LINKING CROSS-COMPLIANCE AND AGRI-ENVIRONMENTAL SCHEMES: A CASE STUDY IN EMILIA ROMAGNA

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Abstract

Agri-environmental schemes (AES) have been studied under different perspectives in Europe, since the beginning of the '90s. Under regulation 1698/2005, agri-environmental schemes design has been modified with a more clear identification of a baseline for identifying the commitments and the costs of these prescriptions.

The link between cross-compliance and agri-environmental schemes can be interpreted as a problem of joint design by the decision maker. From the farmer's point of view, private costs of participations in agri-environmental schemes shall be added to the cost to be compliant with the mandatory standard defined for each measure if they are not already implemented. This amount of costs arise when mandatory standard are required in the whole farm, even if agri-environmental schemes are applied in a small portion of the farm.

The objectives of this paper is to investigate the farmer choice under different amounts of control and sanctions about the application to mandatory standards and about the commitments required by agri-environmental schemes, in conditions of moral hazard. A case study in an area of Emilia Romagna (Italy) has been developed. The simulations are referred to an agri-environmental scheme relative to input reductions use. The model offers useful insights about the mechanisms of compliance in agri-environmental schemes and their implications for the effects of policies in the case study area.

Key words: Agri-Environmental Schemes, Cross Compliance, Farmers' Behaviour Modelling, Moral Hazard

JEL Code: Q10, Q18

Introductions

Agri-environmental schemes (AES) and cross-compliance (CC) are the two components of the Common Agricultural Policy (CAP) more explicitly aimed at providing environmental benefits from agriculture. Large part of the literature treats this topic (see for example Hodge, 2000; Dobbs and Pretty, 2004; Osterburg et al., 2005; Helin, 2008).

AES have been studied under different perspectives in Europe, since the beginning of the '90s (see for example Feinerman and Komen, 2003, Dupraz et al., 2002, Bonnieux et al., 2004; Latacz-Lohmann, 2004). Cross compliance is a more recent field of study connected to the implementation of this policy in Europe with the 2003 reform. Literature about this field is enriching in the last years (see for example Varela-Ortega and Calatrava (2004) Fraser and Fraser, 2005; Davies and Hodge, 2006; Bennet et al, 2006). Under regulation 1698/2005, agri-environmental schemes design rationale has been changed, with a more clear identification of a baseline for identifying the commitments and the costs of this prescriptions in order to justify payments. Such a baseline is generally identified as commitments of cross-compliance, as mandatory standards. This connection is now to be interpreted as a major component of policy design and analysis, as it sets the border line between the field of positive and negative externalities.

There are two different perspectives on this connection. On one hand, the linking between cross-compliance and agri-environmental schemes can be interpreted as a problem of the decision maker that would like to jointly design AES and CC. The joint problem in this case may involve the impact of the CC prescription on the design of AES, allocation of funds to the two measures and the connected implementation of mechanisms of control and sanctions that may be able to guarantee the respect of both agri-environmental commitments and of the mandatory standards, defined for each measure. From the farmer's point of view, the implementation of the two policies brings a decision problem concerning participation and compliance to the combination of the two measures. In particular, private costs of participations in agri-environmental schemes shall be added to the cost to be compliant with the mandatory standard defined for each measure if they are not already implemented. This amount of costs may be very relevant as mandatory standard are required in whole farm even if agri-environmental schemes are applied in a small portion of the farm.

Recently, the Italian ministry of agricultural food and forestry has promulgated a new framework regulating the mechanisms of controls and sanctions to the cross-compliance commitments and mandatory standard when they are pertinent for agri-environmental commitments. This action would like to tailor more effective sanction mechanisms for ensuring the compliance with cross-compliance and agri-environmental commitments.

In spite of the increasing connection between the two policies, to the best knowledge of the authors no study deals directly with the problems raised by the joint design of the two policies. In this paper we investigate the problem from the point of view of the farmer's decision. In fact, the objectives of this paper is to analyze the farmer choice under different amounts of control and sanctions about the application to mandatory standards and about the commitments required by agri-environmental schemes, under moral hazard.

The paper is organised into four further sections. Section 2 is a theoretical analysis of farmers' behaviour facing the joint decision about participation and compliance in CC and AES. Section 3 is a descriptions of an example based on a case study. In sections 4 the results of simulations are presented, while sections 5 provides a discussion.

Model

A large literature treats the compliance of CC or AESs commitments mainly based on targeting of the policy or contract that reduce moral hazard (see for example Choe and Fraser1999, Fraser, 2002; Wu, et al., 2001; Bartolini et al., 2005; Hart and Latacz-Lohmann, 2005; Bartolini et al., 2008a , Bartolini et al., 2008b)

In order to investigate the effect of the linking between CC and AES commitments, a farmer's behaviour model has been developed. This model is an extension of agent's part of the model developed by Bartolini et al. (2008a) with inclusion of the choice to participate to AES contract, but without to obtain an optimum contract design[1].

Let us assume that the farmer can produce some environmental good ε. There will be some level of environmental good that the farmer is obliged to produce through CC (let us say ε^c) without any additional payment (though the compliance is a requirement for maintaining the full single farm payment). If the farmer choose to participate in an AES contract, he uptakes an higher obligation ($\varepsilon^a > \varepsilon^c$) and has the right to require an additional payment for such an obligation. We represent the cost of providing the environmental good as a function $\Psi_i(\varepsilon_i)$, with $\psi_i'(\varepsilon_i) \geq 0$, $\psi_i''(\varepsilon_i) \geq 0$, $\psi_i(0) = 0$ and $\psi_i'(0) = 0$, where *i* represents the farm (type).

We would then represent CC costs as $\psi_c = \psi\left(\varepsilon^c\right)$ for CC; and $\psi_{a+c} = \psi\left(\varepsilon^a\right) + \psi\left(\varepsilon^c\right)$ for cost of both CC and agri-environmental commitment.

Several qualifications apply to this general setting. First of all, CC commitments may be not homogeneous (in terms of environmental good or technical specifications) with the attached AES commitment. In addition, they may be non homogeneous in area of application, as CC have to apply to the whole farms, while some AES requirements apply to only a partial

[1] In Bartolini et al. (2008a) the authors have developed a principal agent-model in order to obtain an optimal policy design. As a consequence of focus of this paper in the joint applications of CC and AESs, we consider in this work only the farmers' choices with the option that farmers can be not compliant with the CC or AESs commitments (moral hazard).

share of the farm. Secondly, farmers may be rather homogeneous, but, more frequently, are heterogeneous with respect to compliance costs.

In addition, not all farmers are obliged to CC, as not all of them receive payments. Finally, if we assume asymmetric information, farmers may be subject to self selection or partial compliance with respect to the theoretical constraints proposed by the public administration. This may apply independently for CC and AES, or jointly.

In this paper we focus on homogeneous AES and CC requirements, applying to the same unit of land, but with heterogeneous farmers. Our focus is farm reaction and the consequences for policy design.

We model compliance to a generic set of prescriptions of CC through a continuous variable $e_i^c = [0,1]$, where e^c represents the degree of compliance of farm type *i*. In addition a generic set of compliance of AES is modelled as continuous variable $e_i^a = [0,1]$ where e^a represents the degree of compliance and *i* represent the farm type.

The farmer *i* receives a single farm payment (SFP) P_i (average per hectare as the average of the whole farm land of each farm) determined by his historical payment entitlements. In case he is not compliant, a sanction is raised. Farmers can also choose to be involved in AES. In his case they receive a fixed payment P_i^a per hectare for the provision of a given amount of public good. Such payment is calculated as a compensation of the income foregone plus the additional costs, based on average conditions in the area involved in the scheme.

The farmer receiving the SFP will provide an amount of environmental good ε_i^c that is equal to the product between the compulsory amount of environmental good under CC (ε_i^{c*}) and the degree of compliance (e_i^c). The decision to provide environmental good under AES contract is structured in the same way. This means that farmer *i* receives agri-environmental payments and in return will provide an amount of environmental good ε_i^a that is equal to the product between commitments of AES (ε_i^{a*}) and the degree of compliance (e_i^a). Under this considerations we could also re-define: $e_i^c = \frac{\varepsilon_i^c}{\varepsilon_i^{c*}}$ and $e_i^a = \frac{\varepsilon_i^a}{\varepsilon_i^{a*}}$. Note that under the assumption that CC and AES are linked and identifiable on a continue functions, the compliance in both AES and CC may be write as: $e_i^{a+c} = \frac{\varepsilon_i^{a+c}}{\varepsilon_i^{a+c*}}$

It should be noted also that, under this formulation, while the cost of the participation to the AES is based only on the differential of costs between those imposed by the AES and those imposed by the cross-compliance, the degree of compliance to AES implies also the compliance to CC (and not the other way round).

Sanctions for not be compliant with CC or agri-environmental commitments are calculated in the same way as a function of the payment ρP, where ρ represents the share of payment subtracted as a sanction. As the punishment for non-compliance relates to the right to receive the payments, in the model we always assume that $\rho \leq 1$. Sanctions for cheating CC standards is equal to $\rho^c P^c$ and sanctions for cheating agri-environmental commitments is equal to $\rho^a P^a$.

Both ρ^c and ρ^a may be treated as policies design variables, as the regulator may have the option of changing/adapting its value to encourage compliance, also by differentiating it across farms. However, as this may create political/equity difficulties we assume it cannot be differentiated among farms.

The probability of non-compliance being detected for both CC and AES commitment depends on a number of parameters, including some random effects (e.g. mistakes or weather conditions). We simplify the problem by calculating the probability of the non-compliance being detected based on two parameters: non-compliance (directly correlated) and monitoring (inversely correlated). We assume that the probability that non compliance is detected, if some non compliance exists, is equal to the degree of non-compliance, i.e. $(1-e_i^c)$ for CC and $(1-e_i^a)$ for AES. Monitoring intensity (m^c, m^a) is the expectation that a farm is monitored respectively for CC and for AES. An estimate of this may be reasonably derived by the announced percent of farms monitored each year. It can take a value between 0 and 1. We use it as a direct representation of the probability that a non-compliance is detected. In other words, in any farm monitored, if it is non-compliant, non compliance is detected with probability $(1-e_i^c)$ for CC and $(1-e_i^a)$ for AES, the total probability that non compliance is detected is equal to $m^c(1-e_i^c)$ for CC and $m^a(1-e_i^a)$ for AES.

The farmer's behaviour model can be presented as problem where the farmer *i* has the options to choose one strategy among a set of four possible, based on the maximizations of the expected farm profit. Formally farmer's behaviour model may be presented as:

$$\pi_i = \max\left(\pi_i^0, \pi_i^c, \pi_i^a, \pi_i^{a+c}\right) \quad (1)$$

With:

π_i^0 = expected farm profit when farmer is involved in neither SFP or AES;

π_i^c = expected farm profit when farmer receives SFP and must applied CC commitment;

π_i^a =expected farm profit when farmer participates in AES;

π_i^{a+c} =expected farm profit when farmer receives SFP and participates in AES.

The profit function when farmer *i* is not involved in neither SFP or AES is identify as: $\pi_i^0 = -\psi_i\left(\varepsilon_i^0\right)$. It is intuitive that without being involved in SFP or AES the optimal amount of environmental good provided by farmer *i* is equal to zero.

The expected profit when farmer *i* is involved only in SFP can be determined by the sum of the profit function in case the non-compliance is not detected and the profit function in case the non-compliance is detected, each one multiplied by the respective probability (Bartolini et al., 2008a):

$$\pi_i^c = \left(1 - \left(m^c(1-e_i^c)\right)\right)\left(P_i^c - \psi_i\left(e_i^c\varepsilon_i^{c*}\right)\right) + \left(m^c(1-e_i^c)\right)\left(P_i^c - \rho^c P_i^c - \psi_i\left(e_i^c\varepsilon_i^{c*}\right)\right)$$
(2)

Following Bartolini et al. (2008a) the first order condition with respect to optimal level of compliance is:

$$\frac{\partial \pi_i^c}{\partial e_i^c} = -\varepsilon_i^{c*}\psi_i'\left(e_i^c\varepsilon_i^{c*}\right) + m^c\rho^c P_i^c = 0$$

which yields:

$$\psi_i'\left(e_i^c\varepsilon_i^{c*}\right) = \frac{m^c\rho^c P_i^c}{\varepsilon_i^{c*}}.$$

The optimal level of compliance depends on the monitoring intensity, the degree of sanction and the payments. When any of the three is zero, the marginal cost of compliance (hence compliance) will be zero.

The expected profit when farmer *i* is involved in AES, similarly to the case of SFP, may be determined by two components: the profit function in case the non-compliance with respect to agri-environmental commitment is not detected and the profit function in case the non-compliance with respect to the agri-environmental commitment is detected, each one multiplied by the respective probability:

$$\pi_i^a = \left(1 - \left(m^a(1-e_i^a)\right)\right)\left(P_i^a - \psi_i\left(e_i^a\varepsilon_i^{a*}\right)\right) + \left(m^a(1-e_i^a)\right)\left(P_i^a - \rho^a P_i^a - \psi_i\left(e_i^a\varepsilon_i^{a*}\right)\right)$$
(3)

The profit function may be simplified to:

$$\pi_i^a = P_i^a - \psi_i\left(e_i^a\varepsilon_i^{a*}\right) + \left(m^a(1-e_i^a)\right)\left(-\rho^a P_i^a\right)$$

Under first order conditions, the optimal level of compliance of AES is determined by:

$$\frac{\partial \pi_i^a}{\partial e_i^a} = -\varepsilon_i^{a*}\psi_i'\left(e_i^a\varepsilon_i^{a*}\right) + m^a\rho^a P_i^a = 0$$

which yields:

$$\psi_i'\left(e_i^a\varepsilon_i^{a*}\right) = \frac{m^a\rho^a P_i^a}{\varepsilon_i^{a*}}.$$

The optimal amount of environmental good depends on the level of monitoring intensity of AES, the degree of sanction and the payments of AES. As for SFP case, when any of the three is zero, the marginal cost of compliance the agri-environmental commitments (hence compliance) will be zero.

The expected farm profit when farmer *i* is involved in both SFP and AES can be interpreted as the sum of equation 2 and 3, plus the increase of probability to be monitored in the CC commitments as a consequences of the adoption of AES. As in equation 2 and 3, the expected profit is determinate by two parts: the profit function in case the non-compliance with respect to CC and agri-environmental commitment is not detected and the restricted profit function in case the non-compliance with respect to CC and agri-environmental commitment is detected, each one multiplied by the respective probability:

$$\begin{aligned}\pi_i^{a+c} = &\left[\left(1-\left(m^c(1-e_i^c)+m^a(1-e_i^{a+c})\right)\right)\left(P_i^c-\psi_i\left(e_i^c\varepsilon_i^{c*}\right)\right)+\left(m^c(1-e_i^c)+m^a(1-e_i^{a+c})\right)\left(P_i^c-\rho^c P_i^c-\psi_i\left(e_i^c\varepsilon_i^{c*}\right)\right)\right]+\\ &+\left[\left(1-\left(m^a(1-e_i^{a+c})\right)\right)\left(P_i^a-\psi_i\left(e_i^{a+c}\varepsilon_i^{a+c*}\right)+\psi_i\left(e_i^c\varepsilon_i^{c*}\right)\right)+\left(m^a(1-e_i^{a+c})\right)\left(P_i^a-\rho^a P_i^a-\psi_i\left(e_i^{a+c}\varepsilon_i^{a+c*}\right)+\psi_i\left(e_i^c\varepsilon_i^{c*}\right)\right)\right]\end{aligned}$$
(4)

This expected farm profit may be simplified as:

$$\pi_i^{a+c} = P_i^c + P_i^a - \psi_i\left(e_i^{a+c}\varepsilon_i^{a+c*}\right) + \left(m^c\left(1-e_i^c\right)+m^a\left(1-e_i^{a+c}\right)\right)\left(-\rho^c P_i^c\right) + m^a\left(1-e_i^{a+c}\right)\left(-\rho^a P_i^a\right)$$
(5)

As a consequence of the simultaneity of adoption of CC and AES in equation 5 the compliance with respect to cross-compliance (e_i^c) can be redefine as $e_i^c = \dfrac{\varepsilon_i^{a+c}}{\varepsilon_i^{c*}}$ that represent the ratio between CC compliance commitments and environmental good produced as a consequence of the fact that the farmer receives SFP. Under this formulation variable e_i^c must have an upper limited $e_i^c = 1$ that implies the complete fulfilling of CC commitments. In the cases in which $e_i^c = 1$, the expected farm profit can be further simplified as:

$$\pi_i^{a+c} = P_i^c + P_i^a - \psi_i\left(e_i^{a+c}\varepsilon_i^{a+c*}\right) + m^a\left(1-e_i^{a+c}\right)\left(-\rho^c P_i^c\right) + m^a\left(1-e_i^{a+c}\right)\left(-\rho^a P_i^a\right)$$
(6)

Under first order condition, the optimal level of compliance of AES is determined by:

$$\frac{\partial \pi_i^{a+c}}{\partial e_i^{a+c}} = -\varepsilon_i^{a+c*}\psi_i'\left(e_i^{a+c}\varepsilon_i^{a+c*}\right) + m^a\left(\rho^a P_i^a + \rho^c P_i^c\right) = 0$$

Which yields:

$$\psi_i'\left(e_i^{a+c}\varepsilon_i^{a+c*}\right) = \frac{m^a\left(\rho^a P_i^a + \rho^c P_i^c\right)}{\varepsilon_i^{a+c*}}$$

The optimal level of compliance of CC plus agri-environmental commitments (with fulfils CC commitments) is depending on the monitoring intensity of AES and the expected reductions of cap and agri-environmental payments.

Otherwise when the CC commitment is not fulfilled ($e_i^c < 1$), the compliance variable can be written as: $e_i^c = \delta e_i^{a+c}$ where $\delta = \frac{\varepsilon_i^{a+c*}}{\varepsilon_i^{c*}}$ that representing the ratio between the agri-environmental commitment and CC commitment. This implies that the expected farmer profit, written in equations 5, can be simplified as:

$$\pi_i^{a+c} = P_i^c + P_i^a - \psi_i\left(e_i^{a+c}\varepsilon_i^{a+c*}\right) + \left(m^c\left(1 - \delta e_i^{a+c}\right) + m^a\left(1 - e_i^{a+c}\right)\right)\left(-\rho^c P_i^c\right) + m^a\left(1 - e_i^{a+c}\right)\left(-\rho^a P_i^a\right) \quad (6')$$

Under first order condition, the optimal level of compliance of both CC and AES is determined by:

$$\frac{\partial \pi_i^{a+c}}{\partial e_i^{a+c}} = -\varepsilon_i^{a+c*}\psi_i'\left(e_i^{a+c}\varepsilon_i^{a+c*}\right) + m^c\delta\left(\rho^c P_i^c\right) + m^a\left(\rho^a P_i^a + \rho^c P_i^c\right) = 0$$

Which yields:

$$\psi_i'\left(e_i^{a+c}\varepsilon_i^{a+c*}\right) = \frac{\left(m^c + m^a\right)\rho^c P_i^c + m^a\rho^a P_i^a}{\varepsilon_i^{a+c*}}$$

The optimal level of compliance (sum of compliance with respect to CC commitments and AES) depends on both monitoring intensity and in both levels of sanctions. Note that the linking between AES and CC has the effect to increase the “weights” of the sanctions of the CC with respect to the sanctions of the AES.

An example

The methodology described in the previous paragraph has been tested in one area of the Emilia Romagna Region, with the main aim of providing a numerical exemplification of the outcome of the model.

The area analyzed is referred to the municipality of Argenta, which is totally included in a nitrate vulnerable zone. As a consequence of this zoning, each farmer must be compliant with the commitments of the nitrate directive (directive 676/91 CEE), that implies the compliance to a maximum amount of nitrogen use (170 kg per ha). Furthermore, with the introductions of the 2003 CAP reform, restrictions due to the nitrate directive have been included in CC commitments as Statutory Management Requirements (SMR). This implies that in return of SFP, the farms that are located in nitrate vulnerable areas must be compliant with the restriction on nitrogen use. Furthermore, in the design of AESs, in particular for the measures of input reduction (indeed nitrogen reduction plays a major role on this measure) the prescriptions of CC have been identified as baseline. This means that the agri-environmental payment has been tailored as a compensation of the further cost deriving by the adoption of agricultural practices that are able to go beyond the CC commitments.

In fact, in the justification of AESs for the program 2007-2013 the Emilia Romagna Region, for these schemes of nitrogen reduction, has linked the nitrogen prescription of CC as the baseline for AESs (Emilia Romagna Region, 2007). The joint application between CC and AESs on nitrogen use reduction has been analyzed with the main objective to investigate the role of monitoring in the farmers' incentives to comply.

An average cost function of nitrogen reduction of the municipality of Argenta has been adopted: $\overline{\psi}(a) = 0.0288a^2 + 0.0814a$

where:

a = reduction of nitrogen use (kg per ha);

$\overline{\psi}(a)$ = average compliance cost.

The cost function has been derived through linear programming modelling of farmers' behaviour in the area of municipality of Argenta, through a parameterization of the amount of nitrogen available in the farm (Bartolini et al., 2007).

For the purpose of discussing the effect of adoption of CC and AES commitments, the diversification among farms is a critical issue. In this case, it has been assumed that cost functions of different farms may be obtained as a fixed proportion of the average cost function, assuming a range of plus or minus a percentage (g). For this purpose a differentiation of plus, minus 10%, 40% 70% with respect to the average cost function has allowed to identify six different farm types with respect to the cost of nitrogen reduction.

The farms are differentiated only according the cost function of nitrogen use reduction; other parameters, such as SFP, AESs payments and both CC and AES commitments are assumed to be the same among farms. Actually SFP has been identified in 100 € per ha, AESs payments in 70 € per ha and the amount of nitrogen use reductions are 50kg per ha for CC and 100 kg per ha for AESs + CC. The value of those parameter are not different from the real applications of cross-compliance and agri-environmental schemes concerning measure of input reduction in Emilia Romagna (Emilia Romagna Region, 2007; De Roest, 2008; Canatossi and Ansovini 2008).

Following the prescriptions of MIPAF (2008), the percentage of payments reduction in the case of fully no-compliance of CC and AESs commitments is equal to 100% of the payments (which means that $\rho^c = 1$ and $\rho^a = 1$). Simulations has been realized using the software GAMS through discontinue non linear programming parametrizing the value of monitoring intensity in CC and AES.

Results

Table 1 presents the results of simulations of the six farm types when $m^c = 0.01$ (monitoring intensity of CC) and with sensitivity analysis between 0 and 1 of monitoring intensity of AESs.

Table 1 - Nitrogen use reductions and payments (SFP and AESs) with $m^c = 0.01$

m^a	farm1		farm2		farm3		farm4		farm5		farm6	
	ε_i^{a+c} (kg/ha)	$P_i^c + P_i^a$ (€/ha)	ε_i^{a+c} (kg/ha)	$P_i^c + P_i^a$ (€/ha)	ε_i^{a+c} (kg/ha)	$P_i^c + P_i^a$ (€/ha)	ε_i^{a+c} (kg/ha)	$P_i^c + P_i^a$ (€/ha)	ε_i^{a+c} (kg/ha)	$P_i^c + P_i^a$ (€/ha)	ε_i^{a+c} (kg/ha)	$P_i^c + P_i^a$ (€/ha)
0	2.57	170	1.99	170	1.80	170	1.73	170	1.66	170	1.62	170
0.1	12.41	170	6.91	170	5.08	170	4.41	170	3.77	170	3.35	170
0.2	22.25	170	11.83	170	8.36	170	7.10	170	5.88	170	5.09	170
0.3	32.08	170	16.75	170	11.64	170	9.78	170	7.99	170	6.83	170
0.4	41.92	170	21.67	170	14.92	170	12.46	170	10.09	170	8.56	170
0.5	50.60	170	26.59	170	18.20	170	1.73	100	1.66	100	1.62	100
0.6	60.44	170	1.99	100	1.80	100	1.73	100	1.66	100	1.62	100
0.7	70.28	170	1.99	100	1.80	100	1.73	100	1.66	100	1.62	100
0.8	80.12	170	1.99	100	1.80	100	1.73	100	1.66	100	1.62	100
0.9	89.95	170	1.99	100	1.80	100	1.73	100	1.66	100	1.62	100
1	99.79	170	1.99	100	1.80	100	1.73	100	1.66	100	1.62	100

Given fix levels of monitoring intensity ($m^c = 0.01$) that could represent the actual level of monitoring intensity[2], the participation in AES and the compliance of CC commitments are different among farm types and changes increasing the value of the monitoring intensity of AESs (m^a). For all level of m^a all farm types receive SFP (showed in table with $P_i^c + P_i^a \geq 100$ €/ha) but farmers are generally not compliant with the prescriptions of CC, let alone commitments of the AES.

[2] Value of monitoring intensity in Italy is around 1% of the farm that benefited of the SFP (Catanossi and Ansovini, 2008).

Only with low value of monitoring intensity of the AES, farmers generally uptake the AES (showed in table 1 with $P_i^c + P_i^a = 170$), but they are cheating with both the CC and the AES commitments.

Only the farm type with the lower compliance cost (farm1) is fully compliant with the CC commitment for an high value of monitoring intensity of AESs ($m^a > 0.5$) but not completely with regard to AES commitments. Increasing monitoring intensity of AESs value, the nitrogen use reduction for all other farm types increases until the farmers decide to remain involved in AES. For further increase of m^a (higher than 0.5) the quantity of nitrogen reduction for farmers' types 2-6 are the same than in the case of not monitoring of agri-environmental schemes ($m^a = 0$).

Table 2 and table 3 present the results of simulations in the six farm type when $m^c = 0.1$ and when $m^c = 0.5$.

Table 2 - Nitrogen use reductions and payments (SFP and AESs) with $m^c = 0.1$

m^a	farm1		farm2		farm3		farm4		farm5		farm6	
	ε_i^{a+c} (kg/ha)	$P_i^c + P_i^a$ (€/ha)	ε_i^{a+c} (kg/ha)	$P_i^c + P_i^a$ (€/ha)	ε_i^{a+c} (kg/ha)	$P_i^c + P_i^a$ (€/ha)	ε_i^{a+c} (kg/ha)	$P_i^c + P_i^a$ (€/ha)	ε_i^{a+c} (kg/ha)	$P_i^c + P_i^a$ (€/ha)	ε_i^{a+c} (kg/ha)	$P_i^c + P_i^a$ (€/ha)
0	12.99	170	7.20	170	5.27	170	4.57	170	3.89	170	3.46	170
0.1	22.83	170	12.12	170	8.55	170	7.25	170	6.00	170	5.19	170
0.2	32.66	170	17.04	170	11.83	170	9.94	170	8.11	170	6.93	170
0.3	42.50	170	21.96	170	15.11	170	12.62	170	10.22	170	8.66	170
0.4	50.00	170	26.88	170	18.39	170	15.30	170	12.33	170	10.40	170
0.5	50.60	170	31.80	170	21.67	170	17.99	170	3.89	100	3.46	100
0.6	60.44	170	36.71	170	5.27	100	4.57	100	3.89	100	3.46	100
0.7	70.28	170	7.20	100	5.27	100	4.57	100	3.89	100	3.46	100
0.8	80.12	170	7.20	100	5.27	100	4.57	100	3.89	100	3.46	100
0.9	89.95	170	7.20	100	5.27	100	4.57	100	3.89	100	3.46	100
1	99.79	170	7.20	100	5.27	100	4.57	100	3.89	100	3.46	100

Table 3 - Nitrogen use reductions and payments SFP and AESs) with $m^c = 0.5$

m^a	farm1		farm2		farm3		farm4		farm5		farm6	
	ε_i^{a+c} (kg/ha)	$P_i^c + P_i^a$ (€/ha)	ε_i^{a+c} (kg/ha)	$P_i^c + P_i^a$ (€/ha)	ε_i^{a+c} (kg/ha)	$P_i^c + P_i^a$ (€/ha)	ε_i^{a+c} (kg/ha)	$P_i^c + P_i^a$ (€/ha)	ε_i^{a+c} (kg/ha)	$P_i^c + P_i^a$ (€/ha)	ε_i^{a+c} (kg/ha)	$P_i^c + P_i^a$ (€/ha)
0	50.00	170	30.35	170	20.70	170	17.20	170	13.81	170	11.63	170
0.1	50.00	170	35.27	170	23.98	170	19.88	170	15.92	170	13.36	170
0.2	50.00	170	40.19	170	27.26	170	22.56	170	18.03	170	15.10	170
0.3	50.00	170	45.11	170	30.54	170	25.25	170	20.14	170	16.83	170
0.4	50.00	170	50.00	170	33.82	170	27.93	170	22.25	170	18.57	170
0.5	50.60	170	50.00	170	37.10	170	30.61	170	24.35	170	20.31	170
0.6	60.44	170	50.00	170	40.38	170	33.29	170	13.81	100	11.63	100
0.7	70.28	170	50.00	170	43.66	170	17.20	100	13.81	100	11.63	100
0.8	80.12	170	50.00	170	20.70	100	17.20	100	13.81	100	11.63	100
0.9	89.95	170	30.35	100	20.70	100	17.20	100	13.81	100	11.63	100
1	99.79	170	30.35	100	20.70	100	17.20	100	13.81	100	11.63	100

Comparing table 2 and table 3 with table 1, it is possible to see that the effect of increasing monitoring intensity to cross-compliance can induce farmers to have higher reductions of nitrogen use than with $m^c = 0.01$. In fact with $m^c = 0.1$ (Table 2) the minimum level of nitrogen reductions is double than with lower monitoring intensity and with $m^c = 0.5$ the minimum level of nitrogen reduction is ten times higher than the level of nitrogen use reductions with lower monitoring intensity. Table 2 and Table 3 show that the nitrogen use reduction in front of different level of monitoring intensity has the same tendency, that has been highlighted in table1. As table 1 shows, the increments of monitoring intensity of AESs has the effect to induce farmers to increase the nitrogen reduction, until the farmers decides to remain involved in AES. However respect table 1 and table 2, with the level of monitoring intensity of CC of 0.5, the farms with low compliance costs (farmer 1 and 2) are generally complying with the CC commitments. Highest value of nitrogen reduced is particularly visible for farm1, that with all values of monitoring intensity of AESs ($m^a \leq 0$) it is fully compliant with CC commitments. This means that increasing the monitoring intensity in CC of from $m^c = 0.01$ to $m^c = 0.1$ the detections of not compliance for CC commitments is quite low.

Discussion

This paper provides an analysis with an application of the farmers' behaviour when cross-compliance and agri-environmental measures are linked and joint adopted. Through the modelling of the choice related to nitrogen use reduction, it was possible to investigate the effect of the different design of monitoring process on farmers' compliance when cross-compliance and agri-environmental schemes are jointly implemented. The results show that all farm typologies are interested to receive SFP, but only a small number is complaint with the cross-compliance commitments. Furthermore all farmer typologies are interested in participating in agri-environmental schemes but they are even more not-compliant in agri-environmental schemes commitments than cross-compliance commitment.

The results confirm that compliance can be increased with a higher intensification of monitoring of CC commitments. On the contrary, it is not possible to derive the same direct proportionality between AESs monitoring intensifications and nitrogen reductions, as a consequence to the additionality of the commitments and the voluountairy structure of the agri-environmental policy.

In the monitoring and sanction conditions assumed in the paper, the results show that the farmers use the agri-environmental payments to pay the cost of CC commitments. This consideration can be derived observing that given fix value of monitoring intensity of the cross-compliance commitments and raising monitoring intensity of AESs, farmers reduces the use of nitrogen . No further reductions of nitrogen use are observed respect those generated by compliance in CC commitments when that the level of monitoring in agri-environmental schemes is equal to zero or high.

Monitoring intensity in agri-environmental schemes and cross-compliance shall be accurate designed and in order to increase effectiveness, the controls and environmental prescriptions themselves should be considered as a variable to be adapted to incentive compatibility criteria.

This paper was an attempt to investigate the effects of simultaneous decisions at farm level about participation to cross-compliance and agri-environmental schemes. No asymmetric information between the public administrations and the farmers has been taken into account in the model, but in order to provide an optimal contract design the structure of principal agent model as well the inclusion asymmetric information could be generate useful improvements of the model. While the main aspects of compliance are caught by the model, other elements, that reflect the simplified assumptions made with respect to complexity of design policy, cross-compliance and agri-environmental commitments, cost structure, asymmetric information, considerations of the whole farm surface and other prescriptions, shall be investigating and analyzing with further research.

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