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Paiements pour services environnementaux en présence de seuils écologiques : préférences des agriculteurs pour un bonus de parrainage

Résumé

Concevoir des incitations pour la fourniture de biens publics agroenvironnementaux avec des effets de seuil nécessite des mécanismes de paiement favorisant la participation d'une masse critique et la continuité des engagements à l'échelle du paysage. Des études montrent que les agriculteurs sont réticents aux exigences collectives mais favorables à un bonus récompensant une action collective. Nous avons réalisé une expérience de choix pour tester l'acceptabilité d'un bonus dans un programme hypothétique d'amélioration de la qualité de l'eau des rivières en France. Nous introduisons un bonus de parrainage chaque fois que l'agriculteur convainc un pair de participer au programme. Ce bonus peut être combiné à un bonus de résultat collectif par hectare si la rivière atteint un niveau supérieur de l'échelle de qualité de l'eau. Nous considérons que l'implication des financeurs locaux pourrait augmenter le consentement à payer au-delà des coûts d'opportunité et des pertes de profit, et proposons des niveaux de paiement plus élevés que les mesures agro-environnementales. Les résultats suggèrent qu'un bonus de parrainage en soi réduit le coût du programme, et que les préférences pour les niveaux de bonus sont hétérogènes.

Mots-Clés : qualité de l’eau, expérience de choix, action collective, modèle logit mixte, modèle à classes latentes

Classification JEL : C25, Q15, Q18, Q25, Q28, Q53

Payments for environmental services with ecological thresholds: farmers' preferences for a sponsorship bonus

Abstract

Designing incentives for agri-environmental public good provision with threshold effects calls for payment mechanisms favouring critical mass participation and continuity of commitments at the landscape scale. Studies show farmers are reluctant to collective requirements but favourable to a bonus rewarding collective action. We conducted a choice experiment to test the acceptability of a bonus in a hypothetical scheme for improving rivers' water quality in France. We introduce a sponsorship bonus each time the farmer convinces a peer into entering the scheme that can be combined with a collective result bonus per hectare if the river reaches a higher step of the water quality scale. We consider the involvement of local financers could increase the willingness to pay beyond opportunity costs and income foregone, and propose higher levels of payment than agri-environmental schemes. Results suggests a sponsorship bonus on its own is cost-effective, and that preferences for the bonus levels are heterogeneous..

Keywords: water quality, choice experiment, collective action, mixed logit model, latent class model

JEL classification: C25, Q15, Q18, Q25, Q28, Q53

1. Introduction

Payments for environmental services (PES) are initiatives supporting farmers voluntary interventions contributing to the preservation of ecological functions (Duval et al. 2016; Wunder 2015). They emerged in the early 1990s, in response to the growing awareness of the value and shortage of agri-environment-climate public goods. In the European Union (EU), the most widely implemented PES are the agri-environmental measures, now called agri-environment-climate measures (AECM), of the common agricultural policy (CAP). Over the past decades, the low environmental additionality, participation rates and cost-effectiveness of AECM have been highlighted in the literature, in particular due to underfunded and poorly designed measures (Zavalloni et al. 2019; Espinosa-Goded et al. 2013; Dupraz and Pech 2007; Cullen et al. 2018). Dedicated PES involving other contractual arrangements and financial contributors are also implemented on a smaller scale (Heinz 2008). Examples include schemes funded by water bottlers such as the Nestlé Waters, or by municipalities such as the water authorities of Munich and New York City (Grolleau and McCann 2012; Déprés, Grolleau, and Mzoughi 2008).

Designing efficient payment mechanisms for public good provision is a challenge that often involves trade-offs between environmental ambition and large acceptance by farmers. Conditionality rules must define environmental services with sufficient effort to reach the environmental objective(s), while remaining attractive enough to ensure significant participation on enough farmland. When the objective is to improve water quality or biodiversity, high participation and spatial continuity of environmental commitments at the landscape scale are necessary to reach environmental improvements (Dupraz et al. 2009). Developing instruments favouring collaboration among land managers, coordination of actions and high uptake within a same area are promising ways to increase the environmental effectiveness of farmers' environmental services, as well as the cost-effectiveness of the payment. In addition to supporting the passing of ecological thresholds, collective approaches provide other advantages, such as fewer transaction costs for financial contributors, and building of social capital for farmers (Lefebvre et al. 2015; Kuhfuss et al. 2016; Pretty 2003).

Collective approaches can take different forms of PES contractual arrangements and payment conditionality (Kuhfuss et al. 2019; T Uetake 2013). Some involve a collective payment. In this case, the contracting party receiving the payment and meeting the requirements is a group of farmers, which distributes the amount to participants according to rules defined by the collective. The Netherlands provide a large amount of examples of successful collective

AECM, in which participants are local groups of farmers organised in environmental cooperatives (Franks 2011). Cases from other EU countries are scarce. One can cite the collective AECM for preserving the European Hamster habitats in France (Eichhorn et al. 2022). Other approaches are based on individual contracting, but the distribution of the payment is conditional to the achievement of a landscape-scale objective (minimum participation or land enrolment, reaching an environmental goal…), or of a collaborative action (coordination of management practices, agglomeration of the plots enrolled…). These conditionality rules can apply to all or part of the payment. In the latter case, the collective component of the contract takes the form of a conditional “reward” or “bonus”. An example of such payment mechanism is the Swiss network bonus (agglomeration bonus) (Krämer and Wätzold 2018).

The literature suggests farmers are reluctant when collective requirements are conditioning the full payment, but favourable to a reward conditioned to collective action on top of an individual payment (Villanueva et al. 2017; Ben-Othmen and Ostapchuk 2019; Le Coent et al. 2017; Sergio Villamayor et al. 2019; Kuhfuss et al. 2016). Villanueva et al., (2015; 2017) show that individual contracting tends to be preferred to collective contracting of a minimum number of farms from a same municipality, especially among older farmers with little experience of participating in cooperatives. Interestingly, Ben-Othmen and Ostapchuk (2019) find an opposite result, with positive preferences for collective contracting, but the threshold number was slightly lower (3 farms from the same municipality against 5 in (Villanueva et al. 2015)). Both case studies included prior information that farmers would be left free to form a group with whom they trust the most, and that only free-riders would be sanctioned in case of noncompliance with management requirements. A key factor of collective AECM acceptance is well-defined group governance and monitoring, what is often emphasized by researchers studying successful Dutch case studies of environmental cooperatives (Franks 2011; Tetsuya Uetake 2014; Barghusen et al. 2021), or more generally collective management of natural resources (Ostrom 2002; Kerr, Vardhan, and Jindal 2014). Le Coent et al. (2017) looked at farmers preferences for biodiversity offsets with the full payment conditioned to a minimum of 20% of participation of farmers from the area. They found that farmers anticipate transaction costs for reaching the participation threshold and prefer contracts without it. Another study measuring preferences for an AECM requiring the coordination of the location of tree planting with neighbouring farms also concluded that farmers were reluctant to the collective approach due to transaction costs and beliefs that other farmers would not be willing to cooperate (Sergio Villamayor et al. 2019). However, they identified a peer effect, with the finding that farmers were more likely to choose an agri-environmental measure recommended by other farmers. When it comes to collective bonus options, a study by Kuhfuss et al. (2016) reveals positive preferences for a conditional bonus if at least 50% of the eligible area is enrolled in the scheme after five years.

Apart from this last study by Kuhfuss et al. (2016) among vine growers, there is still little evidence on farmers' attitudes towards mixed-payment mechanisms promoting collective approaches. Further analyses would confirm or nuance the acceptability of these incentives in other contexts, and provide recommendation for designing successful schemes. This present study aims at providing new elements on the acceptability among farmers of a collective component in PES, designed to meet high participation rates and environmental efforts.

We develop a choice experiment (CE) to measure preferences for a contract targeting the improvement of rivers ecological quality in three regions of northwestern France, characterized by the predominance of livestock farming and concerns about too much release of excess nitrogen and phosphorous into water bodies. CE are particularly relevant to elicit preferences for specific contract characteristics that do not yet exist (Louviere et al. 2000). Two types of bonuses are tested to explore new elements on the design of payment mechanisms: an individual bonus for sponsoring a peer, and a sponsorship bonus combined with a collective environmental result bonus distributed equally to all participants. Another contribution of the study is to offer payment levels which are higher than the range of current AES. By doing so, we consider the possibility for other contributors than public authorities to finance the PES, and we capture farmers' willingness to accept (WTA) beyond income foregone and additional costs.

The paper is organised as follow. Section 2 introduces the choice modelling and experimental design. Section 3 describes the survey data. Section 4 presents and discusses the results. Section 5 provides some concluding remarks and policy recommendations.

2. Method

2.1. Discrete choice experiment approach

A CE is a survey-based method to elicit stated preferences of individuals. Respondents are successively asked to choose their preferred option among a small number of hypothetical alternatives, constituting a choice set, which differ according to several levels of attributes.

CE techniques are based on Lancaster's theory that consumption decisions are determined by the utility derived from the attributes of the good being consumed (Lancaster 1966) and the random utility theory decomposing utility into a deterministic part and a random part (McFadden 1974). They are particularly useful to estimate ex-ante the marginal utility of different characteristics of policy design. The application of CE methods already provided a lot of useful policy recommendations for agri-environmental contracts design, for instance regarding farmers preferences for contract length (Ruto and Garrod 2009; Bougherara and Ducos 2006; Christensen et al. 2011; Latacz-Lohmann and Breustedt 2019; Gruau et al. 2019), payment sequences (Bougherara et al. 2021) and conditional bonuses (Vaissière et al. 2018; Kuhfuss et al. 2016).

2.2. Model specification

Under the random utility theory, the utility U_{njt} that individual n obtains from choosing alternative j out of J alternatives in the choice set t out of a series of T choice sets, is made of an observed component V_{njt} (deterministic part) and a stochastic error term ε_{njt} (random part).

$$U_{njt} = V_{njt} + \varepsilon_{njt} \tag{1}$$

We assume individual n chooses alternative j if and only if that alternative maximises his or her utility amongst all other alternatives i in choice set t. The probability that farmer n chooses alternative j is:

$$P_{njt} = Prob(V_{njt} + \varepsilon_{njt} > V_{nit} + \varepsilon_{nit}) = Prob(\varepsilon_{njt} - \varepsilon_{nit} > V_{nit} - V_{njt}) \; \forall i \neq j \tag{2}$$

The deterministic part of the utility function is typically specified to be linear in parameters. The error terms are assumed to follow the Gumbel Type-1 extreme-value distribution (McFadden 1974), such that a logit model can be applied to estimate the parameters.

Under the conditional logit (CL) model, the β coefficients representing respondents' preferences for the attribute levels X_{njt} are constant across individuals (homogeneous preferences), and the error terms are assumed independent and identically distributed across individuals and alternatives (Equation (3)). It implies that the ratio of choice probabilities for any two alternatives is independent of the attribute levels of a third alternative in the choice set, and is known as the independence of irrelevant alternatives assumption (IIA).

$$P_{njt} = Prob\big(\varepsilon_{njt} - \varepsilon_{nit} > \beta(X_{nit} - X_{njt})\big) \; \forall i \neq j \quad (3)$$

The Hausman test allows to check the independence of irrelevant alternatives (IIA) and validate the CL model specification (Hausman and McFadden 1984). To relax the IIA assumption and account for taste heterogeneity across farmers or across groups of farmers, the mixed logit (ML) (Equation (4)) or latent class (LC) (Equation (5)) models are applied (Greene and Hensher 2003).

$$P_{njt} = Prob\big(\varepsilon_{njt} - \varepsilon_{nit} > \beta_n(X_{nit} - X_{njt})\big) \; \forall i \neq j \quad (4)$$

$$P_{njt|q} = Prob\big(\varepsilon_{njt} - \varepsilon_{nit} > \beta_q(X_{nit} - X_{njt})|class\ q\big) \; \forall i \neq j \quad (5)$$

Both the ML model and the LC model keep the assumption that error terms are independent and identically Gumbel Type-1 distributed, but allow preference parameters to vary. The ML model specifies a continuous distribution of the coefficients such that preferences vary randomly across individuals. The LC model specifies a discrete distribution to the coefficients and relies on the definition of classes of individuals. While preferences are heterogeneous across the different classes, individuals of the same class are assumed homogeneous.

A monetary attribute is included in the CE (ex: individual payment of a PES contract) in order to evaluate the WTA of respondents for each specific attribute level. An estimate of the average WTA for each attribute X_{njt} is obtained from the ratio of the coefficient of the corresponding attribute β_X and the payment coefficient $\beta_{payment}$ (Equation (6)) (Mariel et al. 2021). WTA_X is the average annual payment per hectare a farmer requires to accept a contract for which the level of attribute X is higher by one unit.

$$WTA_X = \frac{-\beta_X}{\beta_{payment}} \quad (6)$$

2.3. Experimental design

A CE was conducted to measure farmers' preferences for a 5-years contract for which participants would enroll all their farmland, targeting the improvement of the water quality of rivers in northwestern France. The regions Brittany, Pays de la Loire, and most of the Normandy region are classified as Nitrate Vulnerable Zones under the Nitrates Directive (MTE and MASA 2011). While the Water Framework Directive targets good chemical and ecological status of European waters by 2027 (EU 2000), only 13% of surface waters have a good ecological status in Pays de la Loire, 32% in Brittany and 29% in eastern Normandy (Agence de l'eau Loire-Bretagne 2020b; 2020a; Agence de l'eau Seine-Normandie 2018). Locally, some areas are of particular concern, such as eastern Brittany (Ille-et-Vilaine department) with only 2% of surface waters with good ecological status (Département d'Ille-et-Vilaine 2022).

Table 1: Attributes and attribute levels in the choice experiment.

Attribute	Description	Levels
Soil cover	Average agricultural soil coverage throughout the year at the farm level (no bare soil, starting from seeding)	85% 90% 95%
Hedgerows	Average density of anti-erosion multi-species multilayer hedgerows at the farm level	20m/ha 60m/ha 100m/ha
Payment	Per-hectare individual annual payment	150€/ha 300€/ha 450€/ha 600€/ha
Bonus	Bonuses conditioned to a collective action : A fixed individual sponsorship bonus of 450€ the farmer receives each time he convinces a peer into entering the scheme ; A collective result bonus of 50€/ha distributed to all participants if the river's status reaches a higher step of the water quality scale	None Sponsorship bonus Sponsorship bonus + collective result bonus

Source: own elaboration.

The contracts proposed in the CE are characterized by (1) management requirements defining the environmental services to be delivered by farmers (soil cover and hedgerows), (2) a per-hectare payment distributed to farmers individually on an annual basis if they comply with management requirements and (3) a bonus option (Table 1).

Evidence shows that hedge networks in agricultural landscapes such as bocage, act as buffer zones and erosion barriers preventing runoffs in water catchments, in synergy with many other ecological side-benefits (Merot 1999; Caubel-Forget et al. 2001; Burel and Baudry 1995). Avoiding long periods of bare soil, in particular in winter, also contributes to limiting soil erosion and runoffs (Souchère et al. 2003). The choice of management and individual per-hectare payment attribute levels was based on evidence from a study undertaken in a similar environmental context in Brittany (Gruau et al. 2019). In particular, their results show that payments of 400€/ha or less restricts the adoption of PES with ambitious levels of management requirements, because some farmers have a higher willingness to accept that cannot be met with this payment range. In France, the 5-years AECM contributing to water quality are typically in a range between 70€ and 350€/ha/year, based on an estimation of average opportunity costs (MASA 2022). In our CE, we introduce individual per-hectare payment levels of the same range than current AECM, but also higher, to include the possibility that other contributors than governmental authorities finance all or part of the payment. The degradation of rivers chemical and ecological quality does not only contribute to biodiversity loss, but also to increase the costs of water treatment for securing drinking water quality. Protecting water resources is of interest for many local stakeholders (water catchment bodies, inhabitants, companies, municipalities…). Real-life contractual arrangements for reducing costs of drinking water depollution show that big municipalities such as Munich have been paying farmers up to 280€/ha/year (Déprés et al. 2008), while the private company Nestlé Waters spent around 230€/ha/year to secure their brand Vittel (Perrot-Maitre 2006). Inhabitants of water catchment areas also exhibit a willingness to pay for reaching a good ecological status (40€/household/year estimated in Normandy), derived from the value they attach to multiple local benefits (recreational use, drinking water, floods prevention, landscape…) (Poirier and Fleuret 2015). Their role as PES scheme financers would better capture society's willingness to pay and cover farmers WTA beyond compensation for foregone profits. WTA includes uncertainty and factors that are not necessarily technical barriers, such as transaction costs or social capital (Espinosa-Goded et al. 2013).

The bonus option levels were defined together with stakeholders involved in the development of experimental PES in the study area. A sponsorship bonus, suggested by a group of farmers from the Seiche Valley (Ille-et-Vilaine, Brittany) (Bailly et al. 2022), is introduced and takes the form of an individual reward for convincing a peer farmer from the water catchment area to enter the PES scheme. A farmer would receive a one-time 450€ per new peer sponsored. Each farmer can be sponsored only once. For the parties financing the PES scheme, offering the sponsorship bonus is an opportunity to increase participation at the water catchment scale while benefiting from the peer effect (communication on the PES, knowledge spillover…). However, sponsoring peers induces new transaction costs for farmers (social commitments, time). A second level of bonus option introduces an additional reward of 50€/ha, distributed to all participants if a collective environmental result is obtained. The environmental result is a higher step for the river's status on the water quality scale. This option aims at encouraging collaborative effort to reach a landscape objective and increase even further the environmental effectiveness of the scheme. Testing the combined introduction of a sponsorship and a collective environmental result bonus is particularly interesting to see if rewarding a collective environmental result affects the WTA of the bonus option relative to the sponsorship bonus only. The interest of the combined bonuses lies in increasing the incentive for reaching a critical mass of participants, and in particular where environmental effort contributes the most to water quality (big farms or located in the upstream of the river). Moreover, the positive effect of the sponsorship bonus on participation stops once all farmers from the eligible area have entered the scheme. The result-based collective bonus would maintain the incentive to pursue coordinated effort towards the environmental objective. A fourth level with the collective result bonus without the individual sponsorship bonus was not included in the experimental design to limit the number of choice cards and minimum number of respondents required.

Choice sets include two contract alternatives and the status-quo (option to opt-out and choose none of the contracts). They were designed by combining the different attribute levels (see Figure 1 for an example of choice card). A d-efficient design of 36 choice sets to be divided into 4 blocks of 9 choice cards was built.

For the econometric analyses, the individual per-hectare payment attribute (*PAYMENT*) is coded as a continuous variable, and the bonus option levels ($BONUS_{sponsorship}$, $BONUS_{sponsorship/collective\ result}$) as dummy variables. We compare continuous and effects coding for the management attributes (*COVER*, *HEDGEROWS)* to choose the best specification (Mariel et al. 2021). We define an alternative specific constant controlling for the status-quo alternative (ASC_{sq}). A statistically significant positive coefficient associated with the ASC_{sq} dummy variable indicates a preference for the status quo alternative. The attribute levels of the status quo alternative are set at 0 for the individual per-hectare payment and bonus option attributes. For the management attributes, we compare a status quo level fixed at 0 and at the farm current values (individual status quo) to identify the best specification. We conduct the analyses using the Apollo package on R (version 0.2.7). In particular, we use the apollo_searchStart function to test a large range of starting values for the model parameters and keep the best candidate for the estimation (Hess and Palma 2022).

Figure 1: Example of choice set of the choice experiment.

Attribute	Contract A	Contract B	Status-quo
Hedgerows	100 m/ha 	60 m/ha 	I prefer to keep my current practices
Soil cover	Bare soil 85% 	Bare soil 85% 	
Payment	300€/ha	150€/ha	
Bonus	None	Sponsorship bonus : 450€/sponsored peer + Collective bonus : 50€/ha	

Source: own elaboration.

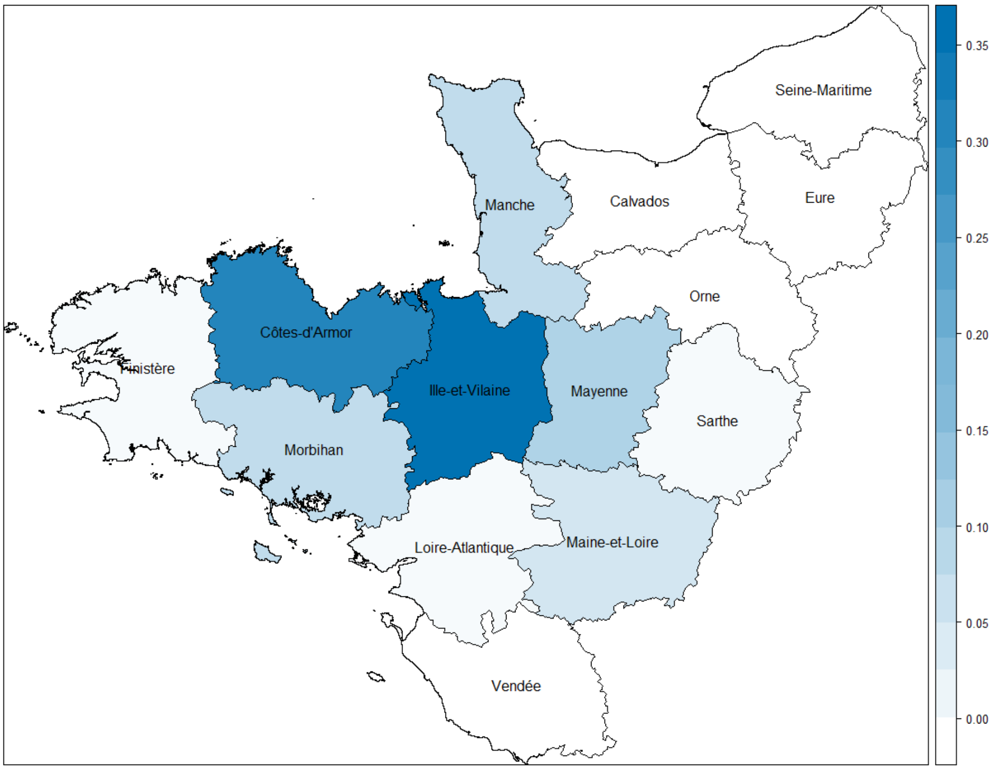
2.4. Survey structure

The CE was included as a section of a pan-EU survey on the acceptability of agri-environmental-climate contract solutions, conducted in France among farmers located in Brittany, Normandy and Pays de La Loire. Voluntary farmers were contacted to organise a face-to-face interview after being recommended by intermediaries (farmers union, organisations of milk producers, farmers associations…). The first section of the survey included general information on farmer and farm characteristics, and the second section questions to evaluate the impact of specific contract characteristics on the willingness to adopt contractual solutions. For instance, farmers were asked to state on a Likert scale from 1 to 5 how much would the possibility to receive a common payment to be distributed among participants increase or decrease their willingness to participate. We use this information as an indicator of attitude towards collective approaches. In the third section dedicated to the CE, respondents were introduced to the context, objective and rules of the game of the CE, and to the contract parameters (those fixed and those varying from one alternative to another). Preliminary questions were also included to help the respondents estimating their current levels of management requirements (individual status-quo). The current soil cover duration was calculated from the stated hectares of permanent grasslands, arable crops, permanent crops and total utilised agricultural area (UAA), as well as the average number of days with bare soil on arable lands and proportion of grass cover on the permanent crops surfaces (bare soil stopping after seeding). The current hedgerows density was calculated from the total UAA and total meters of multispecies multilayer hedgerows currently on the farmland. Farmers were then asked 9 times to choose the preferred option among 2 contract alternatives and the status-quo.

3. Data

The interviews were conducted with 130 farmers between April and July 2021. Among them, 97 farms are located in Brittany, 23 in Pays de la Loire, and 10 in Normandy (Figure 2).

Figure 2: Distribution of the sampled farms in the surveyed regions (ratio).



Departments of Brittany: Finistère, Côtes-d'Armor, Ille-et-Vilaine, Morbihan.
Departments of Normandy: Manche, Calvados, Orne, Eure.
Departments of Pays de la Loire: Mayenne, Sarthe, Loire-Atlantique, Maine-et-Loire, Vendée.
Source: own elaboration.

Descriptive statistics of the sample are provided in Table 2. A comparison with data from the agricultural census and the farm accountancy data network for the surveyed regions shows that our sample presents some biases. This bias can be explained by the non-random sampling procedure respecting the data protection policy, which involved a preliminary selection of volunteers by intermediaries. The average UAA of the sample is 100ha (median of 85ha), and half of the respondents are dairy farmers. The sample is representative of the average UAA of farms of medium and large economic size, but over-represents the share of dairy and organic farms, and under-represents farms specialised in field crops (Agreste 2021). While the share of young farmers below 40 years old is representative of the farming population, farmers between 40 and 50 years old are over-represented (DRAAF Bretagne 2022; DRAAF Normandie 2022; DRAAF Pays de la Loire 2021). The sample is also biased towards highly educated and male farmers.

Table 2: Descriptive statistics of the sample (N=130)

Variable	Sample mean	Standard deviation
Utilised agricultural area (ha)	100.3	64.3
Share of utilised agricultural area :		
Rented	0.72	0.28
Permanent grasslands (4 n.a)	0.36	0.32
Arable land (4 n.a)	0.62	0.32
Share of farms specialised in:		
Dairy	0.51	0.50
Beef	0.09	0.29
Granivores	0.08	0.28
Field crops	0.06	0.24
Share of farms :		
Certified organic	0.39	0.49
Participating in agri-environmental schemes in 2020	0.41	0.49
Share of respondents:		
Female	0.13	0.34
Higher education	0.63	0.48
Below 50 years old	0.55	0.50
Below 40 years old	0.22	0.41
Stop managing farm activities in 5 years or less	0.20	0.40
Farming is less than 70% of household gross revenue	0.11	0.32
In a farmer organisation	0.62	0.49
In an environmental organisation	0.17	0.38
Current level of management attributes :		
Soil cover (%) (4 n.a)	94.9	7.1
Hedgerows (m/ha) (10 n.a)	87.8	73.7

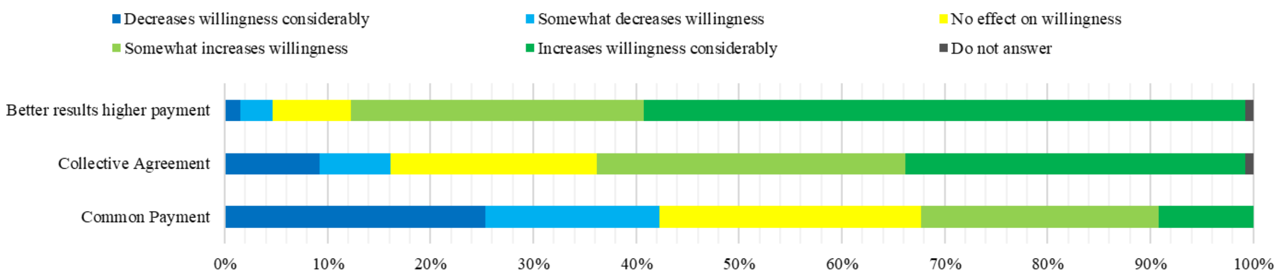
n.a: not answered. m/ha : meters per hectare

Source: own elaboration

The current levels of anti-erosion multispecies multilayer hedgerows density and soil cover duration estimated for the sample are particularly high for the surveyed area, with many farms already fulfilling the highest levels of the hypothetical contracts requirements. Farmers stated few days of bare soil for their arable land (25 days on average), and 88 m/ha of multispecies multilayer hedgerows on average at the farm level. All types of hedgerows considered (including monospecies or monolayer), the observed average density is 49 m/ha in Normandy, 48 m/ha in Brittany, and 55 m/ha in Pays de la Loire (Simon et al. 2019; 2018; Mission Bocage 2011).

Regarding PES characteristics, most of the respondents (89%) have a positive attitude towards higher payments for higher environmental results (Figure 3). Collective approaches are less popular, with 64% of respondents declaring the possibility to agree collectively at landscape-level would increase their willingness to adopt a contract, and 32% for receiving a common payment to be distributed among participating farmers.

Figure 3: Stated effect of contract design characteristics on willingness to adopt.



Survey question: how much would the following contract characteristics increase or decrease your willingness to enroll?

[1] The payment gets higher, the better your environmental results are.

[2] You can collectively agree on environmental targets and measures at landscape-level together with other land managers.

[3] You and other land managers receive a common payment. You jointly agree on the distribution of the payment.

Source: own elaboration, based on CONSOLE landowner survey results in France.

Among the 130 respondents, only five systematically chose the status quo option in the CE. We consider them as protest respondents (Villanueva et al. 2017), and excluded their answers from the sample for the following econometric analyses.

4. Results

As a baseline, we estimate a CL model with attribute levels and the ASC_{sq} as explanatory variables (Equation (3)) (Table 3). Three specifications are tested: continuous coding of management attributes with status quo levels fixed at the current farm level stated in the survey (CL1), continuous coding of management attributes with status quo levels fixed at 0 (CL2), and effects coding of management attributes with status quo levels necessarily fixed at 0 (CL3). They provide similar estimates, in particular for the individual per-hectare payment and bonus attributes. Effects coding reveals nonlinear preferences for hedgerows management requirements. We decide to keep the first specification CL1 with the best goodness of fit measures (AIC, BIC). By capturing the individual status quo levels, specification CL1 better measures preferences for the ASC_{sq}, while limiting the number of variables in the model (Table 3).

Table 3: Conditional Logit estimations

Specification	CL1	CL2	CL3
Attributes			
PAYMENT	**0.004***** (0.000)	**0.004***** (0.000)	**0.004***** (0.000)
COVER	0.007 (0.016)	**0.021**$^{+}$ (0.013)	
COVER - 90%			0.077 (0.066)
COVER - 95%			0.070 (0.073)
HEDGEROWS	**-0.006**** (0.002)	**-0.004*** (0.003)	
HEDGEROWS – 60m/ha			**0.134*** (0.068)
HEDGEROWS – 100m/ha			**-0.246*** (0.108)
$BONUS_{sponsorship}$	**0.419***** (0.127)	**0.409***** (0.118)	**0.426***** (0.124)
$BONUS_{sponsorship/collective\ result}$	**0.265*** (0.138)	**0.256*** (0.129)	**0.277*** (0.131)
Alternative-specific constant			
ASC_{sq}	**0.653**** (0.245)	**2.145*** (1.190)	**0.526**** (0.191)
Goodness-of-fit			
Log Likelihood	-916.15	-986.41	-983.75
Adjusted-R^2	0.19	0.19	0.19
AIC	1844.30	1984.81	1983.49
BIC	1873.98	2014.94	2023.66
Observations	1039	1120	1120
Number of farms	116	125	125

Significance levels: *** robust p-value <0.001, ** robust p-value <0.01, * robust p-value<0.05, $^{+}$ robust p-value<0.1. Robust standard errors in parentheses. ASC_{sq}: alternative-specific constant associated with the status quo alternative. AIC: Akaike information criterion. BIC: Bayesian information criterion.

Source: own elaboration.

The Hausman-McFadden test reveals the IIA assumption is violated and there are preference heterogeneities across respondents, suggesting the need to rely on ML (Equation (4)) or LC (Equation (5)) models to characterise preferences. To disentangle preference heterogeneities, we first apply a ML model with attributes and status-quo coefficients defined as random parameters, except for the individual per-hectare payment coefficient. The ML model identifies for which attributes there are significant heterogeneities of preferences among farmers, and farm and farmer characteristics explaining these heterogeneities. Second, we characterise groups of respondents with similar patterns of preferences using a LC model. Complementary to the ML model, the LC model identifies to which farming population the PES contract can be the most adapted to favour high adoption, and/or how to adapt the contract to the targeted population.

The first ML specification without individual specific variables (ML1) shows the density of hedgerows and the level of the individual per-hectare payment significantly affects respondents' choice with the expected signs (negative effect for the level of hedgerows requirements and positive effect of the level of payment) (Table 4). Preferences for the requirement of soil cover are significantly positive, which can be explained by the already high proportion of farmers fulfilling the highest level. Most of our farmers being located in a Nitrates Vulnerable Zone, they must comply with existing regulation which already involves cover cropping during specific periods of the year. The positive parameter might reveal farmers willingness to be compensated for the effort they already conduct. Farmers exhibit positive preferences for the bonus options, but only the sponsorship bonus by itself is significant. The collective environmental result bonus can be perceived as more risky or insufficiently high, as it does not only depends on farmers' individual effort but also on the cumulated effort of others, as well as other external factors affecting water quality. This result may also reflect that some respondents do not believe the environmental target can be achieved in their area or within the contract length (5 years). The status-quo was chosen in 13% of the choice situations (excluding protesters), and results suggest farmers tend to prefer choosing a contract rather than the opt-out option. The significance of the standard deviation coefficients shows strong preference heterogeneities for both management attributes, the status-quo and the bonus option offering both the possibility of a sponsorship bonus and a collective environmental result bonus. The standard deviation of the sponsorship bonus preference parameter being not significant, we define the coefficient as non-random in the second specification.

Table 4: Mixed Logit estimations (normal distribution of random parameters)

	ML1	ML2
Attributes		
PAYMENT	**0.006***** (0.001)	**0.006***** (0.001)
COVER	**0.036*** (0.017)	0.022 (0.022)
HEDGEROWS	**-0.018**** (0.006)	-0.001 (0.010)
BONUS $_{sponsorship}$	**0.278**+ (0.185)	**0.314*** (0.189)
BONUS $_{sponsorship/collective\ result}$	0.142 (0.244)	**-1.306***** (0.400)
Alternative-specific constant		
ASC_{sq}	**-2.023***** (0.448)	**-0.946**** (0.394)
Interactions		
*COVER*ENVORGA*		**0.094**** (0.039)
*HEDGEROWS*ENVORGA*	-	**0.024*** (0.014)
*HEDGEROWS*ORGANIC*	-	**0.030***** (0.008)
*HEDGEROWS*SHORT-TERM*	-	**-0.041***** (0.011)
*HEDGEROWS*UAA*[1]	-	**-0.002***** (0.001)
BONUS $_{sponsorship/collective\ result}$ **COLPAY*	-	**0.564***** (0.155)
BONUS $_{sponsorship/collective\ result}$ **SHAREPGRASS*	-	**1.349**** (0.499)
ASC_{sq}**ENVORGA*	-	**-6.610***** (0.869)
ASC_{sq}**HHREVENU*	-	**-4.613***** (1.305)
Standard deviation of the parameters		
COVER	**-0.100**** (0.023)	**0.111***** (0.028)
HEDGEROWS	**-0.061***** (0.009)	**0.046***** (0.006)
BONUS $_{sponsorship}$	-0.326 (0.325)	-
BONUS $_{sponsorship/collective\ result}$	**-1.375***** (0.266)	**1.268***** (0.223)
ASC_{sq}	**3.317***** (0.401)	**-3.116***** (0.372)
Goodness-of-fit		
Log Likelihood	-725.21	-686.00
Pseudo-R^2	0.35	0.38
AIC	1472.42	1409.99
BIC	1526.82	1503.97
Observations	1039	1039
Number of farms	116	116

[1] Utilised agricultural area in 10ha. Significance levels: *** robust p-value <0.001, ** robust p-value <0.01, * robust p-value<0.05, + robust p-value<0.1. Robust standard errors in parentheses. ASC_{sq}: alternative-specific constant associated with the status quo alternative. * indicates an interaction between two variables. AIC: Akaike information criterion. BIC: Bayesian information criterion.

Source: own elaboration.

In a second ML specification (ML2), we add interaction terms with individual specific variables collected in the survey. Out of the set of covariates tested, we kept those significantly explaining the heterogeneity of farmers' choices while not deteriorating the model's goodness of fit. As expected, farmers who are members of an environmental organisation (*ENVORGA*=1) and particularly aware of environmental issues, exhibit lower preferences for the status-quo option and higher preferences for higher levels of management requirements attributes. Organic farmers (*ORGANIC*=1) have higher preferences for more ambitious levels of hedgerows density requirements. We can assume organic farms value the multiple ecosystem services delivered by hedgerows (habitats for natural predators of pests, reducing exposure to pesticide spray drift from neighbouring farms…). On the other hand, respondents who plan to stop farming activities in 5 years or less (*SHORT-TERM*=1) have strong negative preferences for hedgerows requirements, which require long-term engagement for maintaining them. Large farms also tend to prefer lower levels of hedgerows requirements, for which compliance might be particularly costly. Regarding the bonus option, the higher the farmer's score (*COLPAY*={0,1,2,3,4}) in terms of impact of a common payment on the willingness to adopt a contract, the higher his or her preferences for the combined sponsorship and collective result bonuses. It suggests that some farmers have a "pro-collective" behaviour. Preferences for the combined bonuses also increase with the share of permanent grasslands in the cropping system (*SHAREPGRASS*). Finally, respondents for which farming contributes to less than 70% of the household gross revenue (*HHREVENU*=1*)* are less likely to choose the status quo option. This is consistent with the findings by Defrancesco et al. (2008) that high dependency of household to agricultural income is a barrier to the adoption of AES.

Farmers' marginal WTA for the attributes are reported in Table 5. Ceteris paribus, a farmer accepts a contract with on average 43€ less of individual payment per hectare if there is a sponsorship bonus of 450€/peer. For a farm of 100ha (average farm size of the sample), it represents a decrease of 4,300€ of individual payment per year. A farmer would need to convince at least 10 new farmers each year to receive the same amount of sponsorship bonuses. This result confirms the result by Kuhfuss et al. (2016) that introducing a bonus option can improve the cost-effectiveness of a PES.

Table 5: Marginal willingness to accept the payment for environmental services contract design characteristics, estimated with the delta method (€/ha/year)

	ML1
COVER	**-5.578*** (2.782)
HEDGEROWS	**2.885**** (0.930)
BONUS $_{sponsorship}$	**-43.485**+ (29.174)
BONUS $_{sponsorship/collective\ result}$	-22.280 (37.854)
ASC_{sq}	**316.320***** (85.869)

Robust standard errors in parentheses. Significance levels: *** robust p-value <0.001, ** robust p-value <0.01, * robust p-value<0.05, + robust p-value<0.1. Robust standard errors in parentheses. ASC_{sq}: alternative-specific constant associated with the status quo alternative.

Source: own elaboration.

We further characterise preference heterogeneities by estimating a LC model. The best model fit was obtained for 3 and 4 classes, as the Bayesian information criterion (BIC) increases starting from 5 classes (Table 6). We decided to keep 3 classes to limit the number of variables in the model and add individual specific variables to explain class membership.

Table 6: Selection of Latent Class model

Number of classes	2	3	4	5	6
Log Likelihood	-796.07	-715.8	-692.42	-673.93	-662.43
AIC	1618.13	1471.6	1438.84	1415.85	1406.87
BIC	1682.43	1570.52	1572.38	1584.01	1609.65
Pseudo-R^2	0.2912	0.3554	0.3697	0.3798	0.3837
Average probability to belong to the attributed class	0.9777	0.968	0.9501	0.9445	0.9254

AIC: Akaike information criterion. BIC: Bayesian information criterion.

Source: own elaboration.

The first class (57% of respondents) describes farmers with positive preferences for both types of bonus options, and with the highest preferences for the individual per-hectare payment (Table 7). Relative to the other classes, the level of financial incentive seems to drive their choice more than technical constraints. Farmers who are members of an environmental organisation, and therefore have experience in collectively working on environmental issues, are more likely to belong to this "pro-incentive" class. The second class of farmers (29% of respondents) exhibits preferences for low management requirements and is not affected by the bonus option. Conventional farmers and farmers stopping their activity within 5 years are more likely to be in this "management change averse" class. The third class (14% of respondents) depicts farms preferring PES contracts with high management requirements and no bonus option. Organic farmers and farmers for which the household income is highly dependent on farming are more likely to be in this "pro-environment individualists" class.

The preference parameter for the individual per-hectare payment is not significant, suggesting that the individuals' choice is more driven by the contract design in itself than by the incentive. While the third class describes a small share of the sample, it reveals the low acceptance of bonus incentives from a part of the farming population in the surveyed area, either because they prefer current action-based PES, or because they are reluctant to collective approaches.

Table 7: Latent Class estimation

	Class 1	Class 2	Class 3
Attributes			
PAYMENT	**0.008**** (0.003)	**0.002**$^{+}$ (0.002)	0.001 (0.001)
COVER	**0.041*** (0.021)	**-0.055**** (0.020)	**0.107***** (0.031)
HEDGEROWS	0.005 (0.004)	**-0.041*** (0.022)	**0.020**** (0.007)
$BONUS_{sponsorship}$	**0.989***** (0.206)	0.103 (0.428)	**-0.708*** (0.395)
$BONUS_{sponsorship/collective\ result}$	**1.216*** (0.523)	-0.392 (0.340)	**-1.027**** (0.400)
ASC_{sq}	**-2.601*** (1.519)	0.335 (0.491)	**-1.952***** (0.464)
Goodness-of-fit			
Log likelihood	-700.61		
Pseudo-R^2	0.3617		
AIC	1457.21		
BIC	1595.7		
Observations	1039		
Number of farms	116		
Probability of class	0.6078	0.1607	0.2314
Share of respondents (%)	56.90	29.31	13.79
Class membership function			
Intercept		-0.129 (0.655)	**-1.726**** (0.609)
SHORT-TERM	-	**1.013**$^{+}$ (0.774)	-0.443 (0.854)
ORGANIC	-	**-0.985**$^{+}$ (0.643)	**1.476*** (0.726)
ENVORGA	-	**-15.615***** (1.392)	**-1.352**$^{+}$ (0.828)
HHDIVREVENU	-	-0.710 (0.809)	**-12.054***** (1.578)

Significance levels: *** robust p-value <0.001, ** robust p-value <0.01, * robust p-value <0.05, $^{+}$ robust p-value<0.1. Robust standard errors in parentheses. ASC_{sq}: alternative-specific constant associated with the status quo alternative. AIC: Akaike information criterion. BIC: Bayesian information criterion.

Source: own elaboration.

5. Concluding remarks

The effectiveness of payment schemes for farmers' environmental services aiming at the delivery of environmental public goods with provision thresholds (biodiversity, water quality) depends on reaching enough farmland enrolment and aggregated environmental effort at the landscape scale. The objective of the present study was to elicit farmers' preferences for a payment mechanism made of a bonus incentivising farmers to adopt a collaborative behavior with other farms from the same area, on top of an individual action-based payment. In comparison to collective requirements conditioning the full payment, the conditional bonus option reduces the risk of receiving no compensation for one's environmental services if the aggregated effort and surfaces are insufficient at the landscape scale. Using a CE approach, we measured preferences for a sponsorship bonus of 450€/sponsored farmer rewarding individual farmers for increasing participation, and a combined bonus option comprising the sponsorship bonus and a collective result bonus of 50€ per hectare delivered to all participants if an environmental target is met at the landscape level.

Findings suggest that on average, respondents prefer contracts with a bonus for sponsoring a peer to no bonus, but are less favorable to a combined sponsorship/collective result bonus. Designing bonuses distributed according to an individual effort for attracting more farmers could be a promising way to increase participation and PES cost-effectiveness, while collective bonuses distributed to all might be counterproductive. We characterised respondents' heterogeneity with a latent class model and identified three groups of farmers with a different attitude towards the bonus options: (i) "pro-environment individualists" with negative preferences for both, (ii) farmers who seem indifferent to both, and (iii) "pro-incentive" farmers with positive preferences for both.

A limit to the generalisation of our findings is that due to the sampling procedure, our data are biased. Asking and controlling for individual status-quo levels allowed us to control part of the bias regarding the already high levels of management requirements implemented by respondents. In addition, there is an over-representation of organic farms (39% of the respondents while the actual share is closer to 10%). Since organic farms are more likely to have a "pro-environment individualist" preference pattern, our results likely overestimate the negative attitude towards the bonus option, in particular towards the combined sponsorship/collective environmental result bonuses.

To ensure sufficient adoption, the introduction of PES with conditional bonuses may require to pay farmers beyond opportunity costs. The involvement of private and local stakeholders in financing PES represents an opportunity to capture a higher willingness to pay for water quality. In particular, bonus-mechanisms rewarding a landscape result or high participation could be of particular interest for stakeholders benefiting directly from the improvement of rivers' ecological quality (water bottle companies, water catchment bodies…). Another issue at stake in capturing a higher willingness to pay for PES is to consider the other public goods provided in synergy with the implementation of hedgerows and the reduction of bare soil duration, such as carbon storage and the protection of agrobiodiversity. On the one hand, the emergence of carbon and biodiversity offsets together with watershed payments represents an opportunity for farmers to find contributors more easily, and value the multiple environmental services they provide. Stakeholders from northwestern France seem particularly interested in developing local carbon markets based on the valorisation of a bunch of public goods (Dupraz et al. 2020). On the other hand, the multiplication of those initiatives could lead to counterproductive effects. Different payment levels for the implementation of the same practices depending if a contributor values more water quality, carbon storage or biodiversity raise the issue of fairness. It might provide an additional incentive for farmers to work together in securing a collective supply of environmental services at the landscape level and increase their bargaining power. In areas where experience in collective approaches is low, building institutions facilitating collective action would support this process (Kerr et al. 2014).

Further research is needed to assess if conditional bonuses are successful in improving public good provision in practice. An AECM to protect the European Hamster in France recently introduced an individual bonus payment when a burrow is detected on a plot (Eichhorn et al. 2022). This case study might provide useful empirical evidence to build on in the future.

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