Do farmers prefer increasing, decreasing, or stable payments in Agri-Environmental Schemes?

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Abstract

Nearly all Agri-Environmental Schemes (AES) offer farmers stable annual payments over the duration of the contract. Yet AES are often intended to be a transition tool, thus decreasing payment sequences would appear particularly attractive for farmers. The standard discounted utility model supports this notion by predicting that individuals will prefer a decreasing sequence of payments if the total sum of outcomes is constant. Nevertheless, the literature shows that numerous mechanisms, such as increasing productivity, anticipatory pleasure and loss aversion can incline farmers to favor an increasing sequence of payments. To understand what drives farmers' preferences for different payment sequences, we propose a review of the mechanisms highlighted by the literature in psychology and economics. We then analyze farmers' preferences for stable, increasing or decreasing payments through a choice experiment (CE) survey of 123 French farmers, about 15% of those contacted. Overall, farmers do not present a clear willingness to depart from the usual stable payments. Moreover, we find a significant aversion to decreasing payments in farmers with a lower discount rate and in those more willing to take risks than the median farmer, contradicting the discounted utility model.

Keywords: Sequences of outcomes; Agri-Environmental Schemes; Discounted utility; Farming practices; Cover crops; Choice experiment

JEL: Q25; Q53; Q57;Q58.

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1 Introduction

In recent decades, the intensification of agriculture and its heavy reliance on chemical inputs have caused serious environmental and public health issues. One popular policy approach to reducing the adverse impacts of agricultural activities is to subsidize farmers for voluntarily adopting environmentally-friendly practices. These incentive-based policies, introduced as part of the European Union (EU)'s Common Agricultural Policy (CAP) in 1992, are called "agri-environmental schemes" (AES). The environmental effect of AES is often hampered by farmers' reluctance to participate (Hanley et al., 1999; Yang et al., 2005; Cullen et al., 2018).

The crucial need for an efficient tool allowing for a transition towards sustainable agri-environmental practices has led numerous researchers to tackle the question of how to improve the design of AES. Christensen et al. (2011) show that farmers value flexible contract terms higher than a reduced administrative burden, Giovanopoulou et al. (2011) study the role of information on environmental issues, Broch and Vedel (2012) scrutinize the role of cancellation and monitoring measures, Kuhfuss et al. (2016) examine the impact of introducing a conditional collective bonus, Vaissière et al. (2018) investigate the role of agglomeration bonuses in biodiversity offset contracts, and Chèze et al. (2020) study the role of health impacts and administrative burden (see Villanueva et al. 2017 and Latacz-Lohmann and Breustedt 2019 for reviews).

Surprisingly, we did not find articles in the literature which study the impact of the sequence of payments on AES adoption. CAP AES provide invariably stable payments over a five-year period: the farmer receives a constant flow of payments that continues as long as he complies with the contract. Stable payment sequences might be aligned with the preferences of the public administration in charge of the payment. Indeed, mobilizing a larger part of the funds early in the case of decreasing payment sequences might be complicated from a treasury point of view. Yet AES are often intended to be a transition tool, designed to trigger a change of practices and not to support new practices indefinitely. From this perspective, a decreasing sequence of payments appears particularly appropriate. The purpose of this paper is to analyze farmers' preferences for alternative payment sequences and their impact on participation rates.[1]

The standard discounted utility (DU) model predicts that individuals will prefer a decreasing sequence of payments if the total sum of outcomes is constant, which may reinforce the attractiveness of decreasing sequence of payments in AES (Samuelson, 1937). Yet, the literature in psychology and in economics indicates that increasing sequences of outcomes (ISO) are often preferred to decreasing sequences of outcomes (DSO) (Loewenstein and Sicherman, 1991; Frank and Hutchens, 1993; Ross and Simonson, 1991). Examples of factors that explain preference for ISO include increasing productivity, the motivation provided by future higher gains, and loss aversion (Tversky and Kahneman, 1992; Loewenstein and Sicherman, 1991; Read and Powell, 2002). Meanwhile, farmers may be attached to the simplicity of the stable payments because this is what they are used to and because a stable cash flow is easier to plan around and manage (Loewenstein and Sicherman, 1991; Read and Powell, 2002). Understanding farmers' preferences for various payment sequences thus requires careful investigation.

The first contribution of this article is to provide a review of the literature in psychology and economics on mechanisms that influence the preferences for an increasing, decreasing and stable sequence of payments. The mechanisms identified do not impel us to formulate specific hypotheses but stand as potential explanations for our empirical results. The second contribution of this article is to propose an empirical test through a choice experiment (CE) survey. In this survey farmers are offered hypothetical contracts that reward the adoption of agri-environmental practices through annual payments over a period of five years. The payment sequences offered are alternatively stable, increasing, or decreasing. These hypothetical contracts reward the implementation of efficient cover crops. Cover crops are grown between two main crops, usually in the fall, to prevent nitrate leaching, because bare soil on watersheds are exposed to water runoff and infiltration. The mechanisms highlighted throughout this study are intended to have a general scope, and cover cropping has desirable properties for studying payment sequences since the annual costs are quite stable, except for the initial investment in

[1] Indirectly related to our research question are the articles of Espinosa-Goded et al. (2010) who study the impact of an upfront premium for the adoption of a new AES, and Kaczan et al. (2013) who test the role of an in-kind upfront payment in a payment for environmental services contract. A study more related to ours is the conference presentation of Carvin and Saïd (2019). Nevertheless, it is still a work in progress and they study only decreasing payment sequences driven by the cost structure of the specific AES they study.

machinery in rare cases, which we control for. Thus, in our experiment, preferences for non-stable payment sequences should not be driven by the cost structure or be practice-specific. To inform the design of our CE, we benefited from multiple exchanges with local stakeholders and farmers. This allowed us to draft realistic contracts, intended to apply to the real-life conditions in the field in our survey area. Consequently, we believe we reduced the hypothetical bias, well-known in choice experiment surveys. Ultimately, 123 French farmers, i.e., 15% of the farmers contacted, answered our survey.

We find that farmers do not present a clear willingness to depart from the usual stable payments. Nevertheless, 17% of farmers state that they prefer increasing payment sequences. Furthermore, there is a significant rejection of decreasing payments from some farmers, contradicting the discounted utility model. These farmers have lower discount rates and are more willing to take risks than the median farmer, which means that implementing decreasing AES payments would require higher average annual compensation than stable payments to gain the participation of these farmers.

The paper is organized as follows: Section 2 proposes a literature review on mechanisms affecting payment sequence preferences. The context of the survey is described in Section 3. Section 4 presents the choice modelling approach and the design of the CE. Section 5 describes the survey and the data. Section 6 reports the results. A discussion of the results is provided in Section 7 and Section 8 concludes.

2 Mechanisms affecting preferences for sequences of outcomes

Samuelson (1937)'s discounted utility (DU) model predicts that a DSO will be preferred to an ISO if the total sum of outcomes is the same. In the 90s, this model was challenged with the identification of several anomalies (see Frederick et al. 2002 and Loewenstein and Prelec 1991 for reviews). Empirical evidence both in psychology and in economics indicates that ISO are often preferred to DSO (Loewenstein and Sicherman, 1991; Frank and Hutchens, 1993; Ross and Simonson, 1991). Yet increasing sequences are less frequently chosen when a constant alternative is offered alongside the increasing or decreasing sequence (Read and Powell, 2002; Frederick and Loewenstein, 2008). The determinants of an individual's preferences for sequences of outcomes are numerous and the literature reflects the difficulty in designing surveys to test for several competing theories (Read and Powell, 2002). We choose to discuss only the motives related to our study on farmer' preferences for sequences of agri-environmental payments. Table 1 provides an organized summary of relevant motives. The summary is a modified and enriched version of Read and Powell (Exhibit 3, p440, 2002), who propose a classification based on economic theory. We use the same classification, augment it, and adapt the arguments to the case of AES. Mechanisms identified fall into one of the five defined motive classes: optimization, constrained optimization, ideal distribution, ideal consumption, and perception bias.

Optimization relates to unconstrained choices. Farmers tend to behave according to the DU model (Samuelson, 1937). The more farmers discount the future, i.e. the more impatient they are, the more they are expected to prefer decreasing sequences of payments. Discounting leads them to prefer to get paid sooner, but they also take into account the usual economic variables, such as inflation, which increases input costs over time. Increased mastery also justifies higher payments if the AES is outcome-based and the farmer becomes able to provide higher levels of environmental services over time (Loewenstein and Sicherman, 1991). Discounting leads the farmers to favor DSO while inflation and mastery incline them to prefer ISO. Uncertainty might also be an impact factor, as it is inherent to any payment delayed in time (Frederick and Loewenstein, 2008). In the specific context of AES under the CAP, uncertainty is strengthened by (i) a history of payment problems under the CAP, and (ii) the fact that when a farmer participates in an AES that spans over several CAP programs, public authorities can propose that the farmer end the contract before the end of the five-year period.[2,3] Hence, uncertainty can lead risk adverse farmers to prefer DSO.

Optimization might be constrained by motivational or cognitive limitations. **Constrained optimization** relates to the lack of self-control that leads individuals to prior commitment.[4]

[2] About delayed payments, see for instance Committee of Public Accounts (2017) or Girard (2019).

[3] CAP programs that, among other measures offer a series of specific AES, span over 6-7 years. AES can be subscribed beyond the second year of the program and thus span over several CAP programs.

[4] In the case of constrained optimization, individuals make second best choices.

First, the willingness “to tie one’s own hands” can lead one to reject DSO (Loewenstein and Prelec, 1991; Ross and Simonson, 1991). Second, the difficulty of managing the budget with a non-stable sequence of payments can incline one to prefer stable sequence of outcomes (SSO) (Loewenstein and Prelec, 1991; Read and Powell, 2002). During the consultation groups and farmer interviews held for this study, those farmers who favored stable payments praised them for their convenience, stating that a stable cash flow is easier to plan around and manage.

Ideal distribution describes a set of motives where utility comes from the distribution of payments, independent of the use of money. Individuals might see an increase in income over time as a sign of accomplishment and of improved social status (Loewenstein and Prelec, 1991; Read and Powell, 2002). Moreover, a farmer might see increasing payments as a reward for maintaining a new agricultural practice longer in time (Loewenstein and Prelec, 1991; Read and Powell, 2002). Nevertheless, individuals tend to favor sequences of outcomes that match their expectations (Chapman, 2000). Since nearly all AES over the past 20 years have offered stable payments, a farmer will expect and may likely prefer stable payment sequences.

Ideal consumption reasons justify preferences for payment sequences to the extent that these sequences match the farmer’s preferred pattern of consumption. Individuals choose a sequence according to its ability to deliver the right amount of money at the time it is needed (Loewenstein and Prelec, 1991; Read and Powell, 2002). Spending needs can of course be entirely independent of the practices implemented. Thus, any payment sequence can potentially be favored. Individuals also seek to delay pleasure (anticipatory pleasure of seeing one’s situation improving) and prefer to experience discomfort earlier rather than later. Finally, people care not only for absolute levels of outcome but also for relative levels (Loewenstein and Prelec, 1991; Read and Powell, 2002). Since the literature shows that farmers are loss averse (see Bocquého et al., 2014; Bougherara et al., 2017, for samples of French farmers), this could incline them to prefer ISO.

Finally, **perception bias** might also play a role in payment sequence preferences. Agents take their decisions by looking at a sequence of outcomes. The final outcome is likely to be the most salient to the decision maker: “If decision makers naturally adopt a retrospective perspective when evaluating outcome streams, then recency effects will cause late periods to be overweighted relative to those that occur in the middle of the sequence" (Loewenstein and Prelec, 1993, , p.93). In that case, ISO would be the preferred payment sequence. Alternatively, a primacy effect (a cognitive anchor on the first outcome of a sequence) would lead to overweighting of the initial outcomes of a sequence and thus, to a preference for DSO. Lastly, a contrast effect can occur if, at each point in time, the last outcome is compared to the previous one, leading to a preference for ISO (Ross and Simonson, 1991).

In addition to the factors presented in Table 1, Read and Powell (2002) and Frederick and Loewenstein (2008) show the importance of the alternatives presented to subjects. When only increasing and decreasing options are presented, subjects tend to choose the increasing sequence. But when a third option is offered, i.e., the stable sequence, it is chosen more often, while increasing sequences are no longer prevalent in subjects' choices.[5]

The mechanisms presented above do not lead us to formulate specific hypotheses. They merely stand as potential explanations in helping us to understand our empirical results. The agri-environmental schemes that is considered in our study leads us to expect certain mechanisms to be more at play than others. We consider a voluntary AES based on farming practices and cost compensation rather than environmental outcome-based payments offered to French farmers. In the optimization category, inflation (which is low in France) and mastery will not be much at play so that net-present value and uncertainty should lead farmers to prefer DSO. In addition, farmers who discount more and who are more risk adverse should prefer DSO more than their counterparts do. In the constrained optimization category, convenience is likely to play an important role since farmers usually struggle with the administrative costs associated with subsidies, leading to a preference for SSO. It is difficult to guess the magnitude of the self-control motive of farmers as compared to the general population. In relation to ideal consumption, constrained optimization and perception bias, we have no information on how our sample compares with the samples studied in the literature. It is difficult to predict farmers' preferences for DSO, SSO or ISO but we attempt to interpret the results with the help of the mechanisms presented in this section. Moreover, two preference parameters are elicited and

[5]Other determinants of preferences for sequence of outcomes (but less closely related to AES) include: the domain - wages versus income rentals - (Loewenstein and Sicherman, 1991), how money is obtained - wages versus lottery gains - (Loewenstein and Sicherman, 1991; Duffy et al., 2015), and the time interval between outcomes (Loewenstein and Prelec, 1991, 1993).

tested directly: individual discount rates and individual risk attitudes.

Table 1: Motives explaining preferences for increasing sequences of outcomes (ISO), decreasing sequences of outcomes (DSO), and stable sequences of outcomes (SSO)

Motive	**Mechanism**	**Reference**	**Preference**
Optimization			
Net-present value	Discounting	Samuelson (1937)	DSO
Inflation	Compensation for increase in input costs	Loewenstein and Sicherman (1991)	ISO
Mastery	Increasing productivity	Loewenstein and Sicherman (1991)	ISO
Uncertainty	About delayed payments	Frederick and Loewenstein (2008)	DSO
Constrained optimization			
Self-control	"Tying one's hands" to avoid spending (prior commitment)	Loewenstein and Sicherman (1991) Ross and Simonson (1991)	reject DSO
Convenience	Ease of managing budget given the proposed sequence	Loewenstein and Sicherman (1991) Read and Powell (2002)	SSO
Ideal distribution			
Signaling	Income increase is a sign of accomplishment	Loewenstein and Sicherman (1991) Read and Powell (2002)	ISO
Motivation	Incentive to work harder, something to look forward to	Loewenstein and Sicherman (1991) Read and Powell (2002)	ISO
Expectations	Sequence is evaluated with respect to expected sequence of outcome	Chapman (2000)	SSO

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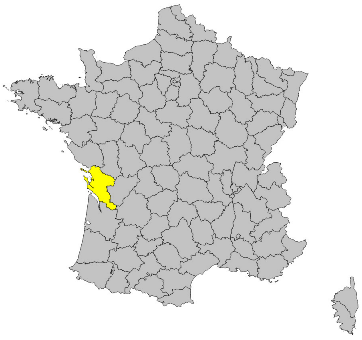
Motive	**Mechanism**	**Reference**	**Preference**
Ideal consumption			
Appropriateness/ Spending needs	Immediate or future needs	Loewenstein and Sicherman (1991) Read and Powell (2002)	DSO or ISO
Savoring/Dread	Anticipatory pleasure/discomfort	Loewenstein and Sicherman (1991) Read and Powell (2002)	ISO
Loss aversion	Losses loom larger than gains. The sequence is viewed as a series of relative gains or relative losses	Tversky and Kahneman (1992)	ISO
Perception bias			
Recency effect	Later periods are overweighted relative to earlier periods	Ross and Simonson (1991)	ISO
Primacy effect	Earlier periods are overweighted relative to late periods	Loewenstein and Prelec (1993)	DSO
Contrast effect	At each point in time, the last outcome is compared to the previous outcome	Ross and Simonson (1991)	ISO

3 Survey context

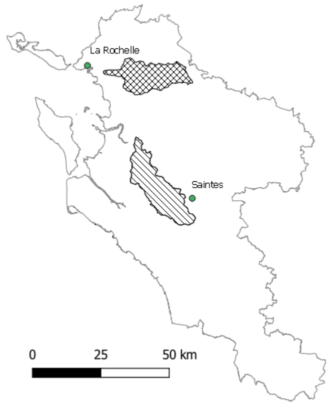
Excess nitrogen being an environmental and public health issue, public authorities providing water services have implemented measures to limit water pollution on their watersheds.[6]

[6]The most striking issue is eutrophication, suffocating aquatic environments and producing toxins. Drinking water that contains elevated levels of nitrate are also suspected to cause serious health problems, in particular

Figure 1: Survey area



(a) Charente-Maritime within France



(b) The two watersheds within Charente-Maritime, La Rochelle (crosshatched), Arnoult (hatched)

Since 1991, the European Commission (EC) Nitrates Directive requires areas of land draining into waters and contributing to nitrate pollution to be designated as Nitrate Vulnerable Zones (NVZ). Farmers with land in NVZ have to comply with mandatory requirements regarding their farming practices. In 2009, the French Grenelle Environment Forum went further by designating Reinforced Action Zones (RAZ) within NVZ, where the maximum nitrate concentration is exceeded, and where additional requirements must be met.[7]

In the French county or "département" of Charente-Maritime, agricultural land covers nearly two-thirds of the surface area and is mostly dedicated to field crops (Agreste, 2019). The widespread use of fertilizers has contributed to the nitrate contamination of ground and surface waters through nitrate leaching, so that the whole region has been classified as an NVZ and part of it as an RAZ. We teamed up with two local Charente Maritime authorities in order to design and test in the field innovative incentives to improve adoption of water-friendly farming practices in two watersheds almost entirely in an RAZ: the watersheds of La Rochelle and Arnoult (see Figure 1).[8]

Consultation meetings were held with rural and agricultural stakeholders (including agricultural cooperatives, professional agricultural associations, municipal representatives and farmers), and a common interest was found in contracts encouraging the implementation of

among infants and pregnant women (WHO, 2017).

[7]In France, the concentration of nitrate in drinking water must not exceed 50 mg NO3/L.

[8]The two local partners are the municipality of La Rochelle and Eau 17.

efficient nitrogen-fixing cover crops. A cover crop is a crop grown to prevent the soil from remaining bare between two main crop cycles, usually in the fall. In the absence of a cover crop, bare soil on the watersheds is exposed to water runoff and infiltration, leading to nitrate leaching. Cover crops fix the excess nitrogen that is still on the ground, and prevent it from migrating to the groundwater or streams, making the stored nitrogen available to future crops and thus reducing the need for additional fertilization (Dabney et al., 2001).

Sowing cover crops is mandatory in NVZs; however, regulatory requirements are not stringent enough to ensure the effectiveness of planted cover crops in preventing nitrate leaching. To maintain a voluntary approach in these zones and encourage farmers to go beyond regulations, we were called upon to design local agri-environmental contracts whose requirements would exceed regulatory ones. The choice experiment presented in this paper is intended to study the design of these new AES.

4 Choice Experiment (CE)

4.1 The method

A CE is a stated-preference method used to assess individual preferences in hypothetical situations (Louviere et al., 2002). The CE approach is widely used to study farmers' preferences regarding agri-environmental contract attributes (e.g., Ruto and Garrod 2009; Espinosa-Goded et al. 2010; Christensen et al. 2011; Broch and Vedel 2012; Kuhfuss et al. 2016; Vaissière et al. 2018, and Villanueva et al. 2017 and Latacz-Lohmann and Breustedt 2019 for reviews). In such choice experiments, farmers are asked to choose their preferred contract among generally two different hypothetical contracts. If none of the contracts suits them, they can keep their current situation by choosing the status quo option. These three alternatives constitute a choice card, and different choice cards are successively presented to farmers. Thus, a CE is used to investigate farmers' ex ante preferences for some attributes of a contract.

4.2 Attributes and levels

Important attributes were identified in consultation with rural and agricultural stakeholders. Moreover, two focus groups were conducted with farmers to determine the final attributes and their levels, as well as the vocabulary and language to be used in the survey. The main objective sought with the new contract was to encourage the planting of cover crops efficient at reducing nitrate leakages. Indeed, the Nitrates Directive makes it compulsory to maintain a land cover in the fall in both zones. The cover must be maintained for a minimum of 2.5 months in NVZs and a minimum of 3 months in RAZs. However, there are no requirements on the type of crop or sowing technique to use. Moreover, since 2015, there have been no more AES to pay farmers for the planting of cover crops in France. As explained, our objective was to design new contracts better suited to these territories that would exceed regulations and impose the necessary technical conditions to ensure that the cover fully plays the role of mitigating nitrate leaching.

In our survey, some characteristics are common to all of the proposed contracts: all contracts last 5 years, which is the standard duration of an AES; the commitment is for a number of hectares and not for specific plots, to allow for crop rotations, and the cover must be composed of a mixture of at least two crops, including at least one legume crop. The contracts vary according to four attributes: two technical attributes (the sowing technique and the duration of the cover), the monetary attribute (required to measure welfare changes), and our attribute of interest here, the sequence of payments.

- The sowing technique of the cover crop can be imposed by the contract terms or freely chosen by the farmer (2 levels). When it is imposed, broadcast seeding is prohibited unless the seed is then rolled or sown in the previous crop.[9]

- The duration of the cover can be 3 months, 3.5 months or 4 months (3 levels)[10].

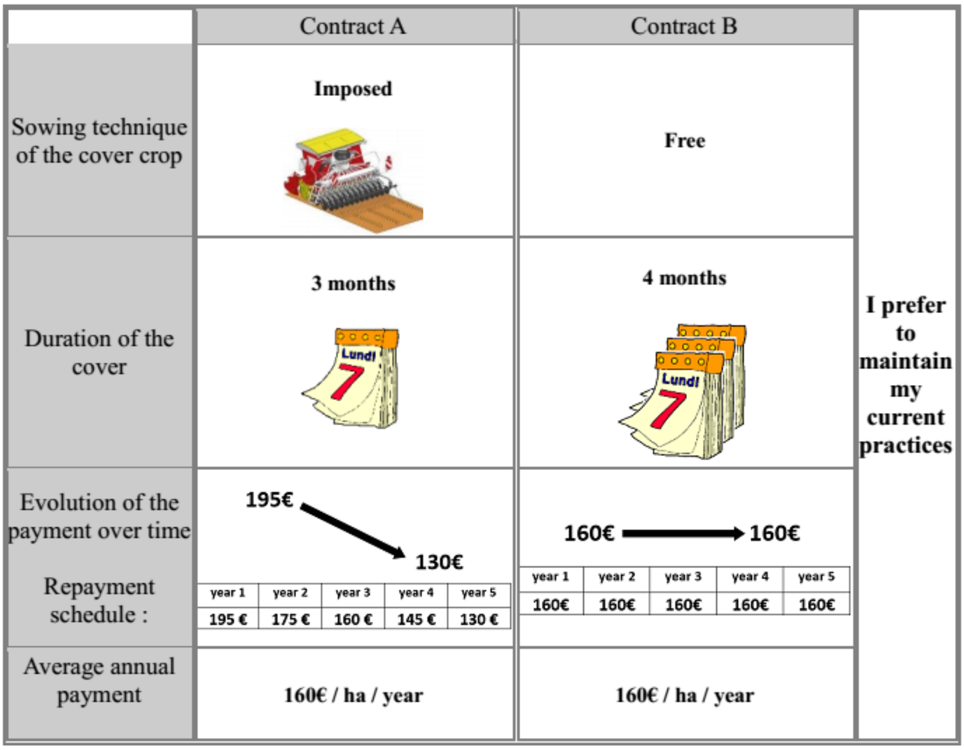
[9] Broadcast seeding (seeds are scattered in the field) does not ensure an optimal dispersion of seeds in the parcel, as is the case with drilling (which requires specific equipment). Broadcast seeding when the seed is sown in with the previous crop is permitted to allow farmers to seed early in the season, which increases the chances to benefit from dense cover when the rainy season comes.

[10] The choice was made to work on the cover duration rather than on sowing and destruction dates, in order to give farmers the possibility to adapt to climatic constraints.

- The average annual payment per hectare varies from €40 to €300 (6 levels: €40, €90, €130, €160, €220 and €300).[11]

- The evolution of the payment over time, i.e., the payment sequence, can be stable (same amount every year), increasing (+10% per year) or decreasing (-10% per year) (3 levels). This information is supplemented by a table that lists the amounts for each of the 5 years of the contract (see Figure 2 which gives an example of a choice card).[12] The choice of a +10/-10% annual change was based on informal discussions about the potential flexibility of public funders, and on information collected in focus groups with farmers regarding their ideal distributions, and were defined with symmetric increase and decrease rates to facilitate interpretation of results.[13]

Figure 2: Example of a choice card



[11]These amounts were calibrated on the basis of information collected in focus groups with farmers about additional costs implied by the lengthening of the cover duration and the use of specific sowing techniques, and analyses of previous measures (the "Indemnité Compensatoire pour la Couverture des Sols" 2000-2006 and the "Engagements Unitaires" for CAP programming 2000-2006 and 2007-2014).

[12]Amounts are rounded up to the nearest 5 or 10 to make the payment sequence more clear and interpretable.

[13]The literature in psychology (Hsee et al., 1991) shows that choices are not only impacted by the payment sequence (increasing or decreasing) but also by the slope, called the "velocity" in the psychology literature. We choose our design to neutralize the effect of the slope.

4.3 Experimental design

The full factorial design of the CE, namely the number of unique choices cards that can be constructed from the selected number of attributes and levels, includes 11,556 choices cards. To generate an efficient factorial design, we used Ngene and initial estimation parameters from our pilot survey on 20 farmers. Our efficient factorial design, found by minimizing the D-error, is composed of two blocks of six choice cards. It minimizes the required sample size and the number of choice cards.

4.4 Model specification

The CE approach is in line with Lancaster's theory of consumer choice (**?**) and the econometric modelling is based on the behavioral framework of random utility theory (**?**). The indirect utility a farmer n obtains from choosing an alternative i in choice card t, U_{nit}, is made of both an observed component V_{nit}, the deterministic part of the utility, and a random (unobserved) component ϵ_{nit}, a stochastic error term, such that $U_{nit} = V_{nit} + \epsilon_{nit}$. Farmer n chooses alternative i over all other alternatives j on choice card t if and only if $U_{nit} > U_{njt}$, $\forall j \neq i$. The probability that farmer n chooses alternative i can therefore be expressed as:

$$P_{nit} = Prob(V_{nit} + \varepsilon_{nit} > V_{njt} + \varepsilon_{njt}) \; \forall j \neq i. \tag{1}$$

The utility that farmer n obtains from alternative i on choice card t can be written as:

$$U_{nit} = \beta \mathbf{X}_{nit} + \epsilon_{nit}, \tag{2}$$

where $\mathbf{X}_{ni}$ refers to the vector of the attribute levels and β represents their associated marginal utility. For instance, the vector $\mathbf{X}_{ni}$ can include an alternative-specific constant (ASC). We define an ASC dummy variable, which takes the value one in the *status quo* alternative, and zero otherwise. A statistically significant positive coefficient associated with the ASC dummy variable indicates a preference for the *status quo* alternative.

The conditional logit (CL) model is widely used to estimate parameters from choice experiments surveys. In this model, the error term ϵ_{nit} is assumed to follow an extreme value type 1 distribution (Gumbell-distribution) and observed choices are analyzed to estimate the β coefficients. However, the CL model assumes the independence of irrelevant alternatives (IIA) and the homogeneity of all the attribute coefficients across the respondents. The IIA hypothesis is a strong assumption which can be tested by the Hausman test (Hausman and McFadden, 1984). To relaxe this assumption and allow for preference heterogeneity across farmers, we also use the mixed logit (ML) model, which allows us to estimate an individual-specific β-coefficient. In the ML, U_{nit} can be rewritten as:

$$U_{nit} = \beta_n \mathbf{X}_{nit} + \epsilon_{nit}. \tag{3}$$

The average marginal willingness to pay (WTP) for each attribute can be obtained by the marginal rate of substitution between the coefficient (individual specific or not) of a given attribute x and the monetary attribute. Since our monetary attribute is not a cost but a payment attribute, we get willingness to accept (WTA). Thus in our study, WTA for attribute x is given by:

$$WTA_x = \frac{-\beta_x}{\beta_{payment}}, \tag{4}$$

where β_x and $\beta_{payment}$ are the parameters associated with attribute x and the monetary attribute. WTA_x is the average annual payment per ha required by the farmer to accept the change implied by an increase of attribute x by one unit.

5 Survey and data

5.1 Structure and questionnaire

The questionnaire is composed of four parts: (i) general questions about the farmer (gender, age, etc.) and the farm (location, utilized agricultural area, cover crops, etc.); (ii) a presentation of the choice experiment and the six choice cards (that are presented in random order to farmers); (iii) follow-up questions to interpret and check the quality of our CE answers; (iv) risk and time preference questions. Most survey questions are straightforward, but risk and time preferences are elicited using two hypothetical questions that deserve a closer look. We choose relatively simple assessments of risk and time preferences due to time and cognitive constraints in the survey. The choice cards are indeed demanding of a farmer's attention.

For risk preferences, we aim to elicit a global assessment of farmers' willingness to take risks, as in Dohmen et al. (2011). We ask: "Do you consider yourself as a person that is generally willing to take risks, or as someone who avoids risk as much as possible?" and use a Likert scale from 1 (not at all willing) to 10 (willing). This elicitation method has proven to be a low-cost, easy-to-implement way of eliciting risk preferences as compared to a series of lottery choices (Dohmen et al., 2011).

We also seek to estimate time preferences using a low-cost, easy-to-implement method. In a recent review, Cohen et al. (2020) show that the multiple price list is the most widely used paradigm for eliciting time preferences. For example, subjects are asked several times to choose between two options: receiving a sum of money at an early period or receiving another larger sum of money at a later period. The binary choices are presented on separate lines and ordered so that the line at which a subject switches from one option to the other (switching point) reveals the individual discount rate. The literature has challenged this elicitation method but there is no consensus yet (Cohen et al., 2020, Section 4). Another issue to consider is the use of monetary incentives. Cohen et al. (2020, Figure 1) find that only 30% of the literature uses real money incentives. They show that, in the existing literature, there is little evidence of systematic differences in switching points between incentivized and non-incentivized experiments (Cohen et al., 2020, Section 4.3). Given these results, we choose to use a non-incentivized multiple price list. Specifically, we use the protocol of Harrison et al. (2002) which assumes linear utility function and risk neutrality but is simple to use. Although the absence of monetary incentives and the aforementioned assumptions could bias elicited discount rates (Andersen et al., 2008; Andreoni and Sprenger, 2012), we believe this protocol is still informative for our study since we do not aim at eliciting absolute discount rates but rather at classifying farmers (relative discount rates). As shown in Table 2, a multiple price list is used. The last column is not shown to the subjects. The basic question is: "Would you prefer 1000 € after one year or $1000 + x$ € after two years?" With the assumption of linear utility, x allows the elicitation of bounds on the discount rate. The line at which the farmer switches from choice A to choice B indicates the lower bound of his discount rate and the next line, the upper bound, as shown in Table 2. We do not impose monotonic switching. When coding a farmer's discount rate, we consider the first switching point.

Table 2: Multiple price list for discount rate elicitation (last column not shown to subjects)

Row	Option A after one year	Option B after two years	Choice *if the farmer chooses B*	*Discount rate*
1	1000 €	1010 €	A or B	$0.01 < \rho <= 0.05$
2	1000 €	1050 €	A or B	$0.05 < \rho <= 0.10$
3	1000 €	1100 €	A or B	$0.10 < \rho <= 0.20$
4	1000 €	1200 €	A or B	$0.20 < \rho <= 0.40$
5	1000 €	1400 €	A or B	$0.40 < \rho$

If the farmer always chooses A, $\rho <= 0.01$.

5.2 Respondent profiles

We collected responses from 123 farmers, i.e., around 15% of the farmers who received the questionnaire sent via email by our field partners. Farmers who specified their geographical location break down as follows: 60 (51% of the sample) are located on the watershed of La Rochelle and 40 (32% of the sample) on the Arnoult watershed. Eleven farmers always chose the status quo and always explained that it was because they refused to be constrained on their practices whatever the monetary compensation. As is standard, we considered these responses as protest answers and removed these farmers from the sample. We end up with a sample of 112 farmers.[14] We provide summary statistics in Tables 3 and 4.

The majority of respondents are males (94%) from 35 to 54 years old (around 70%) and have mainly high school and Bachelor's degrees (around 72%). The average farm size is around 156 ha and uses a high share of area for growing cereals (average of 126 ha). The main productions are cereal crops (around 54% of the sample) and mixed farming (around 38%). 40% of farmers are or have been engaged in an AES and 13% are engaged in organic production. Around 41% of the farmers declare not to be aware that they have lands in an

[14] Pilot surveys are included in this main sample as the questionnaire was almost identical in the pilot and online surveys.

RAZ. We do not possess detailed statistics on farmers in the survey area but the farmers in our sample are younger and more educated and employ more environmentally-friendly practices than the average farmer, based on statistics from the 2010 French agricultural census. This is consistent with the fact that we proposed an online survey (Fan and Yan, 2010) on agri-environmental practices and the fact that organic production in France has more than doubled during the last decade.

We now examine the specific risk and time preference parameters. On average farmers seem willing to take risks, with 51% reporting a risk tolerance above 5. This result is similar to the results of Dohmen et al. (2011, Figure 1) who find a mode at level 5 for the risk attitudes of a sample of the German population. We find more risk-seeking individuals in our sample, however. As for farmers, Iyer et al. (2019, Table 3) review studies that use multi-item scales to elicit the risk preferences of farmers. In their review, the articles that use a 10-item scale and report the sample mean find a sample mean similar to ours. In the time preference task, 53% of farmers switch at row five or never, which indicates a high discount rate ($\rho > 0.40$). This result can be compared to the results of Harrison et al. (2002) who find more patient subjects with an average of 0.29 discount rate, using a sample of the Danish population, a one-year time horizon and monetary incentives. As for empirical measures of discount rates of farmers in developed countries, three studies using monetary incentives are worth mentioning: Duquette et al. (2012) find a 35% discount rate on a sample of US farmers (10-month time horizon), a result in the same range as our results; Bocquého et al. (2013) find a 15% discount rate on a sample of French farmers (one-year time horizon); Hermann and Musshoff (2016) find between 9 and 13% discount rate for German farmers (9-month time horizon). Thus, the values of risk and time preference in our sample are credible regarding the ones found in other studies. Furthermore, we use the elicited risk and time preference in our survey to classify subjects rather than to reveal the absolute parameter values. We therefore have no specific reason to think that our results will be driven by the specificity of the population under study.

Farmers are presented with six choice cards, each with three alternatives. Among the 672 choices made by the farmers (112 farmers times 6), the status quo was chosen 161 times, i.e., in 23.96% of cases.

Table 3: Summary statistics (Quantitative variables)

Variable	#Obs	Mean	SD	Min	Max
Farmers' characteristics					
Female (1=Yes, 0=No)	112	0.06	0.24	0	1
Risk attitude (1=dislikes risk to 10=likes risk)	103	5.79	2.21	1	10
Knowledge of RAZ	109	0.72	0.69	0	2
Farm characteristics					
Total UAA (ha)	112	155.82	76.68	10	450
Area for cereal crops (ha)	112	126.11	77.34	0	450
Area for grassland (ha)	112	13.23	19.72	0	100
Area for long-term cover crops (ha)	112	23.34	22.96	0	150
Area for short-term cover crops (ha)	111	6.76	13.22	0	80
Area in the RAZ	94	32.34	56.70	0	220
AES contract (1=Yes, 0=No)	112	0.40	0.49	0	1
Organic production (1=Yes, 0=No)	112	0.13	0.33	0	1

Table 4: Summary statistics (Qualitative variables)

Variable	Freq.	%	Cumul.
Farmers' characteristics			
Age (112 respondents)			
18-34	11	9.82	9.82
35-44	35	31.25	41.07
45-54	43	38.39	79.46
55-64	21	18.75	98.21
Over 65	2	1.79	100.00
Education (112 respondents)			
No degree or diploma	2	1.79	1.79
Degree (8th/9th grade)	1	0.89	2.68
Middle school diploma (2 years after 8th/9th grade)	17	15.18	17.86
High school diploma	34	30.36	48.21
Bachelor's degree	47	41.96	90.18
Master's degree	10	8.93	99.11
PhD	1	0.89	100.00
Row at which farmer switches to Option B (92 respondents)			
1 (most patient farmers)	5	5.43	5.43
2	9	9.78	15.22
3	16	17.39	32.61
4	14	15.22	47.83
5	25	27.17	75.00
Never (most impatient farmers)	23	25.00	100.00
Farm characteristics			
Main production (112 respondents)			
Cereal crops	61	54.46	54.46
Mixed farming (crops and livestock)	42	37.50	91.96
Vineyards	4	3.57	95.54
Crops and vineyards	2	1.79	98.21
Fruits and vegetables	1	0.89	96.43
Grassland and livestock	1	0.89	99.11
No answer	1	0.89	100.00

Several follow-up questions allow us to determine how farmers behaved in the choice experiment task (see Table 5). Farmers felt quite confident about their choices; 76.41% of farmers reporting a confidence level strictly above the middle value of 5, and 51.89% of farmers reporting a confidence level strictly above 7. As expected, the most important attribute for the farmers, on average, is the mean payment. This attribute gets the highest score (3.12). Next, are the duration of the cover (2.88) and the payment sequence (2.79). The attribute with the lowest score is the sowing technique (2.62). The greatest obstacles to implementing cover crops are the weather and the cost of seeds, then labor/time constraints and machinery, and lastly the savoir-faire and unperceived agronomic benefits.

Table 5: Follow-up questions on the choice experiment

Variable	#Obs	Mean	SD	Min	Max
How do you feel about your choices?					
(1=Not sure at all to 10=Very confident)	106	6.95	2.14	1	10
Please rate the influence of each attribute on your choices on a scale of 1-4.					
(1=Not important to 4=Very important)					
Mean payment	104	3.12	0.85	1	4
Duration	105	2.88	0.94	1	4
Payment sequence	103	2.79	0.95	1	4
Sowing technique	105	2.62	1.00	1	4
Rate the main obstacle to sowing cover crops on your farm.					
(1=Not important to 5=Very important)					
Weather	110	4.16	0.94	1	5
Cost of seeds	110	3.85	1.13	1	5
Labor and time constraints	108	3.24	1.31	1	5
Investments in machinery	108	3.10	1.27	1	5
Savoir-faire	109	2.26	1.24	1	5
No agronomic benefit	109	2.13	1.15	1	5

6 Results

6.1 Preliminary analysis: conditional logit and model specification

As a first step we run CL estimations and attempt to select the most relevant model specification. Estimation results based on our sample of 112 farmers are presented in Table 6. The *status quo* alternative is coded as follows: no sowing technique is imposed, the cover duration is set to 3 months since most of the respondents are required to keep their winter covers at least three months in this area, the annual payment per hectare is €0, and the payment sequence is coded as stable.

In Column (1), we consider a model with only the attribute levels as explanatory variables. The sowing technique and the payment sequence are introduced using dummy variables and the average payment and cover duration as continuous variables. As expected, the monetary attribute is significantly positive. The higher the payment per ha, the higher the probability the farmer will choose the contract. However, the evolution of the payment does not seem to significantly impact farmers' choices. Both technical attributes are also significant with the expected sign. More constraining contracts are less often chosen. In particular, the coefficient associated with the duration attribute is significantly negative: a longer cover duration decreases the probability of a farmer's choosing the contract. However, this specification assumes that the impact of duration is linear. To observe a potential non-linear effect, we replace the linear variable by three dummies corresponding to the proposed duration levels. The dummy corresponding to the baseline duration of three months is omitted and serves as the reference level. As shown in Column (2), while a 4-month cover duration has a significantly negative impact, a 3.5-month cover duration does not. This result suggests that the impact of the duration attribute is non-linear, so we model the duration attribute using dummy variables throughout the rest of the paper.

Many elements apart from the attributes can explain the choices of respondents. In particular, costs associated with the requirements common to all contracts, such as administrative burden and aversion to change could explain a preference for the status quo alternative (which amounts to 24% of the responses). In Column (3), we introduce an ASC associated with the status quo alternative (see also Section 4.4) to avoid biased attribute parameter estimates, in line with the current state of the art in discrete choice analysis (Hoyos, 2010, p.1598). The coefficient associated with the ASC is significantly positive, which indicates that farmers require a utility premium for departing from the status quo. In other words, they expect to be compensated for enrolling in a contract, independently of the level of the attributes.

Finally, using dummy coding to measure the impact of the various attributes on farmers' choices can introduce an identification problem since the utility associated with the Lth reference level of the attribute cannot be separated from other elements of utility incorporated in the intercept term, here the ASC. Following Bech and Gyrd-Hansen (2005) and Hauber et al. (2016), we use effect coding instead of dummy coding to measure the impact of the attribute levels on the cover duration, the sowing technique and the payment sequence. The changes in the estimated coefficients associated with the attribute levels follow expectations and the coefficient associated with the ASC variable is unaffected.[15] Consequently, we consider effect coding as unnecessary in our context and use dummy coding in the remainder of the paper, as it allows for a more straightforward interpretation of coefficients than does effect coding. This leads us to choose the specification presented in Column (3) as the baseline specification for the estimations presented throughout the rest of the paper.

The CL model specification is based on the assumption of independence of irrelevant alternatives (IIA). In order to test this IIA property, we conduct a Hausman test (Hausman and McFadden, 1984) for the specification shown in Column (3) of Table 6. We run the Hausman specification test by alternatively excluding contract A, contract B and the status quo alternatives. All three tests are statistically significant, leading us to reject the CL model. In the following section, we present ML model estimations.

[15] The effects coded variable for one qualitative level is set equal to 1 when the qualitative level is present, equal to -1 if the Lth (the arbitrary reference level) is present and equal to 0 otherwise. In effects coding, the reference point is defined as the negative sum of the estimated coefficients. When the attribute has only two levels, 0 and 1, the effect of the attribute level compared to the reference level (as it would be directly given by dummy coding) is simply found by multiplying the estimated coefficient by 2 (Bech and Gyrd-Hansen, 2005). For instance, for the coefficient associated to the sowing technique we can see this is almost exactly the case.

Table 6: Conditional Logit estimations

	Dummy coding			Effect coding
	(1)	(2)	(3)	(4)
Payment	0.008***	0.008***	0.010***	0.010***
	(0.001)	(0.001)	(0.001)	(0.001)
Duration of cover (linear)	-0.340***	-	-	-
	(0.115)			
Duration of cover - 3.5 months	-	-0.293	-0.033	0.063
		(0.191)	(0.202)	(0.128)
Duration of cover - 4 months	-	-0.334***	-0.256**	-0.160*
		(0.115)	(0.122)	(0.089)
Sowing technique	-0.222**	-0.223**	-0.233**	-0.116**
	(0.108)	(0.108)	(0.113)	(0.057)
Increasing sequence of payments	-0.154	-0.137	-0.000	-0.000
	(0.130)	(0.133)	(0.141)	(0.141)
Decreasing sequence of payments	-0.176	-0.164	-0.049	-0.024
	(0.142)	(0.143)	(0.149)	(0.072)
ASC	-	-	0.792***	0.792***
			(0.167)	(0.167)
Observations	2,016	2,016	2,016	2,016
Nb. of farmers	112	112	112	112

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

6.2 Baseline preferences

Table 7: Mixed logit estimations

	Whole sample	Without first card	Without last card	Without unsure resp.
	(1)	(2)	(3)	(4)
Mean coefficients				
Payment	0.016***	0.017***	0.015***	0.017***
	(0.002)	(0.002)	(0.002)	(0.002)
ASC	1.004***	1.163***	0.810***	0.876***
	(0.249)	(0.273)	(0.263)	(0.270)
Duration of cover - 3.5 months	0.361	0.285	0.397	0.247
	(0.548)	(0.551)	(0.583)	(0.603)
Duration of cover - 4 months	-1.030***	-0.945***	-0.925***	-1.215***
	(0.320)	(0.347)	(0.311)	(0.351)
Sowing technique	-0.624**	-0.608**	-0.462	-0.632**
	(0.284)	(0.303)	(0.282)	(0.315)
Increasing sequence of payments	0.024	0.080	-0.002	-0.005
	(0.222)	(0.256)	(0.241)	(0.243)
Decreasing sequence of payments	-0.392	-0.642*	-0.526*	-0.305
	(0.295)	(0.345)	(0.320)	(0.322)
S.D. of mean coefficients				
Duration of cover - 3.5 months	2.808***	2.741***	2.813***	2.766***
	(0.668)	(0.692)	(0.722)	(0.692)
Duration of cover - 4 months	2.283***	2.337***	2.118***	2.291***
	(0.348)	(0.415)	(0.364)	(0.365)
Sowing technique	2.099***	2.135***	1.981***	2.169***
	(0.311)	(0.357)	(0.322)	(0.355)
Increasing sequence of payments	0.646*	0.863**	0.707*	0.673*
	(0.362)	(0.373)	(0.389)	(0.404)
Decreasing sequence of payments	1.171***	1.381***	1.235***	1.223***
	(0.361)	(0.456)	(0.444)	(0.376)
Observations	2,016	1,737	1,737	1,764
Nb. of farmers	112	112	112	98

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. ML estimations.

The first ML model estimation (Column 1) of Table 7 is conducted on the whole sample of 112 farmers. All attribute variables are considered as random parameters except for the payment. We do not consider the payment as a random parameter because considering it as fixed has several advantages. As pointed out by Hole (2008), this ensures that the coefficient has the right sign for all farmers and allows for the calculation of the willingness to accept. This hypothesis will be relaxed later. The results obtained with the ML model confirm the previous results obtained with the CL estimation. The lower part of Table 7 also indicates that there is strong preference heterogeneity across farmers on all attribute levels, though this is less clear on the increasing payment sequence (the standard deviation of the mean coefficient being significant only at the 10% level).

To check the robustness of our results, we apply several specification checks proposed by Johnston et al. (2017). The specification displayed in Column (2) excludes the first choice card in order of appearance to control for a potential learning effect. Alternatively, in Column (3), we exclude the last (here the sixth) choice card to check for a lassitude effect. Lastly, in Column (4), we exclude respondents who are the most uncertain about their choices. Concretely, this estimation does not include the choices of the 14 farmers who answered strictly less than 5 to the question “How do you feel about your choices?", on a scale of 1 "I was not at all sure of my choices" to 10 "I was absolutely certain of my choices".

Altogether our results are stable. As we found with the CL estimations, there is a preference for the status quo. Both the imposed sowing technique and a 4-month cover period have a significant negative impact on willingness to select a contract. Note that for half of the specifications, a decreasing sequence of payments proposed in a contract has a negative impact on participation. This suggests heterogeneity of preference among farmers regarding a decreasing sequence of payments, which is confirmed by the fact that standard deviations are significant at the 1% level in all specifications. In the next subsection, we attempt to understand and qualify this preference heterogeneity.

6.3 Heterogeneity in payment sequence preferences

The preferences for payment sequences was assessed through two different channels: the choice experiment and the direct question, “Overall, what sequence of payments do you prefer?", asked as a follow-up question. This direct question reveals that 70% of the sample prefer a stable payment, 17% prefer an increasing sequence of payments, and less than 3% prefer a decreasing payment. Detailed descriptive statistics are presented in Table 8 below.

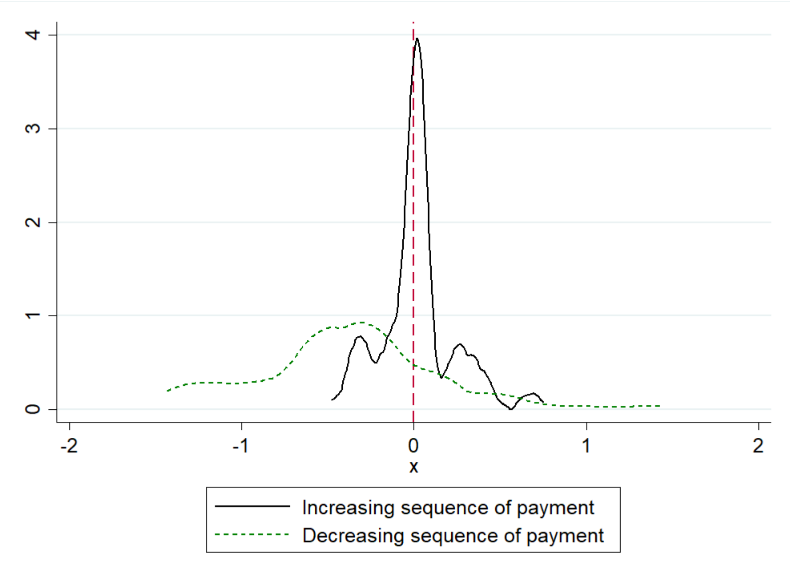
Table 8: Preference for payment sequence (110 respondents)

Variable	Freq.	%	Cumul.
Indifferent	9	8.18	8.18
Decreasing payment (−20% per year)	1	0.91	9.09
Decreasing payment (−10% per year)	2	1.82	10.91
Stable payment	79	71.82	82.71
Increasing payment (+10% per year)	5	4.55	87.26
Increasing payment (+20% per year)	14	12.73	100.00

Results presented in the preceding section do not contradict the answers to this direct question. We do not observe a clear willingness from farmers to depart from the usual stable payment, but there is heterogeneity in preferences.

To further our understanding of this preference heterogeneity, a close look at the distribution of individual β-coefficients (from the ML model presented in Column (1) of Table 7) is instructive. Figure 3 shows that the distribution of individual beta-coefficients associated with the increasing sequence of payments is strongly centered and peaks around 0. One possible interpretation is that individuals are relatively indifferent between an increasing or a stable sequence of payments. Regarding the decreasing sequence of payments, the distribution of coefficients does not present a striking peak and is highly skewed to the left. This confirms the heterogeneity of preferences regarding decreasing payments and might explain why we observe negative and significant coefficients in Table 7. To better understand this heterogeneity in preferences, we use the answers to two follow-up questions on risk and time preferences. Indeed, as shown in Section 2, time and risk preferences will tend to impact preferences for different sequences of payments, notably in the optimization category of motives.

Figure 3: Kernel density estimates β_n (automatic bandwith)



We use the median value of the discount rate and the risk attitude variable to divide the studied sample in two and see whether these farmers' characteristics can help us understand the heterogeneity of the preferences over payment sequences. The 44 farmers with a ρ time preference parameter below or equal to 0.40 are classified as “patient", and the others as “impatient". The 60 farmers who chose a value below or equal to 6 to the question on risk attitude are classified as "less willing to take risks" and the others as "more willing to take risks". Results are presented in Table 9.[16]

[16]Regressions on subsamples are preferred to the introduction of interacted variables, as their interpretation in standard probit and logit models require corrections that have not yet been adapted for ML models (see Ai and Norton, 2003; Greene, 2010; Drichoutis and Nayga Jr, 2011).

Table 9: Impact of time and risk preferences

	Time preference		Willingness to take risks	
	Patient	Impatient	Less willing	More willing
	(1)	(2)	(3)	(4)
Mean coefficients				
Payment	0.013***	0.020***	0.016***	0.018***
	(0.002)	(0.003)	(0.002)	(0.003)
ASC	0.710*	1.530***	1.064***	1.181***
	(0.393)	(0.397)	(0.335)	(0.431)
Duration of cover - 3.5 months	1.051	-0.571	0.849	-0.109
	(0.788)	(0.768)	(0.868)	(0.696)
Duration of cover - 4 months	-0.868**	-1.129**	-1.414***	-0.306
	(0.418)	(0.525)	(0.430)	(0.486)
Sowing technique	-0.089	-1.003**	-0.796*	-0.314
	(0.386)	(0.506)	(0.418)	(0.437)
Increasing sequence of payments	-0.295	0.311	-0.092	0.199
	(0.378)	(0.339)	(0.284)	(0.410)
Decreasing sequence of payments	-0.712*	-0.321	-0.318	-0.923**
	(0.400)	(0.447)	(0.395)	(0.445)
S.D. of mean coefficients				
Duration of cover - 3.5 months	1.567*	2.946***	3.062***	2.230***
	(0.876)	(0.835)	(0.997)	(0.841)
Duration of cover - 4 months	1.844***	2.303***	2.020***	2.347***
	(0.441)	(0.537)	(0.430)	(0.560)
Sowing technique	1.863***	2.371***	2.284***	2.164***
	(0.432)	(0.525)	(0.473)	(0.485)
Increasing sequence of payments	1.099**	0.247	-0.086	1.113**
	(0.466)	(1.173)	(0.771)	(0.484)
Decreasing sequence of payments	0.654	0.846	0.962*	0.118
	(0.772)	(0.630)	(0.510)	(1.254)
Observations	792	864	1,080	774
Nb. of farmers	44	48	60	43

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. ML estimations.

According to the discounted utility model, farmers with a higher discount rate, i.e., “impatient" farmers, will tend to favor DSO more than farmers with a lower discount rate, i.e., “patient" farmers. In Table 9, we see that farmers who dislike decreasing payments are those who give a relatively great weight to the future (i.e., the “patient" ones). Although theoretically “patient" farmers weakly theoretically prefer DSO (as per the discounted utility model), given the other motives identified in Section 2, this preference will be mitigated by preferences for ISO or SSO, which leads to a dislike for DSO. Aversion to decreasing sequences of payments by “patient” farmers can be explained by potential mechanisms, such as the willingness to “tie one’s own hands" or the recency effect. “Impatient farmers" also do theoretically favor DSO and more than patient farmers according to the discounted utility model. However, the other motives are strong enough to induce indifference to DSO in “patient" farmers, making the coefficient associated with the decreasing payment not significant (Column 2).

A similar argument may be at play regarding risk attitudes. Farmers more willing to take risks than the median farmer reject significantly decreasing payments while farmers less willing to take risks do not. Farmers less willing to take risks might also prefer to “tie their hands", for instance, but they are also more sensitive to the risk of not receiving the contractual payments, the uncertainty motive in Section 2. Indeed, experience shows that CAP payments have been delayed by several years in the past and that other measures have been ended before the term of the contract. Receiving a greater amount of money during the initial periods via decreasing payments relieves some of the uncertainty about future payments, thereby counteracting the initial dislike for decreasing payments. Results are robust to sample selection tests proposed in Table 7: the learning effect, the lassitude effect, and choice confidence as shown in Tables A2 and A3 in the Appendix.

Note that the standard deviations associated with the decreasing sequence of payment coefficients have lost significance compared to the baseline estimations presented in Table 7. Regarding the other coefficients, the non-significance of coefficients that were significant in the full sample, such as the sowing technique (in two columns out of four), is potentially due to the mechanical increase in the minimum detectable impact implied by the decrease in sample size when working with subsamples. Finally, note that the two subsets of farmers are significantly different, since only 18 farmers are both “more patient" and “more willing to take risks" than the median farmer.[17]

[17] Furthermore, the Wilcoxon rank sum test of sample comparison indicates that, relative to “impatient” farmers, “patient” farmers are less engaged in organic production and possess a higher level of education. Relative to farmers who are less willing to take risks, those more willing to take risks have smaller Utilized Agriculture Area (UAA) and have a lower level of education.

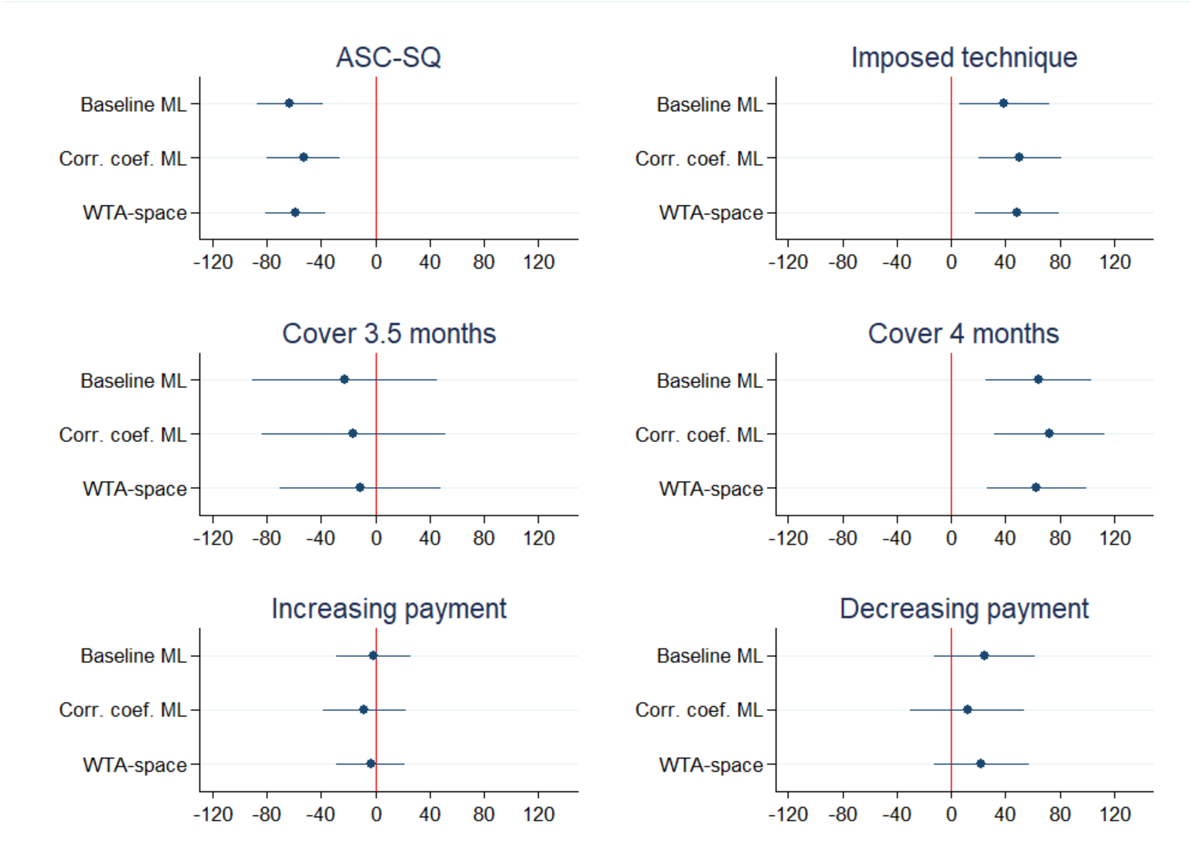
Finally, we also check the sensitivity of our estimated coefficients regarding past participation in AES, the status quo coding, and heterogeneity modeling. Results are stable, including on subsamples of "patient" farmers and farmers "more willing to take risks", as shown in the Appendix.[18]

6.4 WTA estimations

Lastly, we look at WTA. Results are presented in Figure 4. We report average WTA and confidence intervals at the 5% level for ML model with ASC and payment as fixed coefficients and attribute levels as random ones presented Column 1, Figure 7: the 'Baseline ML' model, via the specification but allowing full correlation among utility coefficients (the 'Corr. coef. ML' model, Hess and Train, 2017, presented Column 6 Table A1), and a model estimated in WTA-space, which allows us to consider the impact of the payment as heterogeneous among farmers (the 'WTA-Space' model, Scarpa et al., 2008).

[18]Note that we also collected the number of hectares that farmers would enroll in each chosen contract. A natural second step would be to explain the determinants of the area enrolled. We went through this exercise but none of the attributes or socio-demographic characteristics of farmers we introduced were significant. Most respondents enroll the same number of hectares whatever the contract (27ha on average). This is consistent with the context of the study: cover crops are already compulsory in the area, the proposed contracts would aim mainly at improving practices, not at increasing the number of hectares covered.

Figure 4: WTA



As we can see in Figure 4, farmers demand a base compensation of 60 euros on average to depart from the status quo, reflecting the administrative burden of contractualizing and the costs associated with the use of a mixture of at least two crops, including at least one legume crop for the cover, as required in all contracts. An additional 50 euros is required to get farmers to accept restrictions on the sowing technique. Getting farmers to accept the imposition of a soil cover duration of 4 months requires compensation of about 65 euros. These two last attributes represent additional constraints and were also expected to be positive, due to the additional time, savoir-faire to be acquired, and risks inherent in delaying the destruction of cover crops. Finally, an average premium of 20 euros would be required to impose a contract with decreasing payments, although the WTA is nonsignificant (p-value=0.21 in the model in WTA-space). If we compute the WTA from the baseline ML model for "patient" and "more willing to take risks" farmers, based on estimations in Table 9, the premium climbs to 52 euros (respectively 53) per year on average. Imposing the most highly constraining contract

(4-month cover + imposed sowing technique) would require an AES of $60 + 50 + 65 = 175$ euros, which is within the range of AES usually proposed through the CAP.[19] Nevertheless, for all estimated WTA, confidence intervals are relatively large, which makes it difficult for policymakers to determine the exact design of the optimal contract. This imprecision is potentially due to the sample size.

7 Discussion

Our goal was to explore new ways of incitivizing and remunerating farmers. The sequences of payments tested would be a departure from CAP payments, which have until now been based on opportunity costs, but this might not be the case with the future CAP programs. Some propositions in the Ecoscheme are to pay for the provision of ecosystem services for instance, but other options could still be adopted (Lampkin et al., 2020). In addition, the question of sequences of payments could be relevant for AES outside the CAP or even for payment for environmental services in general. After questioning the likely importance of the rate of payment evolution used, we discuss the impact of the agri-environmental techniques studied. Finally, we examine our results from a policymaker point of view.

We tested only one absolute level of payment evolution, that is +/-10% every year. This rate of evolution might seem low, but if we compute the amount of money it represents, the change in payment is not insignificant. With an average payment of 160€/ha/year as in the example presented in Figure 2, depending on the sequence, whether decreasing or increasing, one can receive either 195/€/ha or 130/€/ha in Year 1 (a difference of 65€/ha). Given that in our study on average farmers enroll 27ha in AES contracts, a decreasing sequence of payments would provide them with 27*65=1,755€ more than an increasing sequence the first year. Average payments proposed through the choice experiment range from 40€ to 300€ per ha per year, which corresponds to a minimum difference of 540€ and a maximum difference of 3,240€ for the first (or the last year). Given that annual revenues of French farmers amount to 30,000€

[19] In the 2007-2014 CAP program for instance, the implementation of cover crops was compensated by an 86 euro payment per hectare per year (but with less restrictive conditions regarding the implementation of the cover) and the conversion to organic production was compensated by amounts ranging from 100 to 600 euros (MAAF, 2006).

a year on average, these differences represent from 2% to 11% of a farmer's revenues. In addition, in a follow-up question, we asked respondents to rate the influence of each attribute on their choices on a scale of 1-4 (1=Not important to 4=Very important). The sequence of payment got an average rating of 2.79, which is greater than the sowing technique, for instance (see Table 5, Section 5). Thus we are convinced that the sequences of payment mattered in decision-making. Nevertheless other rates (than 10%) are obviously worth investigating, especially as some studies in psychology show that this matters (Hsee et al., 1991). Future works in this direction would improve our understanding of farmers' preferences.

The advantage of testing our framework on cover cropping is that annual costs are quite stable, except for the initial investment in machinery in rare cases. Yet it is obvious that some practices, such as the implementation of grasslands, or the reduction of herbicides using mechanical weeding, induce high initial investment. The cost structure of the targeted practices can influence the appropriate annual repayment schedule. Our point with this study is to show that, on top of the cost structure, various general mechanisms can influence the preferred payment sequence and thus the attractiveness of the AES proposed. Of course, the relative importance of these general mechanisms compared to cost structure issues depends on the practice under study.

We find that overall farmers do not present a clear willingness to depart from usual payments. This might be well-aligned with the preferences of the public administration in charge of the payment. Indeed, mobilizing a larger part of the funds early in the case of decreasing sequences might be complicated from a treasury point of view. Furthermore, it really complicates payment recovery in case of failure to comply. At the reverse, increasing sequences of payment would have been an interesting perspective since it allows policymakers to mobilize funds for subsidies later in the future. While our aim was to elicit farmer's preferences, it is obvious that those of policymakers are a critical issue for AES implementation.

8 Conclusion

While nearly all AES today propose stable annual payments over the duration of the contract, other sequences of payments could be implemented. The standard discounted utility model, for instance, predicts that individuals will prefer decreasing payment sequences. Nevertheless, the prospect of seeing one's own situation improved in the future, a tendency toward loss aversion or the recency effect, among other factors, can lead individuals to prefer increasing payment sequences. Alternatively, farmers could be attracted by the simplicity of the stable payments they are used to, as stable cash flows are easier to plan around and manage.

To understand the preferences of farmers over different AES payment sequences, we proposed a review of the literature in psychology and in economics on the mechanisms affecting preferences regarding sequences of outcomes. A variety of these mechanisms relating to optimization, constrained optimization, ideal distribution, ideal consumption, and perception bias have been revealed by previous research projects.

We tested the preference for stable, increasing, and decreasing sequences of payments through a choice experiment survey focusing on an AES encouraging cover crops. Based on the answers of 112 farmers, we find that on average farmers do not wish to depart from the standard stable payments contract. The preferences regarding increasing sequences of payments are rather homogeneous and based on individual-β coefficients: a large percentage of farmers would not increase or decrease their participation rate if increasing payments were used. This perspective is interesting since it allows policymakers to mobilize funds for subsidies later in the future. Nevertheless, it should be noted that if the purpose of the AES is to ensure a change of practices over the long-term, using increasing payments may be counterproductive. In this regard, investigating the preferences for decreasing payment sequences was particularly crucial, as the temptation to use them is great. Our estimations reveal that preferences regarding decreasing payment sequences are heterogeneous. While the coefficient is non-significant on the whole sample, there is a significant rejection of decreasing payments among farmers with low discount rates and those more willing to take risks than the median farmer.

The heterogeneity of preferences revealed by our results opens the question of proposing a menu of contracts with different sequences of payment, but the same net present value of total outcome for the policymaker. Each farmer would choose her preferred contract, and it could theoretically allow her to recruit the same number of farmers for a smaller total cost. Nevertheless, this could increase administrative costs and complicate the recovery of payments in case of non-compliance. As such our study fits into the more general question of the importance of taking heterogeneity into account in policy evaluation. Core structural parameters such as time and risk preferences can, when elicited, help to predict not only the average impact of a policy but also who will win and who will lose (Harrison, 2011). Indeed policymakers usually target the average farmer to enroll acres into environmental programs. They can also propose differentiated contracts, but only when individual preferences are well understood can a policy be effectively tailored using innovative designs.

Further work is needed to disentangle the impact of the rich variety of mechanisms at play that we have identified through our literature review, and additional alternative payment sequences could yet be tested. Nevertheless, our results suggest that, despite their intuitive appeal, the use of decreasing payment sequences to incentivize agri-environmental transition may be costly.

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Appendix

The Appendix section presents robustness checks on the main results and the heterogeneity of preferences.

First, we present regressions on subsamples of AES recipients (Column 1) and non-recipients (Column 2) of Table A1. Estimations show that those who received AES in the past have a smaller ASC as expected. WTA computation shows that the cost of entering AES for previous recipients is 47€/ha/year on average while it is 79€ for non-recipients. It can be due to the fact that previous AES recipients are used to the administrative procedure so it is less costly for them to enter new contracts. As in the general sample, we find those who have been engaged in AES are not different from those who have not regarding preferences for sequences of payments (parameters are not significant, even if the p-value associated to a negative coefficient for non-recipient is equal to 0.14).

Second, in the main estimations, we assumed that all respondents are required to maintain their winter cover crops for at least 3 months even when they choose the status quo alternative. However, this is true in the RAZ only and not in the NVZ, where some respondents may have plots and where the minimum cover duration is only 2.5 months. To take this issue into account, in Column (3) of Table A1, we code the cover duration as follows: the duration is 2.5 months except for the respondents who formally reported having crop plots in the RAZ. The results of this new estimation are qualitatively the same; however the coefficient for the sowing technique attribute is now significant only at the 10% level.[20]

Third, to further check the robustness of our results, we model heterogeneity in various ways. In Column (4), we consider the impact of the ASC as individually heterogeneous. In Column (5), we allow for individual scale heterogeneity in the estimation. Scale heterogeneity occurs when some individuals accord a lower weight to all attributes compared to other farmers. Econometrically, some respondents exhibit a larger variability of the errors relative to the observed attributes than other respondents, which causes heteroscedasticity (Fiebig et al., 2010; Lancsar et al., 2017). Thus it could be important to take it into account (even if it could

[20]Note that another robustness check would be to code all SQ levels for the 2.5-month duration. Yet this would lead to the exact same result as in column (1) of Table 7. Indeed, the SQ-duration would be the same for all farmers and thus would be collinear with the ASC variable.

lead to interpretation difficulties, Davis et al. 2019). Furthermore, Hess and Train (2017) explain that scale heterogeneity is only one cause of a larger phenomenon: coefficient correlation. Another source of coefficient correlation could exist if, for instance, farmers that do not like the imposed sowing technique also do not like the condition of a longer cover period, because they do not like to be constrained in their practices. Hess and Train (2017) demonstrate that the ML model with full correlation among utility coefficients allow for all sources of correlation, including scale heterogeneity. We implement the ML model with full correlation among utility coefficients in Column (6).

Table A1: Status quo specification and heterogeneity modeling

	AES Recipient	AES non-recipient	Change in SQ	Individual ASC coef.	G-MNL	Corr. ML
	(1)	(2)	(3)	(4)	(5)	(6)
Mean Coefficients						
Payment	0.019***	0.015***	0.016***	0.021***	0.059**	0.016***
	(0.003)	(0.002)	(0.002)	(0.002)	(0.026)	(0.002)
ASC	0.881**	1.154***	1.049***	-0.332	2.351*	0.825***
	(0.365)	-0.338	(0.308)	(0.741)	(1.279)	(0.259)
Duration of cover 3 months			0.076			
			-0.417			
Duration of cover 3.5 months	0.344	0.355	0.507	-0.390	-1.332	0.251
	(0.719)	(0.764)	(0.643)	(0.393)	(1.032)	(0.535)
Duration of cover 4 months	-0.986***	-1.245**	-0.952**	-0.710***	-0.811	-1.138***
	(0.332)	(0.562)	(0.474)	(0.273)	(0.562)	(0.329)
Planting Technique	-0.953**	-0.295	-0.515*	-0.676**	-1.446**	-0.791***
	(0.382)	(0.420)	(0.285)	(0.263)	(0.734)	(0.269)
Increasing sequence of payment	0.251	-0.178	0.051	-0.122	0.362	0.125
	(0.332)	(0.302)	(0.230)	(0.226)	(0.433)	(0.244)
Decreasing sequence of payment	-0.096	$-0.650^{(*)}$	-0.242	-0.237	-0.852*	-0.187
	(0.413)	(0.441)	(0.309)	(0.308)	(0.510)	(0.337)
S.D. of mean coefficients						
ASC				5.392***		
				(0.904)		
Duration of cover 3 months			2.101***			
			(0.431)			
Duration of cover 3.5 months	1.874**	3.336***	2.625***	0.000	0.814	
	(0.825)	(1.031)	(0.621)	(0.778)	(0.740)	
Duration of cover 4 months	0.996***	3.443***	2.212***	1.706***	0.791	
	(0.372)	(0.687)	(0.375)	(0.362)	(0.745)	
Planting Technique	1.770***	2.290***	2.005***	1.721***	0.674	
	(0.431)	(0.483)	(0.332)	(0.290)	(0.623)	
Increasing sequence of payment	0.799*	-0.437	0.534	0.209	0.158	
	(0.459)	(0.619)	(0.410)	(0.425)	(0.202)	
Decreasing sequence of payment	1.082**	1.291***	1.075***	1.006***	0.544	
	(0.537)	(0.497)	(0.376)	(0.373)	(0.523)	
Observations	810	1,206	2,016	2,016	2,016	2,016
Nb. of farmers	45	67	112	112	112	112

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, $^{(*)}$ p<0,2. ML estimations.

Results are qualitatively unchanged compared to the baseline results (see Table 7 column (1)), apart from the coefficient associated with the ASC in Column (4), which is no longer significant. However, this hides heterogeneity among farmers since the standard deviation is highly significant. The coefficient associated with the increasing sequence of payments is not significant, neither is its associated standard deviation. The coefficient associated with the decreasing sequence of payments is significant in two column out of six, while the associated standard deviation is significant in most columns.

We are unable to reproduce the results of columns (5) and (6) of Table A1 for the subsamples of "patient" and "more willing to take risks" farmers because of convergence problems of the generalized ML model and correlated ML model on smaller samples, but the results of columns (3) and (4) are reproduced respectively in columns (4) and (5) of Tables A2 and A3, which also reproduce estimations of the Table 7 on these subsamples. Once again, results appear to be robust.

Table A2: Robustness checks on 'patient' farmers preferences

	Without first card	Without last card	Without unsure resp.	Change in SQ	Individual ASC coef.
	(1)	(2)	(3)	(4)	(5)
Mean coefficients					
Payment	0.014***	0.013***	0.014***	0.013***	0.015***
	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)
ASC	0.914**	0.644	0.712*	0.710*	-0.092
	(0.417)	(0.421)	(0.418)	(0.393)	(0.696)
Duration of cover - 3.5 months	0.945	1.081	1.152	1.051	0.633
	(0.793)	(0.821)	(0.857)	(0.788)	(0.834)
Duration of cover - 4 months	-0.759*	-0.833**	-0.972**	-0.868**	-0.565*
	(0.436)	(0.424)	(0.471)	(0.418)	(0.336)
Sowing technique	-0.069	0.149	0.023	-0.089	-0.085
	(0.388)	(0.395)	(0.419)	(0.386)	(0.309)
Increasing sequence of payments	-0.207	-0.472	-0.447	-0.295	-0.222
	(0.411)	(0.420)	(0.421)	(0.378)	(0.301)
Decreasing sequence of payments	-0.674$^{(*)}$	-1.075**	-0.870**	-0.712*	-0.510$^{(*)}$
	(0.424)	(0.450)	(0.425)	(0.400)	(0.379)
S.D. of mean coefficients					
Duration of cover - 3.5 months	1.495*	1.239	1.645*	1.567*	1.432
	(0.904)	(1.065)	(0.910)	(0.876)	(1.365)
Duration of cover - 4 months	1.812***	1.748***	2.003***	1.844***	1.266***
	(0.477)	(0.476)	(0.485)	(0.441)	(0.437)
Sowing technique	1.831***	1.829***	1.973***	1.863***	1.222***
	(0.461)	(0.464)	(0.485)	(0.432)	(0.346)
Increasing sequence of payments	1.182**	1.173**	1.238**	1.099**	0.090
	(0.511)	(0.529)	(0.495)	(0.466)	(0.988)
Decreasing sequence of payments	-0.308	0.523	0.569	0.654	0.672
	(1.074)	(1.271)	(1.075)	(0.772)	(0.691)
ASC					2.821***
					(0.694)
Observations	687	687	738	792	792
Nb of farmers	44	44	41	44	44

$^{***}\ p < 0.01$, $^{**}\ p < 0.05$, $^{*}\ p < 0.1$, $^{(*)}$ p<0,2. ML estimations.

Table A3: Robustness checks on farmers 'more willing to take risks' preferences

	Without first card (1)	Without last card (2)	Without unsure resp. (3)	Change in SQ (4)	Individual ASC coef. (5)
Mean coefficients					
Payment	0.018***	0.017***	0.020***	0.018***	0.022***
	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)
ASC	1.354***	1.166**	0.798*	1.181***	-0.136
	(0.463)	(0.454)	(0.483)	(0.431)	(1.048)
Duration of cover - 3.5 months	-0.179	0.206	-0.253	-0.109	-0.404
	(0.689)	(0.773)	(0.752)	(0.696)	(0.611)
Duration of cover - 4 months	-0.207	-0.105	-0.270	-0.306	-0.147
	(0.467)	(0.485)	(0.512)	(0.486)	(0.485)
Sowing technique	-0.450	0.019	-0.489	-0.314	-0.316
	(0.442)	(0.448)	(0.461)	(0.437)	(0.480)
Increasing sequence of payments	0.345	0.252	0.346	0.199	-0.052
	(0.469)	(0.424)	(0.438)	(0.410)	(0.425)
Decreasing sequence of payments	-0.854*	-1.179**	-0.763$^{(*)}$	-0.923**	-1.148**
	(0.470)	(0.521)	(0.498)	(0.445)	(0.562)
S.D. of mean coefficients					
Duration of cover - 3.5 months	2.146**	2.429**	2.104***	2.230***	0.040
	(0.840)	(0.982)	(0.760)	(0.841)	(0.948)
Duration of cover - 4 months	2.046***	2.185***	2.421***	2.347***	2.237***
	(0.583)	(0.596)	(0.662)	(0.560)	(0.609)
Sowing technique	2.057***	2.153***	1.989***	2.164***	2.165***
	(0.508)	(0.525)	(0.510)	(0.485)	(0.498)
Increasing sequence of payments	1.453**	1.048*	-1.053**	1.113**	0.742
	(0.565)	(0.538)	(0.525)	(0.484)	(0.610)
Decreasing sequence of payments	0.033	0.002	0.614	0.118	0.455
	(1.406)	(1.005)	(1.135)	(1.254)	(0.946)
ASC					4.649***
					(1.425)
Observations	672	672	666	774	774
Nb of farmers	43	43	37	43	43

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, $^{(*)}$ p<0,2. ML estimations.