs are those who easily accomplish measure commitments (i.e., extensive farms). Secondly, the failure of specific territorial targeting of AEMs tends to suggest that the selection process of farmers applications does not properly take into account environmental local needs. Finally, our analysis seems to suggest that, due to lack of rigorous selection, AEMs implementation favors a quantity-based rather than a quality-based funding approach.

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Appendix

Table A1. Description of the agri-environmental schemes in the Lombardy RDP 2000-2006

Commitments	
*AEM*_1	To respect regional rules on integrated production To apply a fertilization plan based on the nutrient balance principle To apply a five-year rotation of at least three crops (only for arable crops) To maintain green cover in permanent crops Control and technical certification of the spreading machinery To apply commitments to the whole UAA Duration of commitments: 5 years
*AEM*_2	To respect the provision of Reg. (EC) 2092/91 about organic production To apply commitments to the whole UAA Duration of commitments: 5 years

Table A1 (cont.). Description of the agri-environmental schemes in the Lombardy RDP 2000-2006

Commitments	
AEM_3	(AEM3-a) to convert arable crops into meadows – only in lowlands and hills (AEM3-bcd) to maintain meadows with obligation of minimum 2/3 cuts per year (AEM3-e) to manage Alpine pastures ensuring a minimum level of grazing livestock density (0,5-1,4 lsu/ha) – only in the mountains Prohibition of chemical inputs utilization Good management of meadows and pastures Duration of commitments: 5 years
AEM_4	Creation and management of hedgerows, agro-forestry systems, buffer areas, wetlands etc. Maintenance and management of the agro-forestry systems for at least 10 years
Eligibility criteria	
AEM_1	At least 1 ha of UAA for arable crops or 0.5 ha of UAA for permanent crops (in the mountains) At least 2 ha of UAA for arable crops or 1 ha of UAA for permanent crops (in the lowlands and the hills) Farms with only meadows or pastures are not eligible
AEM_2	At least 1 ha of UAA for arable crops or 0.5 ha of UAA for permanent crops Farms with only meadows or pastures are not eligible
AEM_3	At least 1 ha of UAA for each intervention, except pasture management which requires at least 10 ha of UAA Farms with only meadows or pastures are not eligible
AEM_4	Depending on the intervention typology
Annual support	
AEM_1	From 50 €/ha to 550 €/ha (depending on the crop)
AEM_2	From 50 €/ha to 740 €/ha (depending on the crop) for maintaining organic farming From 50 €/ha to 815 €/ha (depending on the crop) for conversion to organic farming
AEM_3	500 €/ha for conversion of arable crops into meadows (in the lowlands and the hills) 240 €/ha to maintain meadows (in the lowlands and the hills) 180 €/ha to maintain meadows (in the mountains) 50 €/ha to maintain and manage pastures (in the mountains)
AEM_4	Depending on the intervention typology

Source: Authors compilation from the RDP of the Lombardy region.