Policy Costs and Producer Costs

Empirical Modelling of Agri-Environmental Services

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focus on empirical modelling ...

Marketed Outputs and Non-Marketed Ecosystem Services

(with A.Wossink)

study 1

research problem

How to determine the cost of marginal ecosystem changes and the effectiveness of green payments based on a theoretical and empirical analysis of the production relationships at micro (farm) level.

approach

- Theoretical approach based on generalized joint production model which allows complementary, substitutive and competitive relationships.
- We implement this empirically as a transformation function.
- We include farm/farmer specific impacts and use panel data analysis. We apply our approach to the Environmental Stewardship Scheme (ESS) and the Hill Farm Allowance (HFA).

model

- The two outputs are produced simultaneously but since these are multiple outputs a separate production function is used for each output.
- This leads to a generalised joint production model.
- This model allows for joint inputs and the possibility of varying the proportion of agricultural output and ES.

$$Min_X \quad \{C = pX - c\}$$

$$\text{s.t.} \quad F(X, Z; D) \geq Y$$

$$G(X; D) \geq \overline{Z}$$

constraint on level of ecosystem service to establish marginal cost of trading-off Y for Z

where

Y = agricultural output
Z = non-marketed ecosystem service
X = input contributing to Y and Z
D = site specific biotic and a-biotic environment.

Case 1: *Complementary.* The sum of the direct yield effect and the indirect yield effect of input use is positive (but decreasing) and the farmer can produce more *Z* while also increasing his commodity output *Y*.

Case 2: *Substitutive*. Either the direct yield effect or the indirect yield effect is non-positive but the net yield effect of the rearrangement of input *X* is positive.

Case 3: Competitive. The direct yield effect of reallocating X is nil and there are yield losses caused by the required increase in *Z* needed to satisfy the constraint on the ecosystem services.

$$F_X = \frac{dF}{dX} = \frac{\partial F}{\partial X} + \frac{\partial F}{\partial Z}\frac{\partial Z}{\partial X}$$

study 1

- panel data collected in England and Wales, 2005-2007
- transformation function: $Y_1 = G(\mathbf{Y_{-1}}, \mathbf{X}, \mathbf{T})$, where, Y_1 is the agricultural output of the farms (mainly livestock and crops) and Y_{-1} the vector of other outputs (including ecosystem services related outputs **Z**, and non-agricultural output Y_{NAO}), to represent the technological relationships for the farms in our data sample
- generalized linear functional form, random effects specification

direct and indirect effects

Effect evaluated	Mean	Std. Dev.	Min	Max
dYAO/dX	173.978	259.197	-440.066	1591.110
dYAO/dZESS	.372	2.887	-8.233	12.288
dYAO/dZHFA	-2.529	6.310	-39.071	23.947
(dYAO/dZESS)(dZESS/dX)	0.065	0.032	0.006	0.192
(dYAO/dZHFA)(dZHFA/dX)	0.071	0.058	0.007	0.438
(dYAO/dZESS)(dZESS/dZHFA)	-6.61e-04	5.61e-04	-0.004	-7.01e-05
(dYAO/dYNAO)(dYNAO/dZHFA)	9.03e-05	7.74E-05	1.21e-05	5.83e-04
(dYAO/dYNAO)(dYNAO/dZESS)	-5.03e-05	3.09E-05	-2.24e-04	5.24e-06
(dYAO/dYNAO)(dYNAO/dX)	-0.008	0.005	-0.043	-7.11e-04

study 1

observations per case

Relation	Agric Out ESS	Agric Out HFA	HFA ESS	ESS HFA
Direct Effect	dYAO/dX	dYAO/dX	dYAO/dZHFA	dYAO/dZESS
Indirect Effect	(dYAO/dZESS)* (dESS/dX)	(dYAO/dZHFA)* (dZHFA/dX)	(dYAO/dZESS)* (dZESS/dZHFA)	(dYAO/dZHFA)* (dZHFA/dZESS)
Case I	**314**	**314**	0	0
Case II	0	0	121	**202**
Case III	79	79	**272**	191
Total Obs	393	393	393	393

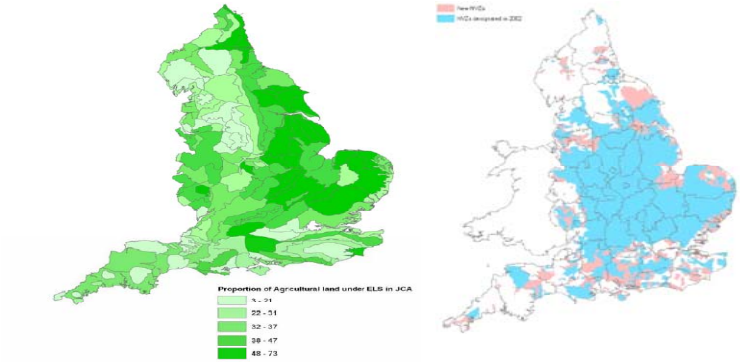
conclusions / current work

- the majority of farms produce agricultural output and ecosystem services in a complementary relationship
- generation of multiple ecosystem services on the same farm showed either a substitutive or competitive relationship.
- changing the composition of the ecosystem services output would have very different implications for individual farms.

- spatial patterns
- investigate significant characteristics of the farms being part of the classes I-III as estimated in our paper

Cost-Effectiveness of Agri-Environmental Instruments – ESS vs NVZ

(with J.Walsh)



research problem

to empirically investigate the costs and effects of different agri-environmental instruments based on a quantitative ex-post evaluation

› a management agreement type instrument

- the *Environmental Stewardship Scheme (ESS)* -

is evaluated along

› a command-and-control type instrument

- the *Nitrate Vulnerable Zones (NVZ)* –

approach/model

different types of costs may be borne by different agencies or at different points in the policy life cycle

different types of policy instruments may entail a different mix of costs or a difference in the costs' relative importance (McCann et al. 2005)

a number of typologies exist in the literature: Dahlman 1979, Stiglitz 1986, Foster and Hahn 1993, Thompson 1999

any relevant framework has to be general enough to include both market and nonmarket policy instruments (see Coase 1960)

study 2

Table 1 - Transaction Cost Components for Agri-Environmental Schemes

Category	Component	Sub-Component
set-up	1) research / information	- surveying of the designated scheme area
	2) design	- area designation and requirements design - re-design/re-notification of requirements
	3) enactment / litigation	- enactment of enabling legislation, lobbying and public participation - changing laws or modifying existing regulations
administration	4) contracting	- scheme promotion to potential participants - negotiation between agency and participants
	5) contracts' administering	- contract administration (especially transfer of payments)
monitoring	6) inspection of contractors / non-compliance detection	- controlling at participants' premises and land
	7) enforcement of requirements	- legal enforcement of participants' scheme compliance
evaluation	8) scheme analysis	- research/information with respect to environmental effects - static and dynamic monitoring and analysis
	9) scheme evaluation	- overall evaluation of policy instrument

(extension of Falconer et al 2001 and McCann et al 2005)

study 2

let *TC* denote the sum of all scheme *j* related transaction cost components: fixed and variable costs for the set-up (*SU*), administration (*A*), monitoring (*M*), and scheme evaluation (*E*) for the time period t = 1, ..., T

$$TC_{jt} = \sum_{t=1}^{T} (SU_{jt} + A_{jt} + M_{jt} + E_{jt})$$

total scheme costs *SC* (or exchequer relevant costs) for scheme *j* in year *t* comprises compensatory payments *CP* and the sum of transaction costs *TC* and is a function of scheme related factors *sc* and factors related to scheme *j's* farmers' compliance behaviour *c*

$$SC_{jt} = CP_{jt}(sc_{jt}) + TC_{jt}(sc_{jt}, c_{jt}) = F_{jt}(sc_{jt}, c_{jt})$$

study 2

farmers' costs of compliance c

a function of managerial skills (*m*), technological characteristics (*tech*), spatial differences (*l*) but also individual attitudes and experiences (*att*)

scheme related factors sc

area under agreement (*aagr*), the number of agreements (*nagr*), the scheme age (*st*), other scheme specific characteristics (*z*), and potential overlap of the covered area with other agri-environmental instruments' target area (*in*) as e.g. other conservation schemes and/or pollution taxes

to obtain estimates of the production structure and performance of each farm participating in the scheme we rely on a transformation frontier model

$$Y_{p,it} = F(Y_{it}, X_{it}, C_{it}, V_{it}, U_{it})$$

the empirical estimation yields an efficiency estimate per farm and year (eff_{it}) as well as first order derivatives ($el_{P,S}$; $el_{P,k}$) to approximate the farmers' input and output choices as well as his cost of compliance with scheme *j*

study 2

to obtain valid proxies for the farmers' specific production risk we can describe a profit function for each farm *i* at time *t*

$$\omega_{it} = F(R_{it}, P_{it}, C_{it}, V_{it})$$

profit per farm and year ϖ as a function of variable input prices $\boldsymbol{R}$ relevant output prices $\boldsymbol{P}$, and a vector of extra profit shifters $\boldsymbol{C}$ as well as an iid error term $\boldsymbol{V}$

$\Rightarrow$ the estimated moments (μ_o) of the profit function can be used as proxies for the individual farmer's production risk and deliver empirical evidence on his risk related behaviour, hence, also his compliance behaviour with scheme *j's* contractual requirement

study 2

1 - differences in the scheme's overall rate of compliance have to be considered, by weighting the total scheme costs by the rate of compliance in the specific year (SC_c)

2 - to make inferences at the relevant administrative scheme level (i.e. to adequately reflect budget authority) we consider the scheme costs e.g. at the regional (i.e. subnational) level (*gor*)

3 - to consider the environmental effects side of the scheme - in terms of a cost-effectiveness type perspective - we can use a proxy for the sum of environmental effects per space unit (e.g. per ha land covered)

study 2

we re-write our total scheme cost function as an average scheme cost function or scheme cost per ha function

$$\left(\frac{SC_c}{ha}\right)_{gor,jt} = F(\cdot)_{gor,jt}$$

for the command-and-control type instrument we slightly modify this model by neglecting compensatory payments

different hypotheses regarding specific cost factors can be investigated by interpreting the individual parameters estimated for the elements of F(·)

data

annual data on the different transaction cost components with respect to all full years (2006 to 2008) the ESS scheme is in operation

NVZ: annual data on the different transaction cost components with respect to the period 2000 to 2008, at the Environmental Agency regional budget level

for the estimation of risk, technological characteristics and economic performance we use data on farm level contained in the FBS

econometrics

summary of the complete estimation procedure

risk proxies

→ flexible profit function and central moments procedure (RE)

efficiency estimates

→ flexible frontier transformation function (RE)

cost effects

→ different panel data regressions (RE GLS, RE GLS AR(1))

bootstrap based resampled estimation procedures to receive evidence on the statistical robustness of the estimated SE (10,000 replications)

Self-Selection in PES Schemes

(with N.Russell)

research problem

- investigate farmer participation in PES schemes using ESS
- consider the problems arising from asymmetry of information between participating farmers and the contracting agency
  → focus on 'hidden information' rather than 'hidden action'
- the extent to which self selection by farmers can impair the efficiency of PES schemes
- point to specific strategies that might be used by a government agency to mitigate these effects

model

- use the case of an uninformed buyer as benchmark example (e.g. Akerlof's used car buyer)
  - any offer price will attract only sellers with lower quality units to sell; average value of units on sale will always be less than the offer price
  - reducing the offer price will not improve matters since sellers with higher quality units withdraw as offer price decreases
- no market equilibrium may be possible even where some potential trades exist; unable to exploit gains from trade
- one key parameter is the positive relationship between offer prices and quality of units available

model

quality categories $e^1 \ldots e^N$,

$$\bar{e} = \frac{\sum_n h^n e^n(p)}{\sum_n h^n(p)}$$

farmer participation function

$$h^n = h^n(p); \quad \frac{\partial h^n}{\partial p} > 0$$

contract demand function

$$D = D(p, \bar{e}); \quad \frac{\partial D}{\partial p} < 0, \quad \frac{\partial D}{\partial \bar{e}} > 0$$

slope of the contract demand function (depends on sign of $\frac{d\bar{e}}{dp}$)

$$\frac{dD}{dp} = \frac{\partial D}{\partial p} + \frac{\partial D}{\partial \bar{e}} \frac{d\bar{e}}{dp}$$

sign of $d\bar{e}/dp$

$$\frac{d\bar{e}}{dp} = \frac{\left[\sum_n \frac{\partial e^n}{\partial p} h^n + \sum_n e^n \frac{\partial h^n}{\partial p}\right] \sum_n h^n - \sum_n e^n h^n \sum_n \frac{\partial h^n}{\partial p}}{\left[\sum_n h^n\right]^2} = \frac{\left[\sum_n \frac{\partial e^n}{\partial p} (h^n)^2\right]}{\left[\sum_n h^n\right]^2}$$

- scheme payments are higher on land that is farmed more intensively
- ecological quality is lower as land use intensity increases (Kleijn 09)

together these mean a negative relationship between ecological quality and scheme payments for an individual parcel of land

i.e. $\frac{\partial e^n}{\partial p} < 0$

data

data on individual agreements for farmers in the UK's ESS

includes information on characteristics of the farmer and of the farming operation for over 10,000 scheme participants enrolling over 2005-09

linked to GIS based information on ...

... spatial characteristics of the land

... production and socioeconomic characteristics of the participating farms

empirics

assume that key relationships define a reduced form relationship that can be represented by an implicit function

$$F\{e, p, h \ldots .\} = 0$$

e = ecological quality; p = scheme payments;
h = hectares in the agreement

estimate the parameter values using h as dependent variable

compute the relevant marginal impacts based on the IFR

$$e.g. \frac{\partial e}{\partial p} = -\frac{F_p}{F_e}$$

problems to discuss …

- environmental / ecological effects' measurement and model integration?

- how useful are monetary proxies here?

- can we really identify producers' behavioural responses?

- do we actually have the data to use robust statistical models?

THANK YOU!