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## Conference Paper

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# Understanding the participation in agri-environmental schemes: evidences from Tuscany Region

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## **Abstract**

Agri-Environmental Schemes (AESs) represent one of the main agricultural policy instruments which address environmental objectives in Common Agricultural Policy. In spite of twenty years of application and its high share of RDP budget, several evaluation reports and scientific literature have measured a low environmental impacts compared with expectations. Economic literature has identified in low target level of schemes, low participation rates, spatial heterogeneity and asymmetric information between farmers and public administration the main reasons for low impact.

The objective of the paper is to provide a comprehensive analysis of determinants of agri-environmental adoption. The objective is pursued combining results of farm level adoption analysis with spatial analysis of participation rate. Results show that both micro and meso-characteristics strongly affect participation to AESs. In fact, farm and household structure, quality of advice services and territory endogeneity, significantly affect AESs adoption.

**Keywords:** Agri-environmental schemes, Determinants, Econometrics model, Spatial econometrics

**JEL:** Q18 - Agricultural Policy; Food Policy, Q12 - Micro Analysis of Farm Firms, Farm Households, and Farm Input Markets

## Introduction

Since introduction with accompanying measures of McSharry Reform, Agri-Environmental Schemes (AESs) represents the main agricultural policy instrument which address environmental objectives into Common Agricultural Policy.

AESs are compensation payments, aimed to encourage farmers to adopt agricultural practices/prescriptions which affect positively environment. Agri-environmental payments are designed to compensate (on the average) income foregone, and operational and transaction cost increase due to AESs commitment.

AESs have been for long time of the main chapter of the RDP budget. Overall the greater part of AES budget is allocated to incentive the introduction or the maintenance of organic or integrated production. In the new programming period (2014-2020) AES, which are now called Agri-Environmental Climate schemes are confirmed be compulsory for all member states with a minimum allocation of RPD budget about 30%.

Objective of AESs into new program are: a) restoring, preserving and enhancing biodiversity, including in Natura 2000 areas and high nature value farming, and the state of European landscapes; b) improving water management; c) improving soil management; d) reducing nitrous oxide and methane emissions from agriculture; e) fostering carbon sequestration in agriculture

European Commission (2013) has identified two criteria to support AESs, when there is a clear environmental benefits of the practice and when there is a clearly proved risk that the practice would be abandoned if no AEC support was provided.

Such elements are not trivial, and have allows room for research to investigate policy mechanism effectiveness and analysis of AESs adoption process and determinants.

In spite of twenty years application and its high share of RDP budget, several evaluation reports and scientific literature have measured a low environmental impacts compared with the expectations. Economic literature has identified in low target level of schemes, low participation rates, spatial distribution heterogeneity and asymmetric information between farmers and public administration the main reasons for such AESs lower impact.

Since preliminary work of Morrison and Potter 1995, motivations and incentive mechanisms were identified as determinant AESs participation. The Authors described four categories of behaviour in front of adoption: active adopters, passive adopter, and conditional non adopter and reluctance

adopters. Then Authors identified in motivations, payments and information determinants of the movement among the categories. In a similar field, the adoption of multifunctional practices has been identified into post-productivism farm pathways (Wilson 2001).

Agricultural economic literature has highlighted positive effects of incentive mechanisms in increasing farmers' participation (Drake et al., 1999; Defrancesco et al., 2008). Such literature has identified farm, farmer and household characteristics as determinant of participation. The agricultural economics literature has also the effects of uncertainty in market and climatic conditions as drivers of AESs adoption (Ridier, 2012). In fact, due to farmers' risk aversion, farmers prefer to receive lower but with certain payments (i.e. payments by landscape measure or twenty years set-aside) instead of uncertain income (even if is higher). A growing literature has investigated the role of transaction costs and social capital as determinants of AESs participation (Mettepenningen et al., 2009). Such literature branch has identified elements of trust and networking, as main motivational factors which affect AESs participation (Jongeneel et al., 2008), and then on amount and quality of information available (Giovanopoulou et al., 2011). Very large literature investigate threshold and transaction costs effects on participation (see for example Dupraz et al., 2008; Ducos et al., 2009). Several papers investigate farmer's preference in front of new contract for provision of public goods. In this field, very large literature has applied choice experiment model to investigate willingness to accept under trade-off between AESs commitments and payments (see for example Espinosa-Goded et al., 2010).

A growing literature investigates participation to RDP measures or spatial diffusion of AESs participation, focusing on agglomeration effects and spatial spillovers. For example Bartolini et al., (2012) investigates spatial distribution of participation to measure 121 of Emilia Romagna RDP, using alternative assumption about spatial regime. Schmidtner et al., (2012), analyses the spatial distribution of share of organic farming in Germany Municipalities and found spatial spillover which could explain agglomeration of participation.

The objective of the paper is to provide a comprehensive analysis of determinants of agri-environmental adoption. Paper focused on the adoption of organic and integrated production as the two main and relevant farming systems. These two alternative farming systems are competitive with conventional production. The objective is pursued joint insight of farm choice model results about adoptions of AESs analysis with spatial analysis of participation rate in Tuscany municipality. The first analysis is undertaken applying multinomial logit, in order to identify the main farm, farmer and household (micro) characteristics which positively or negatively affect the probability to

participate in AESs. The second model is undertaken applying spatial analysis in order to include into the analysis of determinants of alternative spatial patterns. Through comparison of three regression models (OLS, spatial lag and spatial error models) determinants at territorial level are investigated. Data are obtained by Tuscany 2010 Census, merged with ARTEA database (regional RDP payments agency) and contains participation during years 2007-2010 (both new applications and participation under previous program).

The paper is structured as follow. In coming section methodology is presented, then follows results and conclusion sections.

## Methodology

The paper aims to investigate determinants and motivations AESs participation towards organic and integrated production adoption. Data used are obtained by micro-data of 2010 Agricultural Census and from ARTEA database (regional payments agency).

Economic literature has described adoption of integrated or organic farming as an investment decision problem. Following Schmidtner et al., (2012) model, the choice among alternative farming systems (such as for example integrated, conventional or organic) could be represented by the optimal investment choice during time horizon T. Formally:

$$\left( -U_t(TCa^j) + \sum_o^T E[U_t(\pi_t^j - TCco_t^j) + Ua_t^j] e^{-rt} \right) - \sum_0^T E[U_t(\pi_t^{co})] e^{-rt} > 0 \quad (1)$$

Where:  $\pi_t^j = \sum_{i=0}^I p_t^{ij} q_t^{ij} (v_t^{ij}, F) - c_t^{ij} v_t^{ij} + pay_t^{ij}$

$j = or; in$  or= organic and in= integrated production;

$TC_t^j$  = Transaction costs of conversion; a= ex-ante TC; o= ongoing TC.

$\pi_t^j$  = profit of generic year t of the system j

$U_t^j$  = utility of the system-j for the year t

$Ua_t^j$  = additional utility/disutility associated to the farming system j

$p_t^{ij}$  = vector of output price of the i-crops

$q_t^{ij}$  = vector of produced quantities

$v_t^{ij}$  = vector of input quantities

$c_t^{ij}$  = variable cost of input

$F$  = production factors (e.g. labour; land)

$pay_t^{ij}$  = payment under AESs.

Following Schmidtner et al., (2012), some vector, such prices, costs, production factors are assumed be affected by agglomeration effects, and then are assumed spatially dependent. In addition also TC could be assumed affected by spatial agglomeration due difference in extension services and institutional quality, networking among farmers.

In this paper determinants of adoption of alternative farming systems (organic or integrated production) are investigated. We applied two methods in parallel. Firstly through multinomial logit model determinants to the adoption of alternative farming systems at farm level are investigated, while applying spatial regression analysis the determinants of share of participation at municipality level are identified. We present first methodology applied to multinomial logit and the spatial methodology applied to spatial econometric model.

Let  $U_{ij}$  denote a non observed utility that farm  $i$  derives in the adopt alternative farming systems ( $j$ ), with  $j = (1,2,3)$ ; it is possible to write  $U_{ij} = \mu_{ij} + \varepsilon_{ij}$  where  $\mu_{ij}$  is an observable portion of the utility function which is a linear combination of the covariates (set of observed variables) and  $\varepsilon_{ij}$  is an unobservable term (Werbeek, 2004).

Assuming that  $\varepsilon_{ij}$  are independent and with Gumble distribution (extreme value distribution Type

1), the probability that the  $i$ -th farm belong farming system ( $j$ ) is:  $P_{ij} = \frac{\exp\{\mu_{ij}\}}{\sum_j^M \exp\{\mu_{ij}\}}$  with

$j = 1,2,3$  alternatives. Under this notion, it is automatically assumed that  $0 \leq P_{ij} \leq 1$  and  $\sum_j^M P_{ij} = 1$ .

Assuming that  $\mu_{ij}$  is a linear function, which means that it is possible to write  $x_{ij}'\beta = \mu_{ij}$ , where the matrix  $x_{ij}'$  contains the set of the explanatory variables. Under the assumptions of linearity and error distribution it is possible to rewrite a normalised form of probability calculation as:

$$P_{ij} = \frac{\exp\{x'_{ij}\beta\}}{\sum_j \exp\{x'_{ij}\beta\}} \text{ for each } j = 1, 2, 3 \text{ alternatives.}$$

Under this notion, the probability for the  $i$ -th farmer choice to have a behaviour ( $j$ ) facing the policy change, among a set of  $M$  alternatives is a function of the explanatory variables  $x'_{ij}$  and of the  $\beta$  coefficients (Green, 2000).

The second model applied allows describing determinants of the agglomeration effects of AESs adoption. Spatial econometric models are undertaken using share of organic and integrated production in Tuscany municipalities. Such models allow improving the estimation including alternative regime of spatial associations of explanatory variable or in the error term.

Following LeSage and Pace (2009), the spatial dependency could be modelled as an extension of the standard linear regression model. As a result, the regression could be written as (Breustedt and Habermann, 2011):

$$\begin{aligned} r &= \rho W_1 r + X\beta + \varepsilon \\ \varepsilon &= \lambda W_2 \varepsilon + \mu \\ E[\mu_i^2] &= \sigma^2 h(z_i); E[\mu_i \mu_j] = 0 \text{ with } i \neq j \end{aligned} \tag{2}$$

Where  $r$  is the observed participation rate;  $X$  is the  $n \times k$  matrix of the  $k$  determinants of the participation rate,  $\beta$  is the regression parameter to be estimated,  $\varepsilon$  is the error term,  $W_1$  and  $W_2$  are the  $n \times n$  matrix of spatial weights;  $\rho$  are the spatial lag parameter; and  $\lambda$  spatial error coefficient. Where  $i$ th element of  $W_1 r$  represent the spatial weighted average of the participation rate for municipality  $i$  and  $W_2 \varepsilon$  are the error lag and represent a specification of the error term.

Under several assumptions about of the  $\rho$  and  $\lambda$  the equation 1 could yield:

with  $\rho = 0$ ;  $\lambda = 0$  the equations return a standard linear regression model (model A);

with  $\lambda = 0$ ; the equations return a spatial lag model (model B);

with  $\rho = 0$ ; the equations return a spatial error model (model C);

Spatial lag model and spatial error model take into account differently the spatial patterns of the participation to AES. In a spatial lag model it is assumed that participation of one area is affected by the participation of neighbouring areas; while in the spatial error model, some unknown variables shared with the neighbourhood influence the participation rate.

## Data

In the paper micro-data collected by agricultural census at year 2010 and ARTEA database are used. The databases contain both data about adoption of AESs and the set of covariates related to farm, farmer and household characteristics. The database is integrated with data of location, territorial description of the area, and with data about touristic supply. In this paragraph we first present the data used in farm choice model (multinomial logit model) and then we present data used for spatial analysis.

Dependent variable and explanatory variables used in multinomial logit model are presented in table 1 and table 2.

Table 1. Participation to organic and integrated production

aes_choice	Freq.	Percent	Cum.
0= conventional production	66,836	91.95	91.95
1 = Organic production	2,384	3.28	95.23
2= Integrated production	3,466	4.77	100
Total	72,686	100	

The greater part of the surveyed farms does not adopt neither integrated nor organic productions. While farms who adopt organic production are more than 2,000 (3.28%), while integrated production adopters are more than 3,000 which represent the 4.77% of the farmers.

Explanatory variables belonging to location, farmers and households, and farm policy categories are identified. Such explanatory variables are obtained using the information of Census data. Table 2 shows the descriptive statistics of selected explanatory variables.

Explanatory variables are classified into 5 categories. The first category includes RDP zoning and location to environmental protected area. RDP zoning is based on inhabitant density per municipality. Tuscany territory has been classified in 5 zones. To the first one, namely that of municipalities with highest density of inhabitants (poli\_urb) belong farms located into urban areas. The second category (rur\_int) contains farms located in the rural areas (density less than 150 inhabitants per square km) and with intensive agricultural productions. Finally three other zones, which correspond to rural areas, are characterised by increasingly socio-economic concerns, namely: rural areas in transition (rur\_trans), declining rural areas (rur\_desc) and rural areas with development problems (rur\_probsv). The covariate d\_protected is a dummy variable that identify whether a farm is located in one of the sic or zps or vulnerable nitrogen area.



Table 2. Descriptive statistics of explanatory variables used in micro-level models.

	Variable	Obs	Mean	Std. Dev.	Min	Max
Location	rur_int	72686	0.1009	0.3011	0	1
	rur_probsv	72686	0.1431	0.3502	0	1
	rur_trans	72686	0.3409	0.4740	0	1
	rur_decl	72686	0.2413	0.4279	0	1
	poli_urb	72686	0.1738	0.3789	0	1
Household	d_protected	72686	0.3243	0.4681	0	1
	live_on	72686	0.8403	0.3663	0	1
	lav_FTEall	72686	1.1225	1.6322	0	90.81
	lav_partime	72686	0.4606	0.4984	0	1
Farm characteristics	lav_onlyfam	72686	0.9422	0.2334	0	1
	c_diff	72686	0.1279	0.4576	0	10
	d_quality	72686	0.1343	0.3410	0	1
	sau_vl	72686	0.1458	0.3529	0	1
	sau_vs	72686	0.4522	0.4977	0	1
	sau1_ha	72686	10.3781	35.0867	0	2,292
	d_grazing	72686	0.1780	0.3825	0	1
	d_coltene	72686	0.0005	0.0232	0	1
	sauaff_d	72686	0.1553	0.3622	0	1
	corpi_1	72686	0.5548	0.4970	0	1
	spec_perm	72686	0.5872	0.4923	0	1
	spec_arable	72686	0.1739	0.3790	0	1
	cond_coltdir	72686	0.9562	0.2047	0	1
	cond_oth	72686	0.0060	0.0770	0	1
	totbov	72686	1.1745	15.9962	0	1,965
	inform_d	72686	0.0590	0.2357	0	1
	d_old	72686	0.4138	0.4925	0	1
Farmer characteristics	edu_agr	72686	0.0389	0.1933	0	1
	edu_low	72686	0.6697	0.4703	0	1
	edu_high	72686	0.3314	0.4703	0	1
Policy	sfpr_year	72686	1,411.35	5,758.93	0	426,822
	sfp_ha	72686	134.7563	243.4906	0	16,325

In the second category, explanatory variables belonging to household characteristics are considered. These variables aim to investigate relation between farmers' household characteristics and farm strategies. Farms' household characteristics include: farmers living, or not, in the farm (live\_on), the relation between household and external labour (lav\_FTEall; lav\_onlyfam) and part-time farms (lav\_partime). The third category of explanatory variables includes farm characteristics, grouped into legal status of the farm (cond\_coltdir; cond\_oth), farm specialisation mainly (spec\_permanent, spec\_arable), farm size (dummies of quartile uaa\_vs; uaa\_s; uaa\_l; uaa\_vl and amount of operated land sau1\_ha), quality of production (d\_quality), and number of plots (dummy variable of single plot). The fourth explanatory variables category contains farmers' characteristics. Belong to the category education level (edu\_high in case of education higher than secondary school, edu\_low when farmers have education lower than secondary school and edu\_agr when farmers have an agricultural education), age (dummies variable for older or younger than 40 years old and square function of the age) and use of internet for farming activities (inform\_d). Finally, policy category contains the SFP received for each unit of Usable agricultural Areas (sfp\_ha) or per farm (sfp\_year). Table 3 presents data used to spatial model, both dependent and explanatory variables.

Table 3. Descriptive statistics of variable used in spatial analysis models.

	Variable	Obs	Mean	Std.Dev.	Min	Max
Dependent variable	share_org	285	3.4937	3.5455	0	25
	share_int	285	4.0276	4.6297	0	35.71
Location & altitude	plain	285	0.0877	0.2834	0	1
	poli_urb	285	0.0702	0.2559	0	1
	rur_decl	285	0.2421	0.4291	0	1
	rur_int	285	0.1088	0.3119	0	1
	sic_zps	285	9.5464	16.0281	0	100.00
	zvn	285	2.7296	9.6664	0	68.16
	aree_prot	285	6.1899	13.2987	0	100.00
Turistic features	alb_pl_agri	285	166.5474	223.9870	0	1,745.00
	alb_pl_alb	285	650.7368	2,265.1640	0	30,385.00
household	fteall_farm	285	1.1625	0.3642	0.37	3.17
	ftefam_farm	285	0.9984	0.2775	0.35	1.83
	lav_onlyfam	285	94.0636	5.7277	50	100.00
Farm characteristics	av_sau_pf	285	11.0442	9.8382	1.14	67.02
	d_quality	285	9.8850	12.2398	0	51.73
	diver	285	0.1720	0.1777	0	1.29
	vite_ha	285	8.1993	10.6310	0	53.67
	totoli_ha	285	15.7847	16.7895	0	75.18
	totbos_ha	285	33.5510	19.9469	0	86.05
	totind_ha	285	2.6396	4.8394	0	38.59
	d_totbov	285	6.6807	7.3750	0	43.75
	corpi_l	285	58.6955	19.1846	16.81	100.00
	sau_aff_d	285	15.2782	8.3972	0	57.14
	totene_ha	285	0.0261	0.1340	0	1.33
	sau_prop_d	285	86.0294	7.2725	44.24	100.00
	hedgerow	285	13.1287	13.6355	0	76.96
	spec_arable	285	17.4731	13.3312	0	90.48
	sau_aff_d	285	15.2782	8.3972	0	57.14
	forgiu_indiv	285	92.5186	5.5687	50	100.00
	cond_coltdir	285	95.0991	4.8396	50	100.00
	cond_oth	285	0.8218	1.4277	0	12.50
Farmers characteristics	inform_d	285	5.9556	4.4668	0	38.65
	d_old	285	40.1942	7.3462	0	65.22
	av_etacapaz	285	59.9584	2.7019	43.1	72.00
	edu_agr	285	3.6538	2.8284	0	23.73
Policy characteristic	p_disacc_ha	285	559.5715	380.9898	0	3,289.01

The share of organic and integrated production adoptions are strongly diversified across the 285 Tuscany municipalities. These two variables have value between zero (means no adopter) and 25% and 35% respectively for organic and integrated productions.

With regards to table 2, data presented in table 3 even if same coding has been maintained, represent the count, sum or the average value per aggregated per municipality. Explanatory variables are classified in the same categories of table 2 with the inclusion of an additional category which is based on touristic supply. This category contains variables which measure the number of bed in hotel (alb\_\_pl\_alb) and in rural tourism (alb\_\_pl\_agri) for each Tuscany municipality. Such data has been collected using ISTAT data, about official statistics of Italian municipalities. Location variable are mainly composed by dummies variable which consider RDP zoning and the share of

the UAA of the municipality under SIC or ZPS (sic\_zps), Nitrogen sensitive area (zvn) or all protected areas, including also regional protected areas (aree\_prot).

Variables belonging to farm characteristic category are the share of usable agricultural areas allocated to main crops growing in the regions: olive oil (totoli\_ha), forestry (tot\_bos), vegetable (tot\_ind) and grapewine (vite\_ha), energy crops (totene\_ha). Further variables in the same category are presented by the average farm size (av\_sau\_pf) and by dummy variables which describe the land tenure characteristic of the farm in the municipality (sau\_prop\_d= share of farms who are owner of the land; sau\_aff\_d= share of farms who rent-in land). In this category variable that describe share of farmers diversified by legal status are presented (forg\_giu = society; cond\_dir = farm allocated on farm more than 1/3 of the household labour and get the greater part of the household income from agricultural activity). Finally, variable that describes typology and intensity of productions are presented. These variables referred to share of farms that sold certified quality productions (quality) and the share of farm that diversified production through allocation of labour to on-farm activity different from crop cultivation and animal rearing (diver).

Considered farmer characteristics are the average age of the land manager, and the share of farmers that use internet to buy or sell farm inputs/outputs and share of farmers with agricultural education. Altogether explanatory variables used in both models trying to investigated the same determinants but are aggregated at different spatial level.

## **Results and discussion**

In this paragraph multinomial logit model results are presented and then spatial regression model results follow. Both models are addressed to investigate determinants of participation to organic and integrated production. The two models approaches, estimate determinants of participation to AESs in a different ways. Within Multinomial logit model determinants at farm level are identified, while applying spatial analysis determinants at territorial level are applied. Is worthy to note that even if analysis use same data, the two modelling approach does not return necessarily the same results due to explicitly consideration of spatial issues and development on the territory. In fact, in the latter models determinant of agglomeration effects are considered instead of simple adoption. Altogether, discrepancies among model could be consequence of spatial spillovers and by selection mechanism

implemented at territorial level, which are not captured by farm choice model and by unbalanced frequency of famers among the territorial areas.

Results of farm choice model toward adoption of organic farm or integrated production are presented in table 4.

Table 4. Multinomial logit model results.

VARIABLES	Organic system	Integrated production
rur_probsv	0.144*	0.220***
rur_trans	0.225***	0.134***
poli_urb		0.277***
d_protected	0.624***	0.797***
c_diff	0.556***	0.186***
d_quality	0.654***	0.297***
sau_vl	0.790***	1.045***
sau_vs	-2.562***	-1.553***
sau_l_ha	0.00362***	0.00293***
d_pratipascoli	0.187***	-0.117**
sauaff_d	0.132**	0.462***
corpi_l	-0.173***	0.394***
spec_perm	0.357***	0.271***
spec_arable	-0.507***	-0.158***
inform	-0.686***	-0.355***
d_old	-0.934***	-0.885***
edu_agr	-0.208**	0.147*
edu_low	-0.583***	-0.228***
live_on	0.286***	0.422***
lav_partime	-0.275***	-0.657***
lav_onlyfam	-0.472***	
cond_oth	-0.682**	
totbov		0.00126**
sfpr_year	5.31e-06**	3.80e-06*
sfp_ha		0.000779***
Constant	-1.709***	-3.087***
Observations	72,686	72,686
Adjusted R2	0.237	

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

The positive/negative sign of  $\beta$  coefficient, when significant, can be interpreted as the increase/decrease of the probability that a farmer with a certain characteristic adopted organic or integrated production compared with conventional systems. In fact, for both models (organic or integrated production), conventional production is the base outcome.

Variables which affect positively the probability to observe organic adoption are the location to rural areas with development problem or in transition. Farmers located in these areas show also, positive probability to adopt integrated production. Altogether, results confirm literature which identifies in the marginal areas (with lower quality or with disadvantages) these areas with lower

compliance costs. Otherwise, farms located in the urban area show higher probability of integrated production adoption, which are mainly consequences of higher opportunity wage for off-farm income (note that organic requires more labour than integrated and then conventional farming systems).

Results show that farm characteristics have same effects in explaining probability of integrated or organic production adoption. In particular, the quality production and on-farm diversification adoption positively affect the probability to observe adoption for integrated or organic systems. Furthermore, results confirm threshold effects on farm size on participation to both measures. In particular, transaction costs represent a barrier to participate into integrated and organic production for small farms. Different sign between determinant of organic and integrated production adoption are observed for specialisation and for farm efficiency. While participation to both measure are observed by permanent crops, farmers with areas allocated to grassland and meadow show positive probability to be involved in organic production. Such results are consequences of high payments compared with very low compliance costs for introduction or maintenance of these crops under organic farming system. Otherwise farmers with more than one plots shown high probability to be involved into integrated production due to high flexibility of the measure compared with organic productions, or possibility to disentangled production between plots.

Coherently with literature findings, farmers' characteristics such as age and education affect attitude and skill and they are relevant to explain organic or integrated production adoption. Young and well educated farmers show high probability to participate to AESs (Drake et al., 1999). Noteworthy that agricultural education positively affects integrated production adoption, while negative influence is associated to organic production adoption. Thus, result support high technical competence for integrated production due to the low quality in extension services received, comparing with organic.

Labour endowment and allocation of household labour among off-farm and off-farm activity are determinants of adoption of either integrated or organic. Results show that households who live on their farms have higher probability to adopt integrated or organic production, while, part-time farming affects adoption in different direction.

Connection between first and second pillar policies are strengthens by the results. In fact, Single Farm Payments, which are income support instruments, positively affect the probability to adopt AESs. In particular, amount of payments received per years highlights a positive correlated with organic and integrated production adoption. While intensity of payment (payments received per ha of UAA) positively affects integrated production adoption. Economic literature has identify SFP as

main component which enable to reduce credit market imperfections and then provide support adoption of innovative business models (such as for example organic and investment in equipments and tools for organic production). Furthermore empirical findings shown that eligible crops for SFP entitlement are mainly COP crops which require less compliance cost for integrated instead organic to maintain high level of quality in the productions.

In the remaining part of the paragraph the spatial model results are presented. Firstly a test of spatial dependency and spatial heterogeneity to share of organic and integrated production are performed. In table 5 test of spatial dependency and spatial heterogeneity are presented.

Table 5. Spatial dependency and spatial heterogeneity test of participation to AESs.

	organic production		integrated production	
	Statistic	p-value	Statistic	p-value
Moran's I	3.363	0.001	2.491	0.013
LM (spatial error)	6.328	0.012	3.109	0.078
Robust LM (spatial error)	3.029	0.082	0.33	0.566
LM (spatial lag)	3.348	0.067	8.265	0.004
Robust LM (spatial lag)	0.049	0.825	5.486	0.019

The Lagrange Multiplier Tests show that both spatial dependence and spatial heterogeneity significantly affect the distribution of the share of organic and integrated production. Tests positively support the application of spatial econometric models to improve estimation of the agglomeration effects of AESs adoptions. As supported by literature many of explanations variables could have spatial dependence and several elements which are not captured by the model (e.g. quality of institution, development and quality of networks) have spatial heterogeneity and could affect alternative performance in participation to AES across the several territorial areas. Then, following Anselin (1988), implementing spatial econometrics model instead of traditional OLS model allows to apply more robust estimation.). Thus determinants of share of adoption of organic (model 1) and share of adoption of integrated production (model 2) between Tuscany municipalities are provided in table 6.

Table 6. Results of spatial analysis models.

	Organic production (model 1)			Integrated production (model 2)		
	a-spatial	spatial lag	spatial error	a-spatial	spatial lag	spatial error
	Model A	Model B	Model C	Model A	Model B	Model C
plain	-3.835**	-3.777**	-4.196**	-9.189**	-7.433*	
zvn				0.613***	0.520***	0.569***
poli_urb	5.969***	6.273***	6.508***	16.76***	15.63***	15.74***
rur_decl	-2.079**	-2.098**	-2.396**			
alb_pl_agri	0.0303***	0.0294***	0.0303***	0.0600***	0.0569***	0.0592***
alb_pl_alb	0.00485**	0.00481***	0.00460***			
lav_onlyfam	0.271*	0.283**	0.348**			
av_sau_pf	0.187***	0.168***	0.187***	-0.296*	-0.274*	
d_quality	0.141***	0.128***	0.153***			
d_totbov				0.414**	0.414**	0.358**
corpi_1				0.152**	0.135**	0.139**
totoli_ha				0.233***	0.232***	0.219***
totene_ha		-4.897*	-5.199*	-15.98**	-17.33**	-17.60**
hedgerow	0.0727**	0.0691**	0.0711**			
spec_arable	-0.0950**	-0.0876**	-0.0891**	0.296**	0.303***	0.288**
sau_aff_d	0.135*	0.115*				
cond_coltdir				1.216***	1.128***	1.183***
Constant		-23.48*	-30.59**	-142.3***	-137.4***	-134.4***
rho		0.101*			0.182***	
lambda			0.251***			0.183*
Observations	285	285	285	285	285	285
R2	0.664	0.668	0.661	0.515	0.5312	0.5132
ADJ R2	0.6317			0.4717		

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

For each AESs considered (organic and integrated), model A refers to the OLS, while model B and C refer respectively to the spatial lag and spatial error models.

The  $R^2$  values vary among the models. Both spatial models shown high  $R^2$  values, which confirm an improvement of the estimation for both spatial lag and spatial error models. Spatial dependence ( $\rho$ ) and spatial error coefficients ( $\lambda$ ) are significant and positive. Altogether significance and positive signs of both  $\rho$  highlight that inter alia, increasing of one percent the share of organic or integrated production in one municipality there are, in neighbourhood municipalities, increments more than 0.10 for organic production and almost 0.20 for integrated production. Thus, results pointed out a more agglomerated participation to integrated production rather than organic.

Results highlight that location affects the share of adoptions. In particular location in the plain has negative effect on expected share of organic production. While share of integrated production are mainly due to spatial heterogeneity as confirmed by non-significance of the variable under spatial error model. Results of Multinomial logit model show opposite effects of this variable on AESs participation. The share of integrated production is positively affected by share of nitrogen

vulnerable areas into municipality, which represent a spatial priority for the both measure. The positive and significant coefficient is determinate by design of integrated production measure. In fact, priorities to targeted areas are applied. Otherwise, zoning is not a determinant of share of organic farming. Then results show that agglomeration effects of organic adoption are driven mainly by motivation rather than by policy mechanism. RDP zoning strongly affected the share of participation. Positive effect on the share of both AESs is observed by location in urban areas due to closeness to urban markets.

Undertaken spatial analysis allows the inclusion, as explanatory variable, of some elements of territory endogeneity, such as for example touristic supply/demand. Then, results show that area with high touristic supply (measured as number of bed in hotel per municipalities) increase the expected value of participation of AESs. Share of organic farming are also positively correlated with development of rural tourism in the areas. Results confirm previous literature finding, where high intensity of diversification has been observed by organic farming and represent a farm business strategy (Bartolini et al. 2013).

Spatial model results show that both farm and farmer characteristics have relevant role in explaining adoptions. Results confirm finding of farm choice model, where endowment of household labour and legal status affect participation. Particularly, household labour use positively affects organic farming adoptions while direct cultivation legal status positively affects integrated productions.

Results show that with the exception of farm size, which positively increase the share of organic and negatively affects the share of integrated production, other farm variable, such as land use, number of plots, livestock activities, increase the expected value of integrated productions.

Is worthy to note, that share of organic farming and agglomeration of farmers who sold quality products, are strongly correlated each other. In fact, results show positive and significant value of coefficient *d\_quality* highlighting that quality products and organic farming may share relevant network of producers and belong to the same food chain.

Results confirm previous literature findings about substitution effects between AESs and energy crops (Giannoccaro et al., 2013). In fact those areas whit high share of land allocated to energy production show lower share of AESs, as consequences of negative and significant coefficient (*totene\_ha*). Spatial analysis confirms difference effects of specialisation in arable crops between integrated and organic farming.



## Conclusions

In this paper determinants of AES adoption are investigated. The Methodology applied allows comparing hints from farm level model (multinomial logit model) and territorial level model (spatial econometric analysis). Dependents and covariates variables are referred to the same dataset, but with different spatial aggregation. The first model (Multinomial logit) investigates determinants of adoption at farm level of organic or integrated production, while the second model analyses agglomeration effect of participation to organic or integrated production in Tuscany municipalities.

Results are consistencies among models in explain determinants of integrated and organic production adoption and through model results comparison is possible to get better understands of the AESs participation mechanism. Results confirm previous literature finding, identifying in farm, farmers, location and household characteristics the main determinates to explain multifunctional practices adoptions.

Models investigate determinants of adoption of organic under AESs, however not all organic farmers participate to agri-environmental schemes, but many farmers sell organic production without to be involved in the AESs. The main reason is identified in high transaction costs to participate to AESs, or in less flexibility of the measure. Thus this paper focus only on the participation to AESs and determinants are investigated only for these farmers. Such consideration has some practical implication about design and additionality of the AESs. In fact many farmers will continue to adopt organic production even in case of payment abolishment, due to the motivational elements which are connected with networking and social capital. Then such elements could represent deadweight in the programming implementation.

Results highlight that there are strong connections between first and second pillars policy, and there are not a “paradigm conflict” between models of development, as pointed out by literature. In fact, both first and second pillar maintain viable farming, agricultural profitability, and the promotion of multifunctionality managements systems. Furthermore, results show that inclusion of cross-compliance as baseline of AESs and the linkage between two pillars has the effect to rationalise farm choice and could determine higher adoption, reducing participation costs. Such relation is strength by inclusion of greening, which represents additional green commitments in turn of additional SFP payment as well as represent an additional baseline for AESs. Despite the identification and the design of greening are now under revision and future works on this direction could be relevant to investigate effect on determinants.

Both models show that adoption of organic farming is more affected by motivational, information and networking elements rather than integrated production. As a result, the agglomeration of organic production is less sensitive to priority mechanisms implemented by local administrations to spatially concentrate the participation. The development of better policy target is a central issue into the design and implementation of RDP program. Particularly for environmental objectives a spatial agglomeration and spatial concentration in targeted areas is key factor to measure program effectiveness. Despite, results show that priority mechanisms or selection criteria implemented by local administration have no effect to determine desirable spatial distribution of participation to organic farming. To strength participation to targeted area may be relevant to develop collective participation in order to improve networking and social capital and information flows among farmers.

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