



**HAL**  
open science

## An investigation of policy administrative costs using panel data for the English environmentally sensitive areas

Katherine Falconer, Pierre Dupraz, Martin Whitby

► **To cite this version:**

Katherine Falconer, Pierre Dupraz, Martin Whitby. An investigation of policy administrative costs using panel data for the English environmentally sensitive areas. *Journal of Agricultural Economics*, 2001, 52 (1), pp.83-103. 10.1111/j.1477-9552.2001.tb00911.x . hal-01931678

**HAL Id: hal-01931678**

**<https://hal.science/hal-01931678v1>**

Submitted on 21 Oct 2024

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial 4.0 International License

# An Investigation of Policy Administrative Costs Using Panel Data for the English Environmentally Sensitive Areas

Katherine Falconer, Pierre Dupraz  
and Martin Whitby

**T**his paper explores transactions costs in the context of agri-environmental policy schemes based on management agreements. While transactions costs encompass a wide range of organisational costs, the focus here is on the public-sector administrative costs of policy implementation. Empirical administrative cost functions were estimated to investigate the factors affecting the magnitude of such costs, using panel data spanning five years for the 22 English Environmentally Sensitive Areas. The extent of participation appears to be important in explaining administrative cost variability across areas. The data suggested the existence of size economics with regard to the numbers of agreements made in any one ESA, and a significant effect of scheme experience in exerting downwards-pressure on administrative costs. Policy budgeting and evaluation should take into account the non-trivial costs of organisation, particularly if agri-environmental schemes based on the procurement of conservation goods through management agreements are to be extended in future.

## 1. Introduction

Policies have developed across the EU since the 1980s to encourage the provision of agri-environmental goods, following concerns that agricultural support has led to rising levels of land use intensity, threatening widely-valued characteristics of the countryside. The economic justification for these policies has two principal rationales: first, the existence of externalities, both positive and negative; and second, the public good nature of the targeted agri-environmental goods (such as biological diversity or landscape beauty), the consumption of which is neither rival nor excludable (at low cost). Thus, agri-environmental goods are unlikely to be provided through the market at their socially-optimal levels, and preliminary cost-benefit analyses of agri-environmental schemes have indicated positive net social welfare outcomes (see Hanley *et al.*, 1999).

Spash and Simpson (1994) have discussed the tensions between utilitarian and rights-based approaches to conservation. Under the former approach, the government's objective is in effect to maximise the supply of conservation goods subject to an

---

■ Martin Whitby is at the Department of Agricultural Economics and Food Marketing, University of Newcastle upon Tyne. Katherine Falconer was in the same department at the time of writing this article but is now at Scottish National Heritage. Pierre Dupraz is at INRA-ESR, Rennes, France. Grateful acknowledgement is made to MAFF for data and comments on an earlier draft, and to the two anonymous referees. The usual caveats apply.

exchequer budget constraint; conservation is considered in the context of willingness to pay and human welfare rather than intrinsic rights. In the case of Sites of Special Scientific Interest (SSSIs), for example, policy objectives are set out in legislation (in particular the Wildlife and Countryside Act 1981), but the actual policy achievements are limited by the costs, including both compensation and administration, involved in management agreements covering the designated sites. In practice, the main financial cost component for schemes such as those implemented under Regulation 2078/92 relates to farmer compensation for voluntary adherence to environmental management agreements. However, scheme organisational costs are also a substantial component of total policy costs (see Falconer and Whitby, 1999) and so should also be taken into account as such in policy evaluation.

In the case of the Environmentally Sensitive Area (ESA) scheme, the provision of agri-environmental goods is derived from farmers' voluntary participation and the environmental performance of the resulting management agreements. These two components are a function of the level and nature of scheme administration, principally in relation to scheme design and to managing contracts to undertake specified activity. In particular, the more precise the design of the management prescriptions and the designation of areas eligible for their implementation, the more effective will be the scheme, and the lower the potential for contractors to extract economic rents. However, the higher will be the administrative costs. Hence there is a trade-off to resolve: administrative costs should be optimised jointly with other costs (namely payments to farmers) to fulfil all the objectives of policy-making (see Falconer and Saunders, 2000). Therefore, the behaviour of administrative costs in relation to scheme features, the circumstances of implementation and the environmental outcomes is of great interest. The contribution of this paper relates strongly to the supply-side of agri-environmental economics. There are two sides of the same coin to consider: how to maximise agri-environmental benefits within a given budget constraint, and/or how to minimise the total costs of achieving specific agri-environmental objectives.

To date, while considerable attention has been given to the opportunity costs of policy in terms of lost production, only a few policy evaluations in the agri-environmental literature have included administrative costs in empirical terms (e.g., McCann and Easter, 1998, and Whitby and Saunders, 1996), despite widespread recognition of their importance (for example, Stavins, 1993). The costs of agri-environmental schemes to public administrations are of growing contemporary importance in practical policy-making discussion (National Audit Office, 1997). Most governments currently fail to report scheme implementation costs, with the potential, consequently, of failing to ensure the best outcomes in terms of value for money of environmental improvements.

Assessment of the magnitude of the administrative costs involved in policy implementation, their determinants and the implications of such costs for policy development would be a useful contribution to policy debates. The view is often that administration activities should be minimised rather than having a productive economic function. However, in a world of scarce resources, organisational costs should be balanced with maintaining sufficient levels of conservation activity to fulfil the objectives of the policy; it is net scheme costs that matter. A more complex, targeted scheme might bring forth greater environmental benefits, but the link between targeting and benefits needs to be transparent. Given that administrative arrangements such as agri-

environmental schemes can provide useful mechanisms through which to resolve resource use conflicts in relation to externalities or public goods, we need to know how agri-environmental expenditures relate to improving environmental quality and social welfare, as compared to the “policy-off” situation. Better understanding of the factors that cause schemes to be more or less costly to run would enable policy-makers to identify where adjustments might be made in existing schemes to improve their efficiency, as well as providing lessons for the design of future schemes.

Section 2 examines the nature of agri-environmental transactions, focusing on voluntary management agreements between the state and private producers. A conceptual analysis of agri-environmental organisation is then developed in Section 3, to provide a basis for the development of an empirical model of the administrative costs of the English Environmentally Sensitive Area (ESA) scheme. Section 4 presents the results of some econometric modelling, and Section 5 discusses the findings in their broader context. Section 6 concludes the paper.

## **2. Transactions Costs Analysis for Agri-environmental Policy**

A challenge to economic analysis is the absence of a clear definition of transactions costs. In the broadest sense, they might be defined to encompass the costs of running the economic system (Arrow, 1969). They arise not from the production of goods, but from their transfer from one economic actor to another (Niehans, 1971); a typology might be developed based on the different phases of exchange (Coase, 1960).

Transactions costs are fundamental to the existence of externalities, presenting barriers to the efficient resolution of conflict through the market mechanism, particularly linked to identification costs and information asymmetries (especially with regard to opportunity costs and willingness to pay). The public-good rationale for policy intervention is also linked to transactions costs: if these are high, economic agents who enjoy jointly a good in short supply will fail to co-ordinate to achieve an improved resource allocation. If it is impossible to exclude people at low or zero cost from consuming a public good, free-riding will occur, leading to the under-provision of the good. Where transactions costs exist, the incentives for individuals to complete transactions will be reduced.

In the agri-environmental sphere, free-market exchange between individuals is often prohibitively expensive. Information costs (for example, search and co-ordination) are high, given characteristics such as the variable, often highly location-specific, nature of agricultural production technology; the variable natural heritage value of land; and the low observability of much management. For example, the “victims” of nitrate pollution will incur search costs in trying to identify the source of the pollution; those affected by an externality may also incur search costs in identifying each other, in order to co-ordinate their response.<sup>1</sup> Information asymmetry between those causing externalities and those affected by them also gives rise to significant problems and the possibility of the extraction of rents. Variability in the attitudes and objective functions of each individual land-owner means that there will be different levels of opportunism against which to safeguard.

<sup>1</sup> Particularly in the context of the “beneficiary-pays” principle (see Hanley *et al.*, 1998).

The transactions costs that inhibit the development of a private market for agri-environmental goods will also have implications for the cost-effectiveness of policy mechanisms to provide them, as the nature of the goods remains unchanged (see, for example, Rodgers and Bishop (1999) with regard to SSSIs). Assuming that the government aggregates correctly consumers' willingness to pay for public goods in the countryside, their procurement from private producers entails transactions costs. These costs will influence the outcome of the contractual relationships established to implement policy.

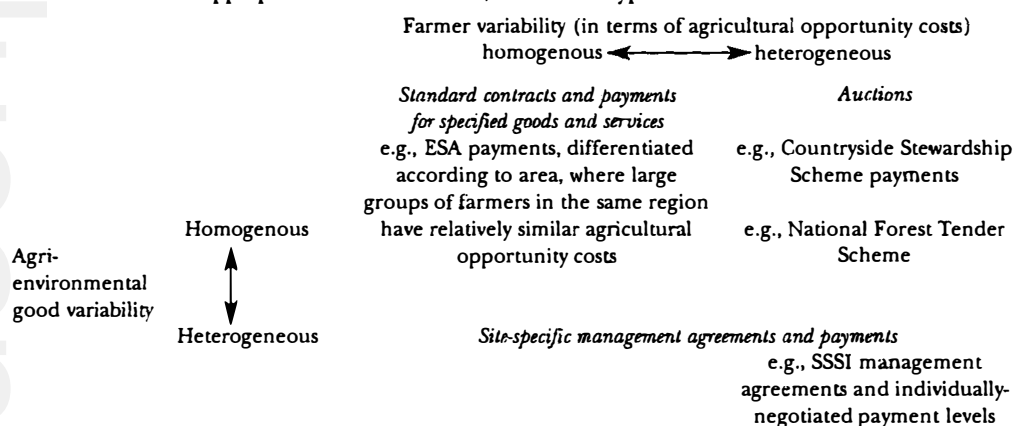
Transactions cost economics can provide some insights into the relative appropriateness (efficiency) of different approaches to policy regarding the provision of agri-environmental goods, given non-zero transactions costs (Williamson, 1985). For economic efficiency, the scheme (or mix of schemes) that maximises the benefits stemming from the *total* costs (of compensation - reflecting the opportunity costs of producing agri-environmental goods *and* administrative costs) should be chosen; production and organisation should not be considered separately.

Agri-environmental goods production in the EU has been stimulated in recent years by the development of administratively-run markets: compensation payments are made to land-owners who agree to manage the land in specified ways. Such mechanisms facilitate agri-environmental transactions (for example, by reducing search costs), allowing improvements in the resource allocation to be made. However, different types of market might be established. The varying characteristics of goods mean that the relative appropriateness of any given policy mechanism should vary for improving conservation provision, linked closely to the transactional attributes of any scenario. Important attributes include, for example, the degree of information asymmetry between farmers and the government, and the level of farmer opportunism, the economic importance of which will be related to the heterogeneity of producers' opportunity costs and the attributes of the conservation output.

For example, standard payments might be used where farms are homogenous in terms of their agricultural opportunity costs and their potential environmental outputs, but auctions of entitlements to agri-environmental payments might be more appropriate where homogenous agri-environmental contracts are offered to heterogeneous farmers (see, for example, Latacz-Lohman and Van der Hamsvoort, 1998). Targeted payments might be more appropriate where heterogeneous farmers are supplying heterogeneous goods (see Table 1). However, higher degrees of heterogeneity are likely to result in higher transactions costs, so it is necessary to assess systems in relation to the value of their output.

A third continuum, alongside the heterogeneity of farmers and environmental goods, relates to varying levels of uncertainty and risk in the supply of agri-environmental goods. This aspect relates to risk management by regulators. For example, either flexibility is needed in ESA management prescriptions and adjustment to these as time passes (according to indications of whether or not the desired conservation objectives have been achieved), or more research must be carried out by policy-makers *ex ante* to develop schemes to limit the uncertainty of what will happen in any given situation. This dimension is an important area for further work.

**Table 1 Instrument Appropriateness and Producer/Production Type**



Before taking the theoretical analysis further, we need more information on the actual incidence and magnitudes of administrative costs in the agri-environmental sphere. Section 3 introduces some empirical analysis for the operation of the ESA scheme in England.

### 3. Empirical Transactions Cost Analysis for Schemes

Scheme administration costs have resource use implications in both the public and the private sectors. They may constrain the type, and number of exchanges made, for example, given the buyer’s wealth constraint and the seller’s profit-maximising constraint (see Spash and Simpson, 1994). This study focuses on the direct set-up and operating costs of schemes. The dominant policy approach of voluntary management agreements with private landowners is particularly interesting in the transactions-economics context as it requires substantial levels of farmer/agency transacting. Table 2 summarises the

**Table 2 Categories of Transactional Costs Incurred in the Implementation of Voluntary Schemes Based on Compensated Management Agreements and Cost Incidence**

Main Category	Sub-Category	State Agency Costs		Participant Costs	
		Fixed at the level of the scheme	Variable with no. of participants	Fixed at the level of the participant	Variable, e.g., with hectares entered
Information	- surveying of the designated area	✓			
	- designation of area and designing prescriptions	✓			
	- re-design/re-notification of prescriptions	✓			
Contracting	- promotion of scheme to farmers	✓	✓	✓	
	- negotiation between organisation and farmer		✓	✓	✓
	- administration of contract (including making payments to farmers)		✓	✓	
Policing	- enforcement of farmer compliance		✓	✓	✓
Evaluation	- environmental monitoring and scheme evaluation	✓			

principal components of administrative costs for such schemes. Some management agreement costs have both fixed and variable components. For example, the negotiation costs for participants include a fixed cost of contacting the government agency implementing the scheme, to indicate the farmer's wish to negotiate entry. However, there is also a degree of variability to costs as the scope of negotiation will vary with farm size, e.g., as a proxy for the range of habitats found there.

Table 3 shows the relative importance of the main administrative cost components for English schemes implemented under Regulation 2078/92. The variation in the relative shares of scheme expenditure is partly related to the nature of individual schemes, but also reflects the stage of scheme development. New schemes require fixed-cost development-type activities in their first year, as the details of implementation are finalised and the scheme is set up; participation-related transactional activities then rise in relative importance. The ESA is the major agri-environmental scheme in England, in terms of its coverage and expenditure, and is examined in more detail below.

**Table 3 Policy Expenditure Components for Six Schemes in England, 1995/6**

	<i>Percentage of Overall Policy Expenditure, 1995/6</i>						
	<i>All</i>	<i>ESAs</i>	<i>NSAs</i>	<i>Habitat Scheme</i>	<i>Organic Aid Scheme</i>	<i>Countryside Access</i>	<i>Moorland Scheme</i>
Payments to farmers	71.2	82.6	67.2	55.1	57.4	16.8	0.0
Running costs (information, contracting and policing)	19.9	12.4	20.5	33.0	27.7	74.8	100.00
Environmental monitoring costs (evaluation)	9.0	5.1	12.3	11.9	14.9	8.4	0.0

Source: House of Commons (1997). NB No agreements had been made under the Moorland Scheme in 1995/6. The Habitat, Countryside Access and Moorland Schemes have now been incorporated into the Countryside Stewardship Scheme.

### 3.1 The English ESA Scheme

The ESA scheme is targeted on areas of national environmental importance and aims to maintain, improve and extend habitat or landscape features on agricultural land. Further agricultural intensification is strongly discouraged. Management prescriptions and payments are unique to each area; farmers choose from menus of management options with fixed-rate compensation rates. Management prescriptions are classed in two tiers, "basic" (tier 1) and "enhancement" (tier 2), aiming respectively at the maintenance and enhancement (improvement or extension) of the agri-environmental resource. The majority of agreements made to date related to the basic tiers (MAFF, pers.comm.). Table 4 shows the absolute levels of public expenditure on the ESA scheme over time. Compensation costs have risen each year, with participation increases and payment rises; administrative costs fluctuated around £12m each year until the late 1990s when reductions were observed, probably linked at least in part to the response to the recommendations of the Public Accounts Committee hearing.

**Table 4 The Absolute Levels of the Public Costs of ESA in England, 1992/ 1996.7, £m**

	1992/3	1993/4	1994/5	1995/6	1996/7 (Estimated)	1998/9
Payments to farmers	10.9	16.5	20.1	29.1	32.5	36.4
Administration	11.1	13.9	12.2	13.3	10.1	6.6
Gross Costs	22.0	30.4	32.3	42.4	42.6	43.0

Source: NAO (1997); MAFF *pers.comm.* (last column).

Administration costs relate to activities in three main organisations: Ministry of Agriculture, Fisheries & Food (MAFF) headquarters (overseeing, evaluating and developing the operation of the scheme); the Agricultural Development and Advisory Service (ADAS, now the Farm and Rural Conservation Agency (FRCA)) in providing assistance for farmer applicants, and carrying out environmental monitoring; and the regional offices of MAFF (the Regional Service Centres, RSCs) in relation to the administration of applications. In 1995/6, the breakdown was respectively £0.3m, £4.9m and £1.4m (MAFF/IBAP, 1999).

### 3.2 A Conceptual Administrative Cost Model for the ESA Scheme

A conceptual model of factors affecting the magnitude of administrative costs for the English ESA scheme is summarised in Table 5.

Interest lies primarily in the characteristics of individual ESAs. For example, having a large number of land-owners potentially eligible to enter the scheme in an area would be expected to entail more administrative work than if fewer land-owners were eligible. Costs relate both to those individuals who actually participate, and to those who do not; costs may still be incurred in relation to the latter through answering inquiries and promotional activities by the implementing agency. Trade-offs may exist between

**Table 5 Factors Affecting the Level of Administrative Costs of Schemes Based on Voluntary Management Agreements and the Hypothesised Direction of Likely Effects**

<i>Independent Variable</i>	<i>Scheme Set-up</i>	<i>Contracting</i>	<i>Compliance Monitoring and Enforcement</i>
Number of participants, both cumulative numbers and new entrants in any year		↑	↑
Level of promotional efforts	↑	↓?	↓?
Geographical characteristics such as remoteness of farmers, ecological variability, location within an LFA	↑	↑	↑
The area of common land contained within the ESA		↑	↑
Area entered into the scheme (total and per farm)		↑	↑
Positive farmer attitudes towards conservation		↓	↓
Levels of entry into the scheme and stringency of requirements	↑	↑	↑
Entry requirements such as whole farm entry		↑/↓	↑/↓
Participation of farmers in other schemes		↑/↓	↑/↓
Number of years since scheme's introduction		↓	↓



different types of scheme-organisational expenditures. For example, greater expenditure on scheme promotion and farmer information may allow savings to be made with regard to negotiating or enforcing management agreements, given improved understanding of requirements and objectives. Although there is a menu of prescriptions with fixed payments rates, the precise “package” for any one farm is negotiable. There is of course some flexibility for farmers in relation to which prescriptions are included, and the amount of land to be covered by an agreement in ESAs which do not mandate whole-farm entry. However, negotiation is generally significantly more straightforward than for SSSIs, for which both payments and prescriptions must be negotiated.

A scheme with more management options might be expected to raise the costs of negotiating and enforcing agreements. Requirements such as whole-farm entry may complicate or simplify the negotiation of management agreements. However, positive farmer attitudes towards conservation and the scheme might be linked to lower transactions costs. The broad co-operation of entrants with the agency would mean that environmental agencies could rely far more on self-enforcement, thus reducing compliance checks. There may be some positive spillover effects from the implementation of, and participation of farmers in, other related agri-environmental schemes: total administration costs might increase in a non-linear way with the number of additional schemes as the costs of activities such as initial farm surveys and ecological monitoring can be shared. However, administration costs may rise, given the need to co-ordinate schemes and prevent overlap, double payments and so on. Costs might be expected to fall with scheme experience for both farmers and the administering body.

Locational factors should be considered too. The overlap of the ESA with a Less Favoured Area (LFA) could increase administrative burdens given the greater geographical remoteness and greater travel time required of project officers. The inclusion of a substantial area of common land in the ESA may increase administrative costs through increasing the complexity of negotiating management agreements (MacFarlane, 1998).<sup>1</sup> Finally, idiosyncratic factors such as staff turnover or competence levels will affect administrative efficiency.

### 3.3 Empirical Models of the Administrative Costs of ESAs

The econometric work aimed to estimate administrative cost functions for the English ESAs based on the empirical data available. However, no data were available on some important variables such as staff competencies, the number of enquiries that failed to result in a signed management agreement, the area entered into different prescription

<sup>1</sup> Generally, for common land to be entered into agri-environmental schemes, management must be agreed by the owner(s) and all right-holders. Full co-operation is needed, but universal agreement is rare, especially where the agri-environmental management restrictions must apply to the whole farm (see Rodgers and Bishop, 1999). However, in some areas (such as the Cambrian Mountains in Wales) where the majority of commons are managed on an *ad hoc* basis by only a few right-holders (in effect “privatised”, Wilson and Wilson, 1997), it is relatively straightforward to enter the ESA scheme on an individual basis as “sole owners”. Where such privatisation has not occurred, it is generally necessary for a commons management association to be formed. This is authorised to act on behalf of commoners, so government agencies no longer have to approach each individual separately to conclude a management agreement. Negotiation internal to the Association determines the division of payments and stocking reductions.

and tiers,<sup>1</sup> the geographical diffusion of participating farmers or potential participants, and their attitudes to conservation. The administrative costs incurred in direct relation to the ESA scheme are generally not precisely costed. Challenges to measuring organisation costs relate, for example, to the low separability of administrative functions at the level of any particular agency. Although individual files on participating farms were unavailable, panel-data were obtained on ESA-level administrative costs, disaggregated across the twenty-two English ESAs, for the five years 1992/3 to 1996/7. There were three main components to these costs: ADAS/FRCA and RSC management costs, environmental monitoring costs, and other “overhead” costs. MAFF adopted fairly simple methods to attribute some overhead costs to each ESA, since so far this had not been required for financial management purposes. The reported costs did not include the costs of support services, accommodation and so on, and were spread equally across all ESAs. The relative crudeness of the data must be stressed; in particular, some of the ESA-level data were disaggregated from higher-level estimates. The financial variables were not deflated as attention was given to the current costs, in which an interest lies for budgeting purposes. In any case, the period was one of low inflation. However, although the available observations for the dependent variables in the analysis below are imperfect, they have utility in providing ball-park figures and hence a starting point for discussion and future analysis.

An inherent limitation to this analysis is that actual administrative expenditures do not necessarily reflect the administrative effort thought to be required for efficient scheme running. Expenditure will depend to a large degree on how well farmer participation is forecasted, and also administrative resource needs relative to the likely workload in each year. Prediction and budgeting are never perfect; unfortunately, there is little available information on how satisfactory staffing levels and competencies are, despite the impact of these on the overall efficacy and efficiency of scheme organisation.<sup>2</sup> These constraints upon the public budget setting process mean that administrative inputs are unlikely to be optimal at any given time, so the results of empirical analysis must be interpreted with caution. The inflexibility in administrative structures must also be considered: for example, planned staffing adjustments are likely to be made only on a yearly basis. Furthermore, the varying calibres of staff inputs must be taken into account when evaluating administrative performance; quality differences are not necessarily reflected in wage costs.

### 3.4 *The Econometric Model Specification*

The annual total scheme exchequer cost  $EC$  comprises compensatory payments  $P$  and administrative costs  $C$ . The exchequer cost may depend on the area under agreement  $s$ , the number of agreements  $c$ , the scheme age  $d$  and ESA-specific characteristics  $Z$  such as premium levels, the menu of management options, and the other regionally implemented policies. Using econometric methods, a number of hypotheses can be tested.

*Ceteris paribus*, the exchequer cost is expected to increase with the number of agreements because of the administrative costs involved in establishing each agreement

---

<sup>1</sup> For example, the Lake District ESA has more than twenty separate premiums on its “menu”.

<sup>2</sup> NAO (1997); see also Land Use Consultants (1995) with regard to the Countryside Stewardship Scheme.

setting. Holding all other factors constant, particularly compensation levels, the exchequer cost is also expected to increase with the area under agreements, because the corresponding compensatory payments are made on a per-hectare basis. The exchequer cost is also expected to fall with years following scheme implementation due to administrative cost savings from fine-tuning and the learning processes that occur over time (leading the individuals and the administrations involved to learn to streamline processes, through building human capital, developing their understanding of the other transacting party and so on). Furthermore, over time, changes in the mix of administrative activities are needed, linked to the time profile of scheme take-up. For example, after a few years, the balance will switch from “set-up” activities such as promoting the scheme and entering into contracts to more routine “maintenance” activities, related to making annual payments and checking compliance with prescriptions. These routine activities would be expected to be less costly than the set-up activities.

As administrative costs include overhead costs which are partly fixed costs regarding the number of agreements, the administrative, and hence exchequer, cost functions are expected to exhibit size economies (falling marginal costs per agreement). The payment function and the administrative cost function are considered separately. The difference between the marginal exchequer cost per hectare and the marginal administrative cost per hectare should correspond to the premium paid for the marginal hectare, and hence will be positive. These hypotheses are specified mathematically below.

$$EC(c, s, d, Z) = P(s, Z) + C(c, s, d, Z)$$

$$\left. \frac{\partial C}{\partial c} \right|_{s, d, Z} > 0$$

$$\left. \frac{\partial C}{\partial d} \right|_{c, s, Z} < 0$$

$$\left. \frac{\partial^2 C}{\partial c^2} \right|_{s, d, Z} < 0$$

$$\left. \frac{\partial P}{\partial s} \right|_Z = \left. \frac{\partial EC}{\partial s} \right|_{c, d, Z} - \left. \frac{\partial C}{\partial s} \right|_{c, d, Z} > 0$$

Flexible functional forms, providing a second order differential approximation of any twice continuously differentiable cost function (Diewert and Wales, 1987), are appropriate to test the second order condition of the cost function, such as for decreasing marginal cost (Baumol *et al.*, 1982). The transcendental logarithmic function was tested, but it failed to yield any significant results, whereas the generalised quadratic functional form did. The parameters to be estimated are then easy to interpret because they correspond to the first and order derivatives of the dependent variable. To ensure the identification of all of the parameters, the classical assumption of symmetric second order parameters was made.

The data set relates to 22 ESAs over a five-year period. The variables  $c$ ,  $s$  and  $d$  vary over time and ESAs, while the  $Z$ -vector variables  $(Z^1, \dots, Z^k, \dots, Z^1, \dots, Z^K)$  are constant over time.

The quadratic cost function could be estimated as a linear regression where the independent variables  $x$  depend on both time  $t$  and individuals  $i$ , and where the other independent variables  $z$  depend only on individuals  $i$  (i.e., the ESAs). In the equation below, the scalar  $a$  and the vectors  $b$  and  $g$  are the parameters of interest,  $u$  is the error term and  $y$  is the dependent variable (either EC, C or P):

$$y_{it} = a + x_{it}'b + z_i'g + u_{it} \quad E(u_{it}) = 0, \quad \text{Cov}(u_{it}, u_{i't'}) = 0 \quad \text{if } (i, t) \neq (i', t')$$

$$x_{it} = (c_{it}, s_{it}, d_{it}, 1/2 c_{it}^2, 1/2 s_{it}^2, 1/2 d_{it}^2, c_{it} \cdot s_{it}, c_{it} \cdot d_{it}, s_{it} \cdot d_{it}, c_{it} \cdot Z_i^k, d_{it} \cdot Z_i^k, s_{it} \cdot Z_i^k)_{k=1, \dots, K}$$

$$z_i = (Z_i^k, 1/2 Z_i^k \cdot Z_i^l)_{k=1, \dots, K; l=1, \dots, K}$$

The  $Z$ -vector includes observed and unobserved variables. The omission of unobserved variables in an ordinary least squares regression results in heterogeneity bias if they are correlated with any available explanatory variables. In the case here, it is likely that uptake in any ESA is correlated with the unobserved premium levels and management requirements. Suppose that only the first  $L$   $Z$ -vector variables, denoted as  $(Z^k)_{k \leq L}$ , are observed. As the other relevant variables  $(Z^k)_{L < k \leq K}$  are unknown, a number of linear regressors included in both vectors  $z$  and  $x$  are unavailable. With regard to vector  $x$ , the missing regressors  $(c_{it} \cdot Z_i^k, d_{it} \cdot Z_i^k, s_{it} \cdot Z_i^k)_{k > L}$  correspond to second-order parameters which will be assumed to be equal to zero, which is not a very strong hypothesis. With regard to the vector  $z$ , the missing regressors correspond to both first-order and second-order parameters and may have strong individual fixed effects. The unknown individual fixed effect that corresponds to the missing regressors is denoted as  $w$ . Symbol  $z$  is then reserved for the available variables ( $z_i = (Z_i^k, 1/2 Z_i^k \cdot Z_i^l)_{k=1, \dots, L; l=1, \dots, L}$ ) and  $g$  for their corresponding parameters.

Hence, the econometric model is now written as:

$$y_{it} = a + x_{it}'b + z_i'g + w_i + u_{it} \quad E(u_{it}) = 0, \quad \text{Cov}(u_{it}, u_{i't'}) = 0 \quad \text{if } (i, t) \neq (i', t')$$

The individual fixed effect  $w$  gathers the impact of the unobserved variables, such as premium levels, for each of the different ESAs and is expected to be a significant determinant of both compensation and administrative costs. The ordinary least squares (OLS) estimator of the parameter  $(a, b, g)$  depends on the covariance between  $w$  and  $x$  as well as  $z$ , so the omission of  $w$  in the OLS regression will result in bias. For example, given a positive  $w$  impact on  $y$ , a negative correlation between  $w$  and  $x$  would underestimate the parameter  $b$ .

The simplest approach to this problem is to use the within-groups estimator, which deletes the individual fixed effects and the related biases (Green, 1997). The within-groups estimator is equivalent to performing an OLS estimation on a transformed data set where the variables are centred on their inter-temporal average for each individual, as summarised over:

$$y_{it} = a + x_{it}'b + z_i'g + w_i + u_{it} \quad E(u_{it}) = 0, \quad Cov(u_{it}, u_{i't'}) = 0 \quad \text{if } (i, t) \uparrow (i', t')$$

$$y_i = \frac{1}{5} \sum_{t=1}^5 y_{it} \quad x_i = \frac{1}{5} \sum_{t=1}^5 x_{it} \quad z_i = \frac{1}{5} \sum_{t=1}^5 z_{it} \quad w_i = \frac{1}{5} \sum_{t=1}^5 w_{it} \quad u_i = \frac{1}{5} \sum_{t=1}^5 u_{it}$$

$$y_{it} - y_i = a - a + (x_{it} - x_i)'b + (z_i - z_i)'g + (w_i - w_i) + (u_{it} - u_i)$$

$$\Leftrightarrow \begin{cases} e_{it} = (u_{it} - u_i), \quad E(e_{it}) = 0, \quad Cov(e_{it}, e_{i't'}) = 0 \quad \text{if } (i, t) \uparrow (i', t') \\ y_{it} - y_i = (x_{it} - x_i)'b + e_{it} \end{cases}$$

#### 4. Results

Three regression functions were estimated using polynomial functions and within-groups estimators.<sup>1</sup> The annual administrative costs per ESA (Table 6), the annual compensation costs per ESA (Table 7) and the annual combined administrative and compensation costs per ESA (Table 8) were used as dependent variables. All three regressions were statistically significant (at the 95 per cent level, at least) according to the calculated Fisher coefficient.

**Table 6 Annual ESA Administrative Costs Regression Coefficients, Using the Within-Groups Estimator**

<i>Explanatory Variables</i>	<i>Number of Agreements Squared</i>	<i>Eligible Area x Agreements</i>	<i>Total Agreements</i>	<i>LFA x Area Under Agreement</i>	<i>Years Since Designation</i>
<i>a priori</i> expected sign	+	+	+	+/-	-
estimates	-7.98	0.01	2353.13	-4.27	-60244.69
t-student	-9.01	3.96	6.93	-2.44	-3.28
$R_w^2$	0.50	Degrees of freedom		105	
$R_B^2$	0.57	Calculated Fisher coefficient		21.11	
$R_T^2$	0.79				

**Table 7 Annual ESA Compensation Costs Regression Coefficients, Using the Within-Groups Estimator**

<i>Explanatory Variables</i>	<i>Number of Agreements Squared</i>	<i>Number of Basic Tiers x Number of Agreements</i>	<i>Total Number of Agreements</i>	<i>Area Under Agreement</i>	<i>Years Since Designation</i>
<i>a priori</i> expected sign	+	+/-	+	+	+
estimates	2.59	-266.20	1460.13	23.87	30755.69
t-student	5.36	-2.48	3.15	8.58	2.39
$R_w^2$	0.93	Degrees of freedom		105	
$R_B^2$	0.77	Calculated Fisher coefficient		259.16	
$R_T^2$	0.98				

<sup>1</sup> The variables given in the tables were derived from more broad-ranging regression analyses. Inclusion of all potential interactions systematically was impossible given the available data-set, hence a multi-stage procedure was used to select the variables of most interest. The objective was to explain the maximum share of the sample variability with a minimum number of first and second order explanatory variables (i.e., minimising the calculated Fischer value). The inter-individual variability ( $R_B^2$ ) represents 57 per cent of the total variability (see Annex 2). As the within-groups regression ( $R_w^2$ ) explains 50 per cent of the remaining 43 per cent, the model explains 79 per cent (= 0.57 + 0.50\*0.43) of total variability (i.e.,  $R_T^2$ ). See Annex 1.

**Table 8 Annual ESA Total Costs Regression Coefficients, Using the Within-Groups Estimator**

<i>Explanatory Variables</i>	<i>Total Agreements</i>	<i>Area Under Agreement</i>	<i>Years Since Designation</i>	<i>Number of Agreements Squared</i>	<i>Number of Basic Tiers x Number of Agreements</i>	<i>Eligible Area x Number of Agreements</i>	<i>LFA Dummy x Hectares Entered</i>
<i>a priori</i> expected sign	+	+	-	+	+	+	+/-
estimates	4060.62	22.21	-25954.43	-5.78	-337.46	0.01	-379
Standard error	883.26	6.29	20446.18	1,11	193.60	0,004	1.93
$R_w^2$	0.85	Degrees of freedom		103			
$R_B^2$	0.83	Calculated Fisher coefficient		84.81			
$R_T^2$	0.97						

The most important first-order variable (in terms of its statistical significance and its coefficient value) is the number of agreements which have a positive effect on both compensation and administrative costs and hence on the total cost.<sup>1</sup> The marginal annual administrative cost per agreement appears to be around £2,350 (Table 6). The number of years since ESA designation is also highly significant, and importantly, has a negative coefficient, suggesting that there is a possible “learning effect” of ESA administration, and downwards pressure on annual administrative costs flowing from experience and fine-tuning. *Ceteris paribus*, this purely time-related cost reduction is of the order of £60,245 per annum.<sup>2</sup> However, it is also possible that this cost effect is related to a switch in the types of administrative activities required in relation to farmer participation over time, such as the switch between agreement set-up activities to more routine agreement management.

Two other significant second-order variables provide further information. The larger the targeted area (i.e., the eligible area times number of agreements), the higher the administrative costs and hence the total cost per agreement. The increase is only one penny per agreement per eligible hectare, but it is clearly significant (Table 6). This may be related to the higher cost associated with the scheme management in large areas due to the greater dispersion of farms and the need for project officers to travel further for planning and monitoring visits. The variable “number of agreements squared” is negative when the marginal administrative cost per agreement is decreasing. The indication is that there are economies of size (because of fixed administrative costs). The more agreements there are within a scheme, the less expensive administratively is the last agreement. This relationship is reversed for compensation costs; as total agreements increase, marginal compensation rises (new agreements might involve higher compensation if these farmers have higher opportunity costs and have waited for payment rates to increase, for example). Economies of size appear to prevail for the total costs function, which is a striking empirical result (not *a priori* expected) which shows the importance of taking administrative costs into account.

<sup>1</sup> Note that the number of agreements is more significant than the area under agreement, for example, which is more associated with the technical characteristics of the agreement than with the transactions in themselves.

<sup>2</sup> As noted above, the financial variables were not deflated. The within-groups estimator deletes any effect of over-weighting more recent schemes compared to older ones, as this is included in the individual fixed effect. There is a risk that the most observations for each scheme would be over-weighted too. However, if it was significant, this would make the scheme age effect to be less negative than it is in reality for the administrative and total cost functions, and more positive for the compensation function. In such a case, the existence of a learning and fine-tuning effect in regression using deflated variables would in fact be even more significant than displayed here.

The most significant variable in the compensation regression is the area under agreements. However, it is interesting to note that ESA administrative costs do not depend on the area under agreements, except in LFA areas where they seem to fall with the area under agreements, given the number of agreements. The second-order variable (LFA times the number of hectares entered into the ESA) is significant, with a negative coefficient, implying that the coincidence of ESA designation with a LFA reduces administrative costs by £4.27 per hectare. A possible explanation is that farms in LFAs are keen to enter the ESA scheme given the marginal nature of their agricultural production and its recent instability, thus reducing negotiating and enforcement costs. The function is quadratic, and the second-order term of the number of agreements squared is both highly significant and negative, supporting the hypothesis of administrative economies of size (decreasing average (or marginal) costs) with regard to the number of agreements.<sup>1</sup> Such economies are very likely given the level of fixed administrative costs for each ESA related to environmental and socio-economic monitoring and policy evaluation/development activities. The size effect is clearly disentangled from the learning effect here.

The results reported in Table 7 show an opposing effect of the years since ESA designation and the number of agreements squared on annual ESA compensation costs. The compensation cost of the marginal agreement increases with the number of agreements. Furthermore, the compensation costs rise over time, holding the area under agreements and the number of agreements constant. This effect might reflect an increase in the average premium or structural changes over time in the uptake of the different tiers. The majority of producers join the ESA scheme with a basic tier management agreement only (requiring little actual change in existing farm management, in general), but over time, some may adjust their contracts to include enhancement management prescriptions for which higher compensation is paid.<sup>2</sup>

The results in Table 8 show that the size effect observed on the administrative cost function is sufficiently strong to be observed in the total cost function too, in spite of the increasing marginal compensation cost per agreement. Although significant at only a low level, the effect of the number of years on the total cost had a negative regression coefficient. *Ceteris paribus*, compensation costs rise by £30,000 per year whereas the administrative costs decrease by £60,000 per year (given a learning effect), resulting in a decrease in total cost over time.

The compensation cost per agreement, and hence the total cost per agreement, falls with the number of different basic tier management options, with respective cost reductions per agreement of £266.20 and £337.46 respectively, per additional tier, given the number of agreements and the overall area under agreements. A possible explanation of this observation is that a broader range of management options means that participants in the scheme can find an option more appropriate to their business and the agro-ecological system within which they operate. Broadening the range of tiers may

<sup>1</sup> "Economies of size" is used in this context of expansion in activity levels under a fixed set-up cost; "scale economies" would be appropriate in a situation where all inputs were changing proportionately (see Chambers, 1988).

<sup>2</sup> NB the numbers of enhancement prescriptions potentially available in each ESA were not considered here as previous analyses indicated no significant effect.

be an appropriate strategy to limit the compensation payments, although this must be balanced against increasing the administrative complexity of the scheme. There did not appear to be any significant effect linked to the number of management options of administrative costs.

OLS quadratic functions were also estimated. For a given parameter, the bias of the OLS estimator is proportional to the covariance of the individual fixed effect with the corresponding explanatory variable. Hence, comparison of the biased OLS estimation with the unbiased within-groups estimation provides information on the inter-scheme variability of the sample. The explanatory power of the OLS regression with regard to annual ESA administrative cost ( $R^2 = 0.64$ ) was lower than the within-groups estimator regression ( $R^2 = 0.79$ ). Compared to the latter, the cost of the marginal agreement and the cost of the marginal hectare did not appear to be significantly biased.

The scheme age effect appeared to be heavily underestimated in absolute value (i.e., negatively biased), implying that the oldest schemes are more expensive in terms of administrative cost than the youngest, all other known variables held constant. That is, there is a positive covariance between scheme age and the individual fixed effect affecting the administrative costs (the older the scheme, the higher the administrative costs, although the decline in costs with time still holds firm, in accordance with the unbiased within-groups estimation). The observed effect may be explained by more-problematic agreement negotiation in the oldest schemes, given the lack of familiarity with scheme procedures and expectations, or from positive spill-over related to scheme management from oldest towards youngest schemes. The second-order parameters related to these variables which were significant in the within-groups regression (squared number of agreements and agreements times LFA dummy) are not in the OLS one. The latter does not confirm decreasing administrative marginal costs with regard to the number of agreements, but it demonstrates the decreasing cost of the marginal hectare per agreement (with a significant but very low value). Another interesting second-order parameter appears in the OLS estimation, revealing that marginal agreement costs fall with the age of the scheme, again capturing clearly the learning effect discussed above and perhaps part of the size effect as the number of agreements increase over years within each scheme.

## 5. Discussion

The results of the econometric analysis imply the existence of administrative economies of size related to scheme participation. Generally the rate of change in participation over time is negative, and costs fall as fewer new agreements need to be established. Hence, activities related to farmer entry into the scheme are replaced by lower-cost scheme maintenance activities (at least up to the year of agreement termination or re-negotiation and renewal). Further work is needed on the scope for economies of size for each of these. However, generally, over time, fewer agreements are made (total entry levels are finite), and it is very likely that negotiations become increasingly complex, as the more “straightforward” agreements (i.e., ones with lower agricultural opportunity costs or ones with lower transactions costs) would in all likelihood have been made much earlier. The site-specificity of individual farms and the choice faced by farmers of different sets of



prescriptions mean that blue-prints for the set-up and monitoring of agreements can only go so far. Thus, the marginal administrative costs of scheme participation should rise over time, opposing the cost-reducing impact of any economies of size.

Another cost-reducing factor, though, is experience, related to the administrative learning curve and economies made over time from fine-tuning procedures. Furthermore, the set-up costs should be considered as an investment in an “asset” (the natural capital protected and maintained or enhanced, and perhaps information relating to conservation activities). Agencies should try to keep successful agreements running for as long as possible, and where possible, build on them. There is substantial investment in human capital as a result of the transacting process: loss of this should be avoided where possible. The continuity of the relationship between farmers and project officers is very valuable and a long-term perspective should be encouraged for both project officers and participants.

The issue now is how agri-environmental policies can be designed to minimise public administration and private transactions costs, in relation to delivery of benefits, i.e., with regard to the optimal allocation of public resources to schemes and the division of expenditure between administrative costs and participant compensation payments. Improvements have been made to the present ESA scheme, particularly following the NAO (1997) enquiry. A best practice review of the RSCs has been undertaken, and the head-quarters policy branch of MAFF involved in ESA development has been reduced in size (MAFF, pers. comm.). In addition, scheme development activities are to be combined for the ESA scheme and the Countryside Stewardship Scheme, saving on overhead costs. The NAO (1997) suggested that MAFF should identify priority areas within each ESA and focus field inspections and environmental monitoring work on them.<sup>1</sup> Targeting field inspections on agreement holders who represent the greatest risk could permit reductions in checking levels without reducing the effectiveness of compliance monitoring.

Stewart *et al.* (1998) also made several recommendations to improve the benefit delivery of ESAs, for example, the increased provision of advice and support facilities and improved co-ordination between farmers and environmental organisations and the government. Promotional activities can play extremely important roles. The socio-economic survey results found that the reluctance to move to higher management tiers was explained by perceived difficulties in complying with the more demanding or restrictive prescriptions, or because of the impression that payment levels offered inadequate compensation. Scheme participation was found to have had a constructive effect: increasing awareness of environmental issues. Project officers now promote the scheme more proactively, rather than waiting for expressions of interest or applications for entry to be made (MAFF, pers. comm.), and might also target areas affected by environmental degradation. However, much more detail of the individual ESA schemes and administering units is needed for precise recommendations to be made for practical administrative efficiency improvements.

Well-designed and implemented administrative activities are crucial to scheme success. It is crucial to keep such costs in perspective, while assessing whether available funding is

<sup>1</sup> It was also suggested that areas with poor take-up could be removed from ESA designations, with the Countryside Stewardship used instead to protect and improve the environment (NAO, 1997).

being utilised effectively, to fund the optimal levels and mix of activities. There is a clear distinction between *financial* analysis and broader *economic* analysis: policy transactions costs cannot be discussed in the abstract as ultimately analysis must be related to the policy objectives and the extent of their achievement if decisions are to be made to maximise economic efficiency in resource allocation. However, full cost-benefit assessment is complex and there are many practical challenges (see Hanley *et al.*, 1999). Even if we knew what changes were occurring in the countryside and the rural environment, there are great problems in linking cause and effect. In addition, despite a number of environmental valuation studies (see Stewart *et al.*, 1998), there are still insufficient estimates of the values of the complete range of benefits stemming from agri-environmental policies, and those estimates found in the literature are not beyond controversy. The next step, linking the organisational costs to the achievement of the policy objectives, is a subject for future work. In addition to the methodological problems associated with environmental monitoring, there are conceptual issues in relation to benefit measurement: for example, is the maintenance of the *status quo* really a benefit to society or not? The answer depends on what would have happened in the absence of the policy, and on the perspective taken, using the notion of the “reference point” (Bromley and Hodge, 1990).

Although policy organisation can demand a substantial share of the total gross public cost of policies, the costs are often overlooked. They may be sufficiently important to constrain the resources available for implementing such policies, especially in times of public expenditure scrutiny. Greater transparency with regard to administrative costs is required as a safeguard against inappropriate public policy spending and lower levels of overall social welfare than might otherwise be possible. Another issue is the fact that administrative costs are important as policy administration is the only element of the costs of agri-environmental schemes that are borne entirely at the member-state level, even when the policy is to fulfil EU requirements. Scheme compensation payments may be reimbursed in part from the EU under Regulation 2078/92. Some member-states are constrained in developing their agri-environmental frameworks; hence there is perhaps an argument that support should be available from the EU for policy administrative costs as well as for the compensatory aspects of agri-environmental schemes.

## 6. Concluding Comments

This paper has highlighted the costs of agri-environmental scheme organisation. The econometric analysis suggested that the numbers of scheme agreements are important determinants of annual ESA administrative costs, as expected given that management agreements require two-way interactions between landholders and the administering agency. There appears to be some scope for economies of size related to scheme participation, perhaps implying that larger, more general schemes could be more efficient (or at least cheaper to implement) than a set of smaller schemes focused on particular agri-environmental aspects or localities. However, administrative costs were observed to vary greatly across the ESAs even when participation levels were taken into account, implying that there are a number of other factors to consider. The “learning effects” and fine-tuning in the years following designation may well be important.

Agri-environmental policies are still in their infancy and need rational development. High transactional costs will check their progress. There are questions relating not just to the levels of administrative expenditures on agri-environmental schemes, but also to the mix of activities funded by such expenditures. Trade-offs will in all likelihood be required: scope for economising in one area will be balanced by increased requirements in another. Furthermore, it is essential not to lose sight of the underlying goals of policies, namely environmental improvements, whilst (perhaps) maintaining farm income.

Greater knowledge of a number of aspects touched on only lightly here would improve future analysis. For example, participant attitudes could have a very important link to public administrative costs; positive attitudes towards conservation could reduce the overall transactions costs (both public and private) of establishing management agreements as there would be less conflict between conservation and farmer objectives. While ESAs have overcome a traditional division between landscape protection and nature conservation, catering also for archaeological concerns, the scheme still falls short of a fully-integrated approach to environmental management. Clearly we have not yet reached a fully-evolved agri-environmental policy framework. Further development is likely, and the administrative cost implications should be considered as an integral part of public policy decision-making.

#### References

- Arrow, K. (1969). The Organisation of Economic Activity: Issues Pertinent to the Choice of Market Versus Non-Market Allocation, in *The Analysis and Evaluation of Public Expenditure: The PPB System*. Volume 1, US Joint Economic Committee, 91st Congress, Washington DC. US Government Printing Office.
- Baumol, W. J., Panzar, J. C. and Willig, R. D. (1982). *Contestable Markets and the Theory of Industry Structure*. Harcourt Brace Jovanovich Inc. 510 pages.
- Bromley, D. W. and Hodge, I. (1990). Private Property Rights and Presumptive Entitlements: Reconsidering the Premises of Rural Policy. *European Review of Agricultural Economics*, **17**, 197-214.
- Chambers, R. G. (1988). *Applied Production Analysis Using the Dual Approach*. Cambridge University Press, Cambridge.
- Coase, R. (1960). The Problem of Social Cost. *Journal of Law and Economics*, **6**, 1-44.
- Diewert, W. E. and Wales, T. J. (1987). Flexible Functional Forms and Global Curvature Conditions. *Econometrica*, **55**(1), 43-68.
- Falconer, K. and Whitby, M. (1999). The Transactions Costs of Countryside Stewardship Policies: An Investigation for Eight European Member States. Research Report, Centre for Rural Economy, University of Newcastle upon Tyne.
- Falconer, K. and Saunders, C. (2000). Negotiating Agri-Environmental Management Agreements: Farm-Level Transaction Costs for SSSIs and Policy Design. Paper presented at the Agricultural Economics Society Conference, 14-17 April 2000, Manchester.
- Green, H. W. (1997). *Econometric Analysis*. Third Edition. Prentice Hall International, London.
- Hanley, N., Kirkpatrick, H., Oglethorpe, D. and Simpson, I. (1998). Principles for the Provision of Public Goods from Agriculture. *Land Use Economics*, **74**(1), 102-113.
- Hanley, N., Whitby, M. and Simpson, I. (1999). Assessing the Success of Agri-Environmental Policy in the UK. *Land Use Policy*, **16**, 67-80.
- House of Commons Agriculture Committee (1997). *Environmentally Sensitive Areas and Other Schemes Under the Agri-Environmental Regulation*. Volume I. HMSO, London.
- Land Use Consultants (1995). *Countryside Stewardship - Monitoring and Evaluation*. Third Interim Report to the Countryside Commission. Countryside Commission, Cheltenham.

- Latacz-Lohman, U. and Van der Hamsvoort, C. P. C. M. (1998). Auctions as a Means of Creating a Market for Public Goods. *Journal of Agricultural Economics*, 49(3), 334-345.
- MacFarlane, R. (1998). Implementing Agri-Environmental Policy: A Landscape Ecology Perspective. *Journal of Environmental Planning and Management*, 41(5), 575-596.
- MAFF/IBAP (1999). The Government's Expenditure Plans 1998-1999 to 1999-2000. Cm 1903. Ministry of Agriculture, Fisheries and Food/Intervention Board, London.
- McCann, L. and Easter, K. W. (1998). Estimating the Transactions Costs of Alternative Policies to Reduce Phosphorous Pollution in the Minnesota River. Staff Paper P98-7, Department of Applied Economics, University of Minnesota.
- National Audit Office (1997). *Protecting Environmentally Sensitive Areas*. HMSO, London.
- Niehans, J. (1971). Money and Barter in General Equilibrium with Transactions Costs. *American Economic Review*, 61(5), 773-778.
- Rodgers, C. and Bishop, J. (1999). Management Agreements for Promoting Nature Conservation. Royal Institute of Chartered Surveyors, London.
- Spash, C. and Simpson, I. (1994). Utilitarian and Rights-Based Alternatives for Protecting Sites of Special Scientific Interest. *Journal of Agricultural Economics*, 45(1), 15-26.
- Stavins, R. N. (1993). Transactions Costs and the Performance of Markets for Pollution Control. Discussion Paper QE-16. Resources for the Future, Washington.
- Stewart, L., Hanley, N. and Simpson, I. (1998). Economic Valuation of the Agri-Environmental Schemes in the UK. Report to HM Treasury and MAFF, Environmental Economics Group, University of Stirling.
- Whitby, M. C. and Saunders, C. M. (1996). Estimating the Supply of Conservation Goods in Britain: A Comparison of the Financial Efficiency of Two Policy Instruments. *Land Economics*, 72(3), 313-325.
- Williamson, O. E. (1985). *The Economic Institutions of Capitalism*. Free Press.
- Wilson, O. and Wilson, G. (1997). Common Cause or Common Concern? The Role of Common Lands in the Post-Productivist Countryside Area, 29(1), 45-58.

## APPENDIX 1

### The Share of the Explained Variability in Covariance Estimator Regressions

The covariance (or within-groups) estimator of parameter  $b$  in equation (1) is equivalent to the OLS estimation of  $b$  in equation (2).

$$y_{it} = a + x_{it}'b + z_i'g + w_i + u_{it} \quad (1)$$

$$y_{it} - y_i = (x_{it} - x_i)'b + e_{it} \quad (2)$$

Let  $\hat{b}$  be the covariance estimation of  $b$ . The explained variability of the total variability of the dependent variable ( $y_{it} - y_i$ ) is calculated as:

$$R_W^2 = \frac{\sum_i \sum_t [(x_{it} - x_i)' \hat{b}]^2}{\sum_i \sum_t [y_{it} - y_i]^2}$$

Equation (2) is equivalent to equation (3):

$$y_{it} = y_i + (x_{it} - x_i)'b + e_{it} \quad (3)$$

The explained variability share of the total variability of the dependent variable ( $y_{it}$ ) is given by (4) and refers to the standard  $R^2$  ratio:

$$R_T^2 = \frac{\sum_i \sum_t [y_{it} + (x_{it} - x_i) \hat{b} - y]^2}{\sum_i \sum_t [y_{it} - y_{..}]^2} \quad \text{with } y_{..} = \frac{1}{22} \cdot \frac{1}{5} \sum_i \sum_t y_{it} \quad (4)$$

If  $R_B^2$  is the inter-individual variability share in the total variability,

$$R_B^2 = \frac{\sum_i \sum_t [y_i - y_{..}]^2}{\sum_i \sum_t [y_{it} - y_{..}]^2}$$

Given (4), the explained variability share can also be calculated by the equation (5):

$$R_T^2 = R_B^2 + (1 - R_B^2) \cdot R_W^2 \quad (5)$$

proof:

$$R_T^2 = \frac{\sum_i \sum_t [y_{it} + (x_{it} - x_i) \hat{b} - y]^2}{\sum_i \sum_t [y_{it} - y_{..}]^2}$$

$$\frac{\sum_i \sum_t [y_i - y_{..}]^2 + \sum_i \sum_t [(x_{it} - x_i) \hat{b}]^2 + 2 \sum_i \sum_t (y_i - y_{..}) \cdot (x_{it} - x_i) \hat{b}}{\sum_i \sum_t [y_{it} - y_{..}]^2}$$

and  $\sum_i \sum_t (y_i - y_{..}) \cdot (x_{it} - x_i) \hat{b} = \sum_i (y_i - y_{..}) \cdot \sum_t (x_{it} - x_i) \hat{b}$

with  $\sum_t (x_{it} - x_i) \hat{b} = \sum_t (y_{it} - y_i) = 0$

## APPENDIX 2

### Analysis of the Total Exchequer Cost Variability

This Appendix explains in more detail the mathematical model specified in Section 3.4. Total exchequer cost EC equals compensation payments P plus the administrative cost C, for each ESA  $i$  in each year  $t$ :

$$EC_{it} = P_{it} + C_{it}$$

The following notations are used for the total, inter-individual, individual inter-temporal variability and empirical covariance (COV):

$$S_T^y = \sum_i \sum_t [y_{it} - y_{..}]^2 \quad S_B^y = \sum_i \sum_t [y_i - y_{..}]^2 \quad S_W^y = \sum_i \sum_t [y_{it} - y_i]^2$$

$y \in \{EC, P, C\}$

$$\text{Cov}_T^{P,C} = \sum_i \sum_t [P_{it} - P_{..}] \cdot [C_{it} - C_{..}]$$

$$\text{Cov}_B^{P,C} = \sum_i \sum_t [P_i - P_{..}] \cdot [C_i - C_{..}]$$

$$\text{Cov}_W^{P,C} = \sum_i \sum_t [P_{it} - P_i] \cdot [C_{it} - C_i]$$

The following relationships show the disaggregation of the total exchequer cost variability between the inter-individual and time dimensions of compensation payments and administrative costs:

$$S_T^y = S_B^y + S_W^y \quad R_B^2(y) = \frac{S_B^y}{S_T^y} \quad y \in \{EC, P, C\}$$

$$\text{Cov}_T^{P,C} = \text{Cov}_B^{P,C} + \text{Cov}_W^{P,C}$$

$$S_T^{EC} = S_T^P + S_T^C + 2 \cdot \text{Cov}_T^{P,C}$$

$$S_T^{EC} = S_B^P + S_B^C + 2 \cdot \text{Cov}_B^{P,C} + S_W^P + S_W^C + 2 \cdot \text{Cov}_W^{P,C}$$

The empirical correlation between compensation and administrative cost was found to be

$$\rho_T = \frac{\text{Cov}_T^{P,C}}{S_T^P \cdot S_T^C} \cong 0.55$$

Hence, the variability of exchequer cost is higher than the sum of the compensation and administrative cost ones:

$$\frac{S_T^P}{S_T^{EC}} = 0.62 \quad \frac{S_T^C}{S_T^{EC}} = 0.10 \quad \frac{2 \cdot \text{Cov}_T^{P,C}}{S_T^{EC}} = 0.28$$

The administrative costs contribute only 10 per cent of the variance of exchequer cost variability, while the compensations contribute 62 per cent.

In the cross section dimension, the correlation between compensation and administrative cost is much higher:

$$\rho_B = \frac{\text{Cov}_B^{P,C}}{S_B^P \cdot S_B^C} \cong 0.87. \text{ This means that the larger the scheme, the higher the administrative costs.}$$

Hence, the inter-individual variability of exchequer cost is much higher than the sum of the compensation and administrative cost ones:

$$\frac{S_B^P}{S_B^{EC}} = 0.58 \quad \frac{S_B^C}{S_B^{EC}} = 0.07 \quad \frac{2 \cdot \text{Cov}_B^{P,C}}{S_B^{EC}} = 0.35$$

The administrative costs contribute only 7 per cent of the inter-individual variability in exchequer cost variability while the compensation cost variability contributes 58 per cent and the empirical covariance 35 per cent.

In the time dimension, the correlation between compensation and administrative cost is negative and very

$$\text{small: } \rho_W = \frac{\text{Cov}_W^{P,C}}{S_W^P \cdot S_W^C} \cong -0.10.$$

This means that compensation and administrative cost are almost independent in the time dimension. Hence, the inter-individual variability of exchequer cost is lower than the sum of the compensation and administrative cost variabilities:

$$\frac{S_W^P}{S_W^{EC}} = 0.84 \quad \frac{S_W^C}{S_W^{EC}} = 0.25 \quad \frac{2 \cdot \text{Cov}_W^{P,C}}{S_W^{EC}} = -0.09$$

The share attributable to administrative costs of the exchequer cost individual inter-temporal variability is 25 per cent. As the entire exchequer cost variability comes from covariance in the cross section dimension, this explains why  $R_B^2$  is higher for the exchequer costs than for both the compensations and the administrative costs.