Do we care about sustainability? An analysis of time sensitivity of social preferences under environmental time-persistent effects.

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Abstract: Environmental cost-benefit analysis has traditionally assumed that environmental policies' social benefits are sensitive to the timing of the improvement. Indeed, it has relied on the idea that policies' outcomes, taking place at different moments in the future depending on the intervention's performance or on environmental dynamics, are preferred if occurring earlier. However, this assumption needs to be verified as it may lead to consider as socially desirable policies being less so. This is especially important when interventions aim at counteracting time-persistent environmental problems, whose impacts occur in the long- and very long-term, respectively involving the present and future generations. In this framework, with the objective to test for the role of sustainability concerns, this study analyzes the time sensitivity of social preferences for preservation policies of adaptation to climate change stresses. Results have shown that preferences are time insensitive due to sustainability issues, as current generations equally care about nature preservation in the long-term, when they will enjoy it, and in the very long-term, when future generations will. These outcomes are relevant to better inform policy-making in the face of time-persistent environmental problems, by pointing out that, to be welfare-maximizing, interventions also need to be sustainable.

Keywords: time-persistent environmental problems, sustainability, preference analysis, choice experiment, time sensitivity, climate change.

JEL codes: D6, D90, Q51, Q54, Q56.

1. Introduction

Environmental cost-benefit analysis (ECBA) focuses on assessing the social profitability of environmental projects or policies by comparing their associated social benefits and costs, which take place at different moments in time. Often, financial costs arise in the present while environmental benefits occur at some point in the future, depending on policy implementation and performance and/or on the complexity of ecosystems' dynamics (Meyer 2013). In this sense, ECBA literature has long recognized that the time profile of environmental benefits is a critical issue for the analysis of a policy's social return. This is because, for more than 50 years, applied welfare economics has been concerned with individuals' sensitivity to social benefits' timing through the analysis of social discount rate issues, finding that time affects preferences.

Especially over the last decade, the analysis of individuals' inter-temporal choices has demonstrated that society tends to prefer sooner to later rewards, as evidenced by the positive discount rates found by researchers (Pindyck 2007; Hanley and Barbier 2009). This also reflects the conduct individuals adopt when making inter-temporal choices over private monetary benefits, based on experimental economics' studies. The result that society should assign a greater weight to sooner outcomes and, hence, that the future should be discounted have also been pointed out by a normative social discounting literature (Cropper et al. 2014). Though, consensus is just apparent, as it is still debated what discount rate should be employed (Almansa and Calatrava 2007; Birol et al. 2010). Taking into account the increasing environmental problems requiring urgent policy design and implementation, research on individuals' sensitivity to policy benefits' timing becomes of high relevance. Indeed, the assumptions made about how people value environmental benefits arising over different time periods can have big impacts on policy's social profitability.

This is especially true when it comes to interventions whose environmental results occur not only in the long-term, affecting the present generation, but more importantly in the very long-term, affecting the future generations. These policies usually pursue to counteract the effects of an increasing number of time-persistent environmental problems -like climate change (CC), nuclear waste or pollution- which arise because of the accumulation in the environment of some long-lasting pollutants which interact in a complex way with ecosystem processes' dynamics (Underdal 2010). In this context, the time sensitivity assumption that individuals allocate a lower weight to policy benefits occurring in the long-term but especially in the very long-term future can have important negative welfare implications for unborn generations (Scarborough 2011). Indeed, the social discounting literature has shown that the consideration of a positive discount rate could make socially unacceptable those policies whose major environmental benefits arise in the very long-term future (Weitzman 1998; Azqueta 2002; Gollier 2013). In other words, assuming individuals discount the future could prevent policy makers from undertaking environmental policies with positive welfare impacts on the unborn. Under these premises, given that there is a concern for the welfare not only of the present but also of future generations, the analysis of the time sensitivity of current generations' preferences for policies oriented to avoiding impacts in the long- and very long-term future acquires special importance. Given that current generations represent, as trustees, the unborn (Thomson 2010), considering results from this analysis in ECBA can better inform decision-makers. In fact, it can lead to the design of welfare-maximizing policies that can also include sustainability considerations, which are expected to play an important role in this context.

Sustainability concerns may exist when current generations' preferences for environmental benefits occurring in the very long-term are equal or higher with respect to those for benefits occurring in the long-term. This is because sustainability is about equity of use and non-use welfare opportunities between the present and future generations (Baumgärtner and Quaas 2010; Kuhlman and Farrington 2010). In these terms, the above definition of sustainability responds to a precautionary principle, which seems to be recommendable due to the fact that the future is characterized by inherent uncertainties. Inherent uncertainty, which has been found to significantly affect social preferences in Torres et al. (2015), refers to the fact that, due to non-linear and chaotic behavior of ecosystems, environmental impacts are unpredictable and uncontrollable and, consequently, so are the results

2

of policies to counteract them. Based on this, in the face of unpredictable changes in ecosystems' functioning, which can potentially lead to irreversible environmental damages, if current generations are concerned about sustainability they should be willing to preserve at least the same critical level of environmental resources for themselves and for future generations. In other words, they should at least equally care about conservation in the very long-term as in the long-term. Then, this idea of sustainability differentiates from the more commonly used concepts of weak and strong sustainability. With respect to weak sustainability, it rejects the idea that intergenerational equity can be achieved by allowing for unlimited substitution between natural and non-natural capital (i.e. man-made, human capital, etc.), provided their aggregated level is maintained over time. In other words, despite accepting some degree of substitution, it argues that the loss of natural capital beyond some thresholds leads to irreversible losses that cannot be fully compensated by increased availability of other forms of capital (Luckert and Williamson 2005). With respect to the idea of strong sustainability, it agrees that some constraints should be put on natural capital to avoid environmental losses, even though it additionally argues that these should be set taking social preferences into account (Crowards 1998; Berrens 2001). Despite the increasing claims for incorporating inter-generational equity issues into the design of environmental policies (Barr 2008; Carlsson et al. 2011; Moldan et al. 2012), the role of sustainability concerns over preferences' time sensitivity has been underexplored in economic valuation studies.

This is attributable to the fact that within the stated preference (SP) valuation literature, which needs to be considered when ex-ante social benefits of future environmental policies are to be estimated, little attention has been dedicated to the sensitivity to time of social preferences. Most importantly, the disregard for the role of sustainability concerns has been motivated by the choice of the temporal frame in this scarce literature, which has examined social preferences over different time scenarios either in the long- or in the very long-term. According to this, the question of whether the value current generations assign to a given future environmental outcome when it occurs in the long-term is the same as that assigned to it when it occurs in the very long-term still remains unanalyzed. Consequently, the issue of whether values are driven by intergenerational equity reasons is still an open question. So: *which is the role of sustainability concerns in explaining the time sensitivity of social preferences in a context of time-persistent environmental effects?*

To find an answer to this question, this paper will examine which are the values individuals attach to a given environmental improvement in the long- and the very long-term and whether there are differences between them. In this framework, our study will rely on a choice experiment application examining preferences for interventions of CC adaptation. The fact that the benefits of these policies will emerge from counteracting CC impacts, which are expected to arise both in the long- and in the very long-term (Hasselmann et al. 2003; IPCC 2013), makes the focus on this challenging problem very appropriate for the present analysis. For a better measurement of social preferences in the long- and very long-term, the analysis will be undertaken by considering the existence of inherent uncertainty, based on the recommendations in Torres et al. (2015) that this should be included in hypothetical SP valuation studies for its significance in welfare terms. The structure of the paper is as follows. Next section reviews the literature concerned with the time sensitivity analysis of social preferences for environmental policy results. Section 3 describes the methodology used. Results are reported in section 4, followed by a discussion and conclusions section that ends the paper.

2. Time sensitivity in the environmental SP valuation literature

Individuals are expected to value environmental policies' outcomes differently depending on when they take place. For this reason, over recent years, the issue of time sensitivity of preferences has attracted the attention of environmental economists working with SP methods. On the one hand, researchers have focused on the time sensitivity of social preferences for environmental policies generating health benefits, expressed as lives saved or mortality risk reductions (Cairns 2001), finding that individuals prefer not to delay improvements in their health

status (Cropper et al. 1994; Alberini and Chiabai 2007; Krupnick 2007; Rheinberger 2011). On the other hand, some attention has been given also to the analysis of the sensitivity to time of social preferences for environmental improvements.

With respect to this latter, two groups of studies, consisting of Choice experiments (CE) and Contingent valuation (CV) applications, can be identified: those focusing on different time horizons in the long-term and those in the very long-term. The first group has examined time sensitivity of social preferences in the long-term and it has assumed that environmental benefits will only accrue to the current generation. Indeed, these studies have considered policies whose timing of outcome provision will be less than one or two decades at most, depending on how policy-makers design and implement the intervention. In specific, this research has been concerned with various issues around the measurement of individuals' time preferences.

Crocker and Shogren (1993), by means of a CV study, have investigated the role of dynamic inconsistencies in the discounting of future environmental benefits. They have found that the yearly marginal rate of time preference for avoiding delayed access of 2 years to a mountain environment in North Carolina commercial ski areas is lower than the yearly rate for acquiring extended access to it over the following 10 years. Strazzera et al. (2010), in the framework of a CE exercise to value the benefits of a plan to improve environmental quality in an Italian beach, have investigated the implicit discount rate that individuals employ. In specific, by considering an attribute reflecting the duration of the project, either 10, 15 or 20 years, they have found high but acceptable rates of discount. Viscusi et al. (2008) and Meyer (2013) have both focused on identifying which discounting specification, among the exponential and the hyperbolic ones, works better. They have answered this question by introducing a specific time attribute in their CE applications about hypothetical water quality improvements, namely '*year when the improvement begins*' (with levels 'now' or '2, 4 or 6 years from now'), and '*time when cleanup is fulfilled*' (with levels set to '0, 1, 2, 3, 4 or 5 years from now'), respectively. While for Viscusi et al. (2008) there is evidence of hyperbolic discounting, for Meyer (2013) the exponential specification is superior. Kim and Haab (2009), by means of a split sample approach in a CV analysis, have focused on improving the methodology for measuring temporal sensitivity of WTP. In particular, and taking into account a hypothetical oyster reef restoration program in Chesapeake Bay in Maryland, they have analyzed sensitivity to different payment schedules and time of completion of the project, either 5 or 10 years in the future. Findings have shown that individuals care about the final environmental result of the program but not about the timing of its delivery. Excluding this latter case, results of these studies have concluded that individuals are sensitive to the timing of the environmental benefits and, in specific, that they prefer earlier to delayed outcomes when these accrue to the present generation.

The second group of studies has focused on environmental policies to generally counteract CC impacts, assumed to take place in different moments in the very long-term and benefiting future generations. In this case, the analysis of time sensitivity of preferences has been motivated by the fact that environmental impacts and, consequently, policy results in the very long-term are characterized by uncertainty, such that there is a lack of scientific knowledge concerning their timing of occurrence. However, these studies have tended to present the different time horizons by means of a split sample approach, such that each respondent only faced one time scenario and hence did not consider any uncertainty during his choice.

Macmillan et al. (1996) have examined, through a CV approach, the social value of avoiding ecosystem declines in the Scottish Highlands due to acid rain deposition in 20 and 120 years. Layton and Brown (2000) have examined, through a CE exercise, preferences for CC mitigation policies to avoid adverse forest impacts in the Rocky Mountains area in 60 or 150 years. Kinnell et al. (2002), through a CV study, have focused on the willingness to pay (WTP) of hunters for policies to avoid duck population decline in the Prairie Pothole Region due to combined agriculture and global warming pressures in 40 and 100 years. By means of a follow up question to the CE exercise, Riera et al. (2007) have asked individuals whether their preferences for policies to avoid CC impacts such as wildfires, soil erosion and shrubland loss occurring in Catalonia over 50 years would have changed if the scenario was 25 or 100 years in the future. All these studies have concluded that individuals are

supportive towards very long-term policies benefiting future generations, but they do not distinguish between the different time scenarios considered. Slightly diverging outcomes have been reached by Layton and Levine (2003), who have combined the data employed in Layton and Brown (2000) concerning the most preferred alternatives with information about the least preferred ones. Their findings have shown that people tend to slightly prefer policy benefits occurring in 60 rather than in 150 years.

Despite the contribution of these studies to the environmental valuation literature, none of them has considered social preferences in both the long- and very long-term, thus overlooking the role of sustainability concerns in social welfare. Our analysis will try to address this research gap.

3.   Methodology

To examine social preferences when hypothetical future contexts are concerned, the CE represents the most suitable among the SP methods (Hanley et al. 1998; Hanley et al. 2001; Torres et al. 2011). Indeed, it allows to estimate welfare measures associated with a range of possible variations in multiple environmental or non-environmental attribute levels simultaneously considered and, for this reason, it emerges as a highly informative tool. In CEs, hypothetical alternatives are constructed by means of different combinations of attribute levels and they are aggregated in various choice sets. Among each choice set people are required to choose their most preferred option. By statistically modelling how individuals change their choices for their preferred options in each choice set when attribute levels' combinations vary, information can be obtained about the preferences of respondents for each attribute in the experiment.

3.1.   The choice experiment application

To investigate the role of sustainability concerns on the social benefits of preservation, we rely on the data collected between April the 15th and June the 30th, 2013 through the CE presented in Torres et al. (2015). This becomes a suitable reference study because it is developed in a context of CC, which represents an excellent example of time-persistent environmental problem. This CE examines the preferences of visitors for different management attributes in S'Albufera wetland (Mallorca, Spain), an outstandingly exposed Mediterranean humid land to CC threats. As explained later in this section, identifying these preferences has been possible because the alternatives in the CE have been described by diverse attributes, each showing the results of a different policy effort, taking different levels. In specific, the focus has been on one attribute, reflecting the outcomes of an adaptation policy aimed at avoiding potential CC-induced losses in the number of 'specialist' bird species, being characteristic of the site. In fact, if management efforts are not strengthened, declines in these species are expected to take place under CC due to intensified salinization induced by increased temperature and decreased precipitation rates.

Despite Torres et al. (2015) has only considered preference information collected over a time horizon of 10 years (T=10), representing an example of long-term scenario, sampled individuals have also been confronted with a very long-term situation. This has made these data suitable to fulfil the purposes of the present research. In fact, respondents were requested to imagine that the timing of the alternatives' results, initially set to T=10, would be 70 years in the future instead (T=70). In this sense, it needs to be remarked that 70 years was identified as a sufficiently long period in the future to oblige individuals to think beyond their lifetime and it was elicited based on focus group discussions. After choosing their preferred alternatives for T=10, individuals were requested to state whether their preferences over the same choice sets would have changed for T=70. If they reported their choices would have been different, they were invited to repeat the choice exercise and to indicate how their preferences would have changed for T=70. Otherwise, their preferences over T=10 were also maintained over

5

T=70. Thus, for each individual, information is available on preferences over T=10 and T=70.[1]

Whether individuals decided to change their choices for T=70 or not, they were asked about their underlying motives in order to help understanding the role of sustainability-related issues in their choice to support or not support nature preservation in the distant future. By eliciting among some predetermined options, they could state that their choices had been driven by the willingness to give future generations the possibility of either enjoying access to environmental resources or simply benefiting from nature conservation regardless of use. Alternatively, they could state that they were not interested in preserving the environment for such a long period of time. Multiple responses were also allowed. With the major purpose of identifying protesters in the hypothetical market set for T=70 years, an 'open answer' option was additionally included.

Given that both T=10 and T=70 represent future situations, the analysis has taken into account information about the inherent uncertainty of the scenario, following the approach presented in Torres et al. (2015). To reflect the idea that there is uncertainty regarding CC impacts, it has supposed that the levels of the 'specialist' bird species attribute, reflecting the results of current or business-as-usual (BAU), moderate and high efforts, are subject to two possible states of nature for each given time horizon: impacts' occurrence or impacts' non-occurrence. On the one hand, if current efforts are maintained, it assumes there can be a decline by 10 in the number of 'specialist' bird species under a scenario of impacts' occurrence (state 1). On the other hand, if CC impacts do not occur (state 2), no change is considered in the number of 'specialist' bird species under current efforts. Of course, also the outcomes of adaptation policies aimed to avoid the decline in the number of 'specialist' bird species through moderate or high efforts are presented as being inherently unpredictable. In fact, under inherent uncertainty, policy results cannot be guaranteed, even though interventions are perfectly designed. This way, under moderate efforts, it is assumed that the policy can either achieve the maintenance of current levels of species or an increase by 5, depending on whether impacts occur or not, respectively. Instead, under high efforts, it is assumed that the policy can either generate an increase by 5 or by 10, depending on whether impacts take place or not, respectively. Table 1 presents the levels considered for the 'specialist' bird species attribute when there is inherent uncertainty concerning impacts' occurrence:

Table 1 Levels for the 'specialist' bird species attribute[a]

	States	
	State 1 (impact occurrence)	State 2 (impact non-occurrence)
BAU	-10	0
Adaptation	0[b]/+5[c]	+5[b]/+10[c]

[a]Changes with respect to current levels.
[b]Changes in the number of 'specialist' bird species under a moderate management effort.
[c]Changes in the number of 'specialist' bird species under a high management effort

In this context, while under inherent uncertainty it is difficult to forecast the occurrence of an environmental loss, it is assumed that scientific research can help to make predictions about the probability of being close to a critical threshold. However, despite it is assumed that the probability of impacts' occurrence (p_1) and, consequently, the probability of impacts' non-occurrence ($1-p_1=p_2$) can be formulated, the analyst is not sure about how 'critical' the situation could really be with respect to species' extinction. To reflect this uncertainty, two scenarios of probability of impacts' occurrence have been taken into consideration for the 'specialist' bird species attribute levels presented in Table 1. One scenario depicting a very critical situation with a probability of

80% of occurrence and 20% of non-occurrence of impacts (from now on, *Inherent_80*) and another one showing a less critical situation with a probability of 60% of occurrence and 40% of non-occurrence (from now on, *Inherent_60*). The levels of 'specialist' bird species attribute under these different scenarios of inherent uncertainty are shown in Table 2:

Table 2 Levels of the 'specialist' bird species attribute under each inherent uncertainty scenario[a]

	Inherent_80		*Inherent_60*	
	p_1=80%	p_2=20%	p_1=60%	p_2=40%
BAU	-10	0	-10	0
Adaptation	0[b]/+5[c]	+5[b]/+10[c]	0[b]/+5[c]	+5[b]/+10[c]

[a]Changes with respect to current levels.
[b]Changes in the number of 'specialist' bird species under a moderate management effort.
[c]Changes in the number of 'specialist' bird species under a high management effort

As anticipated at the beginning of this section, apart from the 'specialist' bird species attribute, other attributes have been included in the experiment to reflect different management aspects (Table 3). These include an attribute for the change in the number of 'generalist' migratory bird species, not being characteristic of the site and coming to S'Albufera for resting and breeding. Indeed, due to climatic variations, responsible for advanced departure and arrival of migratory bird species at the destination, these latter might not find the optimal nesting conditions if nothing is done, such that they would either move to another breeding site or die. This is assumed to lead to a reduction by 10 in the number of 'generalist' migratory bird species in S'Albufera under current management efforts, while, under increased efforts, their current number could be either maintained or increased by 5. Additionally, other two non-environmental attributes are considered: waiting time for a seat in an observation cabin, reflecting either current or reduced congestion levels at the site, and the number of rest-stop benches, indicating current or increased availability of infrastructure and services in S'Albufera. Finally, an entrance fee is incorporated as a payment vehicle. Together with the 'specialist' bird species attribute, these attributes and their levels have been combined by means of a D-efficient Bayesian design into alternatives. These consist, for each of the 6 choice sets faced by individuals, of a fixed BAU alternative, showing what will occur in a given time horizon if management efforts are not strengthened with respect to current situation, and two options, showing improvements in at least one attribute, as a result of increased management efforts.[2]

Table 3 Other attributes' description and their levels

Attribute	Description	Levels
'Generalist' migratory bird species	Change in the number of species[a]	+5 0 -10[c]
Waiting time	Minutes waited for an observation cabin's seat	About 3 About 7 About 15[c]
Rest-stop benches	Number of benches throughout the park[b]	Triple Double Equal[c]
Entrance fee	Entrance fee per adult visitor and trip (in euros)	4, 8, 12, 16, 20, 24

[a] Changes with respect to the current number of 'generalist' migratory bird species.
[b] Number measured with respect to the current level of rest-stop benches.
[c] Business-as-usual (BAU) levels, being €0 for the Entrance fee attribute.

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[2] See Faccioli et al. (2015) and Torres et al. (2015) for more details about the experimental design.

The CE was then structured in different versions, one for each inherent uncertainty scenario considered. To reduce the cognitive burden on respondents, each person was exposed, thanks to a split sample approach, to only one CE version. Therefore, each respondent had to consider two time horizons in the CE exercise for just one scenario of inherent uncertainty. Information concerning the inherent uncertainty of the scenario has been included as a framing statement in the CE and in textual and visual form in the choice cards.[3] For illustrative purposes, an example of choice card for each inherent uncertainty scenario is reported in the Appendix. For the CE with a probability of occurrence of 80% and for that with a probability of 60%, sample sizes accounted for 321 and 310 individuals, respectively, taking into account a 5.5% sample error, calculated over a 95% confidence interval.[4]

3.2. Modelling choices

Preference analysis in CEs is carried out on the basis of the random utility maximization (RUM) theory, which assumes respondent n chooses the alternative j providing him with the highest utility level from among a set of options. As shown in Equation 1, utility is defined as the sum of two components. On the one hand, a deterministic part $V_{nj}(\cdot)$, consisting of the alternative's non-monetary (X_{nj}) and monetary ($X_{COST_{nj}}$) attributes, as well as a set of parameters (β) to be estimated. On the other hand, a stochastic part (ε_{nj}), capturing all the unobserved factors affecting choice and indicating the analyst's incomplete knowledge about the individual decision process:

$$U_{nj} = V_{nj}(X_{nj}, X_{COST_{nj}}, \beta) + \varepsilon_{nj} \tag{1}$$

To estimate preferences over T=70 and compare them with those obtained over T=10, the same RUM model specification as in Torres et al. (2015) has been considered for each time period and under each scenario of probability of impacts' occurrence. The model is a random parameter logit (RPL) to take individual-specific preferences into account, which requires assuming that parameters are random. In our model, only the cost parameter has been specified as random and it has been assigned a lognormal distribution to constrain the coefficient to have the same sign over all individuals (Torres et al. 2011). Taking into account that individuals make their choices of their preferred alternatives in the face of risks of impacts' occurrence on 'specialist' bird species, the utility function specification used for estimation purposes, which is illustrated in Equation 2, follows the expected utility (EU) theory approach. This represents the standard framework of decision-making in the face of risk and uncertainty and it assumes that individuals linearly weight the possible outcome levels by the associated probability. In addition, the utility specification incorporates a reference to the time horizon considered (t):

$$
\begin{aligned}
U_{njt} = {} & \beta_{1t}[(p_1 \cdot X_{SPEC1_{njt}}) + (p_2 \cdot X_{SPEC2_{njt}})] + \beta_{2t} X_{GEN_{njt}} + \beta_{3t} X_{TIME(less)_{njt}} \\
& + \beta_{4t} X_{BENCHES(double)_{njt}} + \beta_{5t} X_{BENCHES(triple)_{njt}} \\
& + \beta_{6t}[(p_1 \cdot X^2_{SPEC1_{njt}}) + (p_2 \cdot X^2_{SPEC2_{njt}})] + \beta_{7t} X^2_{GEN_{njt}} \\
& + \beta_{8t} X_{GEN_{njt}} \cdot [(p_1 \cdot X_{SPEC1_{njt}}) + (p_2 \cdot X_{SPEC2_{njt}})] \\
& + \beta_{9t} X_{TIME(less)_{njt}} \cdot [(p_1 \cdot X_{SPEC1_{njt}}) + (p_2 \cdot X_{SPEC2_{njt}})] \\
& + \beta_{10nt} X_{COST_{njt}} + \varepsilon_{njt}
\end{aligned} \tag{2}
$$

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[3] See Torres et al. (2015) for more details about the framing statement.
[4] More information on the sampling procedure is available in Faccioli et al. (2015) and Torres et al. (2015).

For respondent n, alternative j and time horizon t, $X_{SPEC1_{njt}}$ is the level of the 'specialist' bird species attribute under a probability of impact occurrence equal to p_1 (either 80% or 60%), and $X_{SPEC2_{njt}}$ is the attribute level under a probability of impacts' non-occurrence of p_2 (either 20% or 40%, respectively); $X_{GEN_{njt}}$ is the level of the 'generalist' migratory bird species attribute; $X_{TIME(less)_{njt}}$ is a dummy variable taking value 1 for less than 15 minutes waiting time for a seat in an observation cabin and 0 otherwise and it is considered as a proxy for congestion reduction; $X_{BENCHES(double)_{njt}}$ and $X_{BENCHES(triple)_{njt}}$ are two dummy variables taking value 1 when the number of benches throughout the park is double and triple with respect to the current one, respectively, and 0 otherwise; and β_{1t}, β_{2t}, β_{3t}, β_{4t}, β_{5t}, β_{6t}, β_{7t}, β_{8t} and β_{9t} are the fixed attribute coefficients and β_{10nt} is the individual-specific parameter for $X_{COST_{njt}}$.

The monetary value individuals assign to each attribute has been calculated by using the Hanemann (1984)'s formula for compensating variation, which provides information on the WTP for an increase in the attribute from the BAU, that is from the policy-off situation, to a policy-on context. Based on Equation 2, the WTP for a unit change in the expected number of 'specialist' bird species is shown in Equation 3:

$$
\begin{aligned}
WTP_{X_{SPECnjt}} = -\frac{1}{\beta_{10nt}} \{ &\beta_{1t}[(p_1 \cdot (X_{SPEC1_{njt}}{}^1 - X_{SPEC1_{njt}}{}^0)) \\
&+ (p_2 \cdot (X_{SPEC2_{njt}}{}^1 - X_{SPEC2_{njt}}{}^0))] \\
&+ \beta_{6t}[(p_1 \cdot (X^2{}_{SPEC1_{njt}}{}^1 - X^2{}_{SPEC1_{njt}}{}^0)) \\
&+ (p_2 \cdot (X^2{}_{SPEC2_{njt}}{}^1 - X^2{}_{SPEC2_{njt}}{}^0))] \\
&+ \beta_{8t} \cdot X_{GEN_{njt}}{}^0 \cdot [(p_1 \cdot (X_{SPEC1_{njt}}{}^1 - X_{SPEC1_{njt}}{}^0)) \\
&+ (p_2 \cdot (X_{SPEC2_{njt}}{}^1 - X_{SPEC2_{njt}}{}^0))] \\
&+ \beta_{9t} \cdot X_{TIME(less)_{njt}}{}^0 \cdot [(p_1 \cdot (X_{SPEC1_{njt}}{}^1 - X_{SPEC1_{njt}}{}^0)) \\
&+ (p_2 \cdot (X_{SPEC2_{njt}}{}^1 - X_{SPEC2_{njt}}{}^0))] \}
\end{aligned}
\tag{3}
$$

where superscripts ^{1} and ^{0} respectively indicate the level of the attribute after the change and in the BAU scenario.

4. Choice experiment results

RPL models have been estimated for T=10 and for T=70 in each scenario of inherent uncertainty *(Inherent_80 and Inherent_60)*. After excluding invalid and protest questionnaires, 289 and 279 surveys have respectively been considered for T=10 and T=70 in *Inherent_80*, providing a total of 1734 and 1674 observations, while in *Inherent_60,* 291 and 274 surveys were collected, supplying 1746 and 1644 observations, respectively. Only 26 respondents have changed their choices when moving from T=10 to T=70 in *Inherent_80* and 15 in *Inherent_60*. Tables 4 and 5 report models' results for T=10 and T=70 in both scenarios of inherent uncertainty.

Table 4 Results from RPL models for T=10 and T=70 under *Inherent_80*[a]

	T=10		T=70	
	Coeff.	*Std. error*	Coeff.	*Std. error*
Variables				
Fixed parameters				
$p_1 \cdot X_{SPEC1} + p_2 \cdot X_{SPEC2}$	1.956***	*0.181*	1.727***	*0.170*
X_{GEN}	0.568***	*0.177*	0.533***	*0.170*
$X_{TIME(less)}$	1.118***	*0.118*	1.172***	*0.115*
$X_{BENCHES(double)}$	0.116	*0.109*	0.280***	*0.106*
$X_{BENCHES(triple)}$	0.838***	*0.140*	1.001***	*0.137*
$p_1 \cdot X^2_{SPEC1} + p_2 \cdot X^2_{SPEC2}$	-1.567***	*0.236*	-1.764***	*0.231*
X^2_{GEN}	-0.968***	*0.256*	-0.822***	*0.243*
$(p_1 \cdot X_{SPEC1} + p_2 \cdot X_{SPEC2}) \cdot X_{GEN}$	-0.998***	*0.151*	-0.710***	*0.142*
$(p_1 \cdot X_{SPEC1} + p_2 \cdot X_{SPEC2}) \cdot X_{TIME(less)}$	-1.901***	*0.173*	-1.720***	*0.164*
Random parameters[b]				
X_{COST}_mean	1.087***	*0.073*	0.892***	*0.078*
X_{COST}_std. deviation	0.861***	*0.053*	0.928***	*0.060*
Log-likelihood	-1,061.169		-1,076.351	
Observations	1,734		1,674	
N	289		279	

[a] ***Significant at 1% level; **Significant at 5% level; *Significant at 10% level.
[b] Coefficients of the normal distribution associated with the lognormal one.

Table 5 Results from RPL models for T=10 and T=70 under *Inherent_60*[a]

	T=10		T=70	
	Coeff.	*Std. error*	Coeff.	*Std. error*
Variables				
Fixed parameters				
$p_1 \cdot X_{SPEC1} + p_2 \cdot X_{SPEC2}$	1.613***	*0.180*	1.619***	*0.183*
X_{GEN}	1.729***	*0.188*	1.699***	*0.192*
$X_{TIME(less)}$	0.150	*0.109*	0.136	*0.110*
$X_{BENCHES(double)}$	0.600***	*0.125*	0.569***	*0.127*
$X_{BENCHES(triple)}$	0.274*	*0.140*	0.233	*0.143*
$p_1 \cdot X^2_{SPEC1} + p_2 \cdot X^2_{SPEC2}$	-1.841***	*0.249*	-1.933***	*0.256*
X^2_{GEN}	0.685***	*0.226*	0.612***	*0.231*
$(p_1 \cdot X_{SPEC1} + p_2 \cdot X_{SPEC2}) \cdot X_{GEN}$	-1.097***	*0.165*	-0.978***	*0.167*
$(p_1 \cdot X_{SPEC1} + p_2 \cdot X_{SPEC2}) \cdot X_{TIME(less)}$	-0.075	*0.215*	-0.132	*0.220*
Random parameters[b]				
X_{COST}_mean	0.996***	*0.076*	0.942***	0.081
X_{COST}_std. deviation	0.966***	*0.061*	1.004***	0.065
Log-likelihood	-1,183.264		-1,121.929	
Observations	1,746		1,644	
N	291		274	

[a] ***Significant at 1% level; **Significant at 5% level; *Significant at 10% level.
[b] Coefficients of the normal distribution associated with the lognormal one.

Results in Tables 4 and 5 indicate that there are few differences in the estimated parameters between T=10 and T=70 and both the sign and significance of these coefficients tend to be maintained. In specific, regardless of the probability scenario, similar patterns can be observed between T=10 and T=70 for what concerns the main and interaction effects associated with '$p_1 \cdot X_{SPEC1} + p_2 \cdot X_{SPEC2}$', being the focus of the analysis, and from now on defined as $E(X_{SPEC})$, that is, the expected number of 'specialist' bird species. In fact, preferences for a marginal increase in

E(X_{SPEC}) have been found to increase at decreasing rates and to decline with both X_{GEN} and $X_{TIME(less)}$, being perceived as substitute goods for E(X_{SPEC}).[5]

To investigate the time sensitivity of welfare in the face of different scenarios of probability, implicit prices have been considered for the 'specialist' bird species attribute. Based on Equation 3, the mean marginal value of E(X_{SPEC}), that is, the WTP for an expected unit increase in this attribute from the BAU situation has been calculated. The BAU level has also been considered for the interacting attributes. As summarized in Figure 1 and Table 6, the mean marginal value of E(X_{SPEC}) seems to increase when moving from T=10 to T=70 both in *Inherent_80* and *Inherent_60*. However, based on the results of the Poe et al. (2005)'s test presented in Table 6, there is no significant difference between the welfare measures obtained in T=10 and T=70 under each scenario of probability.[6]
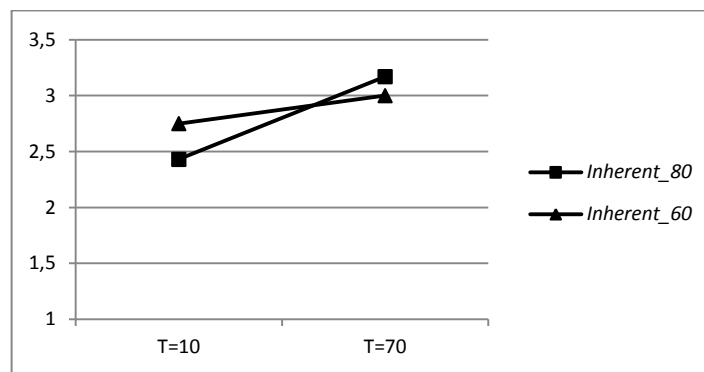
Figure 1 Mean marginal value of E(X_{SPEC}) for T=10 and T=70 in *Inherent_80* and *Inherent_60*

Table 6 Mean marginal value of E(X_{SPEC}) for T=10 and T=70 under *Inherent_80* and *Inherent_60*

	Test 1		Test 2	
	Inherent_80		*Inherent_60*	
E(X_{SPEC})	T=10	T=70	T=10	T=70
Mean marginal value	2.43	3.17	2.75	3.00
Standard deviation	(2.21)	(3.58)	(3.29)	(3.82)
Interval[b]	[-0.22; 1.44]		[-0.57; 1.12]	

[b] Confidence intervals for the differences in mean marginal values are based on a 10% significance level.

The fact that WTP for environmental preservation over T=10 is not significantly different from that over T=70 indicates that individuals are not sensitive to the timing of benefits' provision, despite the considerable temporal distance between the time horizons elicited. This emerges to be true for both *Inherent_80* and *Inherent_60*, suggesting that the level of probability of impact occurrence does not appear to play a role in determining social preferences' sensitivity to time. Then, individuals are equally willing to contribute to avoid the risk of losing species by supporting preservation, regardless of both the likelihood of species extinction or, in other words, how critical the situation is, and whether they will be the beneficiaries of these interventions or not. Hence,

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[5] The only exception is *Inherent_60*, in which the level of waiting time has been found to play no role over the effect of E(X_{SPEC}) on utility.

[6] To perform this test, the mean marginal value of E(X_{SPEC}) both in *Inherent_80* and in *Inherent_60* has been simulated for T=70 through 1,000 bootstrapped replications of the underlying RPL models, analogously to what has been done in Torres et al. (2015) for T=10. Taking into account the resulting vectors of simulated mean marginal values, confidence intervals have been calculated for the differences between all elements of the vector of WTP in T=10 and all elements of the vector in T=70, for each given scenario of probability. For given significance levels, entirely positive or negative confidence intervals indicate significant differences, while the opposite is true when the Xterval includes both positive and negative values.

individuals are adopting a 'risk averse' and precautionary attitude independently of 'which generation' is exposed to risks. All this indicates that they display a positive attitude towards sustainability issues.

A better picture about the role of sustainability concerns can be obtained by examining the motivations provided by individuals in their choice process. Table 7 summarizes the reasons provided by respondents for changing or not changing their preferred alternatives over T=70 with respect to T=10. Most of respondents have reported not to have changed their preferences because in the long-term they had already considered the need to preserve nature also for the very long-term. In specific, it appears that if the situation is very critical (*Inherent_80*), respondents are primarily concerned with conserving nature for giving future generations the same possibility as current generations of enjoying and having access to environmental resources. If the situation is less critical (*Inherent_60*), they seem to be motivated not only by the fact that environmental quality provides use opportunities but also because it is a source of utility regardless of its use. Based on this, there is the impression that sustainability concerns of individuals mostly rotate around the need to preserve nature especially for the use benefits it offers. In fact, preserving nature for recreational and access purposes represents their main motivation when the situation is critical, while consideration of nature preservation regardless of its use by humans appears to be a weaker driver of preferences and it acquires more importance only when the situation is less critical.

Table 7 Reasons underlying respondents' choices for T=70

	Inherent_80		*Inherent_60*	
	Not changing	Changing	Not changing	Changing
Preserve the environment in itself[a]	22.58%	2.87%	14.24%	0.73%
	25.45%		14.97%	
Preserve the environment for future generations' enjoyment[a]	*50.18%*	*2.15%*	*39.05%*	*1.09%*
	52.33%		*40.14%*	
Preserve the environment in itself and for future generations' enjoyment[a]	15.41%	4.3%	40.15%	3.28%
	19.71%		43.43%	
Not interested in environmental preservation for such a long period	0.36%	0.00%	0.00%	0.00%
	0.36%		0.00%	
Other[b]	2.15%	0.00%	1.10%	0.36%
	2.15%		1.46%	
TOTAL	90.68%	9.32%	94.54%	5.46%

[a] The need to preserve the environment in itself, for future generations' enjoyment or for both reasons had already been considered in T=10 by those individuals using these motivations for not changing their preferences in T=70.

[b] Other reasons provided, include: *'the choice made is the best option for T=70'* and *'I will not be alive in 70 years'*

To check for the robustness of the role of sustainability issues, a sensitivity analysis has also been undertaken by considering different levels of the interacting variables, X_{GEN} and $X_{TIME(less)}$. The reason for this analysis is to examine whether the endowment of other forms of capital affect sustainability concerns for $E(X_{SPEC})$. In fact, on the one hand, X_{GEN} indicates the number of 'generalist' migratory bird species, which reflects the level of a different form of natural capital with respect to $E(X_{SPEC})$. On the other hand, $X_{TIME(less)}$ could be interpreted as reflecting the level of man-made capital, given that a lower degree of waiting time and congestion can be achieved through increasing the availability of observation cabins in S'Albufera. To examine the significance of the difference between mean marginal values of $E(X_{SPEC})$ in T=10 and T=70 under each level of X_{GEN} and $X_{TIME(less)}$ and for each scenario of probability, Poe et al. (2005)'s tests have been conducted. Results of the sensitivity analysis are reported in Table 8.

Table 8 Mean marginal value of $E(X_{SPEC})$ for T=10 and T=70 as a function of $X_{TIME(less)}$ and X_{GEN}

		Inherent_80		Inherent_60	
	X_{GEN}	T=10	T=70	T=10	T=70
	-10	2.43	3.17	2.75	3.00
$X_{TIME(less)}=0$	0	1.97	2.73	2.11	2.38
	+5	1.74	2.51	1.79	2.07
	-10	1.56	2.10	2.75	3.00
$X_{TIME(less)}=1$	0	1.10	1.66	2.11	2.38
	+5	0.87	1.43	1.79	2.07

Findings seem to confirm the conclusions obtained in Table 6 and Figure 1. Despite showing that the mean marginal value of $E(X_{SPEC})$ in T=70 tends to be higher than in T=10, WTP has emerged not to be significantly different between the two time horizons for whatever scenario considered, based on the results of the Poe et al. (2005)'s test.[7]

However, preferences for $E(X_{SPEC})$, which determine the level of 'specialist' bird species that individuals would be willing to conserve for themselves and for future generations, appear to be affected by the endowment of a different type of natural capital (i.e. X_{GEN}) or of man-made capital (i.e. $X_{TIME(less)}$). This is because the marginal value of $E(X_{SPEC})$ has been found to significantly decrease at 1% level with both X_{GEN} and $X_{TIME(less)}$, based on the results of Poe et al. (2005)'s tests, due to the substitution patterns identified between these attributes and $E(X_{SPEC})$.[8] In this sense, these findings show that despite respondents are willing to conserve 'specialist' bird species in the same way over the long- and very long-term, they accept some degree of substitution between different forms of capital, and are willing to give up some 'specialist' bird species if there is more endowment of other natural capital or man-made capital. In specific, when the endowment of man-made capital is higher, namely when waiting time is low ($X_{TIME(less)}=1$), individuals have been found to be willing to conserve a lower level of $E(X_{SPEC})$ for present and future generations when the situation is more critical (*Inherent_80*) than when it is less critical (*Inherent_60*). This is because, when waiting time becomes low ($X_{TIME(less)}=1$), the marginal value of $E(X_{SPEC})$ decreases at either 1% or 10% level under *Inherent_80*, based on the results of the Poe et al. (2005)'s test, while it does not change under *Inherent_60*. Without entering more into details, all this indicates that, despite sustainability concerns have been found to be strong determinants of respondents' preferences, the level of environmental quality that respondents wished to equally preserve for present and future generations displays some context-dependency.

5. Discussion and conclusions

This paper has examined the role of sustainability issues on social preferences for policies to avoid time-persistent environmental problems, which take place over the long- and the very long-term due to complex environmental dynamics. In other words, given that environmental impacts occurring in the long-term affect the present generation and those occurring in the very long-term affect the future generations, the present analysis has addressed the question of whether social preferences for conservation policies in this context are driven by intergenerational equity concerns. By examining, through a CE application, social preferences for environmental

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[7] For this robustness analysis, the confidence intervals resulting from the Poe et al. (2005)'s tests are available from the authors upon request.
[8] Such substitution patterns have been detected in all scenarios, except in *Inherent_60*. There, the partworth utility of $E(X_{SPEC})$ has been found not to be sensitive to variations in $X_{TIME(less)}$.

preservation in the face of CC impacts in the long-term (T=10) and very long-term (T=70), results have shown that individuals assign the same weight to environmental quality conservation regardless of whether the present or the future generations will benefit from it. Hence, they are strongly driven by sustainability concerns when making choices in the face of time-persistent environmental problems.

These results are relevant because the role of sustainability concerns in social preferences has been an overlooked issue by the economic valuation literature, despite the increasing claims for incorporating intergenerational equity considerations in environmental policy design. Indeed, some research has been undertaken to explore the time-sensitivity of social preferences but it has only focused either on the long- or on the very long-term (Layton and Brown 2000; Viscusi et al. 2008; Kim and Haab 2009; Meyer 2013). To our knowledge, no study has explored the value that current generation assigns to an environmental outcome occurring over the very long-term with respect to the long-term and, hence, whether there are sustainability concerns. By showing that current generations give the same importance to outcomes accruing to present and future generations, the results of our analysis have proved that the usual approach in ECBA to give priority to earlier than later results, can have important social welfare implications. This is not only because the welfare of future generations is at risk if environmental policies generating improvements especially in the very long-term are seen as less socially desirable. It is also because, due to sustainability concerns, current generations are negatively affected from the knowledge that future generations' wellbeing is at stake.

Based on our results, most of sampled individuals already considered over T=10 the need to equally preserve nature for present and for future generations, especially to provide the unborn with the same use opportunities associated with nature conservation. In addition, even though to a lesser extent, they also reported to be equally interested in environmental conservation over the long- and very long-term for the importance that nature preservation acquires for people, regardless of use. These results can be explained by considering the profile of our respondents, who are nature-based recreationists to S'Albufera wetland. As argued in Viscusi et al. (2008), visitors to natural areas are, in general, more future-oriented and, hence, they are more forward-looking when making their choices over T=70, which seems to be especially true if visitors display an emotional attachment to the environmental good. This is the case with our recreationists, being repeat visitors in 81.18% of cases when residents are considered and 57.35% when non-resident visitors are taken into account. In addition, they also display particularly high levels of environmental consciousness, which might have contributed to make them so sensitive to the environmental situation in the very long- in addition to the long-term. In fact, a good portion of sampled respondents are active members of environmental groups (38.76%) and they regularly practice recycling (98.41%). Given that in our study the focus is on the preferences of this very specific segment of individuals, it would be interesting to compare our findings with others taking into account different publics, with a less nature-based orientation, which becomes especially important when the focus is on non-use values in addition to use values.

The analysis under T=10 and T=70 has been undertaken by considering the existence of inherent uncertainty, which refers to the unpredictability of environmental dynamics, making the results of policy interventions unknown in advance. This decision has been motivated by the results in Torres et al. (2015), showing the significance of the effect on WTP of inherent uncertainty. In specific, inherent uncertainty has been expressed as the uncertainty around the occurrence or non-occurrence of future adverse impacts on 'specialist' bird species. Based on the recognition that scientific knowledge can help to make predictions about how close the system is to the risk of extinction, even though no such prediction can be guaranteed, two different probability scenarios have been considered, of either 80% or 60% probability of impacts' occurrence. Results of our study have shown that preferences for preservation policies are driven by intergenerational equity concerns regardless of how dangerous the situation is expected to be. In other words, respondents appear to be worried about sustainability independently of how significant the risk of environmental quality loss will be. This result reflects expectations that in the presence of inherent uncertainty a precautionary attitude towards sustainable conservation is adopted by individuals. Hence, the risk of irreversible environmental losses both for present and future

generations might have motivated the willingness to conserve the same critical level of natural resources in the long- and in the very long-term future. However, the level of natural capital that should be preserved, which depends on individuals' preferences, has emerged to be influenced by the specific context of the analysis. Indeed, individuals in our case study have been found to be willing to substitute, to some extent, some level of environmental quality if the availability of other forms of capital, both natural and man-made, is increased. All this indicates that, despite sustainability concerns always drive support for nature preservation, the level of environmental resources that individuals wish to conserve can be context-specific.

Despite these findings, one may also argue that the results of the analysis don't reflect a genuine concern for intergenerational equity but rather depend on the design employed in our CE application. In fact, given that individuals have first been requested to choose over T=10 and, then, they were asked whether they would change their preferences over T=70, it would be legitimate to think that they might have reported to be unwilling to modify their preferred choices over the longer time horizon to avoid repeating the exercise. In this sense, one might assert that the analysis of time sensitivity should have best been performed by splitting the sample of respondents into different groups, each of which presented with a separate time scenario, as commonly done in the valuation studies dealing with time-sensitivity. Even though the split sample approach may be argued to be more desirable because it minimizes the cognitive burden on respondents (Day et al. 2012), it can be replied that a relatively low percentage of respondents in our study protested against the prospect to think about an additional time horizon (3.11% in the split sample with 80% probability and 5.48% in the split sample with 60% probability). Apart from the low protest rate, no important signs of cognitive burden were detected by interviewers during field work. Hence, there are no clues that the design might have driven our results. In any case, the issue of outcomes' consistency between the results in our approach and in a split sample treatment of time-sensitivity, remains one of interest for future research.

Similarly, it would be interesting to investigate whether the order through which temporal horizons have been presented to respondents may have affected their choices. In any case, based on tests undertaken during the pilot survey, it is sure that individuals could clearly distinguish between the two time horizons elicited, such that the 'temporal embedding effect' can be safely discarded as a possible reason for time insensitivity in the analysis (Arrow et al. 1993). In this sense, despite the results of our study indicate that individuals do not choose differently depending on the timing, it still remains of interest to investigate the issue of time sensitivity by taking into account more periods, to check for the consistency of respondents' conduct. In fact, it remains to be clarified why research focusing on the long-term has commonly found that earlier outcomes are preferred, while studies over the very long-term have usually found time-insensitivity. Also, it could be of interest to test for possible ways of communicating information about different horizons in a time-persistent framework. Indeed, instead of using specific time horizons, which might mean different things to respondents depending on their age, another way of obtaining preferences in an intergenerational context might be to describe the scenarios in terms of 'who' will be affected (i.e. the respondent, his children, his grandchildren, etc.). To have a better picture of social preferences over different time horizons, more research should be done in this sense. The analysis of the role of sustainability could be further extended by additionally taking into consideration distributional and, hence, intra-generational equity issues, as these also form part of sustainability concerns, according to Baumgärtner and Quaas (2010). In this sense, it would be necessary to know whether individuals are sensitive to distributional questions regarding who gains and who loses from a given situation, to better inform policy makers in the design of sustainable policies (Barbier et al. 1990).

To sum up, despite numerous questions still remain unanswered, the results of this study add to the emerging literature dealing with environmental valuation over time. They provide evidence that, due to sustainability concerns, individual preferences are insensitive to time regardless of the scenario considered, this indicating the importance of intergenerational equity issues. Findings also suggest that earlier environmental improvements are not necessarily always preferred, as traditionally assumed in ECBA (Pindyck 2007) and, hence, that the time sensitivity of welfare measures should not be arbitrarily set, but rather it should be based on preference analysis.

In this sense, our work shows the importance of including sustainability issues in the analysis of social preferences to better inform ECBA. Thus, it offers a basis for an effective intergenerational allocation of natural endowments taking welfare maximization principles into account, even though it also acknowledges that more research in this direction is warranted.

Acknowledgements
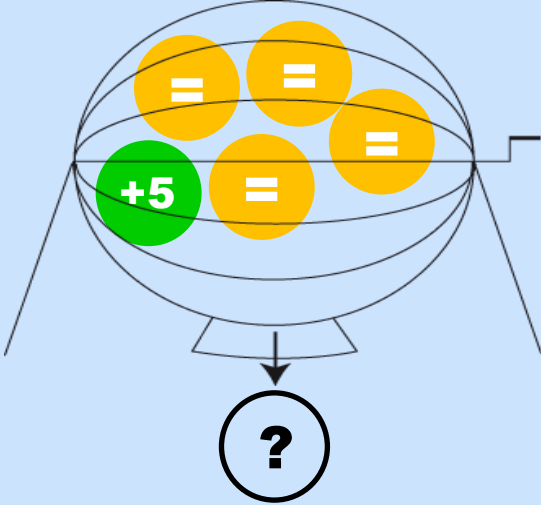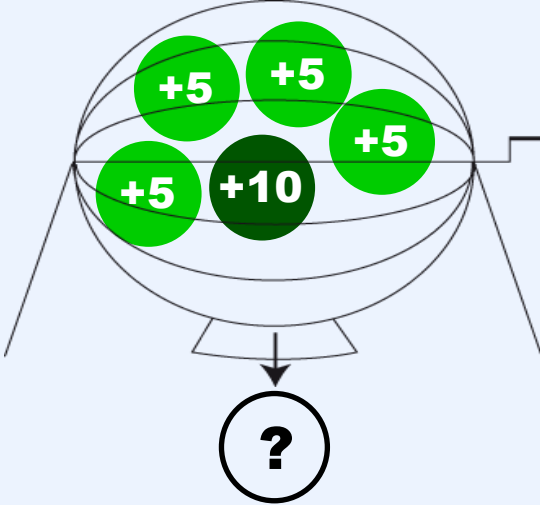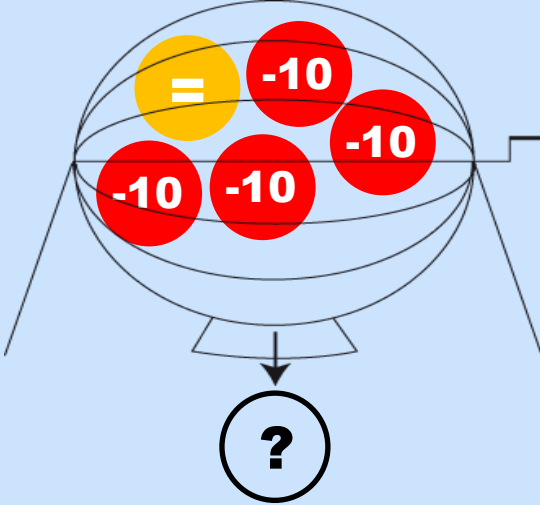
References
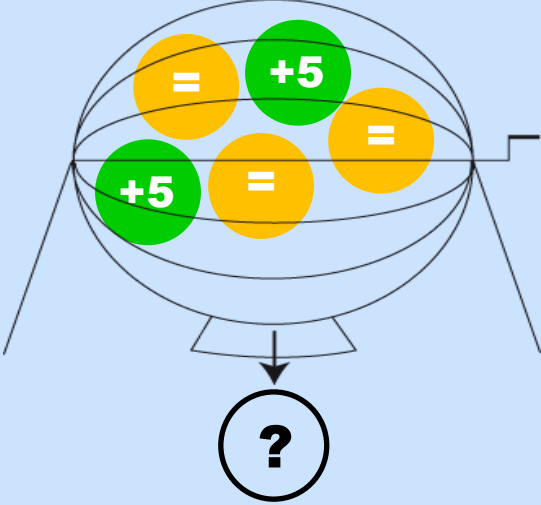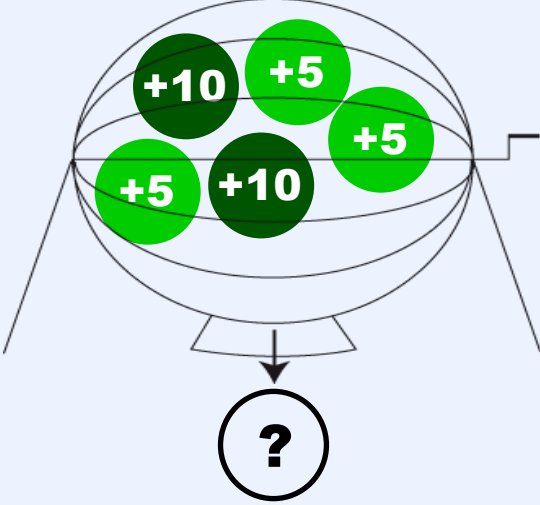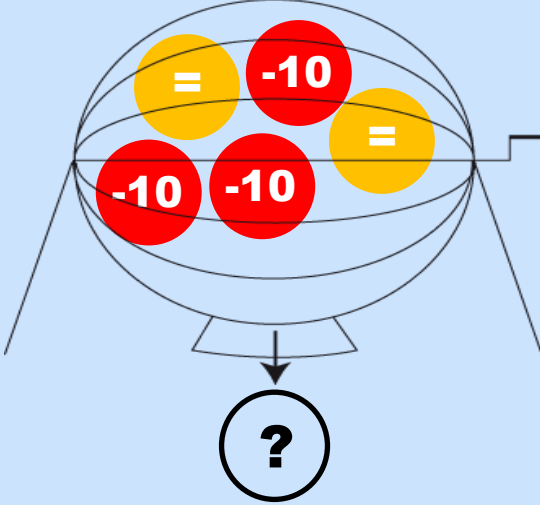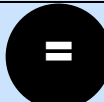
Alberini, A., Chiabai, A. (2007). Discount rates in risk versus money and money versus money tradeoffs. Risk Anal. 27(2): 483–491.

Almansa, C., Calatrava, J. (2007). Reconciling sustainability and discounting in Cost–Benefit Analysis: A methodological proposal. *Ecol. Econ.* 60(4): 712-725.

Arrow, K., Solow, R., Portney, P.R., Leamer, E.E., Radner, R., Schuman, H. (1993). Report of the NOAA Panel on contingent valuation. Federal Register 58 (10): 4602-4614. Washington (USA): NOAA.

Azqueta, D. (2002). *Introducción a la Economía Ambiental*. Madrid (Spain): McGraw-Hill.

Barbier, E.B., Markandya, A., Pearce, D.W. (1990). Environmental sustainability and cost-benefit analysis. *Environ. Plann. A* 22: 1259-1266.

Barr, S. (2008). Environment and Society: Sustainability, Policy and the Citizen. Hampshire (UK) and Burlington (USA): Ashgate Publishing Limited.

Baumgärtner, S., Quaas, M. (2010). What is sustainability economics? *Ecol. Econ.* 69: 445-450.

Berrens, R.P. (2001). The safe minimum standard of conservation and endangered species: a review. *Environ. Conserv.* 28(2): 104-116.

Birol, E., Koundouri, P., Kountouris, Y. (2010). Assessing the economic viability of alternative water resources in water-scarce regions: Combining economic valuation, cost-benefit analysis and discounting. *Ecol. Econ.* 69: 839–847.

Cairns, J. (2001). Discounting in economic evaluation. In: Drummond, M., McGuire, A. (Eds), *Economic evaluation in health care: merging theory with practice*. Oxford (UK) and New York (USA): Oxford University Press.

Carlsson, F., Kataria, M., Lampi, E. (2011). Do EPA administrators recommend environmental policies that citizens want? *Land Econ.* 87(1): 60-74.

Crocker, T.D., Shogren, J. (1993). Dynamic inconsistency in valuing environmental goods. *Ecol. Econ.* 7: 239-254.

Cropper, M.L., Aydede, S.K., Portney, P.R. (1994). Preferences for life saving programs: How the public discounts time and age. *J. Risk Uncertainty* 8: 243-265.

Cropper, M.L., Freeman, M.C., Groom, B., Pizer, W.A. (2014). Declining Discount Rates. *Am. Econ. Rev.* 104(5): 538-543.

Crowards, T.M. (1998). Safe minimum standards: costs and opportunities. *Ecol. Econ.* 25(3): 303-314.

Day, B., Bateman, I.J., Carson, R.T., Dupont, D., Louviere, J.J., Morimoto, S., Scarpa, R., Wang, P. (2012). Ordering effects and choice set awareness in repeat-response stated preference studies. *J. Environ. Econ. Manag.* 63: 73-91.

Faccioli, M., Riera, A., Torres, C. (2015). Valuing the recreational benefits of wetland adaptation to climate change: a trade-off between species' abundance and diversity. *Environ. Manage.* 55(3): 550-563.

Gollier, C. (2013). *Pricing the planet's future: the economics of discounting in an uncertain world*. Princeton (USA) and Oxford (UK): Princeton University Press.

Hanemann, W.M. (1984). Welfare evaluations in contingent valuation experiments with discrete responses. *Am. J. Agr. Econ.* 66 (3): 332-341.

Hanley, N., Barbier, E.B. (2009). *Pricing nature: cost-benefit analysis and environmental policy*. Cheltenham (UK) and Northampton (USA): Edward Elgar Publishing.

Hanley, N., MacMillan, D., Wright, R.E., Bullock, C., Simpson, I., Parsisson, D., Crabtree, B. (1998). Contingent Valuation Versus Choice Experiments: Estimating the Benefits of Environmentally Sensitive Areas in Scotland. *J. Agr. Econ.* 49(1): 1-15.

Hanley, N., Mourato, S., Wright, R.E. (2001). Choice Modelling Approaches: A Superior Alternative for Environmental Valuation? *J. Econ. Surv.* 15(3): 435-462.

Hasselmann, K., Latif, M., Hooss, G., Azar, C., Edenhofer, O., Jaeger, C.C., Johannessen, O.M., Kemfert, C., Welp, M., Wokaun, A. (2003). The challenge of long-term climate change. *Science* 302: 1923-1925.

IPCC (2013). Technical Summary. In: Stocker, T.F., Qin, D., Plattner, G.K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V., Midgley, P.M. (Eds.), *Climate Change 2013: The Physical Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge (UK) and New York (USA): Cambridge University Press.

Kim, S.-I., Haab, T.C. (2009). Temporal insensitivity of willingness to pay and implied discount rates. *Resour. Energy Econ.* 31: 89-102.

Kinnell, J., Lazo, J.K., Epp, D.J., Fisher, A., Shortle, J.S. (2002). Perceptions and values for preventing ecosystem change: Pennsylvania duck hunters and the prairie pothole region. *Land Econ.* 78(2): 228-244.

Krupnick, A. (2007). Mortality-risk valuation and age: stated preference evidence. *Rev. Environ. Econ. Policy* 1(2): 261-282.

Kuhlman, T., Farrington, J. (2010). What is sustainability? *Sustainability* 2(11): 3436-3448.

Layton, D.F., Brown, G. (2000). Heterogeneous preferences regarding global climate change. *Rev. Econ. Stat.* 82(4): 616-624.

Layton, D.F., Levine, R.A. (2003). How much does the far future matter? A hierarchical Bayesian analysis of the public's willingness to mitigate ecological impacts of climate change. *J. Am. St. Assoc.* 98(463): 533-544.

Luckert, M.K., Williamson, T. (2005). Should sustained yield be part of sustainable forest management? *Can. J. For. Res.* 35: 356-364.

Macmillan, D., Hanley, N., Buckland, S. (1996). A contingent valuation study of uncertain environmental gains. *Scot. J. Political Econ.* 43(5): 519-533.

Meyer, A. (2013). Estimating discount factors for public and private goods and testing competing discounting hypotheses. *J. Risk Uncertain.* 46(2): 133-173.

Moldan, B., Janoušková, S., Hák, T. (2012). How to understand and measure environmental sustainability: Indicators and targets. *Ecol. Indic.* 17: 4-13.

Pindyck, R.S. (2007). Uncertainty in Environmental Economics. *Rev. Environ. Econ. Policy* 1(1), 45-65.

Poe, G.L., Giraud, K.L., Loomis, G.B. (2005). Computational methods for measuring the difference of empirical distributions. *Amer. J. Agr. Econ.* 87(2): 353–365.

Rheinberger, C.M. (2011). A mixed logit approach to study preferences for safety on alpine roads. *Environ. Resour. Econ.* 49: 121–146.

Riera, P., Peñuelas, J., Farreras, V., Estiarte, M. (2007). Valuation of climate-change effects on Mediterranean shrublands. *Ecol. Appl.* 17(1): 91-100.

Scarborough, H. (2011). Intergenerational equity and the social discount rate. *Aust. J. Agr.Resour. Ec.* 55: 145–158.

Strazzera, E., Cherchi, E., Ferrini, S. (2010). Assessment of regeneration projects in urban areas of environmental interest: a stated choice approach to estimate use and quasi-option values. *Environ. Plann. A* 42(2): 452-468.

Thomson, D.F. (2010). Representing future generations: political presentism and democratic trusteeship. *Critical Review of International and Political Philosophy* 13(1): 17-37.

Torres, C., Faccioli, M., Riera, A. (2015). Delivering inherent uncertainty information in stated preference methods: A framework to estimate preservation benefits. Paper presented at the 21st Annual Conference of the European Association of Environmental and Resource Economists, Helsinki (Finland), June 24-27 2015.

Torres, C.M., Hanley, N., Riera, A. (2011). How wrong can you be? Implications of incorrect utility function specification for welfare measurement in choice experiments. *J. Environ. Econ. Manag.* 62: 111-121.

Underdal, A. (2010). Complexity and challenges of long-term environmental governance. *Glob. Environ. Chang.* 20(3): 386-393.

Viscusi, W.K., Huber, J., Bell, J. (2008). Estimating discount rates for environmental quality from utility-based choice experiments. *J. Risk Uncertain.* 37: 199-220.

Weitzman, M. (1998). Why the far-distant future should be discounted at its lowest possible rate. *J. Environ. Econ. Manage.* 36(3): 201-208.

ATTRIBUTES	POLICY A	POLICY B	NO POLICY INTERVENTION (C)
'SPECIALIST' BIRD SPECIES	**80% chance**, keep the current number **20% chance**, increase the current number by 5	**80% chance**, increase the current number by 5 **20% chance**, increase the current number by 10	**80% chance**, decrease the current number by 10 **20% chance**, keep the current number
'GENERALIST' MIGRATORY BIRD SPECIES	**+5** Increase the current number by 5	**+5** Increase the current number by 5	**-10** Decrease the current number by 10
WAITING TIME	**≃15'** Wait about 15 minutes for a seat in observation cabins	**≃3'** Wait about 3 minutes for a seat in observation cabins	**≃15'** Wait about 15 minutes for a seat in observation cabins
REST-STOP BENCHES	**=** Keep the current number	**x3** Triple the current number throughout the park	**=** Keep the current number
ENTRANCE FEE	**8€**	**16€**	**0€**

ATTRIBUTES	POLICY A	POLICY B	NO POLICY INTERVENTION (C)
'SPECIALIST' BIRD SPECIES	= +5 = +5 = ? **60% chance**, keep the current number **40% chance**, increase the current number by 5	+10 +5 +5 +5 +10 ? **60% chance**, increase the current number by 5 **40% chance**, increase the current number by 10	= -10 = -10 -10 ? **60% chance**, decrease the current number by 10 **40% chance**, keep the current number
'GENERALIST' MIGRATORY BIRD SPECIES	= Keep the current number	-10 Decrease the current number by 10	-10 Decrease the current number by 10
WAITING TIME	≃15' Wait about 15 minutes for a seat in observation cabins	≃15' Wait about 15 minutes for a seat in observation cabins	≃15' Wait about 15 minutes for a seat in observation cabins
REST-STOP BENCHES	x3 Triple the current number throughout the park	x2 Double the current number throughout the park	= Keep the current number
ENTRANCE FEE	16€	24€	0€