Assessing Farmers' Willingness to Accept "Greening": Insights from a Discrete Choice Experiment in Germany[1]

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Abstract

This paper explores farmers' prospective responses to the "greening" of the Common Agricultural Policy. The analysis is based on discrete choice experiments with 128 German farmers. Participants were asked to choose between a "greening" option with a given set of management prescriptions and an "opt-out" alternative with a stipulated cut of the single direct payment. A binary logit model is used to identify the variables affecting the likelihood of "greening" being chosen. In addition, latent class estimations are carried out to group respondents into latent classes of "compliers" and "non-compliers". We find that farmers' choices are driven by "greening" policy attributes, personal and farm characteristics, and interactions between these two groups of variables. Farmers perceive "greening" as a costly constraint, but not all farmers are equally affected and not all "greening" provisions are regarded as equally demanding. Specialised arable farms on highly productive land and intensive dairy farms are most likely to opt out of "greening" and voluntarily forgo part of their single payment entitlements. The paper concludes with a set of recommendations for improving the design of a second-best policy.

Keywords: Greening; Common Agricultural Policy; discrete choice modelling; latent class estimation.

JEL code: *Q18, Q24*

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1. Introduction

2014 will see the launch of a revised Common Agricultural Policy (CAP). According to Matthews (2013, p. 1) “The most prominent innovation [is] … undoubtedly to earmark a proportion of direct payments as a mandatory green payment for farmers who follow a number of practices beneficial to the environment and climate.” With the new CAP entering into force, farmers will have to comply with three generalised, non-contractual, annual “greening” provisions in order to remain eligible for full CAP support (EU Commission, 2011a):

1. Ecological focus area (EFA): farmers shall ensure that at least 7% of their arable land is an “ecological focus area” such as land left fallow, terraces, landscape features, buffer strips and afforested areas.
2. Crop diversity: cultivation on a farm’s arable land shall consist of at least three different crops where the arable land of the farmer covers more than 3 hectares and is not entirely used for grass production, entirely left fallow or entirely cultivated with crops under water for a significant part of the year; none of those three crops shall cover less than 5% or more than 70% of the arable land.
3. Grassland maintenance: farmers shall maintain as permanent grassland the areas of their holdings declared as such in the application for claim year 2014. Farmers shall be allowed to convert a maximum of 5% of their reference areas under permanent grassland.

Farmers who choose not to comply with the above provisions lose eligibility for the “greening” premium which accounts for 30% of the annual national budgetary envelope. It is unclear at the time of writing whether such payment cuts are partial or total and whether they also extend to the basic payment entitlements (70% of the annual national ceiling).

Since publication of the Commission’s proposal in October 2011, “greening” has given rise to a lively and mostly critical debate (Hart and Little, 2012; House of Commons, 2012; Matthews, 2012b, 2013). Proponents emphasise the potential benefits for biodiversity of leaving land uncultivated in intensively used arable landscapes, arguing that “greening”, as a universal set of measures which applies to all farms, would close gaps in the spatial coverage of voluntary agri-environmental schemes (Wissenschaftlicher Beirat für Biodiversität und Genetische Ressourcen, 2012; SRU, 2013). Critics, by contrast, regard “greening” as a poorly targeted policy instrument which is unlikely to meet its environmental objectives. Matthews (2012a) sees potential for positive environmental effects with less budgetary expense if cross compliance rules were strengthened to include “greening”. However, after details of the “greening” policy emerged, he concludes that practical environmental benefits will be negligible (Matthews, 2012b, 2013). Tangermann (2012) argues that “greening” the direct payments may serve the political purpose of suggesting they have a reasonable justification, but he considers the greening provisions unsuitable to generate the environmental benefits sought.

In its *ex-ante* impact assessment of the CAP reform proposals (EU Commission, 2011b), the Commission states that the challenge lies in designing “greening” such that considerable environmental and climate change benefits can be reaped without undermining the long-term competitiveness of the agricultural sector and unduly complicating the administration of direct payments. It is argued that “this is possible although some administrative burden cannot be avoided. The resulting negative impact on income remains moderate on average (but varies significantly between Member States, regions and farming systems).” (EU Commission, 2011b, p. 79). Farmers’ unions have contested this view. They also question the appropriateness of converting 7% of arable land area into EFA in times of global food shortages and high commodity prices (COPA-COGECA, 2013; Deutscher Bauernverband, 2012).

The heated political debate in the run-up to the agreement on the future CAP suggests that “greening” will remain contentious in the years to come. The agreed provisions are thus likely to be subject to scrutiny and change. Any future changes to the policy will affect its environmental effectiveness through two counteracting forces: by determining the environmental benefits per hectare and the land area offered by farmers. Policy-makers will thus have to balance the additional environmental benefits from tightened “greening” requirements with the risk of farmers opting out. It is therefore important for policy-makers to know which factors affect farmers’ willingness to comply and how farmers are likely to respond to future changes to the “greening” requirements.

Against this background, this paper investigates farmers’ prospective responses to alternative designs of “greening”. In particular, we aim to: investigate how the “greening” provisions and their levels set by policy are likely to affect farmers’ willingness to comply; assess the perceived farm-level costs of the “greening” provisions; explore the heterogeneity of preferences and costs among farmers; and draw conclusions for improving the design of the policy.

The empirical analysis is based on discrete choice experiments (DCE) with 128 German farmers carried out in the summer of 2012. The DCE approach allows us to derive willingness-to-accept (WTA) compensation estimates for marginal changes in individual policy attributes. These may be interpreted as marginal *perceived* costs of participation in that the WTA includes non-monetary motives that farmers may have in respect of "greening".

The remainder of the paper is organised as follows. Section 2 describes the choice experiment and explains the empirical model. The section starts with a brief review of existing studies applying choice modelling to assess farmers' willingness to participate in agri-environmental schemes. Section 3 presents and discusses the empirical findings. Section 4 concludes and derives implications for policy.

2. Methodology

2.1. Discrete choice modelling and agri-environmental policy

Discrete choice experiments (DCE) are a common tool for assessing people's preferences and/or decisions in hypothetical situations, e.g. before a new product is launched or a new technology becomes available. Respondents are asked to choose their most preferred alternative from a choice set with several alternatives characterised by so-called attributes. Discrete choice models are based on random utility theory and stem from Luce and Tukey (1964), Quandt (1968) and Theil (1970). McFadden (1974) and Louviere and Woodworth (1983) developed econometric methods to analyse DCE data. In contrast to revealed-preference methods using real-world data, DCE obviously fall into the category of stated-preference methods, more precisely contingent valuation methods. Within this class, the discrete choice format is considered to reflect the nature of many real-world decision-making processes better than classic conjoint analysis, which asks respondents to rank the alternatives on offer. The discrete choice format is also more robust to strategic responses than the open-ended format often used in contingent valuation studies (Adamowicz *et al.*, 1998). Finally, Louviere *et al.* (2010) prefer DCE to conjoint analysis since the former has a sound theoretical foundation in random utility theory.

In the field of agri-environmental policy, DCE has been applied to assess farmers' willingness to participate in voluntary conservation schemes (e.g. Ruto and Garrod, 2009; Espinosa-Goded *et al.*, 2010; Christensen *et al.*, 2011). Espinosa-Goded *et al.* (2010) investigate the factors affecting farmer's willingness to participate in a hypothetical programme paying Spanish farmers to cultivate alfalfa (a nitrogen-fixing crop). Free choice of the land offered for the programme and unrestricted use of the alfalfa crop significantly increase respondents' willingness to sign a contract, as does previous experience with agri-environmental scheme participation. Christensen *et al.* (2011) conduct a DCE with 444 Danish farmers to assess their willingness to sign contracts for pesticide-free buffer zones. Farmers prefer contracts with a flexible zone width, short contract period, greater flexibility in fertiliser use, and the option to quit the contract from year to year. The last option is valued at €137 per hectare and year. Ruto and Garrod (2009) confront respondents with alternative designs of a hypothetical conservation scheme, each characterised by five attributes: compensation payment, contract length, whole farm or partial area participation, degree of flexibility in implementing conservation practices, and administrative burden for the farmer. In addition to these contract attributes, farmer characteristics such as age and education are also considered to influence farmers' choices. Respondents request higher payments for participating in schemes with longer contracts, less flexibility and higher administrative effort.

2.2. The discrete choice experiment

The present paper investigates farmers' preferences for alternative "greening" provisions which are yet to enter into force. For this purpose, we conducted an online survey of arable farmers in Germany in the summer of 2012 – at the height of the political debate about "greening". "Greening" is a serious concern in rural areas of Germany, and one which farmers are both aware of and sensitive to.

Farmers were recruited for the survey through calls for participation in agricultural magazines, online newsletters and forums. The online questionnaire was generated with the help of survey design tools developed by Globalpark (www.globalpark.de) and was easily made available on the Department's homepage. Given the widespread use of computers and the internet among German farmers, the online questionnaire was deemed to be an appropriate and cost-effective tool for obtaining a good spatial coverage of respondents from all parts of Germany.[2] Breustedt *et al.* (2008) also administered an online DCE survey in Germany to explore the factors affecting farmers' willingness to cultivate genetically modified oilseed rape. Prior to the main online survey, a pre-test of the questionnaire was conducted with a sample of farmers both face-to-face and online. This resulted in adjustments to the wording of the questionnaire to ensure that respondents fully understood all questions.

[2] According to Vennemann and Theuvsen (2004), 70% of farm households in Germany use the internet in managing their farms. In 2011, 77% of all households in Germany had internet access (Destatis, 2011).

A total of 302 farmers started the online survey, which yielded 128 completed questionnaires from all parts of Germany. Although most respondents are located in the northwest of Germany, all other federal states, with the exception of Thuringia, are represented in the survey. However, because of the relatively low coverage of East Germany, the sample is not representative of the German farming community. Also, administering the survey online has resulted in small farms being underrepresented. The sample size is comparable to Espinosa-Goded *et al.* (2010) who interviewed 100 farmers in the region of Andalusia and 200 farmers in the Aragon region.

As indicated in the first section, compliance with the “greening” provisions is voluntary and thus at the farmers’ discretion. Non-compliance does not constitute a breach of law or violation of a contract and thus does not result in legal action against the farmer. However, farmers who choose to opt out of “greening” will face reductions in their single payments. To mimic this situation in the experiment, farmers were asked to choose between a clearly specified “greening” alternative or a reduced single payment instead. We term the latter the “opt-out” alternative which is characterised by a pre-specified cut of the single payment per hectare of arable land. The “greening” alternative is characterised by a set of five attributes, with varying attribute levels:

1. Share of ecological focus area (EFA);
2. Minimum land share of the three crops;
3. Land creditable against EFA;
4. Permissible use of EFA; and
5. Location of EFA plots.

The first three attributes are taken from the Commission’s proposal. The last two attributes have emerged in the political debate after publication of the Commission’s proposal and relate to implementation issues which are likely to impact the farm-level cost of “greening”. For example, the option of cultivating EFA land with leguminous crops instead of setting it aside will allow farmers to earn some profit. Conversely, if farmers are required to maintain the EFA in the same location for a number of years, they will not be able to reap the benefits of including EFA land into tight crop rotations.

Table 1 is an example of a choice set. Table 2 displays the levels chosen for each attribute. Attribute levels must be varied in any DCE to enable estimating the effect of individual attributes on respondents’ choices. In the present study, levels were chosen with reference to proposals made in the political debate. The German National Farmers’ Association

(Deutscher Bauernverband, 2012) considers 7% EFA as proposed by the Commission as being too high, whereas environmental lobby groups such as BUND demand 10% EFA (Ribbe, 2012). The Commission's proposal stipulates that at least three different crops shall be grown, none of which shall cover less than 5% or more than 70% of a farm's arable land. In our experiment, we varied the minimum crop share between 5% and 25% to account for the possibility that crop diversity requirements might be tightened in future policy revisions. Note that the 25% share for the smallest crop implies a maximum share of 50% for the biggest crop – an option raised in EU Commission (2011b).

Table 1

Sample choice set

"Greening" attributes	**"Greening" alternative**	**Opt-out alternative**
Ecological Focus Area (EFA)	10% of arable land	Single payment cut by **€175 per hectare of arable land** No greening provisions
At least 3 crops, each covering no less than …	5% of arable land	
Land creditable against EFA	Land enrolled in agri-environmental schemes	
Permissible use of EFA	Leguminous crops may be grown on EFA	
Location of EFA plots	EFA location fixed for 3 years	
I would choose…	**O**	**O**

Table 2

Greening attributes and their levels in the choice experiment

Greening attributes	Attribute levels
Ecological Focus Area	5% / 7% / 10% of a farm's arable land
Arable crop diversity	At least 3 crops (in excess of EFA), each covering no less than 5% / 15% / 25% of arable land
Land creditable against EFA*	None Land enrolled in agri-environmental schemes (AES) Landscape features (hedges, ponds, stone walls, etc.) Land in AES **and** landscape features
Permissible use of EFA*	Leguminous crops Leguminous crops, but they must be grown on twice the EFA No productive use (EFA must be set aside)
Choice of EFA location*	Location of EFA can be freely chosen each year EFA location fixed for 3 years
Reduction of single payment in case of opt-out	€35 / €70 / €105 / €140 / €175 per hectare of arable land per year

Note: * Attribute levels are represented by dummy variables in the estimations.

What types of land can be counted as EFA is a question that has been the subject of heated political debate. The Commission's proposal mentions landscape features such as buffer strips, terraces or afforested areas. The German Conference of Agriculture Ministers proposed also counting land enrolled in agri-environmental schemes (AES) as EFA (Agrarministerkonferenz, 2011). Our experimental setup additionally captures the two extreme cases of either none or both of these two land categories being counted as EFA. For permissible uses of EFA land, views range from strict set-aside through cultivation with leguminous crops (or other crops grown without pesticides and fertilisers) to giving farmers the choice between set-aside and growing leguminous crops on twice the EFA area, as proposed by Agrarministerkonferenz (2011). Whether farmers will be required to maintain EFA land in one location for a number of years (three in the experiment) or whether they are allowed freely to choose the location of the EFA from year to year is also likely to affect choices. In the experiment, this implementation detail is represented by the attribute "choice of EFA location" (Table 1).

It is important to note that our “opt-out” alternative differs from the Commission’s proposal in one aspect: the single payment cut refers to a farm’s arable land only and not to a farm’s total eligible land area. Otherwise, a farm’s total payment reduction would be proportional to its share of arable land, implying that farms with a relatively high share or permanent pasture would virtually always adhere to the “greening” requirements (most of which relate to arable land).[3] Since payment reductions are likely to be subject to review and change in future policy revisions, we varied the payment cuts between €35 and €175 per hectare of arable land, representing roughly 10% to 60% of the current single payment rates in Germany. The higher cut reflects the possibility of the basic payment being affected by non-compliance. The lower reduction rate accounts for the possibility of a substantially “softened” policy package being implemented.

The SPSS software package was used to generate the choice sets. This yielded 25 choice sets out of all possible attribute combinations representing a reduced orthogonal experimental design. The D-efficiency is 95.8 – sufficiently close to the maximum value of 100 for a perfectly orthogonal and perfectly balanced design. Espinosa-Goded’s *et al.* (2010) experiments have a D-efficiency of 91.3. In the survey, each farmer was confronted with eight randomly chosen choice sets.

The survey also elicited information about farm and farmer characteristics as well as attitudes towards “greening”. Farm organisational features are likely to affect the costs of implementing the “greening” provisions. Dairy farmers may find it more difficult than pig or poultry farmers to comply with “greening” because of fears that the loss of maize silage on EFA land may force them to scale down their herds. Pig and poultry farmers, by contrast, can easily buy fodder on the market. Likewise, livestock farms may be more affected than arable farms because the former need all their land for manure spreading. Farmers’ attitudes towards “greening” were elicited by asking respondents to state, on a Likert scale, their agreement or disagreement with a number of statements. We also asked farmers whether they believed that

[3] In deciding whether or not to comply with the “greening” provisions, farmers will balance the costs of compliance with the payment cut in case of “opt-out”. Given the nature of the “greening” provisions, compliance costs will be incurred only on arable land. In the Commission’s proposal, the payment cut however relates to a farm’s total eligible land area (including permanent pasture). As a consequence, the “penalty” of opting out increases with a farm’s permanent pasture area. The higher the share of pasture, the greater is the incentive for a farmer to comply. In a farm with 90% permanent pasture, the payment cut per hectare of arable land is 10 times as high as in a 100% arable farm. Such incentives would distort the effect of the attribute “single payment cut” in the experiments. We have therefore chosen in the experimental design to relate the single payment cut to the area on which compliance costs are incurred, i.e. arable land only.

"greening" would result in an increase in the demand for arable land and thus contribute to high land rents.

2.3. The choice model

The discrete choice model is based on random utility theory and assumes that the respondents choose their most preferred alternative: the "greening" option or the "opt-out" alternative. A farmer's *i* random utility *U* for alternative *j* is assumed to be:

$$U_{ij} = V_{ij} + \varepsilon_{ij} = \mathbf{x_j}\alpha + \mathbf{z_i}\beta + \varepsilon_{ij},$$

where ε is the disturbance term, i.e. the stochastic part of utility which cannot be observed or estimated by the researcher, *V* is the deterministic utility which is determined by the attribute levels of an alternative represented by vector **x** and by the personal and farm characteristics represented by vector **z**. α and β are vectors of regression coefficients to be estimated.

The respondent chooses alternative j^* which yields the highest utility – a choice which is observed in the experiment. In the case of only two alternatives, the choice can be estimated by means of a common binary logit regression. The exogenous variables are the respondents' personal and farm characteristics **z** and the difference between the attribute levels in the two competing choice alternatives. As explained above, there is no single payment reduction in the "greening" alternative, and there are no "greening" provisions in the "opt-out" alternative. Consequently, the differences between the two alternatives are the attribute levels of the "greening" alternative and the single payment cut from the "opt-out" alternative.

Some of the greening attributes may be valued differently by different farmers. For example, farmers who already have many landscape attributes on their land are likely to prefer, *ceteris paribus*, the alternative that allows counting such attributes as EFA. We account for this heterogeneity – besides including socio-economic variables – by introducing three interaction variables between policy attributes $\boldsymbol{x}$ and farm/farmer characteristics $\boldsymbol{z}$.[4] The first interaction term, following directly from the above example, is the product of the policy attribute "landscape features creditable against EFA" and a dummy variable indicating whether a farm has such landscape features on its land. The second interaction term is the product of the variable "leguminous crops on twice the EFA" and a dummy variable denoting whether legumes are cultivated on the farm. The third cross term links the policy attribute "Land

[4] Although this specification is not standard in estimating DCE it can be found, for example, in Berning *et al.* (2010), Birol *et al.* (2006) or Mazzanti (2001).

enrolled in agri-environmental schemes (AES) creditable against EFA” with a dummy variable indicating whether a farm has land enrolled in AES.

In addition to the standard binary logit model, we carry out a latent class estimation as an alternative approach of accounting for heterogeneity in preferences among respondents. The deterministic utility is assumed to be affected only by the attributes and the cross-terms and their respective (logit) regression coefficients. In contrast to the binary logit regression, these regression coefficients are allowed to vary among the (latent) classes, thus accounting for different preferences among the classes. The membership of a class is determined by a logit function including the respondents’ characteristics. The likelihood function to be maximised considers several sets of α – one for each class. The observations are weighted by the likelihood of belonging to each of the classes based on the membership function. In contrast to the logit model, the latent class estimation assumes that the respondents’ characteristics do not impact the utility of the alternatives. The characteristics are assumed only to separate respondents with different preferences for the attributes. Since in our case there is no convincing argument to prefer one of the estimation approaches to the other we report the results of both approaches.

The signs of the attribute and cross-term regression coefficients indicate whether an increase in the variable in question increases or reduces the probability of the “greening” alternative being chosen. No direct inference, however, can be drawn from the regression coefficients as to the strength of this relationship. A convenient way of making regression coefficients interpretable is to compute marginal willingness-to-accept (WTA) figures for both policy attributes and farm/farmer characteristics. These WTA estimates represent the monetary equivalent of increasing the attribute value by one unit. For example, a marginal WTA of–€6.32 for the EFA attribute (shown in Table 5 below) means that an increase in the EFA by one percentage point reduces the choice probability for the “greening” alternative as much as an additional payment cut of €6.32 per hectare of arable land. Put differently, offering the farmer €6.32 per hectare in compensation restores the initial probability of choosing the “greening” alternative. The WTA estimates may thus be interpreted as the perceived marginal cost of complying with the “greening” provisions. In the logit model, WTAs are also estimated for the farm/farmer characteristics. In the latent class estimations, by contrast, the farmer characteristics only affect class membership.

In a logit model, the marginal WTA is computed by dividing the regression coefficient of the respective variable by the regression coefficient of the monetary variable, i.e. the single payment reduction. For dummy variables, the discrete change in the probability of choosing the "greening" alternative (all other variables being kept at the sample mean) is calculated by changing the dummy's value from zero to one. To obtain the corresponding WTA estimate, this discrete change in the probability is divided by the change in the "greening" choice probability of raising the payment cut by one Euro.

The conditional logit estimations are conducted by means of the *asclogit* command in *Stata* 12.1 and the latent class estimation is based on *Stata* code by Pacifico and Yoo (2012).

3. Results

3.1. Descriptive statistics

Table 3 presents the descriptive statistics of our sample of 128 respondents. Eighty percent are full-time farmers, the average farmer is 43 years old and cultivates 161 hectares of agricultural land, 24% of which is permanent pasture. The distribution of farm size is skewed to the right, with a mean of 161 hectares and a median of 87 hectares. Both figures are well above the average for Germany (55.6 hectares).[5] Also, respondents are younger than the average farmer in Germany, and the share of full-time farms in the sample is significantly higher than in Germany as a whole (50%). The land quality index (*Ackerzahl*) of 45 indicates that the survey farms have, on average, medium-quality soils. The index can assume values between 16 and 100.

The biggest crop in the respondents' rotations covers on average 47% of arable land. Respondents keep on average slightly more than one livestock unit (LU = 500 kg of live-weight) per hectare of land. Thirty-eight percent of the survey farms produce milk, slightly more than in Germany as a whole (30%); 19% are involved in biogas production. Nine per cent of respondents grow leguminous crops, 29% participate in agri-environmental schemes (AES), and 54% have landscape features on their land.

[5] The averages for Germany in this section are taken from BMELV (2011).

Table 3

Summary statistics of survey respondents (N = 128)

Variable	Mean (Standard Deviation)	Explanation
Full-time*	0.80 (0.40)	1 = Full-time farm
Age	42.9 (13.2)	Age of farmer in years
Farm size	161.4 (344.2)	Utilisable Agricultural Area (UAA) in hectares
Arable land quality	45.3 (16.5)	Average *Ackerzahl* (a land quality index) of arable land
PP share	0.24 (0.28)	Share of permanent pasture in UAA
Main crop share	0.47 (0.23)	Share of biggest crop in arable rotation
LU/ha	1.16 (1.25)	Livestock Units per ha (1 LU = 500 kg live-weight)
Dairy*	0.38 (0.48)	1 = Farm with dairy cows
Dairy stocking rate	0.36 (0.55)	Number of dairy cows in LU per hectare of UAA (all farms)
Biogas*	0.19 (0.39)	1= Farm involved in biogas production
Plot allocation**	3.80 (1.22)	Share of plots 3 km around farmstead (1 = 0 – 20% in 3 km radius)
Nature reserve*	0.08 (0.27)	1= Farm with land in a nature reserve
Leguminous crops	0.09 (0.29)	1 = Farm cultivates leguminous crops
AES*	0.29 (0.45)	1= Farm participates in agri-environmental schemes
Landscape features*	0.54 (0.50)	1= Farm with landscape features on its land
AES-landscape features*	0.21 (0.41)	1= Farm participates in AES and has landscape features on its land
Conservation attitudes**	3.61 (1.26)	"Nature conservation is an important public benefit provided by agriculture" (5 = I fully agree)
Greening = set-aside**	3.88(1.38)	"Greening (Ecological Focus Area) is tantamount to set-aside" (5 = I fully agree)
Greening = bureaucracy**	4.52 (1.01)	"Greening means more bureaucracy" (5 = I fully agree)
Greening ≠ eco**	3.87 (1.35)	"Greening yields no ecological benefits" (5 = I fully agree)
Greening = higher rents**	4.06 (1.29)	"Greening raises land rents" (5 = I fully agree)
County stocking rate	0.93 (0.55)	Average stocking rate (LU/ha) in county (data from Statistisches Bundesamt, 2010 farm structural survey)
Land rent	578.5 (284.7)	Land rental rates for new leases in € per hectare arable land

Notes: * Dummy variable, ** measured on a Likert Scale 1–5.

The final part of Table 3 shows the responses to statements designed to elicit the farmers' attitudes towards "greening" and nature conservation in broader terms. While the statement "nature conservation is an important public benefit provided by agriculture" reaches an average score of 3.6 on a Likert scale from 1 (I fully disagree) to 5 (I fully agree), the statements relating to "greening" meet stronger opposition. Both statements "greening is tantamount to set-aside" and "greening does not yield ecological benefits" received an average score of 3.9. Respondents were quite unanimous in their view that "greening" will result in more bureaucracy (score 4.5) and rising land rents (score 4.1). With respect to the latter, Table 3 also displays average stocking rates at the county level (as an important driver of local land rents) and the level of land rents paid for new leases.

3.2 Estimation results: binary logit model

A total of 1,024 choice sets were included in the estimation (128 respondents, 8 choice sets each). Fifty-seven percent of choices were in favour of "greening". By contrast, 14% of respondents never chose a "greening" alternative and must therefore be considered to be strictly opposed to "greening". Table 4 shows the regression results for both a rich and a parsimonious specification of the conditional logit model. The probabilities in the table follow from robust standard errors. The upper section of Table 4 shows the policy attribute variables, the lower section displays the farm/farmer characteristics variables together with regional variables. The three interaction terms between policy attributes and farm characteristics are shown in the middle part of the table. The rich specification includes all exogenous variables. The parsimonious specification omits insignificant variables based on a robust Wald test (χ^2-value is 8.01 with $\alpha = 0.784$). The McFadden pseudo R^2 of the rich model is 0.197 while that of the parsimonious specification is 0.201.[6]

3.2.1. Factors affecting "greening" choices

As expected, the higher the single payment cut, the more likely a farmer is to choose the "greening" alternative. Conversely, raising the percentage of EFA lowers the probability of choosing "greening". It is also not surprising that allowing more freedom in cropping choices increases the likelihood of "greening" being preferred to "opt-out": both the option of growing leguminous crops and the possibility of choosing the location of EFA plots on an

[6] According to Louviere *et al*. (2000), values of pseudo R^2 between 0.2 and 0.4 are considered to be indicative of extremely good model fits.

annual basis raise the odds for the "greening" alternative.[7] Interestingly, five of the nine policy attributes are not significant: minimum crop share, land in AES and landscape features creditable against EFA (on their own and in combination), and the option of growing leguminous crops on twice the EFA instead of setting EFA land aside. However, the interaction terms in the middle section of Table 4 indicate that the option of growing legumes on twice the EFA raises the odds for "greening" for farmers who already grow legumes. Likewise, the possibility of counting landscape features against the EFA requirement raises the probability of "greening" being chosen by farmers with landscape features on their land. Interestingly, the cross term between AES participation and AES land creditable against EFA is not significant, indicating that farmers who participate in agri-environmental schemes do not attach a higher value to the option of counting AES land as EFA than non-AES farmers. Farmers may fear that future agri-environmental programmes could offer lower payments if the respective land is counted as EFA.

As can be seen from the lower section of Table 4, many of the farm and socio-economic variables included in the estimation have an impact on choices. Full-time farmers are, *ceteris paribus*, more likely than part-time farmers to choose the "greening" alternative. This may be attributable to the higher opportunity cost of labour on full-time farms, which may lead farmers to prefer "greening" as a means of freeing labour time. Higher stocking rates (*LU/ha* and *dairy stocking rate*) lower the probability of "greening" being chosen. Farmers may fear that "greening" could have an adverse effect on roughage production or could reduce the land area available for manure spreading. The positive sign of the *dairy* dummy variable in conjunction with the negative sign of the *dairy stocking rate* variable indicates that the "greening" provisions are particularly problematic for intensive dairy farms with a small roughage area per cow.

[7] From an agronomic point of view, the attribute "fixed location of EFA" devalues the option of growing leguminous crops since these would need to be integrated into the rotation. We tested for this effect by including two additional interaction terms between "fixed location of EFA" and both "cultivate leguminous crops on EFA" and "cultivate leguminous crops on twice EFA". These cross terms turned out to be insignificant. They can be omitted from the rich specification together with the omitted exogenous variables in Table 4. The χ^2-value is 10.16 with $\alpha = 0.7501$ for the corresponding robust Wald test.

Table 4

Factors affecting farmers' "greening" choices (conditional logit model)

N = 1,024	Rich estimation		Parsimonious estimation	
Log of simulated likelihood	–557,54		–561,29	
Variable	Coefficient	Prob.	Coefficient	Prob.
Single payment cut	0.015	0.000	0.015	0.000
Share of Ecological Focus Area (% of arable land)	–0.090	0.014	–0.095	0.006
Crop diversity: minimum crop share	–0.004	0.710		
AES land creditable against EFA	–0.383	0.107		
Landscape features creditable against EFA	–0.128	0.634		
AES and landscape features creditable against EFA	–0.125	0.550		
Leguminous crops allowed on EFA	0.487	0.017	0.317	0.039
Leguminous crops allowed, but on twice the EFA	0.236	0.248		
EFA location fixed for 3 years	–0.301	0.049	–0.292	0.054
Leguminous crops allowed, but on twice EFA x Leguminous crops grown on farm	1.057	0.008	1.114	0.004
Landscape features creditable against EFA x Farm with landscape features on its land	0.527	0.144	0.508	0.035
AES deductible x AES participation	0.606	0.125		
Full–time	0.857	0.000	0.911	0.000
Age	–0.005	0.422		
Farm size	0.0001	0.606		
Arable land quality	–0.015	0.006	–0.016	0.002
PP share	–1.300	0.001	–1.429	0.000
Main crop share	–1.067	0.003	–0.988	0.003
LU/ha	–0.132	0.105	–0.130	0.065
Dairy	1.290	0.000	1.319	0.000
Dairy stocking rate	–0.968	0.000	–0.985	0.000
Biogas	–0.513	0.016	–0.514	0.013
Plot allocation	–0.014	0.840		
Nature reserve	–0.494	0.098	–0.568	0.055
AES	–0.536	0.078	–0.515	0.062
Landscape features	0.165	0.391		
AES and landscape features	0.886	0.020	1.120	0.001
Conservation attitudes	0.151	0.018	0.155	0.008
Greening = set-aside	–0.328	0.000	–0.356	0.000
Greening = bureaucracy	0.663	0.000	0.653	0.000
Greening ≠ eco	–0.261	0.001	–0.259	0.000
Greening = higher rents	–0.215	0.004	–0.194	0.009
County stocking rate	–0.093	0.622		
Land rent	0.0003	0.317		

Farmers with land in a *nature reserve* or those participating in agri-environmental schemes (*AES*) are less likely to choose the “greening” alternative. These farmers already face management constraints on their land and are thus less inclined to accept further constraints through “greening”, all else constant. The sign of the *bureaucracy* variable is counterintuitive: farmers who believe that greening results in more bureaucracy are more likely to choose the “greening” alternative. We have no serious explanation to offer for this result.

A number of farm/farmer variables are not significant. These include *age* and *farm size* as well as the share of arable land more than 3 km distance from the farmstead (*plot allocation*). We had expected a positive impact of the plot allocation variable to the extent that farmers may offer remote parcels as EFA. The impact of existing *landscape features* (not significant on its own) is likely to be captured by the interaction variable discussed above. Finally, neither regional land rent levels nor livestock densities at the county level are significant.

3.2.2. Willingness-to-accept (WTA) estimates

We now turn to the marginal WTA estimates for the variables in the parsimonious model specification. Table 5 reports the estimates of the variables’ marginal effect on the likelihood of the “greening” alternative being chosen, the marginal WTA estimates and their 95% confidence intervals. The confidence intervals were computed with the use of the delta method (see e.g. Greene, 2003) which is a common approach in discrete choice modelling (see e.g. Espinosa-Goded *et al*., 2010, and Ruto and Garrod, 2009).

As explained above, the WTA estimate of–€6.32 for EFA means that an increase in the EFA by one percentage point lowers, on average, the probability of choosing the “greening” alternative by the same amount as a €6.32 additional cut of the single payment per hectare. To check whether this estimate is realistic, assume that a farmer is indifferent between “greening” and “opt-out” at 7% EFA and €70 single payment cut. This is tantamount to assuming that the farmer would be willing to pay €70 per hectare of arable land to avoid the 7% EFA. The estimate of–€6.32 means that the farmer is also indifferent between a €76.32 payment cut and 8% EFA. An additional hectare of arable land that would become EFA is thus valued at €632 by the farmer: in a 100 ha arable farm, for example, one percentage point EFA means one hectare of EFA. This is valued at €6.32/ha*100 ha. This figure looks realistic in that it is close to the land rents for new land rental contracts from the survey (€578/ha, Table 3). Farmers are thus willing to accept payment cuts to avoid EFA which are similar to the price they would have to pay on the land rental market to replace land “lost” to EFA.

The option of cultivating leguminous crops on EFA land is equivalent to an additional payment cut of €21 per hectare of arable land. We can use this estimate to derive the value of cultivating one hectare of leguminous crops on EFA land. In a 100 ha arable farm, the additional payment cut amounts to 100 ha * €21/ha = €2,100. At 7% EFA (medium level in the experiment), 7 hectares of legumes would be grown on the EFA. One hectare of leguminous crops is thus valued at €2,100/7 ha = €300/ha. This figure is in line with gross margins of fodder beans, peas and lupines in northern Germany (Landwirtschaftskammer Niedersachsen, 2011).

Fixing the EFA location instead of allowing farmers to choose annually is equivalent to an additional payment cut of nearly €20 per hectare of arable land. Analogous to the previous example, we obtain an estimate of €2,000/7ha ≈ €286 per hectare of EFA land: farmers value the option of choosing the EFA location flexibly at €286 per hectare of EFA. The free choice of EFA location allows farmers to integrate EFA land into their crop rotations, enabling them to ease tight rotations. Farms with heterogeneous land may place less value on EFA flexibility. Such farms may choose the least fertile land and the smallest, worst shaped or most distant plots for EFA. It is reassuring that our estimate is well below the value of €632 for a hectare of additional EFA land. A loss of flexibility in the location choice can be expected to be smaller than the "loss" of the land to EFA.

Turning to the farm/farmer variables, Table 5 shows that an increase in land quality *(Ackerzahl)* by ten points (out of 100) is equivalent to a €10.40 higher single payment cut per hectare of arable land. The higher the land quality, the higher the opportunity costs of converting arable land to EFA. In our 100 ha arable farm, the additional payment cut would amount to €1,040. Although differing by region and between years, a ten-point increase in land quality increases physical yields by between half a ton and one ton of grain per hectare. At current grain prices, this range translates into €100 to €200 per hectare. Consequently, our estimate of €1,040 is well within the range of €700 to €1,400 for the additional yield loss for 7% EFA on better land.

The crop diversity requirements are more binding in farms with only one or two dominating crops. This is reflected in the WTA estimate for the variable "main crop share". Table 5 shows that an increase in the share of the main crop by one percentage point is equivalent to an additional payment cut of €0.66 per hectare of arable land. In absolute terms, this amounts to an "acceptable" payment cut of €66 for an additional hectare of the main crop. Farmers with tight crop rotations are thus less inclined to choose the "greening" option. They would be willing to accept an additional payment reduction of €66 per additional hectare of the main crop. This estimate appears reasonable in that it reflects the difference in gross margin between the main crop and alternative crops required to meet the crop diversity requirements.

Livestock farmers' preferences for "greening" are reflected by the WTA estimates for the variable livestock units per hectare (*LU/ha*), the dummy variable for dairy farms (*dairy*) and the *dairy stocking rate*. First note from Table 5 that an increase in the variable *LU/ha* by one unit[8] reduces the probability of "greening" being chosen by 3.12%. An additional payment cut of €8.68 per hectare of arable land is required to restore the initial probability.[9] The effect of higher *dairy* stocking rates is even more pronounced: an increase by one *dairy* LU per hectare reduces the odds for "greening" by 23.67%, which is equivalent to an additional payment cut of €65.76 per hectare of arable land. We can thus conclude that, *ceteris paribus*, farms with high livestock densities are less likely to choose "greening". For dairy farms, however, the negative effect of the dairy stocking rate on "greening" choices is counteracted by the positive effect of the *dairy* dummy variable. A dairy farmer is, *ceteris paribus*, 29.76% more likely to choose "greening" than a farmer who does not keep dairy cows. This is equivalent to a WTA of €82.66 per hectare of arable land. For the average dairy stocking rate in our sample (0.95 cow LU per hectare), the combined effect of the three variables above *LU/ha*, *dairy stocking rate* and *dairy*, results in a WTA estimate of €11.94 per hectare of arable land: –€8.68 * 0.95 + €82.66 – €65.76 * 0.95. This means that a dairy farmer with the average stocking rate is more likely than non-livestock farmers to choose the "greening" option: everything else constant, the dairy farmer chooses "greening" with the same probability as non-livestock farmers at a €11.94 lower payment cut. A successive increase in the dairy stocking rate would erode and eventually reverse the dairy farmer's preference for "greening". Preferences are reversed at dairy stocking rates in excess of 1.1 dairy LU per hectare. We can thus conclude that highly intensive dairy farms find it significantly harder to cope with "greening" than their less intensive counterparts. In our data sample, 36% of dairy farms keep cows in excess of the critical 1.1 LU per hectare.

[8] Note that the average livestock farm keeps 1.7 LU per hectare. This is not to be confused with the value of 1.16 LU per hectare reported in Table 3, which is the average across all survey respondents.
[9] This WTA is only significant on the 5%-level for a one-sided test (see Table 5).

Table 5. Marginal effects, WTA and 95% confidence intervals for the parsimonious estimation

	Marginal effect	WTA	Confidence interval 2.5/97.5 percentile
“Greening” attributes			
Single payment cut	0.004***		
Share of Ecological Focus Area (% of arable land)	–0.023**	–6.32***	(–10.86 / –1.78)
Leguminous crops allowed on EFA	0.076**	20.96**	(0.78 / 41.14)
EFA location fixed for 3 years	–0.071*	–19.58*	(–39.56 / 0.39)
Interaction terms			
Leguminous crops allowed, but on twice EFA x Leguminous crops grown on farm	0.225***	62.54**	(10.34 / 114.74)
Landscape features creditable against EFA x farm with landscape features on its land	0.116**	32.23**	(0.16 / 64.29)
Farm and socio-economic variables			
Full-time	0.223***	61.96***	(30.83 / 93.08)
Arable land quality	–0.004***	–1.04***	(–1.72 / –0.37)
PP share	–0.344***	–0.95***	(–1.46 / –0.44)
Main crop share	–0.238***	–0.66***	(–1.10 / –0.21)
LU/ha	–0.031*	–8.68*	(–18.04 / 0.68)
Dairy	0.298***	82.66***	(42.79 / 122.53)
Dairy stocking rate	–0.237***	–65.76***	(–97.26 / –34.27)
Biogas	–0.126**	–34.98**	(–62.53 / –7.43)
Nature reserve	–0.140*	–38.97**	(–77.86 / –0.09)
AES	–0.125*	–34.84*	(–71.40/ 1.72)
AES and landscape features	0.243***	67.40***	(20.95 / 113.84)
Conservation attitudes	0.037***	10.33**	(2.23 / 18.43)
Greening = set–aside	–0.086***	–23.79***	(–34.55 / –13.03)
Greening = bureaucracy	0.157***	43.63***	(27.65 / 59.60)
Greening ≠ eco	–0.062***	–17.29***	(–27.34 / –7.25)
Greening = higher rents	–0.047***	–12.94**	(–23.10 / –2.78)

Notes: *, **, *** represent significance levels α = 10%, 5%, 1%, respectively.

Respondents’ attitudes towards nature conservation and “greening” exert an important influence on the WTA. The WTA estimate for the statement “Nature conservation is an important public benefit provided by agriculture”, measured on a 1 to 5 Likert scale from “I do not agree” to “I fully agree”, is €10.33. This means that, *ceteris paribus*, an increase in the strength of agreement by one point is worth an additional payment cut of €10.33 per hectare

(Table 5), [10] or €1,033 for a 100 ha farm. Farmers who strongly agree that nature conservation is an important public benefit of agriculture thus have a higher preference for greening than other farmers. Interpretation of the “greening” statements (the last four variables in Table 5) must take into account that the responses among these statements are positively correlated between 0.36 und 0.54.[11] The sign of the combined effect, however, matches the sign of the separate effects. The “higher rent” statement – taking into account correlations with the other greening statements – has the smallest marginal effect on the likelihood of “greening” being chosen by respondents. Nevertheless it is quite similar in magnitude to the estimate for the “nature conservation” statement. Farmers who believe that EFA is tantamount to set-aside are quite strongly opposed to “greening” Among the “greening” attitudes statements, the “set-aside” statement has the highest marginal effect on choices and thus the highest WTA. An increase in the strength of agreement by one point has an even higher effect on choices than the combined effect of the policy attributes “Leguminous crops allowed on EFA” and “EFA location fixed for 3 years”. Since the latter has the potential to affect the financial performance of farms, the WTA estimate for the statement about “set-aside” appears quite high.

3.3. Additional insights from the latent class estimations

The latent class estimations allow parameter estimates to vary among the (latent) classes, thus accounting for heterogeneous preferences among respondents. Following Boxall and Adamowicz (2002), the number of classes is decided based on the Bayesian Information Criterion (BIC). It is lowest for two classes with 25 variables (16 attributes and cross-terms as well as 9 membership variables) and amounts to 1,021.4. Table 6 reports the WTA estimates, Appendix Table A1 shows the regression coefficients. Class 1 has an average membership probability of 69%, class 2 of nearly 31%. The class 1 average probability of choosing the “greening” alternative (weighted by the individual membership probability) is 54%, whereas this likelihood is only 3.3% for class 2. We thus label class 1 members “compliers” and class 2 members “non-compliers”. The low likelihood of choosing “greening” in class 2 can be explained by the membership function estimates in Appendix Table A1. In essence, farms with high opportunity costs of arable land (e.g. high land quality, high share of permanent pasture) or high opportunity costs of crop diversification (e.g. high main crop share) are

[10] Note that the average response is 3.61 and the standard deviation is 1.26. There are thus many statements that differ by at least one point on the Likert Scale.
[11] Note that the nature conservation responses are not significantly correlated with the greening statement responses.

significantly more likely to be a class 2 member. Here the “quasi-separation” effect of the latent class estimation becomes obvious.

Nevertheless, some of the class 1 WTA estimates correspond well to the conditional logit estimates in Table 5. In particular, the WTA estimates for the share of EFA and the option of growing leguminous crops on the EFA are of similar order of magnitude in both estimations. In addition, the WTA for the crop diversity attribute is not significant in either of the two estimations.

Table 6 reveals substantial differences between class 1 and class 2 WTA estimates. The WTA for the share of EFA for the “non-compliers” is more than five times that of the “compliers”, indicating that class 2 farmers face high opportunity costs for arable land. This conjecture is supported by the high WTA estimate in class 2 for the possibility of counting landscape features as EFA in farms which have such landscape features on their land. Another important difference between the two classes relates to the option of growing leguminous crops on EFA land. “Non-compliers” do not seem to value this option while the “compliers” do. A similar argument holds for land in agri-environmental schemes. The possibility of counting such land as EFA is valued by class 1 but not by class 2 respondents. Note that in the conditional logit model the option of growing leguminous crops on twice the EFA is significant only for farmers who do grow such crops (see Table 4 above). The “quasi-separation” property of the latent class estimation substitutes for the dummy effect found in the conditional logit model.

An important qualification for WTA estimates in class 2 must be made: the WTA for an additional percentage point of EFA of € 51.4 per hectare of arable land (equivalent to €5,140 per hectare of additional EFA) seems unrealistically high. We suspect that the ratio of the regression coefficients for the variables “share of EFA” and “single payment cut” does not yield an appropriate WTA estimate at the sample mean since the likelihood of choosing “greening” is very low in class 2. The average likelihood of “greening” being chosen weighted by each observation’s membership probability for class 2 is only 3.3%. Clearly, the likelihood of “greening” choices weighted by the membership probability for class 2 respondents is much lower at the sample mean than it is for choice sets with a low EFA share and a high payment reduction, i.e. choice sets with an “attractive” greening alternative. Consequently, both the likelihood of “greening” being chosen and the number of actual “greening” choices are rather low around the sample mean, so that point estimates at the sample mean must be treated with caution.

Table 6
WTA estimates from the latent class estimation

	WTA (Euro/ha) (2.5 / 97.5 percentile)	
	Class 1	Class 2
Average membership probability:	69.2%	30.8%
Share of Ecological Focus Area (% of arable land)	–8.9*** (–10.9/–6.9)	–51.4** (–99.7/–3.1)
Leguminous crops allowed on EFA	38.7*** (15.9/61.5)	–37.0 (–181.4/107.5)
Leguminous crops allowed, but on twice the EFA	21.0** (0.1/41.9)	–63.5 (–207.5/80.5)
EFA location fixed for 3 years	–10.7 (–27.6/6.3)	–153.7 (–438.3/130.9)
Leguminous crops allowed, but on twice EFA x Leguminous crops grown on farm	27.9 (–13.1/68.9)	–208.4 (–2,856.7/2439.9)
Landscape features creditable against EFA x Farm with landscape features on its land	17.3 (–5.0/39.5)	378.6** (70.7/686.6)
AES deductible x AES participation	37.7* (4.2/71.3)	–77.3 (–426.0/271.4)

Note: *, **, *** represent significance levels α = 10%, 5%, 1%, respectively.

Summarising, the latent class estimations allow respondents to be split into two groups, “compliers” and “non-compliers”. The heterogeneity of preferences is reflected in different WTA estimates for the policy attributes. Although the group of “non-compliers” is smaller than that of “compliers”, the WTA estimates for “non-compliers” indicate that farmers in that class are very strongly opposed to “greening”. The WTA estimates for the class of “compliers”, with an average membership probability of around 70%, correspond well to most of the conditional logit estimates. Nevertheless, compared to the conditional logit results, the latent class WTA estimates for class 1 are slightly higher on average because farmers who do not respond to variations in the attribute levels are allocated a low weight in the latent class model.

3.4. Discussion

It is difficult to compare our quantitative estimates with previous work using DCE to estimate farmers’ willingness to participate in voluntary agri-environmental schemes. First, the attributes of agri-environmental contracts differ from the “greening” provisions. Second, the surveys were carried out in different countries and different years, meaning that the opportunity cost of participation cannot be compared. This said, Christensen *et al.* (2011) and Espinosa-Goded *et al.* (2010) also highlight the importance of heterogeneity in how farmers assess the costs of individual contractual obligations. Both studies, as well as that of Ruto and Garrod (2009), find that more stringent management prescriptions and less flexibility in implementing conservation practices reduce farmers' willingness to participate. Christensen *et al.* (2011) estimate a reduction in the required incentive payment of €110 per hectare if farmers are allowed to use fertiliser in pesticide-free buffer zones on arable land in Denmark. This is less than our estimate of €632 per hectare of a complete ban of productive use of EFA land. Espinosa-Goded *et al.* (2010) find that a ban on grazing in a hypothetical Spanish alfalfa support scheme (see section 2.1) significantly reduces respondents' willingness to sign a contract. The same holds for restrictions imposed on the choice of parcels which can be offered for the scheme.

It is also difficult to compare our cost estimates to the ones published in the Commission's *ex-ante* impact assessment of the CAP proposal (EU Commission, 2011b). While the Commission's estimates are based upon calculations of income forgone in model farms, our cost estimates rest upon WTA estimates which, in addition to income forgone, capture non-monetary preferences that farmers may have in respect of "greening". Concerning arable crop diversity, the Commission estimates that cultivation would have to be changed on only 0.4% of the arable land in Germany in response to the requirement that the largest crop shall not exceed 70% of a farm's arable land. The affected arable land area increases to only 1.9% if the maximum crop share were set at 50% of a farm's arable land (EU Commission, 2011b, Annex 2d, Table 2, page 11). These small portions of affected land may well explain why the experiment's crop diversity attribute is not significant. As to the cost of converting arable land to EFA, we can compare the assessed costs for a "greening" option with 5% EFA to another option with 10%. The average figure reported for Germany is €194 and €231 per hectare set aside, respectively (EU Commission, Annex 2d, Table 3, page 13). For EFA shares between 5% and 10%, the marginal cost then is €268 per hectare of EFA[12] – well below the €632 WTA estimate from our conditional logit model. This difference could be explained by different price assumptions: a €5 difference in cereal prices would give rise to a €300 difference per hectare at an assumed yield of 6 tonnes per hectare. Alternatively, the

[12] The marginal cost of EFA shares between 5% and 10% must be €268 per hectare to ensure an average cost of €231 per hectare for the entire first 10% of a farm's arable land.

difference between WTA and income forgone estimates could reflect farmers' emotional refusal of retiring productive land.

The reader is reminded at this point that the empirical analysis is based upon a respondent sample which is not representative of the German farming community. As mentioned above, farms in East Germany, small and part-time farms are underrepresented in the survey. We do not think that the latter aspect introduces a significant bias since, for administrative reasons, smaller farms will be exempt from "greening". Nonetheless, the empirical results should be interpreted with that qualification in mind.

4. Conclusions

This paper has explored farmers' prospective responses to the proposed "greening" of the CAP. Survey respondents perceive "greening" as a costly constraint to farming. Not all policy attributes, however, are perceived as equally demanding. The minimum prescribed share of the smallest crop in the rotation does not affect the likelihood of "greening" being preferred to "opt-out", nor does the possibility of counting landscape features or AES land as EFA. By contrast, the share of EFA itself does have a strong impact on choices. Land "lost" to EFA is valued at the rental value of arable land, and opportunities for productive uses of the EFA are assigned a positive value.

Not all farmers feel equally affected by "greening". Among the most heavily affected are specialised arable farms on highly productive land as well as specialised dairy farms with high stocking rates. In more general terms, farmers with high opportunity costs of arable land (e.g. high-quality land, high share of permanent pasture, high stocking rates, biogas plant) will be more inclined to opt out and voluntarily forgo the "greening" premium than farmers with lower land opportunity costs. A small group of farmers will fiercely reject "greening". Fourteen percent of respondents never chose a "greening" alternative, indicating that they are unwilling to consider trade-offs. It remains to be seen whether this conclusion is an artefact of the survey's hypothetical character.

What conclusions can be drawn for future changes to the policy? For improving the environmental effectiveness of "greening", policy-makers have to balance the stringency of management prescriptions and farmer acceptance. In this respect, we conclude that a crop diversity constraint which requires farmers to grow at least three crops, each covering at least 20% of the arable land, does not seem to meet much resistance and may contribute, as a low-cost measure, to more balanced crop rotations and associated environmental benefits in regions of intensive arable farming.

By contrast, converting arable land into EFA is perceived as a high-cost measure. The trade-off between conservation benefits on the one hand and farmer acceptance on the other seems particularly pronounced. Policy is well advised to err on the safe side by demanding only moderate EFA shares. Likewise, fixing the location of the EFA (instead of allowing farmers to choose annually) should only be considered if assigned a high conservation value. Farmers perceive this measure as relatively high cost. Allowing landholders to rotate the EFA will significantly raise the acceptance of “greening”.

The option of growing leguminous crops on EFA land appears very attractive to farmers. It should only be made available if legumes are judged to yield conservation benefits similar to other, less productive uses of the EFA.

Some of the policy provisions proposed in the political debate to ease the burden of “greening” at the farm level are only valued by a minority of farmers. These include the option of counting AES land or landscape features as EFA. The latter is only valued by farmers who have such features on their land (but not by others). Likewise, the possibility of growing leguminous crops on *twice* the EFA, as an alternative to retiring the EFA from production, is only valued by farmers who already grow such crops. Nonetheless, as mentioned in the previous paragraph, the average farmer in our survey would prefer cultivating legumes on EFA land instead of setting it aside.

In addition to the above conclusions which follow directly from the empirical results, the following aspects may also affect farmer acceptance and conservation benefits:

Acceptance of “greening” among dairy farmers with high cow stocking rates may be raised by allowing the EFA to be used as (non-permanent) grassland. This would allow farmers to mitigate the loss of roughage production while contributing to conservation objectives. Such an option would need to be accompanied by management prescriptions (e.g. relating to mowing dates or fertiliser quotas) to target environmental objectives.

The heterogeneity of perceived participation costs among respondents suggests that farmers will be likely to transfer EFA requirements between them. This could be realised by farmers with high opportunity cost renting low opportunity cost land from other farmers. Such trade would result in the EFA being concentrated on the least productive land in a region. If instead a spatially inclusive and comprehensive distribution of the EFA is considered advantageous from an environmental point of view, policy would have to specify the distance from a farmstead within which EFA requirements must be met. Alternatively, the policy could prohibit farmers from maintaining EFA land in one location for a number of years. The requirement to rotate the EFA would ease incentives to rent less productive land in large distances from the farmstead. However, both these options could lead to significant administrative burdens.

The empirical analysis in this paper provides a basic understanding of the likely responses of landholders to the new “greening” instrument. We lay the foundation for predicting landholder willingness to comply as a prerequisite for the policy’s environmental effectiveness. We emphasise, however, that the empirical results reported in this study and the conclusions drawn are tentative in that the sample is not representative of the German farming community. The reader should also note that the analysis in this paper falls short of a comprehensive cost–benefit assessment of “greening”. Such an assessment would balance conservation benefits with farm-level costs and production losses. We have merely focused on the cost aspect. A multidisciplinary effort of economists, ecologists and agronomists is needed to derive a set of recommendations for improving future “greening” policy from a broader societal perspective.

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Appendix

Table A1

Results of the latent class estimation

Variable "Greening" attributes	Class 1; share = 0.69		Class 2; share = 0.31	
	Coefficient	Prob.	Coefficient	Prob.
Single payment cut	0.024	0.000	0.006	0.113
Share of Ecological Focus Area (% of arable land)	–0.214	0.000	–0.307	0.000
Leguminous crops allowed on EFA	0.995	0.000	–0.227	0.609
Leguminous crops allowed, but on twice the EFA	0.521	0.041	–0.384	0.400
EFA location fixed for 3 years	–0.253	0.212	–0.961	0.034
Leguminous crops allowed, but on twice EFA x Leguminous crops grown on farm	0.881	0.077	–12.283	0.000
Landscape features creditable against EFA x Farm with landscape features on its land	0.468	0.139	1.390	0.007
AES deductible x AES participation	1.329	0.014	–0.569	0.569
Class membership variables				
Farm size	0.018	0.003		
Arable land quality	–0.039	0.066		
PP share	–4.483	0.004		
Main crop share	–2.888	0.022		
Dairy	4.312	0.000		
Dairy stocking rate	–2.152	0.003		
Greening = set-aside	–1.029	0.000		
Greening = bureaucracy	0.829	0.004		
Constant	3.353	0.115		

Note: Log likelihood = –473.056; *N* = 1,024.

The following variables have been excluded based on a robust Wald test:
Full-time, Age, LU/ha, Biogas, Plot allocation, Nature reserve, AES, Landscape features, AES and landscape features, Conservation attitudes, Greening ≠ eco, Greening = higher rents, County stocking rate, Land rent.

The χ^2-value is 22.54 with $\alpha = 0.4284$ for the corresponding Wald test.

The following attribute variables are not significant at the 10% level in either class: crop diversity: minimum crop share, AES land creditable against EFA, landscape features creditable against EFA, AES and landscape features creditable against EFA.