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 the value of benefits is sensitive to their timing and that outcomes are valued higher, the sooner in time they occur following implementation of a project or policy. Though, this assumption might have important implications especially for the social desirability of interventions aiming at counteracting time-persistent environmental problems, whose impacts occur in the long- and very long-term, respectively involving the present and future generations. This study analyzes the time sensitivity of social preferences for preservation policies of adaptation to climate change stresses. Results show that stated preferences are time insensitive, due to sustainability issues: individuals show insignificant differences in benefits they can experience within their own lifetimes compared to those which occur in the longer term, and which will instead be enjoyed by future generations. Whilst these results may be specific to the experimental design employed here, they do raise interesting questions regarding choices over time-persistent environmental problems, particularly in terms of the desirability of interventions which produce longer-term benefits.

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 social benefits and costs over time. Often, financial costs arise in the near-present while environmental benefits occur at some point in the future, depending on the specifics of policy implementation and performance and 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 rate of return. This is because, for more than 50 years, applied welfare economics has been concerned with individuals' sensitivity to the timing of benefits and costs, through the analysis of individual and social discount rates (Viscusi et al. 2008).

The analysis of individuals' inter-temporal choices has demonstrated that society tends to prefer earlier to later rewards, as evidenced by the positive discount rates found by many researchers (Pindyck 2007; Hanley and Barbier 2009). This also reflects the conduct individuals adopt when making inter-temporal choices over private monetary benefits. The result that society should assign a greater weight to earlier outcomes and, hence, that the future should be discounted, have also been pointed out by a normative social discounting literature (Cropper et al. 2014). However, what precise discount rate should be employed in any setting is still debated (Almansa and Calatrava 2007; Birol et al. 2010) and assumptions made about how people value environmental benefits arising over different time periods can have big impacts on a policy's social profitability.

This is especially true when it comes to interventions where environmental results occur not only in the long-term, affecting the present generation, but more importantly in the very long-term, affecting future generations. Such policies typically relate to an increasing number of time-persistent environmental problems -like climate change (CC), nuclear waste or groundwater 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 (relative to the present) 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). 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), results from such an analysis can improve decision-making. Sustainability considerations 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, in one sense, is a concern for the fairness of the distribution of welfare opportunities between the present and future generations (Baumgärtner and Quaas 2010; Kuhlman and Farrington 2010; Eason and Cabezas 2012). Concerns over long- and very long-run effects of environmental policies can also be seen as being consistent with the precautionary principle, as 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 of policies to manage 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 some 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. This fairness based idea of sustainability is different to the more commonly-used concepts of weak and strong sustainability (Rowley et al. 2012). With respect to weak sustainability, the fairness based view is not necessarily consistent with 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. 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, our approach adds a consideration of social preferences to the idea of setting some constraint on natural capital losses (Crowards 1998; Berrens 2001).

Despite 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 time sensitivity of social preferences. In addition, this is also due to the choice of the temporal frame in this literature. 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. There is thus a gap in the literature relating to the role of sustainability concerns in explaining the time sensitivity of social preferences in a context of time-persistent environmental effects.

Our attempt to address this gap relies on a Choice experiment (CE) 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. The structure of the paper is as follows. The 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.

2. Time sensitivity in the environmental valuation literature

Individuals are expected to value environmental policy outcomes differently depending on when they take place. For this reason, 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 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, thus assuming 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 forward at most. This research has been concerned with various issues around the measurement of individuals' time preferences.

Crocker and Shogren (1993) investigated the role of dynamic inconsistencies in the discounting of future environmental benefits in a CV exercise. 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 for benefits reaching over either 10, 15 or 20 years. Viscusi et al. (2008) and Meyer (2013) focused on identifying whether exponential or hyperbolic discounting described choices better. They introduced 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 analyzed sensitivity to different payment schedules and time of completion of hypothetical oyster reef restoration projects, 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 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 at different moments in the very long-term and benefiting future generations. In this case, the analysis of the 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 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 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, a SP technique is a suitable choice of method. Here, we use a CE, in which hypothetical alternatives are constructed by means of different combinations of attribute levels which are combined into choice sets. By statistically modeling 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

We use data collected between April and June 2013 for the experiment described in Torres et al. (2015). This is a suitable case study because it focuses on management responses to CC, a time-persistent environmental problem. This CE examines the preferences of visitors for different management attributes in S'Albufera wetland (Mallorca, Spain), a Mediterranean wetland outstandingly threatened by CC. Choice alternatives in the CE are described by attributes, each showing the results of different management efforts. In this paper, we focus on one specific attribute reflecting the outcomes of an adaptation policy aimed at avoiding potential CC-induced losses in the number of 'specialist' bird species at the site. If management efforts are not strengthened, declines in such species are expected to take place under CC due to intensified salinization induced by increased temperature and decreased precipitation rates.

Based on focus group discussions and the views of experts, two time frames for the production of CC impacts and benefits in terms of avoided impacts were introduced into the design: a time horizon of 10 years (T=10) and a much longer time frame of 70 years (T=70), representing examples of long-term (10 year) and very long-term (70 year) scenarios. Respondents were first requested to imagine that the timing of the alternatives' results would be 10 years. They were then asked how their choices would change (if at all) if instead benefits did not arise until T=70. 70 years was identified as a sufficiently long period in the future to oblige individuals to think beyond their own lifetimes. 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 compared to T=10. If they decided not to revise their choices, then their preferences over T=10 were used for the T=70 scenario. 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. 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, 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: impact occurrence or impact non-occurrence. On the one hand, if current efforts are maintained, it is assumed 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. This way, under "moderate" levels of effort, 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. Alternatively, under "high" levels of effort, it is assumed that the policy can either generate an increase by 5 or by 10, depending on whether impacts take place or not. Table 1 presents the levels considered for the 'specialist' bird species attribute when there is inherent uncertainty concerning impacts' occurrence.

[INSERT TABLE 1]

[1] The text of the specific follow-up question that we have used in the survey to ask individuals about their preferences over T=70 after they have completed the CE exercise over T=10, is: "If the attributes' combinations that I have showed you in each card were the result of a given policy in S'Albufera not in 10 years' time but in 70 years' time, would your choices be different from the ones that you have previously made?"

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, even if 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:

[INSERT TABLE 2]

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, these 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]

[INSERT TABLE 3]

The CE was then structured in different versions, one for each inherent uncertainty scenario considered. 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 was 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 the scenario with 60% probability is reported in the Supplementary Material. 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]

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

3.2. Modeling 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*):

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

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 can be 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 has been computed as 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.

[INSERT TABLE 4]

[INSERT TABLE 5]

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 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, 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

[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.

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] Thus, respondents did not significantly change their stated WTP for species protection when the timing of benefit delivery was changed.

[INSERT FIGURE 1]

[INSERT TABLE 6]

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 potential beneficiaries of these interventions or not. Hence, individuals are adopting a precautionary attitude independently of 'which generation' is exposed to risks, which can be interpreted as a positive attitude towards sustainability.

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 scenario they had already considered the need to preserve nature also for the very long-term. In specific, it appears that if the situation is more 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 future recreational and access purposes, while consideration of nature preservation regardless of its use by humans appears to be a weaker driver of preferences.

[INSERT TABLE 7]

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 levels of these attributes, emerging to significantly affect preferences for $E(X_{SPEC})$, influence sustainability concerns for 'specialist' bird species. 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, $X_{TIME(less)}$ can be interpreted as reflecting the value of leisure time. 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

[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=10 and T=70 through 1,000 bootstrapped replications of the underlying RPL models. 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 interval includes both positive and negative values.

analysis are reported in Table 8.

[INSERT TABLE 8]

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}) appear to be affected by the endowment of a different type of natural capital (i.e. X_{GEN}) and by waiting time (i.e. $X_{TIME(less)}$). In fact, 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] This, of course, is expected to affect the level of 'specialist' bird species that individuals would be willing to conserve for themselves and for future generations. In this sense, these findings show that despite respondents are willing to equally preserve 'specialist' bird species over the long- and very long-term, due to sustainability concerns, the level of environmental quality that they 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. 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 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. One interpretation of this result, consistent with reasons provided by respondents for changing or not changing their choices when the time horizon for benefits was altered, is that in this context people were strongly driven by sustainability concerns.

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. Whilst research has been undertaken to explore the time-sensitivity of social preferences, 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 within-respondent variation in values assigned to an environmental outcome occurring over the very long-term compared to the long-term. 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 benefits which are closer-in-time, can have important social welfare implications. This is not only because the welfare of future generations is at risk if environmental policies

[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 $X_{TIME(less)}$.

generating improvements in the very long-term are seen as less socially desirable. Due to sustainability concerns, also current generations are negatively affected from the knowledge that future generations' wellbeing is at stake.

Most respondents already considered in T=10 the need to preserve nature for present and for future generations' enjoyment. In addition, for T=10, they were also motivated by environmental conservation over the long- and very long-term for the importance of nature conservation 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 can be more future-oriented and, hence, they are more forward-looking when making their choices, 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% of cases when residents are considered and 57% 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 sensitive to the environmental situation in the long and very long run. It would be interesting to compare our findings with others taking into account different groups of respondents, 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. Results of our study have shown that preferences for preservation policies are driven by intergenerational equity concerns regardless of how risky 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 a critical level of natural resources in the long- and in the very long-term future. However, what this critical level of natural capital is that should be preserved depends on individuals' preference. Indeed, individuals in our case study have been found to be willing to substitute, to some extent, some level of environmental quality if the level of waiting time was lower and the availability of other forms of natural capital was higher. Whilst uncertainty over future environmental impacts and a lack of discounting of very long run benefits versus long run benefits can both be interpreted as not fitting within the standard model of weak sustainability (eg Arrow et al. 2012), note that we have not tested whether variations in time-specific valuations can be linked to individual perceptions over the substitutability of different forms of capital (eg natural for human) or the perceptions of future environmental risks.

Despite the findings of the analysis, one may also argue that results do not 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 have changed 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. Thus, what looks like a time insensitivity might instead be a concern over the effort of repeating their choices. In this sense, performing a better test might require 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. In any case, 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 having to think again about an additional time horizon (3% in the split sample with 80% probability and 5% 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. Based on tests undertaken during the pilot survey, 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 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. It could also be of interest to test for possible ways of communicating information about different horizons in a time-persistent framework. 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.). 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).

Acknowledgements

This research work has been conducted under the Training Program for University Professors of the Spanish Ministry of Education, Culture and Sport (AP2010-3810). The authors are also grateful for the funds awarded by the Government of the Balearic Islands through the Special Action Program (AAEE025/2012) and for the financial support from the CICYT Program of the Spanish Government (ECO2010-22143). None of these funding sources intervened in or had any effect on the undertaking of this research work. We thank a referee for comments on an earlier version of the paper, and comments from participants at the 2015 Envecon Conference and 21st Annual Conference of the European Association of Environmental and Resource Economists. The first author is especially grateful to the Department of Geography and Sustainable Development at the University of St. Andrews for the support provided while undertaking the first part of this research.

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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.

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.

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] BAU levels, being €0 for the Entrance fee attribute.

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

	T=10		T=70	
Variables	Coeff.	*Std. error*	Coeff.	*Std. error*
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]

Variables	T=10		T=70	
	Coeff.	*Std. error*	Coeff.	*Std. error*
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.

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.

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'*.

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

Figure 1 Mean marginal value of E(X_{SPEC}) for T=10 and T=70 in *Inherent_80* and *Inherent_60*