Compensating environmental losses versus creating environmental gains: Implications for biodiversity offsets

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Abstract

In the economic literature on the motivations underlying voluntary contributions to environmental public goods, little attention is granted to the way the overall objective of the environmental program is framed. A program which contributes to an increase of environmental quality can be perceived differently from a program designed to bring back the environmental quality to its original level, after it was damaged by human intervention, even if net environmental gain is equivalent in both programs. How does it impact participation rates and contribution levels? This paper addresses this issue in the context of agri-environmental contracts for biodiversity conservation. It compares farmers' willingness to participate in two equivalent agri-environmental schemes, one being framed as part of a biodiversity offset program, the other one as a biodiversity conservation program. We demonstrate with a discrete choice experiment that biodiversity –offsets programs must offer a greater payment to enroll farmers compared to the latter. This is explained by the sensitivity of farmers to environmental issues.

Keywords biodiversity offsets, agri-environmental contracts, choice experiments, behaviour

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Introduction

Legislation in an increasing number of countries imposes that unavoidable biodiversity losses resulting from infrastructure development (road, railway line, new buildings etc. …), be compensated by the creation of equivalent biodiversity gains, the so-called Biodiversity Offsets (BO). In the French context, BO requirements have been mainly fulfilled so far through the acquisition of agricultural or degraded land by developers, followed by their ecological restoration.

However, this solution faces land availability constraints and can be very costly in terms of initial investments. Also it is not well accepted by farmers who consider it as an additional source of competition on the land market, driving prices up. An alternative solution, based on the payment for environmental services principle, is emerging in France. Developers finance agri-environmental biodiversity offset schemes (henceforth ABOS) in which they offer contracts to farmers settled in the area where the offset must be supplied (Le Coent et al., 2015). Enrolled farmers accept to adopt farm management, land use and farming practices for a given period (5 years usually) in return for a payment, in order to create "equivalent" favorable habitats for species affected by development. Of course, without farmers' participation, the ABOS option cannot be successful. Developers must therefore anticipate what payment they should propose to ensure sufficient participation.

In practice, ABOS are very similar to existing agri-environmental schemes (AES) financed by the European Union to implement measures of biodiversity conservation on farmland. Indeed it is often the case that the type of habitat that must be created to offset biodiversity losses are also habitats that the European Union seeks to preserve in protected areas. Therefore ABOS compensation contracts often display exactly the same technical specifications as equivalent AES conservation contracts. However ABOS and AES contracts, although similar in their design, differ systematically in two specific features which do not change monetary cost-benefit ratio for farmers but may have an impact on their subjective perceptions of the contracts and therefore on their willingness to participate. First, contract purposes are framed differently: ABOS explicitly aim at compensating biodiversity damages generated by a development project while AES are advertised as contracts for the conservation or the improvement of biodiversity. Second, ABOS are mainly offered and funded by the private sector while AES are traditionally designed and financed by the public sector (usually at national or European levels).

The objective of this article is to determine whether these differences, all other things considered equal, have an impact on farmers' participation in agri-environmental contracts for biodiversity offsets. Standard economic theory predicts that farmers should be indifferent between the two types of contracts since expected monetary costs and benefits are identical under both types of contracts. However, insights from behavioural economics and previous empirical findings on farmers' motivations when joining agri-environmental schemes (such as preferences for the environment or aversion to loss) indicate that the contract framing may change farmers' willingness to accept. A program financed by public money and presented as a contribution to environmental improvement can be perceived differently from a program financed by a "polluter" compelled by law to create environmental services in order to compensate the damages he has created elsewhere.

Since offsetting needs are increasing rapidly, it is crucial for public authorities to anticipate whether ABOS is a relevant mechanism to help developers to fulfill their legal obligation in terms of offset volumes. Developers also need to measure the acceptability of such mechanism, *i.e.* the impact of the specific features of ABOS on farmers' willingness to participate and on the payment they will request to join the scheme and provide adequate offsets. Finally, it should be underlined that ABOS and AES aiming at biodiversity conservation are likely to be activated in the same protected areas. There is therefore a risk of competition between these two types of contracts. If ABOS are preferred by farmers, this may lead to their reduced participation in conservation AES, leading to a substitution of conservation efforts by compensation efforts, and possibly entailing reduced additionality. Understanding the relative preference of farmers for the characteristics of these two contracts will therefore also help to estimate this risk.

Literature on biodiversity offsets has primarily focused on issues related to the calculation of biodiversity equivalence and uncertainties (Quetier et al, 2014; Bull et al, 2013). Economic contributions are more recent and concern mostly the evaluation of offset efficiency for various program designs (Mc Kenney and Kiesecker 2010, Gordon et al, 2011). Our contribution focuses on the acceptability of biodiversity offset contracts as compared to classical biodiversity conservation agri-environmental contracts. Using a choice experiment method, it quantifies farmers' relative preferences for conservation contracts versus compensation contracts.

The survey has been conducted in the South-East of France, in a region where a vast biodiversity offset program is carried out since 2011 following the construction of an 80 km railway bypass for a high-speed train (more specifically in the Gard department, between Nimes and Montpellier). This railway project strongly affects habitats of an endangered bird species, the Little Bustard, *Tetrax tetrax*. The developer has been required to implement a BO program on about 1800 ha for the next 25 years. The developer has acquired land for specific management purposes but has also chosen to implement an ABOS. Contracts were signed on about 1100 ha of farm land since 2011. We decided to carry out the choice experiment there because participants have been already exposed to both ABOS contracts and CAP-financed AES for biodiversity conservation and are therefore well acquainted with those two types of programmes.

Section 1 provides a literature review of the behavioural factors that may influence farmers' acceptability of agri-environmental contracts aiming at biodiversity compensation. Section 2 describes the choice modeling methodology used in this research. Section 3 presents the results in terms of preference for the alternative contracts proposed and factors that may explain these preferences. Section 4 discusses these results and concludes with policy implications.

1. Literature review

In order to investigate the factors that may influence the preference for one contract or the other, we have conducted a choice experiment in which the two contracts were presented as follows:

- Conservation contracts: they are proposed and funded by the **public sector** with the objective to **create or maintain** favorable habitats for threatened species (AES)
- Compensation contracts: they are proposed and paid by a **private company** that must, because of the construction of an infrastructure, **compensate** the degradation of favorable

habitats for threatened species by recreating elsewhere on the territory equivalent favorable habitats (ABOS).

The differences between the two contracts are threefold: (i) the overall purpose of the contract (compensation of a biodiversity loss versus conservation or creation of a biodiversity gain), (ii) the identification of responsibility for biodiversity damages (a private developer versus no clearly specified responsibility), and (iii) the nature of the principal in the contract relationship (private or public)

Purpose difference: compensation vs conservation

The first main difference lies in the contract purpose: compensating the degradation of habitats *vs* creating or maintaining habitats. It can be considered a goal framing issue (Levin *et al.*, 1998). Goal framing is about presenting the consequence of a choice or an action either as positive (it provides a benefit or gain) or as negative (it prevents or avoids a loss). Goal framing is thus associated with a change in the reference point of a decision. Several experimental studies examine the effect of goal framing in the context of public good provision (Brewer and Kramer, 1986; Fleishman, 1988; Sonnemans *et al.*, 1998; Andreoni, 1995). The positive frame consists in giving to a public good fund, whereas in the negative frame subjects take from the public good fund to purchase private goods. There is no clear conclusion from this literature on which frame, positive or negative, has the greater persuasive impact on contributions.

Relying on this literature, Blasch (2015) considers a different experiment in which contribution to a public good is framed as the neutralization of a negative externality. She positions her experiment in the context of voluntary contributions to climate change mitigation. She compares hypothetical donation choices made by respondents in an on-line survey when they are framed as "positive donation" (act of 'doing good' by donating money to a climate change mitigation project) or as "negative offset" (act of 'undoing harm' by donating to a carbon offset program neutralizing one's own CO_2 emission). She also emphasizes the importance of the reference point. In the negative framing, the reference point is in the loss domain and the contribution brings the public good provision level back to the initial level, whereas in the positive framing, the contribution pushes the public good provision level into the gain domain. Relying on the theory of impure altruism (Andreoni 1990), Blasch assumes that contributors to the public good derive a positive utility associated with "undoing harm" in the loss domain because their cold prickle is reduced, and with "doing good" in the domain of gains because they experience warm glow. Combined with elements of the loss aversion theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1991), which states that the utility function does not display the same concavity in the gain and loss domains, she predicts that individuals should contribute more in the negative framing unless they are gain-seeking in terms of altruistic utility.

The same reasoning could be applied to the conservation/compensation contract issue but there are other differences. First, the compensation contract specifies that efforts are undertaken to compensate a biodiversity degradation which has already taken place. This might be a non-neutral information from a behavioural viewpoint. Gregory *et al.* (1993) investigate the effect of "past states" of the environment on the willingness to support mitigation policies. They conduct an experiment in which students are asked to evaluate the desirability of an environmental improvement in several domains. These environmental improvements are either framed as improvements of the current situation or as restoration after a degradation (although they do not specify responsibilities). Results reveal that respondents prefer to support the restoration to the initial state of a previous environmental loss rather than a net environmental improvement. Gregory et al. also invoke the prospect theory and loss aversion to explain the higher willingness of respondents to support an environmental improvement policy. Restoring the environment as it was in the past, i.e. compensating a loss, provides more utility especially for loss averse individuals, than in the environmental gain domain.

Responsibility for the loss

In Basch (2015), the person who takes the decision to compensate is directly responsible for the degradation of the environment in the negative framing since she is the CO2 emitter in the first place. What happens when the degradation of the environment is due to a third party, such as a developer in the case of biodiversity offsets?

Some studies investigate the impact of the cause of threats to the environment. However, they usually focus on how human versus natural causes of environmental degradation influence the willingness to pay for mitigation interventions (Kahneman *et al.*, 1993; Bulte *et al.*, 2005). They find that when human action is the cause of an environmental problem, the willingness to pay to repair damages is higher. They argue that this is due to an “outrage effect” for human-caused environmental issues. Walker *et al.* (1999) study the same type of issue by comparing *inter alia* the willingness to accept to feel compensated for the removal of a street tree, either due to a disease (natural cause) or to the widening of a street (human cause). Unlike previously cited studies, they find a significantly higher willingness to accept (WTA) to compensate a human caused tree removal than for the natural caused one. They consider that the feeling of moral responsibility may play an important role in the WTA evaluation for human caused environmental issues. When looking at human-caused issues, the identity of person or group who is morally responsible for an environmental degradation has a strong effect on people’s preferences for a mitigation policy. This result is however not confirmed by Bulte et al (2005) who do not find any difference between the willingness to pay for the protection of seals threatened by either global warming (common responsibility) or by oil drilling activities (specific responsibility).

The preference for biodiversity offset contracts versus biodiversity conservation contracts may therefore be influenced by two conflicting factors. On the one hand, the compensation could be considered as the restoration of a loss of biodiversity and should therefore be preferred, due to loss aversion. On the other hand, in the compensation frame, the developer is clearly responsible for the environmental degradation and farmers may want to reduce their willingness to contribute to the realization of such contracts, in order not to feel / be considered accomplice of this degradation.

Environmental attitude

This question also relates to the role of attitude towards the environment in the adoption of agri-environmental contracts. Beedel and Rehman (2000) show that farmers belonging to an environmental association are more likely to adopt pro-environmental practices. Mzoughi (2011) emphasizes that the motivation “showing one’s environmental concern to others” is important for organic farmers and farmers adopting integrated pest management practices as compared to conventional farmers. The attitude towards the environment in AES seems to play a greater role for contracts requiring more efforts from farmers (Vanslembrouck *et al.*, 2002; Delvaux *et al.*, 1999). We assume that the effect of the susceptibility to the environment depends on the expected outcome of the policies. In our case study, the end level of biodiversity will be unchanged with ABOS and improved with AES. Considering that farmers who are sensitive to environmental issues are those who value the most the benefits of an environmental public good, we can thus make the hypothesis that they will prefer conservation contracts over compensation contracts.

Trust in contracting partners

Trust between contracting partners is considered a major factor in the adoption of AES. The perception of a trustworthy relationship facilitates participation by reducing transaction costs both before and during the transaction (Ducos *et al.*, 2009 ; Ducos and Dupraz, 2007 ; Louis and Rousset, 2010 ; Peerlings and Polman, 2009). In Europe, AES are generally signed between farmers and state authorities under the Common Agricultural Policy (CAP) framework. They are well-known contracts. In the context of compensation contracts, developers are new stakeholders, generally little known in the farming sector. The fact that they belong to the private sector may be perceived positively, as a source of efficiency and flexibility compared to the bureaucratic red-tape and rigidities, but it may also raise suspicions on their capacity to guarantee payments over the duration of the contract. It is also likely to play a role in farmers' preference for compensation or conservation contracts.

2. Method

Choice experiment approach and model specification

In order to determine the influence of ABOS contract characteristics on farmers' participation, we carry out a choice experiment (CE). The CE approach is based on Lancaster's theory of consumer choice (Lancaster 1966), which establishes that choices are determined by the utility that is derived from the attributes of a good, rather than from the good per se. The econometric modeling is based on the random utility theory, which assumes that utility is composed of a deterministic component, which can be estimated based on observed choices and the characteristics of the alternative, assuming that individuals maximize utility , and a stochastic error component(McFadden, 1974).

The conditional logit is the most commonly used model to analyze CE. It however requires two strong assumptions: the Independence of Irrelevant Alternatives (IIA) and the homogeneity of preferences among respondents (Hausman and McFadden 1984). The IIA supposes that the relative odds of an alternative being chosen over another should be independent of the presence or absence of unchosen third alternatives (McFadden, 1974). These conditions are likely to be violated in our case since we have introduced an opt-out alternative in each choice card. In addition, it is likely that behavioral factors mentioned in the literature review affect farmers' preferences for compensation or conservation contracts in a heterogeneous manner. The heterogeneity of preferences is therefore of particular interest in this study. For these reasons, we have privileged the use of the mixed logit or random parameter model to analyze our data. It allows preferences to vary randomly and continuously across individuals and does not require the IAA assumption (McFadden and Train, 2000)

In the mixed logit model, the utility that respondent n derives from choosing alternative i, in choice situation C_t $(t = 1, \dots, T)$ is given by:

$$U_{int} = \beta_n X_{int} + \varepsilon_{int}$$

where X_{int} are the attributes of alternative i and the coefficient vector β_n, represents the vector of individual tastes.

Individual n will chooses alternative i in choice situation t ($A_{int} = 1$) among all other alternatives j, if this alternative gives him the highest utility in this choice situation:

$$A_{int} = \begin{cases} 1 \text{ if } U_{int} > U_{jnt}, & \forall j \in C_t, j \neq i \\ \text{0 otherwise} \end{cases}$$

Assuming that ε_{int} follows an extreme value distribution, the probability that $A_{int} = 1$ conditional on vector β_n is a standard conditional logit (McFadden 1974).

$$P(A_{int} = 1|\beta_n) = \frac{\exp(X'_{int}\beta_n)}{\sum_{j \in C} exp(X'_{jnt}\beta_n)}$$

The researcher does not observe β_n, only its density $f(\beta)$ is assumed to be known. The probability of observing the sequence of *T* choices:

$$P(A_{in1} = 1, \ldots, A_{inT} = 1) = \int (\prod_{t=1}^{T} \frac{\exp(X'_{int}\beta)}{\sum_{j \in C} exp\ (X'_{jnt}\beta)}) f(\beta) d\beta$$

where $f(\beta)$ can be specified to be normal or lognormal: $\beta \sim N(b, \mathrm{s})$ or ln $\beta \sim N(b, \mathrm{s})$ (McFadden and Train, 2000). The parameters b and s are respectively the mean and the variance of these distributions and are to be estimated by simulation.

We analyze the heterogeneity of preferences by interacting individual specific behavioural characteristics with attribute levels.

Contract attributes

There is a rapidly growing literature using choice experiments to measure farmers' preferences for various technical specifications of agri-environmental contracts. Typically, they study two types of attributes: those having a direct effect on farmers' compliance costs (levels and types of environmental efforts) and those related to contract design (length of contract, contract cancellation options, contract flexibility etc.). Our experiment introduces a novel attribute, which can capture farmers' preferences for the ultimate purpose of the contract. Broch and Vedel (2012) have also introduced a "purpose" attribute in a choice experiment related to Danish afforestation contracts but each level of this attribute (ie biodiversity, water protection or recreation) implied different forest management options and therefore different implementation costs. In our design, all hypothetical contracts include the same technical prescriptions: eligible plots are fields which were either previously planted with cereals, temporary pasture or abandoned land, and must be planted, under contract, with an alfafa crop, which is expected to provide suitable habitats for nesting birds. They incur the same costs for the same farmer. Therefore differences in WTA can be attributed to framing differences, thus triggering various motivations.

The hypothetical contracts offered in the CE differ on three attributes.

The main attribute of interest is the purpose of the contract (purpose): it is presented either as a conservation or as a compensation contract, using the definitions mentioned above. This attribute embodies two major differences: the overall aim of the contract (compensation vs conservation) and the contracting partner (private vs public). Another approach could have been to separate these two characteristics in two distinct attributes and to analyze preferences separately. Our assumption was however that these two characteristics were understood as intimately mingled and that it would have been perceived unrealistic by farmers to present them in a separate way (in particular the case of a conservation contract proposed and financed by a private company).

The second attribute is linked to the specific needs of biodiversity conservation and is therefore relevant in the case of ABOS. It introduces the option to impose (or not) a 20% minimum threshold of farmer participation to trigger the implementation of the contract scheme. This minimum threshold is justified by the need to obtain a sufficiently sized habitat in order to ensure bird successful reproduction. When a minimum level of practice or land use change is necessary to reach a significant environmental impact on a given territory, the policy-maker may decide to set a minimum threshold of enrollment (Dupraz *et al.*, 2007). In this context, if public authorities impose to the developer that such threshold be attained, the developer may wonder whether revealing the existence of the threshold to farmers will encourage or hinder farmers' participation. On the one hand, farmers who do not want to provide environmental effort without any positive environmental outcome might approve such a threshold which guarantees a minimum environmental impact of their land use change. On the other hand, we can expect that farmers might be reluctant to condition their participation on the decisions of others. The effect of such an announced threshold is indeed controversial in the literature. In a threshold public good game experiment, Le Coent et al. (2014) show that the introduction of a minimum threshold of contribution triggering the payment of subsidies tends to increase subjects' contribution. In a choice experiment, Kuhfuss et al (2014) found that farmers have a strong preference for the inclusion of a bonus conditional to a minimum threshold of participation in agri-environmental contracts aiming at reducing herbicides use in vineyards. However, Villanueva et al. (2015) reveal in a choice modeling that the inclusion of such collective threshold tends to discourage participation in agri-environmental contracts because farmers anticipate additional transaction costs.

The third attribute is the payment associated to the contract. It is either 170, 200, 230 or 260€/ha/year. The variation of payment is centered on the present level of payment for this measure in AES and ABOS which is 215€/ha/year. We deliberately included a modest variation of payment because we expected that the payment level could play a very strong role in farmers' decisions as compared to the other two attributes.

The attributes and the payment levels were discussed with the organizations in charge of the implementation of the biodiversity offsets program carried-out in the field. In addition, the questionnaire was tested with a small sample of farmers to check that it was properly understood.

Experimental design

Considering that the choice experiment questions were included at the end of a lengthy questionnaire dedicated to another research, our constraint was to be parsimonious and to limit the set of choices that farmers had to make to a minimum. A full factorial design with 2 alternatives would have required (2x2x4)x(2x2x4-1)= 240 possible choice situations. We therefore used a fractional factorial design. Huber and Zwerina (1996) show that if there are reasonable non zero-priors on the effects of attributes on choice, then these can be used to generate choice designs that are statistically more efficient than a classic orthogonal design, because the alternatives in their choice sets are balanced in utility, i.e. they have more similar choice probabilities. We could not run a pilot due to the limited size of the population and the risk to reduce our end sample. Nevertheless, it was clear that the coefficient of the payment attribute would be positive. We therefore used a D-efficient design in which we only anticipated that the coefficient of the payment attribute was positive. The coefficient of the other attributes was set to 0. We generated a two block design with four choice sets each. Each respondent was randomly affected to one of the block and therefore was confronted with 4 choice sets. In each choice set, respondents had to choose between 2 hypothetical contracts that presented a combination of the above mentioned attributes and an opt-out option which was "neither of the two contracts". A sample choice set is presented in appendix 2.

There is a debate in the literature on the inclusion of an opt-out option in discrete choice experiments. One of the advantage of the "opt-out" option is that it makes the choice situation more realistic and avoids a forced choice (e.g. Batsell and Louviere, 1991; Haaijer *et al.*, 2001). Several studies from the experimental psychology and marketing literatures have shown that respondents faced with a forced choice tend to choose certain options in the choice set that may create biases (Dhar and Simonson, 2003; Dhar, 1997; Tversky and Shafir, 1992; Kontoleon and Yabe, 2003). But one of the disadvantages of the opt-out alternative is that respondents may select the opt-out alternative, not because it provides the highest utility among the alternatives but because it allows them to avoid the cognitive task of comparing alternatives (Dhar and Simonson, 2003; Dhar, 1997). Since the opt-out alternative does not vary across choice sets, it gives no information about preferences for attributes, but it is a way also to determine the potential participation to a program and it should be included if in real life 'not participating' is an option as well. However, the use of an opt-out option may cause the utilities of the choice alternatives to be correlated leading to the violation of the "independence of irrelevant alternatives" underlying the conditional logit model (Amaya Amaya, 2003).

Another issue is whether a "status quo" option or an opt-out option should be used in choice modeling. The "status quo" option for agri-environmental contracts would mean "choose the non hypothetical contract which is presently proposed to farmers". It can be described by specific levels of the CE attributes (whereas the "opt-out" option is not defined by contract attributes) but it forces respondents to pick a contract situation. Among the studies that used choice experiments to estimate the preference for agri-environmental contract attribute, the opt-out option is generally privileged (Espinosa-Goded *et al.*, 2010; Broch and Vedel, 2012; Christensen *et al.*, 2011; Kuhfuss *et al.*, 2014; Ruto and Garrod, 2009).In order to fit to a context in which farmers voluntarily chose to enroll or not in an AES, we chose to include an opt-out option "I chose neither of the two contracts" in each choice sets.

The coding of variables in a choice experiment with an opt-out option poses a number of challenges. Haaijer et al (2001) determine that the best option is to use effect coding for the attributes. Each attribute is coded with an additional level set to 0 for the opt-out alternative. A supplementary two-level attribute is added. It takes value zero for the two contract alternatives and value one for the opt-out alternative. This dummy variable can be interpreted as the utility for the respondent of choosing the opt-out alternative (Vermeulen et al., 2008), capturing a preference for the "no change" option. The coding adopted is presented in table 1.

Attribute	Description	Levels	Coding
Purpose	Aim of the contract	Compensation of biodiversity loss	+1
		Conservation of biodiversity	-1
		Opt-out	0
Threshold	Existence of a minimum threshold of participation of 20% of farmers of the area	Yes	+1
		No	-1
		Opt-out	0
Payment	Payment level per ha and year	170€/ha	170
		200€/ha	200
		230€/ha	230
		260€/ha	260
		Opt-out	0
Opt-out	Neither of the 2 contracts	Opt-out	1
		Contract 1 or Contract 2	0

Table 1: Attributes, levels used and their coding

Data collection

The questionnaire was sent by post to the 1169 farmers who were initially contacted by the developer since 2011 to sign an ABOS contract, of which 59 (5%) have effectively enrolled. Note that the hypothetical contracts described in the CE were not presented as a substitute for their current contract but as new additional contracts on different land. Only farmers who had available cereal field, temporary pasture (without alfalfa) or abandoned land were invited to fill the choice modeling part of the questionnaire. We collected a total of 121 responses (response rate of 10.3%) to the questionnaire of which 82 usable replies to the choice modeling questions. Respondent also had to answer a number of questions on their socio-economic characteristics, and their opinion and attitude towards the environment, and their perception of the trustworthiness of the private contracting partner (the developer).

Descriptive statistics on the socio-economic characteristics of the sample are presented in appendix 2 and are compared to the farmer population in the area. These statistics show that our sample is not biased in terms of gender and age. However, respondents are slightly more educated and farms are bigger than in the population of interest. There are two major differences: 29% of our sample declare themselves as "organic farmers" (they may be certified organic farmers, or in the process of certification, or have organic practices without certification) whereas the average share of certified organic farmers in the region is 12%. It might be partly explained by the fact that the organic qualification in our sample is broader and less restrictive than the definitions used in the official statistics. We can also suspect that there is a self-selection bias: farmers who are more susceptible to environmental issues, such as organic farmers, may have been more inclined to respond to a questionnaire dealing with biodiversity issues. The second difference is participation to contracts: among the 82 respondents, 25 (30% of our sample) have signed a compensation (ABOS) contract, 8 have signed a conservation (AES) contract and two have signed both. Since among the 1169 farmers contacted to sign a compensation contract only 100 farmers have done so, we have also an over-representation of farmers enrolled in compensation contracts in our sample. It may bias our results either in favour of compensation contracts (selection bias) or against it (if those who have signed have experienced dissatisfaction and express their discontent).

3. Results

Preference for contract attributes

In this section, we present the results of the average preferences of respondents of our sample for the contract characteristics. The analysis of the choice experiment data with the mixed logit are presented in table 2. The preference for the opt-out, the aim of the contract and the threshold are considered to be normally distributed while the preference for the payment is log normal, avoiding to have negative preferences for the payment. The estimated price parameters are the mean b and standard deviation s of the natural logarithm of the payment coefficient. The mean and standard deviation of this coefficient are given by $\exp(b + s^2/2)$ and $\exp\left(b + s^2/2 \times \sqrt{\exp(s^2 - 1)}\right)$ respectively (Train 2003).

	Coef.
Mean	
Opt-out	10.14***
Purpose	-0.85***
Threshold	-1.35***
Payment	0.046***
SD	
Opt-out	-3.90***
Purpose	1.51***
Threshold	1.97***
Payment	0.024***
Nb. of observations	984
Nb. of individuals	82
Log likelihood	-228.27
Chi2	188.58

Table 2: mixed logit estimation of choice experiment data.
The sign of SD is irrelevant, must be interpreted as positive
(*p<.1, **p<.05, ***p<.001)

The analysis clearly reveals that on average farmers are more likely to choose a conservation contract than a compensation contract. The WTA difference between attribute levels can be estimated by dividing the attribute coefficient by the payment coefficient. Because we use an effect coding, this ratio must be multiplied by 2. In our sample, farmers require 37€ more to accept a contract with a compensation objective rather than a contract with a conservation objective. This difference represents 17% of the present payment offered in this type of contract, which is surprisingly high for an attribute not entailing direct monetary costs or benefits, and for a sample which includes 30% of respondents who have effectively signed an ABOS.

The estimation of the threshold attribute confirms the results by Villanueva *et al* (2015). Farmers prefer contracts which are not conditional to a minimum participation level. They would require 59€ more to enroll in a contract that includes a 20% threshold of participation rather than in a contract that does not include a threshold. This difference might be linked to anticipated costs of transaction. Farmers are reluctant to engage into a contract procedure (which can be costly in terms of paperwork, compulsory meetings with extension workers etc.) which may not be finalized. Revealing the existence of such threshold might therefore be counterproductive for the developer because it will discourage some farmers to participate in the contracts.

There is also a significant preference for the opt-out option, *i.e.* the non-participation in any of the contracts. This is also a result obtained by other choice experiments on agri-environmental contracts. Quite a large number of farmers prefer the status quo and are reluctant to engage in a contract whatever the contract terms and payments might be.

Analysis of preference heterogeneity

The mixed logit analysis reveals that there is a significant preference heterogeneity for the contract purpose. What are the factors explaining preference heterogeneity? The literature review in section 1 suggests that several behavioral factors may explain the preference for conservation contracts over compensation contracts. The main drivers are expected to be: environmental attitudes, the feeling of responsibility for nature conservation, and trust between contracting partners.

The questionnaire included questions to test these hypotheses.

The level of environmental attitude is evaluated with two variables. The first one is the fact to declare oneself as an organic farmer or not (ORGA variable). The second is built from an opinion question. Respondents were asked to indicate whether they agreed (totally disagree, partially disagree, partially agree, totally agree and don't know) with the statement "The protection of threatened bird species is a priority for our territory" (variable BIODIV).

Trust with the developer (variable TRUST) was estimated by the level of agreement with the statement "I think that developers who fund ABOS are trustworthy". Another way to measure the degree of trust between farmers and the developers is to assume that those who have signed an ABOS have more confidence in the developer's commitments. We thus also use a dummy variable (SIGN) which takes the value 1 if the respondent is already enrolled in a compensation contract.

We measured respondent's feeling of environmental responsibility (variable RESP) by their level of agreement with the statement: "I think it is my responsibility, as a farmer, to act for the protection of threatened bird species".

	Totally disagree	Partially disagree	Partially agree	Totally agree	I don't know
The protection of threatened bird species is a priority for our territory (BIODIV)	2	2	37	31	8
I think that developers who fund ABOS are trustworthy (TRUST)	5	3	32	8	33
I think this is my responsibility, as a farmer, to act for the protection of threatened bird species (RESP)	3	4	35	34	5

Table 3: frequency of response to three questions involved in the interpretation of preference for the purpose of contracts

We decided to turn these variables into dichotomous variables to simplify the analysis, with shaded cells coded as 1 (generally agree) and white cells as 0 (generally disagree or don't know). The coding was slightly different depending on the question in order to ensure a balanced frequency in the classes. The analysis of the interaction between the preferences for the contract was made by repeating the analysis of table 2 with the addition of one simple interaction one at a time (models 1 and 5 in table 4) as well as all interaction terms (model 6 in table 4).

	(1)	(2)	(3)	(4)	(5)	(6)
Mean						
Opt-out	12.28***	10.75***	12.83***	14.74**	13.34***	16.4***
Purpose	-0.60*	-0.74**	-0.70	-1.10**	-0.85**	-0.35
Threshold	-1.61***	-1.05***	-1.09***	-1.24***	-1.20***	-1.92***
Payment	0.063***	0.051***	0.060***	0.074***	0.062***	0.076***
Purpose*ORGA	**-1.32****					**-2.32****
Purpose*BIODIV		0.03				-0.44
Purpose*TRUST			-0.17			-0.00
Purpose*SIGN				0.86		
Purpose*RESP					-0.37	-0.64
SD						
Opt-out	-5.94***	-5.89***	-4.82***	-6.07***	-6.76***	-9.77***
Purpose	-2.08***	1.56***	1.83***	1.87***	1.95***	-1.70**
Threshold	2.52***	2.16***	2.07***	2.60***	2.49***	3.03***
Payment	0.35***	0.028***	0.026***	0.037***	0.033***	0.029***
Purpose*ORGA	-1.58***					-3.49
Purpose*BIODIV		1.53*				-1.00**
Purpose*TRUST			0.13***			-0.66**
Purpose*SIGN				1.08**		
Purpose*RESP					0.03**	1.67**
Nb. of observations	984	960	972	972	972	960
Nb. of individuals	82	80	81	81	81	80
Log likelihood	-222.47	-215.70	-216.68	-215.88	-215.02	-206.47
Chi2	195.84	197.50	203.45	204.81	206.60	209.50

Table 4: mixed logit estimation of choice experiment data. Opt-out, Purpose, threshold and interaction terms are considered normally distributed and payment is log-normally distributed.

The only variable which has a significant interaction parameter with the “purpose” attribute is the variable ORGA (the fact to be an organic farmer) and the significance level holds in the model with multiple interactions (model 6). Farmers who declare to be organic farmers display an even larger preference for conservation contracts than the overall sample. The other variables indicating environmental attitude (BIODIV), environmental responsibility (RESP) or the extent to which farmers trust the developer (TRUST) are not significant. One explanation is that these opinion variables are insufficiently discriminatory. Besides, farmers who are enrolled in a compensation contract (SIGN) do not have significant different preferences with regard to the purpose of the contracts (compensation versus conservation). So, in spite of their over-representation in our sample, they do not influence our results.

However,among the 24 organic farmers of our sample, only 3 have signed a compensation contract. They are three times less numerous to sign such contracts compared to our overall sample. This is coherent with their preference. The questionnaire also included a question, which was asked before the choice experiment, on the respondents’ general opinion on offset programs through agriculture. The answers confirm that organic farmers are more numerous proportionally (74% against 27%) to declare that they have a negative opinion of compensation contracts.

We have confidence that being an organic farmer is a reliable indicator of the farmer's susceptibility to environmental issues. The result tends to confirm that the attitude towards the environment may be the main variable explaining preference for conservation contracts, or, alternatively, aversion for compensation contracts.

4. Discussion-Conclusion

This study is the first choice experiment seeking to measure farmers' relative preferences for the ultimate aim of an agri-environmental contract with equal technical prescriptions. Although the sample size remains limited, the results are noteworthy in several respects, both for operational recommendations on the implementation of offset contract, and for further research on the value of farmers' free contribution to the environment.

On the operational side, this study confirms that all in all offset contracts are an acceptable form of contracts by farmers and could be used as a tool for the implementation of biodiversity offsets. However, developers must be prepared to pay farmers more in ABOS than the level of payment used in equivalent AES, if all other aspects of the contract are equal. This "compensation bonus" will need to be particularly high in areas where farmers are aware and susceptible to environmental issues. Since results confirm that the way contracts are framed has an influence on farmers' participation and willingness to accept, developers may be well advised to mask – or at least not insist on - the fact that contracts are used for the compulsory compensation of biodiversity losses created by infrastructure development. We have confirmed also that farmers are averse to conditional contracting programs which are triggered only if a minimum participation threshold is attained. However, it might well be the only option for developers who need to have a guarantee on the effective delivery of the required offset area and who cannot take the risk to pay contracts without meeting their legal obligations. This has a price since farmers are averse to such conditionality.

Finally, the preference for conservation contracts limits the risk of competition of BO programs with traditional conservation policies, which could jeopardize the additionality of biodiversity offsets. The risk remains however, especially if the developer's willingness to pay is high. This is the case when the land purchase option is much more costly than the contract option.

Our choice experiment also brings new light to the issue of farmers' voluntary contribution to environmental public goods. As stated before, our CE results point towards farmers' preference for conservation contracts, or aversion for compensation contracts. It is in fact difficult to disentangle between the two. If it is interpreted as a dislike for the overall concept of biodiversity offsets (stronger for environmentally aware farmers), signing an offset contract results in a stronger disutility, a kind of outrage, which must be compensated by a higher payment.

The alternative interpretation is to consider that participating to a conservation contract is perceived as a contribution to a public good. For participating farmers, there is an altruistic utility gain from the provision of public good and possibly an impure altruistic utility gain from the warm-glow feeling of "doing good". Their WTA is therefore inferior to the true monetary costs of complying with the contract. Considering that biodiversity offsets do not contribute to an overall improvement of the environment, these benefits are not perceived with compensation contracts, in a sort of eviction of environmental attitude. Participating to a compensation contract is therefore considered as a standard transaction of service between the private developer and the farmer. Farmers therefore require a payment that at least covers their full compliance costs. Following this interpretation, the WTA difference between compensation and conservation contracts would be a monetary estimation of the “free” contribution to the biodiversity conservation that farmers are ready to make when they participate in a biodiversity conservation AES. In our case study, it amounts to nearly 20% of the average payment for such contracts which is relatively high. For organic farmers, it goes up to more than 60 €/ha/year, thus amounting to 28% of average payment. It suggests that conservation contracts could be offered to organic farmers for a payment which is one third lower than presently.

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Appendix 1: example of a choice card

	Contract 1	**Contract 2**	
Characteristic 1 Purpose	Conservation 	Compensation 	
Characteristic 2 Minimum threshold of farmer participation	Minimum threshold 	No minimum threshold 	**Neither of the 2 contracts**
Characteristic 3 Payment	260€/ha/year	200€/ha/year	

Check your preferred option ☐ ☐ ☐

Appendix 2: Descriptive statistics of the survey sample (Reference: General Agriculture Census Agreste 2010 for the Gard department)

Variable	Modality	Freq.	% of the 82 respondents	Reference (%)	Variable	Modality	Freq.	% of the 82 respondents	Reference (%)
Gender	Male	65	79.3	73.8	**Main farm activity**	Field crops	12	15.2	4.5
	Female	17	20.7	26.2		Horticulture	7	8.9	10.9
Age	Less than 40	14	17.1	16.9		Vine growing	34	43.0	53.8
	From 40 to 49	19	23.2	25.0		Orchard	4	5.1	13.2
	From 50 to 59	27	32.9	30.6		Livestock	15	19.0	6.6
	60 or more	22	26.8	27.6		Other	7	8.9	11.0
Farm size	Less than 20 ha	24	29.3	67.5	**Education**	Primary	11	13.4	21.5
	From 20 to 50 ha	28	34.1	21.6		Secondary short	14	17.1	33.9
	From 50 to 100 ha	12	14.6	7.0		Secondary long	26	31.7	21.2
	From 100 to 200 ha	12	14.6	2.6		Superior	31	37.8	23.3
	200 ha or more	6	7	0.6					
Importance of farming activity	Principal	69	85.2		**Organic agriculture**	Yes	24	29.3	12
	Secondary	11	13.6			No	58	71.0	88
	Retired	1	1.2						