EFFECTIVENESS OF CROSS-COMPLIANCE UNDER ASYMMETRIC INFORMATION AND DIFFERENTIATED COMPLIANCE CONSTRAINTS

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Abstract— **The effects of cross-compliance depend on the strategies of participation/compliance of farmers, as well as on the ability of public administration to design appropriate policy mechanisms. The objective of this paper is to present a framework for the analysis of cross-compliance under asymmetric information with the option of differentiating commitments across farmers. The methodology is applied to a case study represented by the province of Bologna (Italy).**

The results show that, in the present conditions of control and sanctions, only a small share of farms is interested in complying with cross-compliance. The profitability of the choice of compliance/non-compliance depends mainly on the amount of single farm payment entitlements compared with the total land. The differentiation of restrictions across farmers, under relevant budget constraints for controls, appears a key strategic components in order to ensure the effectiveness of cross-compliance.

Keywords— **Cross-compliance, Asymmetric information, Single farm payment.**

I. OBJECTIVES

Cross-compliance, introduced with the reform 2003 of the CAP, is a structural part of the present EU policy and is likely to maintain a major importance in the future EU policy strategy [1]. However, the ability of cross-compliance to achieve environmental objectives and the costs of such achievements are still largely unexplored. The effects of cross-compliance depend on the strategies of participation/compliance of farmers, as well as on the ability of public administration to device an appropriate design for restrictions, control and sanctions. In this paper we address the issue of optimal cross compliance design when diverse agents can cheat and control is costly.

The objective of this paper is to present a framework for the design of cross-compliance under asymmetric information, considering different options for the differentiation of restrictions across farmers

This paper first develops a model of optimal control effort, based on the logic of the principal-agent approach under moral hazard. Then the model is tested using empirical information from an area of Emilia-Romagna (Italy), in order to check the relevance of the problem.

The remainder of the paper is broadly divided into four parts. Section 2 gives account of the literature related to the issue of cross compliance under asymmetric information. A model of cross compliance is presented in section 3, followed by the results in section 4. The paper ends with some discussion in section 5.

II. MORAL HAZARD ISSUES IN CROSS-COMPLIANCE

The incentive mechanism adopted in cross-compliance relies on the threat of a sanctions (reduction of payment) in the case non-compliance is detected.

It is a widespread expectation that in many cases this mechanism will not work, either because of the insufficient controls or of the difficulties in detecting non-compliance [2]. However, if the control/sanction mechanism works, the environmental effects are still conditioned to the ability of the payment to cover the costs of compliance. Farmers could prefer to give up the payment rather than have to comply with cross-compliance prescriptions. This consideration may be of major importance where payments are distributed in very small amounts by farm, as in Italy [3].

The information situation of the decision maker can be examined, in economic terms, under the heading of asymmetric information, with both moral hazard (possibility of cheating) and adverse selection (unknowingly differentiated agents).

This problem is to a large extent not addressed in the literature on cross compliance, in spite of its practical importance. Previous works on cross-compliance and the administrative costs of the CAP have already highlighted the role of controls and their costs [4]; [5]. The understanding of these issues may be relevant either in the ex-ante stage, in order to design appropriate incentive mechanisms, and in the evaluation stage, in order to take properly account of the most likely additional environmental effects of cross-compliance.

As incentive mechanisms are concerned, the issue of appropriate level and targeting of monitoring/control activities is a crucial one. Targeting of control activities may be based on past performance or on an ex ante announced concentration of monitoring effort on some sub-groups of agents [6] (Fraser and Fraser, 2005). According to [6] a robust theoretical background to a higher targeting of resource for controls do exist and this can potentially contribute to alleviate the moral hazard problem [7].

However, also tailoring of prescriptions in relation to payments and to environmental priorities have a clear role in policy design [8].

Related literature in the field of agriculture has mostly concerned voluntary agri-environmental schemes and their policy parameters, including mechanism design or compliance monitoring design [9].

Based on a wide stream of general economic literature [10], the problem of moral hazard in agricultural policy has been developed in recent years by a few papers (e.g., [11]; [12]), assuming the possibility of sanctions connected to the detection of non-compliance through monitoring, which effect is to increase the probability that the fraud is detected. Less frequently moral hazard is considered together with adverse selection (e.g., [13]). [7] develops a model when the design of targeting and compliance controls are considered together and in an inter-temporal framework.

These papers emphasise the importance of adequate systems of monitoring and sanctions. However, the mechanisms for non compliance are much more complex than these. Recently [14] have described the farmers' endorsement with the principle of cross-compliance not only as a consequence of perceived private economics advantage, but also as effect of the farmers' environmental attitudes and the acceptability of cross compliance as a governance mechanism. Furthermore there may be lack of information among farmers. Also, farmers may be different in terms of attitude to cheating or being honest, with implications for the optimal policy design and for the probability of non-compliance [15]. Risk aversion may also have a role here [7].

Building on this bundle of literature, this paper adopts a principal agent structure, with possibility of non-compliance and differentiated agents. However, contrary to most moral hazard literature, we assume that non-compliance can be perfectly detected with a sufficient level of control.

III. THE MODEL

We model compliance to a generic set of prescriptions through a continuous variable $e_i = [0,1]$, where e represents the degree of compliance and i represent the farm type. The cost of compliance is represented by a function $\Psi_i(e_i)$, with $\Psi_i'(e_i) \geq 0$, $\Psi_i''(e_i) \geq 0$, $\Psi_i(0) = 0$ and $\Psi_i'(0) = 0$.

Hence both the level of compliance and its cost may be different in different farm types and the cost increases more than proportionally with the increase of the level of compliance.

The farmer receives a payment 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. The sanction is calculated 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 $\rho \leq 1$. This parameter may be treated as a policy design variable, 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 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 ($1-e_i$). Monitoring intensity (m_i) is the expectation that a farm is monitored. 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 and can be differentiated by farm. 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 $(1-e_i)$ and the total probability that non compliance is detected is equal to $m_i(1-e_i)$.

We also assume that compliance is expressed as a percent of the total compliance required by the public administration to each farm type, denoted by E_i with $E_i=[0,1]$. Note that while e_i is a farm decision variable, E_i is a public decision variable exogenous to the farm. Also, e_iE_i represents the total level of implementation of the maximum set of measures under cross-compliance.

In addition e may assume some further transaction costs associated to the fact that non-compliance is detected (τ_i). This may reflect both personal aversion towards embarrassing situations with the public administration (trust, social capital) and pure transaction costs connected to the fact that detected non-compliance may lead to further time spent for controls and costs.

Under this assumption, the problem of the private optimal level of cross-compliance may be written as:

$$\text{Max}:\pi_i=\left((1-m_i)+m_ie_i\right)\left(P_i-\psi_i\left(e_iE_i\right)\right)+ \\ +\left(m_i(1-e_i)\right)\left(P_i-\psi_i\left(e_iE_i\right)-\rho P_i-\tau_i\right) \quad (1)$$

The profit of the farm i (π_i) is determined by two components: the profit in case the non-compliance is not detected and the profit in case the non-compliance is detected, each one multiplied by the respective probability. Note again that the probability of each event is determined by the monitoring level (exogenous to the farm) and by the degree of compliance (endogenous) and there is no further stochasticity due to errors in detection or other factors.

The possibility that the farms consider the costs of compliance too high and decides to give up the payment is not considered here. This is motivated by the fact that considering $\rho\le 1$ and likely $m_i\le 1$, such option will always yield a lower result compared with staying in the payment scheme and give up (part of) the payment only if the non-compliance is detected. Note that this does not apply anymore in case $\rho>1$, as the sanction could produce a cost beyond the payment and would be potentially profitable to stay out of the scheme in order to avoid such cost. This does not imply however that if $\rho>1$, it follows that for the farmer is never profitable to accept the payment, as the actual expected sanction also depends on the probability of detection.

We first note that $\left((1-m_i)+m_ie_i\right)$ and $\left(m_i(1-e_i)\right)$ are complements to one, which simplifies the profit function to:

$$\pi_i=P_i-\psi_i\left(e_iE_i\right)+\left(m_i(1-e_i)\right)\left(-\rho P_i-\tau_i\right) \quad (2)$$

Taking derivatives for e, the first order conditions are:

$$\frac{\partial\pi_i}{\partial e_i}=-\psi_i'\left(e_iE_i\right)E_i+m_i\left(\rho P_i+\tau_i\right)=0$$

Which yields:

$$\psi_i'\left(e_iE_i\right)=\frac{m_i\left(\rho P_i+\tau_i\right)}{E_i} \quad (3)$$

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

Let us now define a function *f*, such that $f_i\left(\psi_i'\left(e_iE_i\right)\right)=e_iE_i$. This is the inverse function of the cost function. It may also be written as:

$$f_i\left(\psi_i'(e_iE_i)\right)=f_i\left(\frac{m_i\left(\rho P_i+\tau_i\right)}{E_i}\right)=e_iE_i \qquad (4)$$

Taking now the point of view of a public administration, we consider the problem of maximising the welfare produced by the policy, by identifying optimal policy parameters. In principle the environmental value of cross-compliance, farmers' cost of compliance and shadow cost of public funds should be considered here. However, assuming a local administrative body in charge of cross compliance implementation, the problem could be largely simplified. In particular, as payments are exogenous and there is no particular benefit from the recovery of payments through sanctions, the problem could be represented as the maximisation of non-weighted compliance, subject to a budget constraint and taking into account farmers' optimal solution.

Assuming a given frequency of each farm type in hectares (λ_i), a total budget for controls *B*, and a cost per hectare of monitored land km_i, where k is the cost of 100% monitoring, we can write the public decision making problem as:

$$\text{Max} \sum_i \lambda_i e_i E_i \qquad (5)$$

s.t. (3) and:

$$\sum_i \lambda_i k E_i m_i \le B \qquad (6)$$

This representation appears realistic enough for the case of Italy and simple enough to be easily tractable both in the derivation of the theoretical solution and for computational purposes.

Based on 4, we can rewrite 5 as:

$$\text{Max} \sum_i \lambda_i f_i\left(\frac{m_i\left(\rho P_i+\tau_i\right)}{E_i}\right) \qquad (5')$$

Taking the Lagrangian this yields:

$$\sum_i \lambda_i f_i\left(\frac{m_i\left(\rho P_i+\tau_i\right)}{E_i}\right)-\gamma\left(\sum_i \lambda_i k E_i m_i - B\right) \qquad (7)$$

where γ is the Lagrangian multiplier for the constraint.

Optimal solution may be identified through the FOC, by taking first derivatives with respect to *E* and m and equalling to zero.

Optimisation (first derivative equalled to zero) with respect to the degree of monitoring yields, after some arrangements:

$$f_i'\left(\frac{m_i\left(\rho P_i+\tau_i\right)}{E_i}\right)=\frac{\gamma k E_i^2}{\rho P_i} \qquad (8)$$

Taking the first derivative with respect to *Ei* and equalling to zero yields:

$$-f_i'\left(\frac{m_i\left(\rho P_i+\tau_i\right)}{E_i}\right)\frac{m_i\left(\rho P_i+\tau_i\right)}{E_i^2}=-\gamma k E_i$$

from which:

$$f_i'\left(\frac{m_i\left(\rho P_i+\tau_i\right)}{E_i}\right)\frac{m_i\left(\rho P_i+\tau_i\right)}{E_i}=\gamma k$$

or

$$E_i = f_i'\left(\frac{m_i\left(\rho P_i+\tau_i\right)}{E_i}\right)\frac{m_i\left(\rho P_i+\tau_i\right)}{\gamma k}$$

The optimal solution found departs from the most common design of cross compliance because more often both monitoring effort and the set of compliance practices are the same across farms. For this reason, in the simulation we compare this result with the same model with the following additional restriction:

$$E_i = E \ \forall i$$

IV. CASE STUDY

The methodology is applied to a case study represented by the province of Bologna (NUTS 3, Emilia Romagna, Italy). The province has been selected as it offers a range of different environmental conditions, farm structure and Single payment entitlements. It covers a UAA of 146 thousand ha.

The province consists of 60 municipalities distributed on plain, hilly and mountain areas. The data used are based on the 2000 census. On the basis of the census structural data, farm types have been defined based on the average characteristics of each combination of municipality and farm size. This yields 600 farm types (60 municipalities by 10 classes of farm size). The payments assigned to every farm type are based on the crop mix and payments in place in the period 2000-2002.

Operationally the cost of compliance has been calculated as a quadratic function with the form $\Psi_i(e_i) = \varphi e_i^2$ and $\Psi_i'(e_i) = 2\varphi e_i$. As φ is considered as equal for all farm types, also $f_i'(m_i \rho P_i)$ will be the same and the difference between farms will be only due to P_i. Differences in P_i may depend on three reasons: the different location, the different mix of eligible crops and the different ratio between eligible crops and non-eligible crops in the crop mix.

About the latest point, an important factor is that cross compliance applies to the whole farm, while the payments do not. As a result, the difference between farms is strictly connected to the difference in the share of area eligible for payments. In fact, the higher the area eligible for payments, the higher the payment/cost ratio connected to cross compliance.

To the knowledge of the authors, a clear estimation of φ from the literature does not exist. Based on values reported in local literature [16], however, a reasonable range of such value has been identified between 10 and 40 euro/ha. Own calculation brings to results in the range of 23 to 110 euro. Taking an average of costs for farms in the plain area, the value of 53.6 euro/ha has been assumed in the simulations.

Based on [5], the control cost has been calculated in the range 5-15 euro/ha. Given the level of uncertainty, the model has been used mainly to for parametrisation purposes. In particular, values have been generated for all combinations of the extreme values of the two variables listed above, three levels of sanction (ρ =0.1, 0.5, 1) and two levels of budget availability (*B*=20.000, 100.000) for the whole area.

τ_i is considered uniform and, for sake of simplicity, equal to 5 euro/ha.

V. RESULTS

The results in the hypotheses of B= 20.000 euro and E=1 show little relevant effects in terms of compliance (table 1).

Table 1 Results at the optimal monitoring level (B=20.000 euro, E=1)

ρ	*k*	UAA controlled	UAA compliant	
	(€/ha)	(%)	(ha)	(%)
0.1	5	3	1276	1
	15	1	440	0
0.5	5	3	5586	4
	15	1	1928	1
1	5	3	10511	7
	15	1	3697	3

As the percent of area under farm types that receive no payment is only 4.6%, in all cases the vast majority of land (total land, minus land without payments, minus compliant land) will receive payments without complying with cross-compliance commitments.

Even when the sanction can be high enough to equal the whole amount of the payments and the cost of monitoring is sufficiently low, only a small amount of land is compliant (about 7%). This combination, however, is rather far from actual situation, where the sanction/payment ratio is 15% maximum and the percentage of area monitored is about 1%.

The controlled UAA is very small (as allowed by the budget) in percentage and only varies with k, as, due to the model structure, it is always preferable to use all the budget for controls till 100% compliance is achieved in a group before shifting to the next.

If a differentiated E is possible, the results are sharply better than in the previous case (Table 2).

Table 2 Results at the optimal monitoring level (B=20.000 euro, differentiated E)

ρ	*k*	UAA controlled	*Ei*	UAA compliant	
	(€/ha)	(%)	(%)	(ha)	(%)
0.1	5	16	17	24761	17
	15	8	12	17168	12
0.5	5	10	27	38787	27
	15	5	18	26893	18
1	5	8	33	48178	33
	15	4	23	33405	23

The effect is that the principal prefers to adapt *Ei* and allow at the subset of farmers with environmental restrictions to be fully compliant. As E is also a part of the cost function of the principal, this also allows to reduce monitoring costs by concentrating them on farmers with cross-compliance restrictions. As a result, optimal E is between 12 and 33% on average, while compliant area jumps to a range of the same amount (which is obvious as e=1 in the farms with restrictions).

This general picture does not change sharply when a more substantial budget for controls is assumed. In the first instance we consider a uniform E=1 (table 3).

Table 3 Results at the optimal monitoring level

(B=100.000 euro, E=1)

ρ	*k* (€/ha)	UAA controlled (%)	UAA compliant (ha)	(%)
0.1	5	14	5747	4
	15	5	2100	1
0.5	5	14	24197	17
	15	5	9055	6
1	5	14	43411	30
	15	5	16601	11

In this case, due to the much higher budget (5 times, but still below 1 euro/ha), the area under control increases substantially, however staying always below 14%. With this level of controls, the lowest levels of sanctions are still connected to negligible amounts of compliance. However, for higher level of sanctions, it is possible to reach about 30% compliance, when the costs of controls are assumed low.

Again, the results are much better in the case of differentiated E (Table 4).

Table 4 Results at the optimal monitoring level (B=100.000 euro, differentiated E)

ρ	*k* (€/ha)	UAA controlled (%)	*Ei* (%)	UAA compliant (ha)	(%)
0.1	5	47	29	42340	29
	15	23	20	29357	20
0.5	5	30	45	66324	45
	15	14	31	45987	31
1	5	24	56	82383	56
	15	12	39	57121	39

However, the differences between fixed and differentiated E are less relevant than in the low budget hypothesis. Noticeably, such differences become also less relevant the higher the sanction, i.e. the higher the percent of compliance.

VI. DISCUSSION

The results show that, in the present conditions of control and sanctions, only a small share of farms is interested in complying with cross-compliance prescriptions. The profitability of the choice of compliance/non-compliance depends mainly on the amount of single farm payment entitlements compared with the cost.

In such a contest, improvement in the organisation of restrictions and controls should be sought. One option is to differentiate compliance restrictions based on incentives rationale, i.e. taking into account expected sanctions and profitability of non-compliance.

Differentiated compliance restrictions may allow to concentrate monitoring efforts on less farmers, ensuring a higher effectiveness of control expenditure and a higher compliance altogether. Gains appear potential substantial based on the exercise described n this paper.

This option does not appear to be (formally) considered at the moment, as cross-compliance restrictions are applied based on zoning and environmental needs rather than on incentive considerations. On the other hand, there appear to be potential conflicts between incentive compatibility and property rights rationale to cross compliance design if this option was considered.

While the main points of compliance are caught by the model, it is clearly based on simplified assumptions with respect to the complexity of cross-compliance prescriptions, cost structure and the ability to detect non-compliance. Improvements may go in the direction of better specified compliance costs functions, possibly distinguishing the cost of single commitments and a better representation of differentiated farmers, for example in relation to their production specialisation. Interaction between monitoring and requirements differentiation could also be considered. Finally, personal attitude to compliance (and related motivations) should be treated in a more realistic way, possibly based on empirical evidence.

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