# Improving the design of agri-environmental policies: a case study in Italy

**Guido Maria Bazzani and Davide Viaggi***

**Abstract**

*The application of agri-environmental policies (reg. EEC 2078/92 and reg. EU 1257/99) has produced a wide literature about the best policy design options. The data arising from the first ex post evaluation exercises have contributed only partially to the discussion about how such measures should be implemented. This paper simulates the results of different policy design options under adverse selection and moral hazard using data obtained from the monitoring of regulation 2078/92 in Emilia-Romagna (Italy). The results show the interplay between policy instruments, monitoring costs and payments. As a consequence a more consistent design of such policy parameters is required.*

**Keywords:** *agriculture, agri-environmental policies, principal-agent, common agricultural policy, contracts, monitoring*

## Introduction

The application of Agri-Environmental Policies (AEP) has raised the issue of the best policy design options for their implementation. Among the relevant policy parameters, the definition of payment levels and the setting up of suitable monitoring procedures are two major issues on which the present policy design appears somehow unsatisfactory. The issue concerns both reg. 2078/92 and reg. 1257/99, that will run up to 2006 (Cesaro and Merlo, 1994; Caggiati et al., 1997; Falconer et al., 2001). The implementation of the Mid Term review and the reform of rural development funds, expected to be implemented in 2007, make such issues even more important in perspective.

In the last years a considerable amount of literature has been devoted to the analysis of these issues. A frequent approach is to use Principal-Agent models in order to evaluate alternative contract design options. While from the theoretical point of view improved instruments such as menus of contracts and auctions of contracts appear to be able to improve policy performance, the regulators show to be rather slow in introducing new solutions.

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The paper is a common work of the authors. In particular, G. M. Bazzani wrote section 2, while D. Viaggi wrote section 3 and 4. The introduction and the conclusions are to be attributed to both authors.

The general objective of this study is to explore the possible margin of improvement in the design of AEPs in Emilia-Romagna (Italy), building on data drawn from monitoring activities carried out in Emilia-Romagna on farms participating in reg. 2078/92. Different policy instruments and policy design options are tested through simulation of their effects under different regulator's objectives. The simulations are carried out using simple models drawn from the Principal-Agent literature and adapted to the specific institutional context of the area under analysis.

The structure of the paper is the following. After a short analysis of the policy parameters considered (section 2- AEPs issues in Italy), the models adopted are illustrated (section 3- The models). The results of the case study are presented in section 4 (A case study), followed by some general discussion.

## AEPs issues in Italy

The design of AEPs requires the definition of a number of policy parameters. Three of them are directly dealt with in this paper: the policy instrument to be adopted; the level and differentiation of payments; the features of monitoring and compliance controls.

The instrument more frequently adopted in Italy up to now is a flat rate payment per hectare, with some level of weak differentiation based on zoning, both under reg. 2078/92 and reg. 1257/99. Monitoring has been mostly viewed as a compliance control instrument. Monitoring frequency was defined a priori, at a level able to guarantee that all farmers were monitored at least once during the application of the programme (5 years). For reg. 2078/92, the monitoring started rather late compared with the first payments and more suitable forms of control have been set up under way.

Non compliance was associated to sanctions. Sanctions are normally set as a proportion of the payment (e.g. 10% or more of the payment), determined by the degree of non-compliance. The upper limit to sanctions is given by the value of the payment itself. This choice was mostly determined by political reasons, as it is reasonably acceptable for farmers.

Monitoring and evaluation activities corroborate the hypothesis that AEPs have been rather inefficient (non cost-effective) up to now (Gallerani et al., 1999; CSA, 1998-2000). Data at the farm level suggest that public expenditure in many cases is not effective or even necessary, because it supports techniques that would be profitable for farmers even without public payments (Regione Emilia-Romagna 2003b) (Table 1).

In addition, compliance costs are also rather heterogeneous, ranging, for integrated production on wheat, from below zero to above 500 euro/ha.

Results of compliance monitoring showed that only 57% of the farmers monitored were fully compliant (Regione Emilia-Romagna 2003a).

These few results corroborate the expert opinion that AEPs were carried out in a rather inefficient way and that improvements are necessary. Improvements may include different ways of setting the payment, closer to the actual compliance costs of heterogeneous farmers, and a more effective design of monitoring.

If the regulator was fully informed about farmers' compliance costs, he would devise a first best policy with payments covering the costs of each single farmer without loss of efficiency (in terms of rents for farmers) and without need of monitoring. Policy experience shows that this is not the case in the real world. Hence, the regulator faces the problems of improving efficiency through the identification of suitable second best policies.

A more cost-effective policy design requires a consistent combination of policy instruments, connected payments levels and differentiation, as well as monitoring.

**Table 1.** Estimated Economic impacts of changing farming practices under reg. 1257

| | Wheat | | Peach | |
|---|---|---|---|---|
| | With payment | Without payment | With payment | Without payment |
| | (euro/ha.) | (euro/ha.) | (euro/ha.) | (euro/ha.) |
| A1 – Integrated production | 411,45 | 260,40 | 1706,60 | 1.173,12 |
| CA1 - Counterfactual | 255,02 | 255,02 | 1062,29 | 106,29 |
| A1-CA1 | 156,43 | 5,38 | 644,31 | 110,83 |
| | | | | |
| A2 - Organic production | 183,83 | 18,05 | 71,66 | -660,97 |
| CA2 - Counterfactual | -16,62 | -16,62 | 151,59 | 151,59 |
| Difference A2-CA2 | 200,45 | 34,67 | -79,93 | -812,56 |

Source: Regione Emilia-Romagna 2003b.

The first issue concerns the choice of the instrument. In the bundle of available instrument options, the flat rate solution is clearly the one preferred up to now in real policy making. On the other hand, more refined instruments are possible, such as differentiated payments, menus of contracts or auctions of contracts. Of the last two, auctions are the main alternative to flat rate payment that can be found in actual policy experiences (Latacz-Lohmann and Van der Hamsvoort, 1998; Bazzani et al., 2002).

The payment should be able to provide incentives to participate, while reducing as much as possible farmers' rents. Hence, on one hand, it must be higher than the actual compliance cost of each farmers, that is unknown to the regulator. On the other hand, payments must be set up coherently with the design of other policy parameters, such as monitoring.

The relationship between payments and monitoring and information activities are at least twofold (White and Ozanne, 1997; Moxey et al., 1999; Bazzani et al, 2000). First, an ex-ante "management monitoring" may be necessary, with the aim of collecting information necessary for the implementation and management of each policy instrument, in particular for setting the payment level. The cost of such monitoring is changing in relation to each kind of instrument. In particular, it is higher for a personalised payment, as it requires more detailed information on the cost of each farm and, possibly, a negotiation effort. On the opposite, it is low or null for auctions, as payments are determined by farmers' bids. Secondly, a "compliance (or enforcement) monitoring" is necessary. Compliance monitoring affects the probability that the farmer is detected when cheating after the contract for the implementation of a given measure has been signed.

Enforcement monitoring ensures compliance only when connected to a consistent level of sanctions. Setting high sanctions can theoretically decrease substantially monitoring costs. However, decision makers rarely take into account such relationship. Sanctions are mostly decided upon ex ante, on the basis of political reasons or some legal reference.

On the basis of these considerations, three policy options where chosen for simulation in this paper (Table 2).

**Table 2.** Policy instruments considered

| | **Policy instrument** | **Description** |
|---|---|---|
| A | Flat rate payment | A payment per hectare is proposed to farmers. The payment is defined ex ante for each crop and area, and is paid to all farmers participating and complying with the farming practices proposed. |
| B | Differentiated payment | A payment per hectare is proposed to farmers. The payment is defined ex ante for each crop and farmer, after information is collected about individual expected compliance costs. The payment is made to farmers participating and complying with the farming practices proposed. |
| C | Auction of contracts | The regulator offers a given contract. Farmers bid their offer (payment required to participate). The regulator pays the $n$ lower bids. |

These policy options are compared through a set of principal-agent models under adverse selection and moral hazard. The models are tested on a specific data set, obtained from the monitoring of regulation 2078/92 in Emilia-Romagna (Italy).

## The models

### *General structure and assumptions*

The models adopt a very simplified principal-agent approach, under asymmetric information with both adverse selection and moral hazard (Rasmusen, 1994; Laffont and Martimort, 2002). This kind of model has gained growing attention in the analysis of AEP throughout the '90s and early 2000 (Fraser, 1993; Richard and Trommeter, 1994; Choe and Fraser, 1998; Viaggi, 1998; Torquati, 1998; Moxey et al. 1999; White, 2002; Gren, 2004). In this paper, well established model structures are adapted in a simplified manner to the specific institutional setting and information conditions of the case study.

The point of view adopted is that of the principal (regional administration) interested in obtaining some environmental improvement through the payments of an agri-environmental compensation to a set of agents (farmers). The policy instruments considered, as illustrated above, are a flat rate payment, a differentiated payment and an auction of contracts. While the models related to the first two have basically the same structure, with minor differences, the third adopts a rather different design.

Assume that there are $n$ farmers, potentially participating in an AEP. The $n$ farmers are a subpopulation of a wider group of farmers ($N$) and are selected as already participating in a previous agri-environmental scheme[1]. Each farmer ($i$) holds a farm with land area $S_i$ and with a single crop on which a single agri-environmental measure is applied, the same for all farmers. In this paper, the technique proposed is integrated agriculture (measure A1 of the regional plan under reg. 2078/92). Note that this technique may assume different names in different countries/schemes. The common point is the reduction of inputs such as fertilisers and pesticides, based on the preventive knowledge of pest population and soil fertility. It also involves pre-defined thresholds in pesticides and fertilisers.

Given the constraints on input use (which produce the environmental improvement) that the administration intends to propose, the *n* farmers have different compliance costs per hectare: $k_1, \ldots k_i, \ldots k_n$.

It is assumed that the only objective of the farmer is profit maximisation and that both the principal and the agent are risk neutral. For each farmer, two alternative technologies (fixed coefficients) are possible: one corresponding to the integrated production technique (as prescribed by regulation 2078/92), and the other corresponding to the conventional technology[2].

It is assumed that the farmers have some private information about such participation costs and the degree of compliance to technical constraints provided for in the agri-environmental contract. The regulator does not have such information. These assumptions are corroborated by empirical evidence illustrated in the previous section.

Given this structure of the problem, it is possible to identify the optimal parameters and the cost of the different instruments of AEP by maximising social welfare given the usual participation and incentive constraints (Laffont and Martimot, 2002; White and Ozanne, 1997; Moxey et al., 1999). This approach normally requires the determination of the environmental benefits of AEP. This is known to be rather a difficult task, particularly in this case where different potential environmental parameters are involved. In order to avoid this problem, it is assumed a cost effectiveness approach by the regulator, i.e. searching the least cost solution to achieve the same environmental objective. This does not solve the problem, as we still are not able to quantify the environmental objective.

For the purpose of these study, the environmental objective to achieve has been approximately measured through the degree of "compliant participation" by farmers. This choice is corroborated by the practice of AEP monitoring and evaluation (see for example European Commission, 2000; Regione Emilia-Romagna, 2003a), where participation is the main parameter the regulator uses to assess the success of the measures. In order to maintain compliant participation equal across models, the objective of inducing to participate all of the *n* farms is assumed as a constraint and the models are constructed in such a way as to make compliance incentive compatible. A simple way of applying this approach to empirical data is to assume an objective corresponding to the maintenance of the results obtained with the reg. 2078/92, i.e. the participation by the *n* farms and the adoption of the same integrated production technique used under regulation 2078/92.

This choice is not usually a profit maximising strategy for the regulator and is usually biased against the flat rate option. However, it may be compatible with applying it to a representative sample of farms already participating to an AEP. This is because they are the result of a selection process that may be expected to have screened the least cost farmers (Cesaro and Merlo, 1994; Sinabell and Streicher, 2004).

Payments can be only positive (there are no taxes for farmers polluting more or gaining more than the conventional technique).

Following the distinction between ex ante information and ex post compliance monitoring, we need to introduce two different variables in the model. The first is the cost of the ex-ante information necessary in order to manage the different instruments of AEP (*KI*). The second variable is the cost of monitoring necessary to induce a potentially dishonest farmer to comply with the constraints proposed by the agri-environmental measure adopted.

To obtain this, it is required a compliance monitoring, which allows to discover frauds with a probability $f$ (monitoring accuracy) variable between 0 and 1. The higher $f$, the higher the cost. We will consider a parameter of compliance monitoring cost ( *KC*), which is the cost per farm when $f = 1$. This formulation represents a simplified version of the model of Choe and Fraser (1999). The hypothesis of linearity for the cost of compliance monitoring can be considered a good approximation though it is not the most precise way of representing monitoring costs (White, 2002). It is further assumed that all monitoring costs are borne by the regulator and that the inaccuracy of monitoring cannot lead to detect a farmer as cheating when he is not (inaccuracy is one sided).

The ability of compliance monitoring to guarantee compliance depends on sanctions, represented in the model through the parameter $s$. The higher the parameter, the higher the sanction in the case the fraud is discovered. The parameter $s$ is defined as a proportion of the given payment. While this does not add particular information to the model, it allow to keep it in line with the way sanctions are quantified in the case study developed below, as, in Emilia-Romagna, they are designed as a percent reduction of payments. Thus, when cheating is detected, farmer is not excluded from the payment *and* submitted to a sanction, but the sanction is just subtracted to the payment. As sanctions are mostly determined according to political feasibility, they will be considered only as an exogenous variable in the model. However, the results will be parametrised upon the sanction level.

As a result of the structure of monitoring and sanctions, the expected sanction is equal to the payment received, times the parameter $s$, times the probability that the fraud is discovered. The expected benefit from cheating (assuming zero additional cheating costs) is equal to $(1 - f \cdot s) \cdot b \cdot S_i$, where $b$ is the payment per hectare. Only when $f \cdot s > 1$ a negative net sanction is possible.

The regulator can be interpreted as being able to have two alternative objective functions. The first is quantified by public expenditure, assuming that the efficiency objective is to spend as little as possible given a specified objective. A different solution is to attribute to the regulator an objective function linked to actual social cost, and, translated into our framework, to minimize the social cost of obtaining a given result. While the latter hypothesis is the one mostly used in the literature and the more correct from an economic point of view (White, 2002), the regulator takes more often decisions on the basis of budget considerations. Hence both options catch an aspect of the decision making process and can be considered relevant for our purposes.

***Flat rate payment***

Given these assumptions, as a first approach, the optimal flat rate payment and monitoring accuracy level can be found through the minimisation of the public cost function, constrained to participation and incentive constraints. Defining $b$ as the flat rate compensation, such minimisation can be represented as:

$$\min \sum_{i=1}^{n} (S_i \cdot b + KI + KC \cdot f) \tag{1}$$

Subject to:

$$\text{PC: } (S_i \cdot b) - (S_i \cdot k_i) \geq 0 \qquad (2)$$

and

$$\text{IC: } (S_i \cdot b) - (S_i \cdot k_i) \geq (1 - f \cdot s) \cdot b \cdot S_i \qquad (3)$$

for $\forall i \in n$

The component *KI* (cost of management monitoring by farm) is fixed and changes only in relation to variations in the number of participating farms (in this case all *n* farms). The application of a flat rate payment requires the collection of a small amount of economic information on a sample of farms.

The term $\sum_{i=1}^{n}(KC \cdot f)$ (cost of compliance monitoring), instead, changes not only as a function of *n*, but also of *f*. Hence, the public decision maker problem is not only to find out the optimal payment, but also to identify the combination of payment and monitoring level *f* that guarantees the minimisation of the public cost for a given result.

Equation PC (participation constraint) guarantees the profitability of participation for all *n* farmers, assuming reservation utility equal to 0. It may be reduced to $b - k_i \geq 0$, i.e. the payment per hectare must be higher than the cost per hectare.

The optimal (minimum) value for *b* (*b**) will be determined by the cost $k_n$ of the "marginal" farmer, i.e. of the last farmer participating, *n*, taking into account the impact of monitoring costs and sanctions. Lower payments will induce to participate only those farmers with cost lower than $k_n$.

From the point of view of the regulator, such configuration of the problem produces not only monitoring costs, but also inefficiencies due to farmers' rents. Such further cost depends on the distribution of compliance costs among the population of farmers. It is easy to understand that when compliance costs are very different over different farms, due to location, farm structure, etc., this kind of instrument is likely to be quite inefficient.

The constraint IC (incentive constraint) guarantees for all farmers the profitability of compliance, compared with total non-compliance (which means taking the payment while maintaining the conventional technology).

Constraint (3) may be reduced to $b - k_i \geq (1 - f \cdot s) \cdot b$ or to $-k_i \geq -f \cdot s \cdot b$ . The first form emphasises the fact that payment and monitoring level are linked, and a higher *f* is necessary when payments are higher. Hence, the level of payments and monitoring expenses are strategic complements in guaranteeing participation and compliance. The second form says that the expected sanction must be higher, in absolute value, than the cost, in order to guarantee compliance.

When assuming that the objective of the regulator is to minimise social cost, its objective function changes to the following:

$$\min \sum_{i=1}^{n} \left[ S_i \cdot (-b + k_i) + S_i \cdot b \cdot (1 + e) + KI + KC \cdot f \right] \qquad (4)$$

subject to (2) and (3).

Compared with the previous formulation, the equation includes the full cost of participation, which is to be considered as a loss of economic welfare, while the payments are not fully considered. Instead, only a part of them is included, calculated by multiplying the payment *b* for the shadow cost of the distortion due to taxation *e*.

***Personalised payment***

Another possibility is that of a personalised payment. The main difference is that the payment will be differentiated farm by farm on the basis of ex-ante collection of information. This requires an economic ex-ante monitoring for each farm. With respect to the previous case, three main differences arise:

- $b$ is substituted by $b_i$, a payment that can be differentiated by (type of) farmer;
- $f$ is substituted by $f_i$, as the monitoring accuracy can also be differentiated by (type of) farmer;
- the parameter $KI$ will be higher, due to the higher amount of information to be collected ex-ante.

***Auction of contracts***

In the case of auction, it is up to the farmer to decide what the requested payment would be, through the formulation of a bid.

The model runs in two stages. The first stage is based on the approach developed by Lactaz-Lohmann & Van der Hamsvoort (1997; 1998). The model assumes that the farmers hold private information about the profit of agricultural activity in their own farms, both under conventional and integrated production technology, denoted as $\Pi_0$ and $\Pi_1$ respectively. The decision about the bid $b_i^a$ (where $a$ is a reminder for auction) that the farmer may submit is determined by the trade off between the payoffs and the probability of acceptance. A higher bid increases the net profit, but reduces the probability of acceptance. The farmer's problem is hence that of determining the optimal bid, according to the maximisation of his utility, above the reservation utility.

Assuming that the farmers are risk neutral and simply maximise their net payoffs and assuming a rectangular distribution[3] of acceptance probability between $\underline{\beta}$ and $\overline{\beta}$ (respectively lower and upper limit of farmer expectations about the maximum acceptable offer) it can be showed that, for a risk neutral farmer, the optimal bid is determined as follows[4]:

$$b_i^{a*} = \max\left\{\frac{\Pi_0 - \Pi_1 + \overline{\beta}}{2}, \underline{\beta}\right\} \tag{5}$$

$$\text{s.t. } b_i^{a*} > \Pi_0 - \Pi_1 \tag{6}$$

Hence, the optimal bid is an increasing function of the opportunity cost and of the maximum bid cap. Under these assumptions, Lactaz-Lohmann e Van der Hamsvoort (1997; 1998) show that farmers truthfully reveal their type (i.e. their compliance cost) through the bidding process. However, some limits of the revelation mechanism are rather evident from (5). For example, even farmers with no participation costs will produce a positive bid, equal to 1/2 $\overline{\beta}$, or, at least $\underline{\beta}$, so behaving as free riders.

In order to apply such model to our problem, it is necessary to assume that:

- the $n$ farmers involved are only a part of a wider population of N farmers, and they expect competition from other farmers or the possibility to be excluded during the bidding process;
- during the selection process, no one of the $n$ farmers considered will be excluded.

These assumptions are rather peculiar, but they allow comparison between different instruments, are consistent with the general structure of the problem and are consistent with the way the sample is selected (see below) as the farms considered already took part in the AEP.

In the second stage, once all the bids are determined, the regulator defines monitoring as follows:

$$\min \sum_{i=1}^{n} (KC \cdot f_i) \tag{7}$$

subject to:

$$\text{IC: } (S_i \cdot b_i^{a*}) - (S_i \cdot k_i) \geq (1 - f_i \cdot s) \cdot b_i^{a*} \cdot S_i \text{ for } \forall i \in n \tag{8}$$

The objective function of the regulator does not include payments as they are determined by the bids of the farmers. In order for equation (8) to be satisfied, $s$ must be sufficiently high, as $f$ can change only in the range 0-1. Once the farmers have qualified through the bidding process, the regulator can change the level of $f$ according to each type of farm. Management monitoring is not included, because ex ante information gathering is not necessary, as the farmers auto qualify during the bidding process.

With the assumptions made in this paper for auctions, the objective function (and hence the outcome) is the same either assuming that the objective is to minimise social cost or to minimise public expenditure.

## A case study

### *Basic data and assumptions*

The models have been applied on ex-post data derived from the monitoring of the application of reg. 2078/92 on wheat production in the province of Bologna (Italy). The AEP measure considered is integrated production as defined above. Two kinds of information are required in order to feed the model illustrated in section 3: farmers' compliance costs and monitoring costs.

As the former point is concerned, data have been collected and elaborated as the difference between the results of integrated agriculture over a sample of 15 farms and the conventional technology in counterfactual farms. Data refer to years 1997-1999, (CSA, 1998-2000). In order to reduce the effects of extreme values, 4 clusters where produced and the average compliance costs taken for each cluster. One of them have a negative compliance cost (-36,5 euro/ha), while the other showed positive values (respectively 29,4, 74,1 and 168,7 euro/ha)

As for management monitoring, the cost for the collection and elaboration of information have been evaluated on the basis of monitoring carried out by Emilia-Romagna Region (Caggiati et al. 1997). Instead, for compliance monitoring, the evaluation of the parameter $KC$, the cost of $f$=1, is not available from past experience. A reasonable estimate is that the monitoring cost is approximately the same as the costs for having a person controlling the farmer during the periods when farming practice are to be performed. This lead to a hypothesis of $KC$=2500 euro. As this parameter is highly uncertain, the results have been later parametrised over a wider range of values of $KC$.

Further basic assumptions for auctions are that the upper bid cap is equal to 1,5 times the maximum cost per farm entered in the programme. In all cases $s$=1, i.e. the sanction is just equal to the payments received by the farmers, as it happens in reality in the case study area. In the absence of readily applicable information about *e*, it has been assumed equal to 0,2, in order to reproduce the magnitude of relevance attributed to this parameter by other studies about the issue of AEP (see, for example, Gren, 2004).

Models are solved using GAMS 2.5.

***Results***

The results of the case study for different policy options are illustrated in Table 3.

Let us first compare the outcome in terms of policy features. The relationship between average payment and monitoring accuracy is rather different for different policy options. While in the case of a flat rate compensation the payment would be very high (463 euro), with a monitoring accuracy around 0,36, in the case of a personalised payment the payment drops to 230 euro/ha, while the monitoring accuracy decreases to 0,18. Finally, auctions induce a further reduction of the average payment (103 euro/ha), while increasing the degree of monitoring. When minimising public expenditure instead of social cost, both policies show a sharp decrease of payments associated with a higher level of monitoring accuracy (more than double in the case of personalised payments).

**Table 3.** Results of the case study

| | Flat rate compensation | | Personalised payment | | Auction of contracts |
|---|---|---|---|---|---|
| | min social cost | min public expenditure | min social cost | min public expenditure | |
| f | 0,36 | 0,81 | 0,18 | 0,40 | 0,39 |
| Average payment (euro/ha) | 463 | 207 | 230 | 103 | 140 |
| **Social cost (euro)** | **231** | **295** | **130** | **161** | **153** |
| Compliance cost | 26 | 26 | 26 | 26 | 26 |
| Management monitoring cost | 12 | 12 | 20 | 20 | - |
| Compliance monitoring cost | 93 | 207 | 46 | 103 | 99 |
| Opportunity cost of public fund | 93 | 41 | 46 | 21 | 28 |
| **Public expenditure (euro)** | **576** | **434** | **288** | **218** | **239** |
| Total payments | 463 | 207 | 230 | 103 | 139 |
| Management monitoring cost | 12 | 12 | 20 | 20 | - |
| Compliance monitoring cost | 93 | 207 | 46 | 103 | 99 |

Both assuming as objective function of the regulator the minimisation of social cost and the minimisation of public expenditure, the personalised payment produces the best results. In comparing it with the flat rate payment, the main issue is the actual feasibility and cost of ex ante monitoring revealing farmers' costs. Data obtained for the case study show a rather low cost in comparison to the saving obtained on payments. However this cost may change greatly and possibly reverse the results in different areas, depending on farm structure, farm technical variability and the availability of previous information. Instead, in comparison with auctions, when minimising social cost, the savings of personalised payment is obtained at the expenses of a higher public expenditure for payments. On the contrary, when minimising public expenditure, the personalised payment produces a social cost higher than auctions.

The different results are brought about by the trade off between payment and monitoring costs when the social objectives switch from minimising social cost to minimising payments. When minimising social cost, payments count only for a fraction determined by the distortionary effects of taxation, while they count fully in the case of public expenditure. It is also to be reminded that social costs due to monitoring are actually higher payments to employees of the regulator and that their increase can also enter as a positive variable in the actual welfare function of the decision maker. On the other side, they are a true social cost only assuming that monitoring requires additional work and cannot be carried out by improving the efficiency of existing administrative personnel.

As for the composition of expenditure, management monitoring is not particularly relevant. The little increase in monitoring costs shifting from a flat rate payment to personalised payment is largely outweighted by the reduction of all other costs. On the contrary, compliance monitoring can take the same weight of payments and assume great relevance in defining policy results.

### *Sensitivity analysis*

The results illustrated up to now depend, on the assumptions about exogenous variables. In particular, *s, KC* and the upper bid cap for auctions. For all of them a sensitivity analysis has been carried out.

Increasing *s*, the total cost of policy implementation drops in all cases (Figure 1).

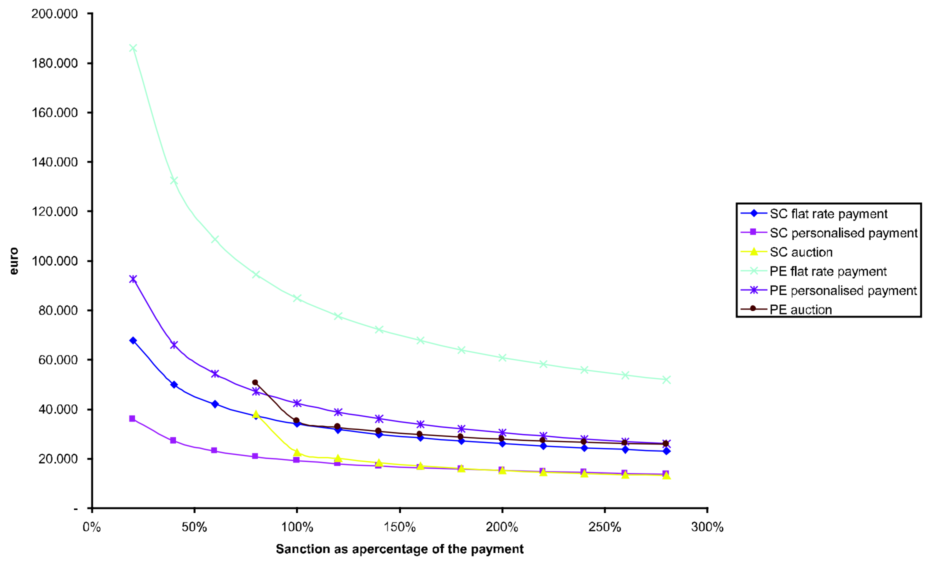


**Figure 1.** Sensitivity to the level of sanctions (*s*)

More interesting, there are some crossing points, in which different policy reverse their relative ranking. In particular, when considering social cost (SC) personalised payments are better for $s$<180% of the payment, while auctions are better above such limit. Taking into account public expenditure (PE), they are quite close for $s$ around 1. Auctions monitoring costs function stops growing under a certain degree of sanctions (around 80% of the payment). This is due to the way payments are defined during the first stage, i.e. the bidding process, that constrains the possibility to use payments in order to reduce monitoring. As a result, when the curve stops, the monitoring is at 1 and the regulator gives up the possibility to fully control farmers' behaviour.

As expected, the total cost increases with the parameter *KC* (Figure 2).

Again the more interesting point concerns crossings between auctions and personalised payments, as they identify areas in which the ranking of the best policy alternative changes. In particular, assuming a social cost function for the regulator, personalised payment is better than auction when KC is approximately between 300 and 1000 euro/farm. When taking into account the objective of minimising public expenditure, the personalised payment is better with KC<900 and is worse above.

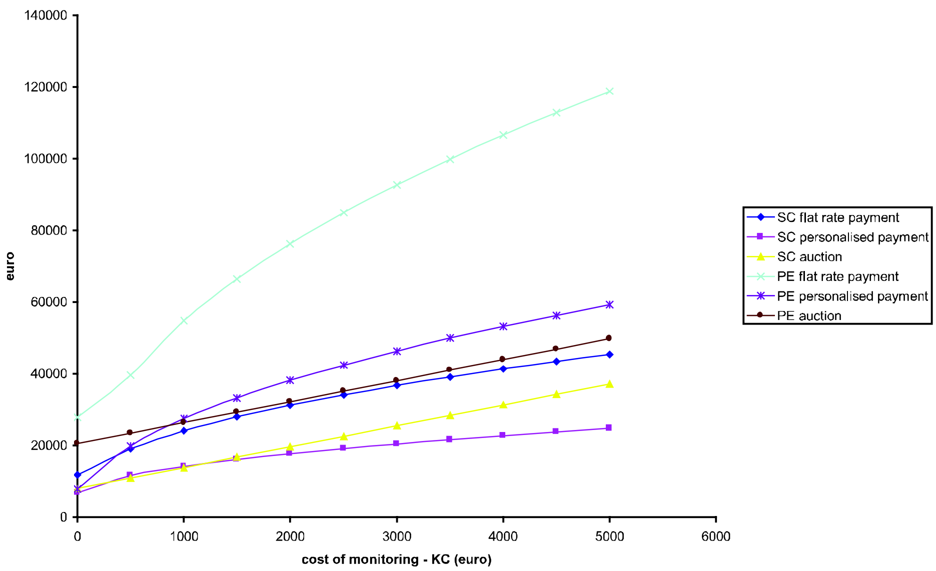


**Figure 2.** Sensitivity analysis to KC

As a consequence, depending on the actual cost of monitoring, the best policy shifts from one to the other. The flat rate payment is not competitive in any case.

Finally, the result produced by auctions depend on the assumption about the upper bid cap. Figure 3 shows the results of auctions as a percentage of flat rate payment, in terms of both social cost and public expenditure.

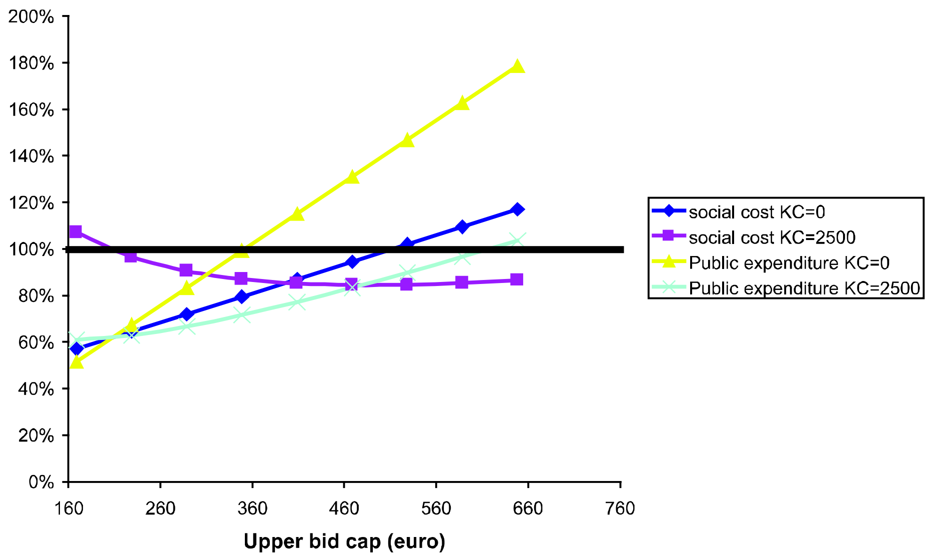


**Figure 3.** Results of auctions as a percentage of flat rate payment

Auctions can be better than the flat rate payment only within a certain range of variation of the upper bid cap. Interesting enough, taking into account social cost and increasing the upper bid cap, while total cost tends to decrease for KC=2500, it tends to increase for KC=0. This is because increasing the upper bid cap means higher payments and, as a consequences, the possibility to save on the monitoring costs. When monitoring costs are zero, or very low, the opposite holds.

Hence, depending on the level of monitoring costs, not only auctions can be more or less likely to be useful to the regulator, but also the creation of expectations about the upper bid cap have to be managed in a different, possibly opposite, way.

## Discussion

The policy instruments used under reg. 2078/92 and reg. 1257/99 show relevant possibilities for improvement. This paper confirms, first of all, that setting the compensation as a flat rate payment is not an obvious solution. On the contrary, it is usually unable to satisfy cost-effectiveness objectives, compared to other instruments.

Management monitoring can be required to perform certain instruments. Though its cost may be relevant, it is usually able to improve policy efficiency, provided that the information collected is properly fed into more "precise" policy instruments.

Compliance monitoring is costly and heavily affecting the efficiency of the policy as a whole. In fact, the choice of a too low level of accuracy results in a reduction of compliance and, consequently, of the environmental effects. On the other side, a too high level of accuracy yields additional costs for monitoring, that are rather relevant compared to the total public expenditure required for AEP.

Summing up, empirical results show the need for a co-projecting of monitoring and the other parameters of AEP, particularly incentive mechanisms and payments differentiation, in order to improve the efficiency of such policies.

The present paper intended to analyse some implications of ex post data from AEP monitoring when fed into simulation models for policy design purposes. For this reason rather peculiar models where used in order to adapt to local conditions. However many developments can be foreseen for this work using relatively standard principal-agent frameworks, such as a proper mechanism design approach, two sided sanctions, probabilistic ability to detect non-compliance and risk aversion.

## Notes

[1] This assumption is necessary to make the three instruments comparable and to make the models suitable to be used with ex post data from AEPs implementation.

[2] This assumption substitutes the quantification of the production function (not available) and fits rather well the use of ex post data about the impact of a complex set of constraints.

[3] The assumption of rectangular distribution is accepted as a reasonable simplification, in the absence of reliable data about the probability of acceptance.

[4] See Lactaz-Lohmann & Van der Hamsvoort (1997; 1998) for related proofs.

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